

SIS INTERNATIONAL RESEARCH™

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ENERGY STORAGE TRENDS SURVEY

JUNE 2023

A Survey of Energy Storage and Battery Solution Providers



As the world's population continues to grow, so does the global need for energy. The use of renewable energy sources such as solar and wind power has gained significant traction in recent years due to their sustainability and restrictions on fossil fuel usage. However, due to the fluctuating output of renewable energy sources, energy storage systems (ESS) are necessary to ensure a consistent energy supply and create stability on the grid.

Companies who produce energy storage systems face various challenges in terms of size, cost, and complexity. The larger and more technical the system, the more difficult it is to manufacture and install — and the more expensive it is to develop. The energy industry is working to overcome these obstacles with advances in technology aimed at reducing costs and improving efficiency, making energy storage solutions more accessible for households, businesses, and the industrial and utility sectors.

In the years ahead, it will be crucial to explore alternative energy sources and storage solutions to deliver power where and when it's needed in an efficient way. To understand current and future trends in energy storage solutions — including battery

and other energy storage technologies, as well as opportunities and challenges for energy storage systems companies — Jabil and SIS International Research fielded an online survey to 204 stakeholders responsible for energy storage and battery solutions at their respective companies. These individuals held roles that included product development, engineering, operations, product management, and supply chain management.

These decision-makers were team managers or above and hailed from the Americas, Europe, the Middle East and North Africa, and Asia-Pacific. Survey questions focused on the types of ESS respondents are developing, how their solutions are manufactured, and future plans for energy storage.





The State of Energy Storage Solutions

Key Findings

- **87%** of respondents are or are considering manufacturing their own batteries.
- Respondents were split along the energy storage system value chain — **33% were end-users, 33% made finished products, and 25% manufactured modules.**
- **88%** of companies are producing solutions for commercial and industrial applications, while **61%** are considering expanding into the residential and commercial/industrial markets.
- More than half (**58%**) of respondents who plan to enter a new energy storage market plan to do so within three to five years.
- Those who are not expanding blame **lack of cost benefits and poor alignment with company strategy**, while those who do plan to expand are doing so to **differentiate and stay ahead of market trends.**
- Approximately two thirds (**66%**) of companies are interested in developing energy storage solutions with energy capacities of 200 kWh to 1 MWh, while **62%** are interested in 20 kWh to 199 kWh capacities.
- North America (**70%**) and Europe (**67%**) are likely to see the most ESS deployments of any regions in the next three to five years.
- Within North America, respondents believe California (**43%**), the Northeast (**42%**), and the Midwest (**41%**) will have the most concentrated distribution of deliveries.





Key Findings

Batteries and Energy Solutions

- More than three quarters of respondents (**78%**) are managing their battery management system software in house, while **63%** plan to have energy provided as a service to their storage system.
- The vast majority of participants say their companies use lithium-ion batteries in their current solutions (**90%**) and plan to use them in their future solutions (**75%**).
- Companies generally choose energy solutions based on their power densities, long lifespans, and sustainability.
- Companies are divided on the need for safer battery chemistry, with **45%** currently working on it and **55%** not.
- **75%** of participants believe in reusing energy storage system batteries that have reached end-of-life in new ESS solutions or other products. However, only **39%** plan to integrate second-life batteries into their own storage systems.





Key Findings

Energy Storage Opportunities and Challenges

- Supporting the demand for renewable energy (**87%**) and a desire for lower long-term energy costs (**75%**) are the main drivers of energy storage solution development.
- On a scale of one to five — with one being “not important” and five being “extremely important” — respondents rated **modularity in energy storage system** design an average of **4.5** in importance.
- Almost three quarters (**74%**) of respondents said increasing material costs is their top supply chain issue.
- Nearly nine in 10 (**88%**) of respondents said an inability to manufacture at the scale needed to meet market demand is their biggest manufacturing challenge.
- More than half (**59%**) of respondents said ramping to meet demand for renewable energy is their biggest ESS deployment challenge.
- Roughly half (**46%**) of companies could deploy their systems one to two years faster if battery prices were **25%** cheaper.
- Over six in 10 (**62%**) companies have uncertain or no plans to reshore their energy storage system manufacturing, while over seven in 10 (**71%**) have uncertain or no plans to outsource their manufacturing.

*As you review the results, please keep in mind that not all percentages may add up to 100 due to rounding.



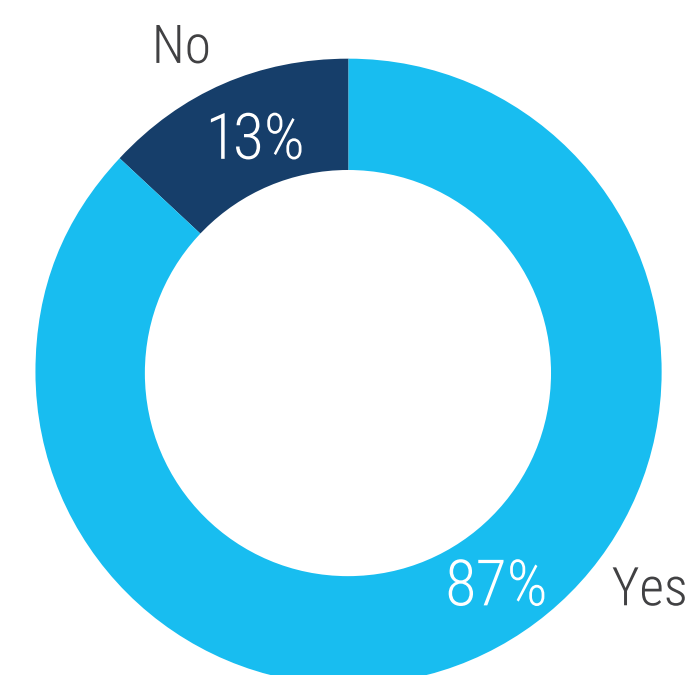
The State of Energy Storage Solutions



Most Companies are or are Considering Producing Batteries Within Their Own Facilities

In recent years, some energy storage systems companies have begun taking battery and module production in their own hands – as indicated by the finding that 87% of respondents are or are considering manufacturing batteries themselves. Companies are using cells to build modules to their exact specifications, avoiding some of the supply chain challenges the industry has seen recently.

Does your company **produce**, or is it considering **producing, batteries** within its manufacturing facilities?

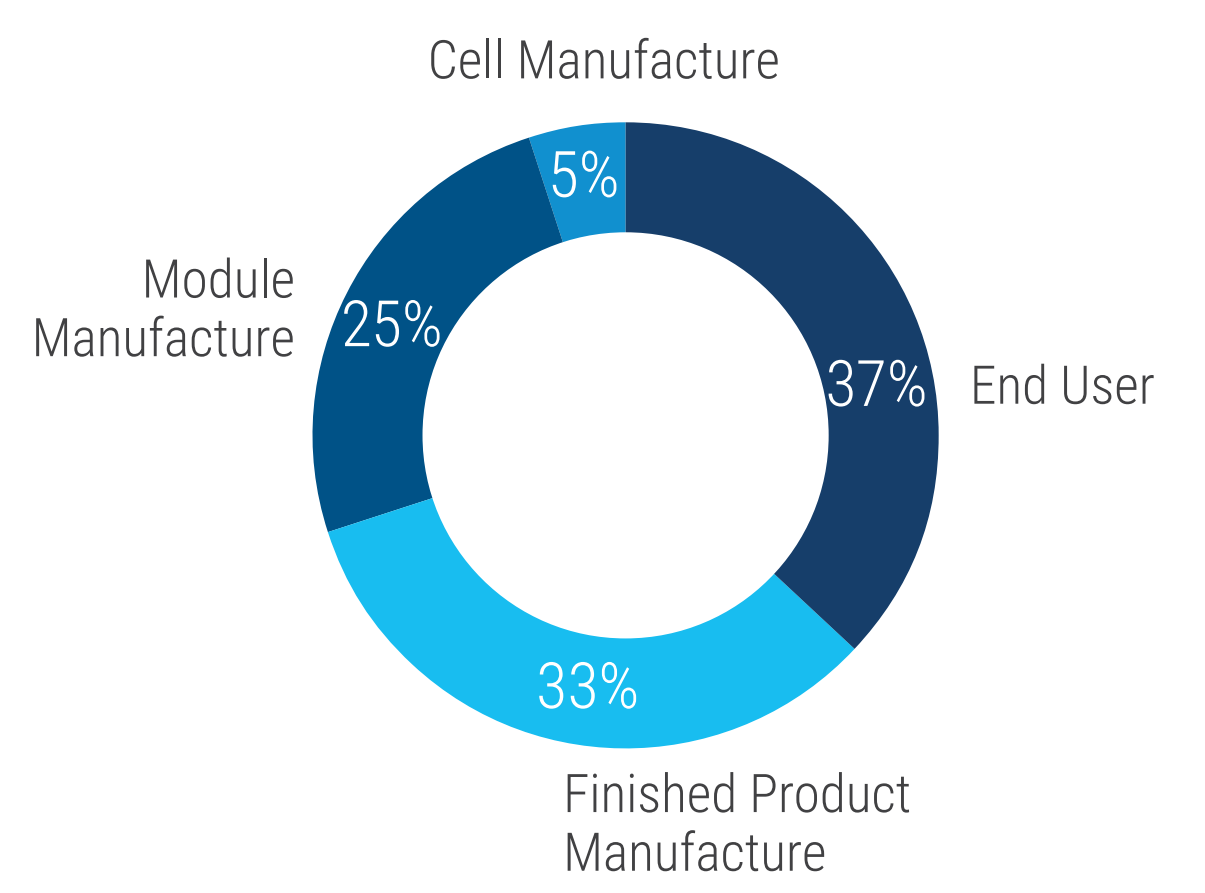




Respondents are Both Using and Producing Energy Storage Systems

Survey respondents represented various steps along the energy storage value chain, including their end use (37%), manufacturing of the finished storage system (33%), module manufacturing (25%), and cell manufacturing (5%).

Which category best describes the **activities** your company engages in in relation to energy storage system development?

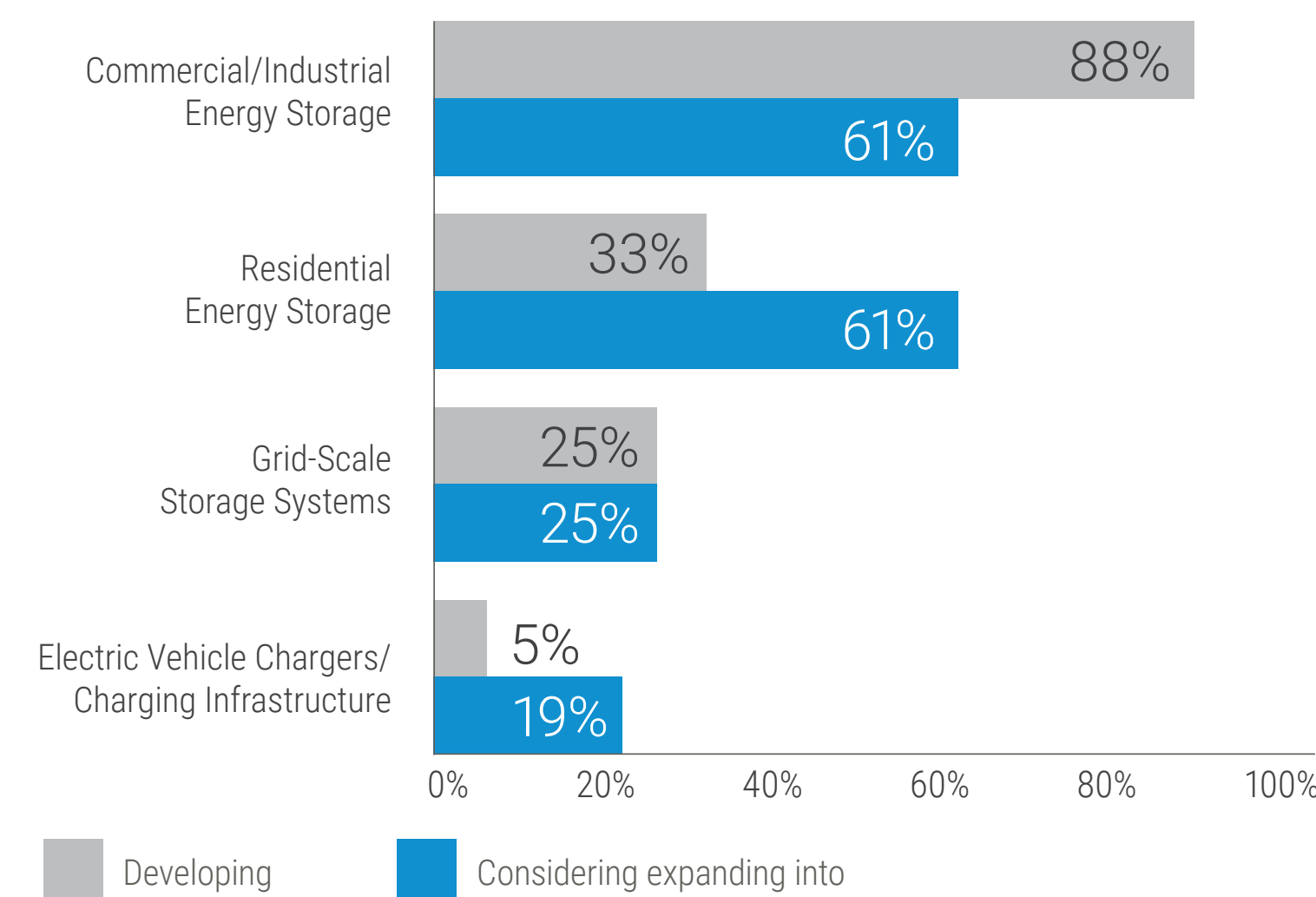




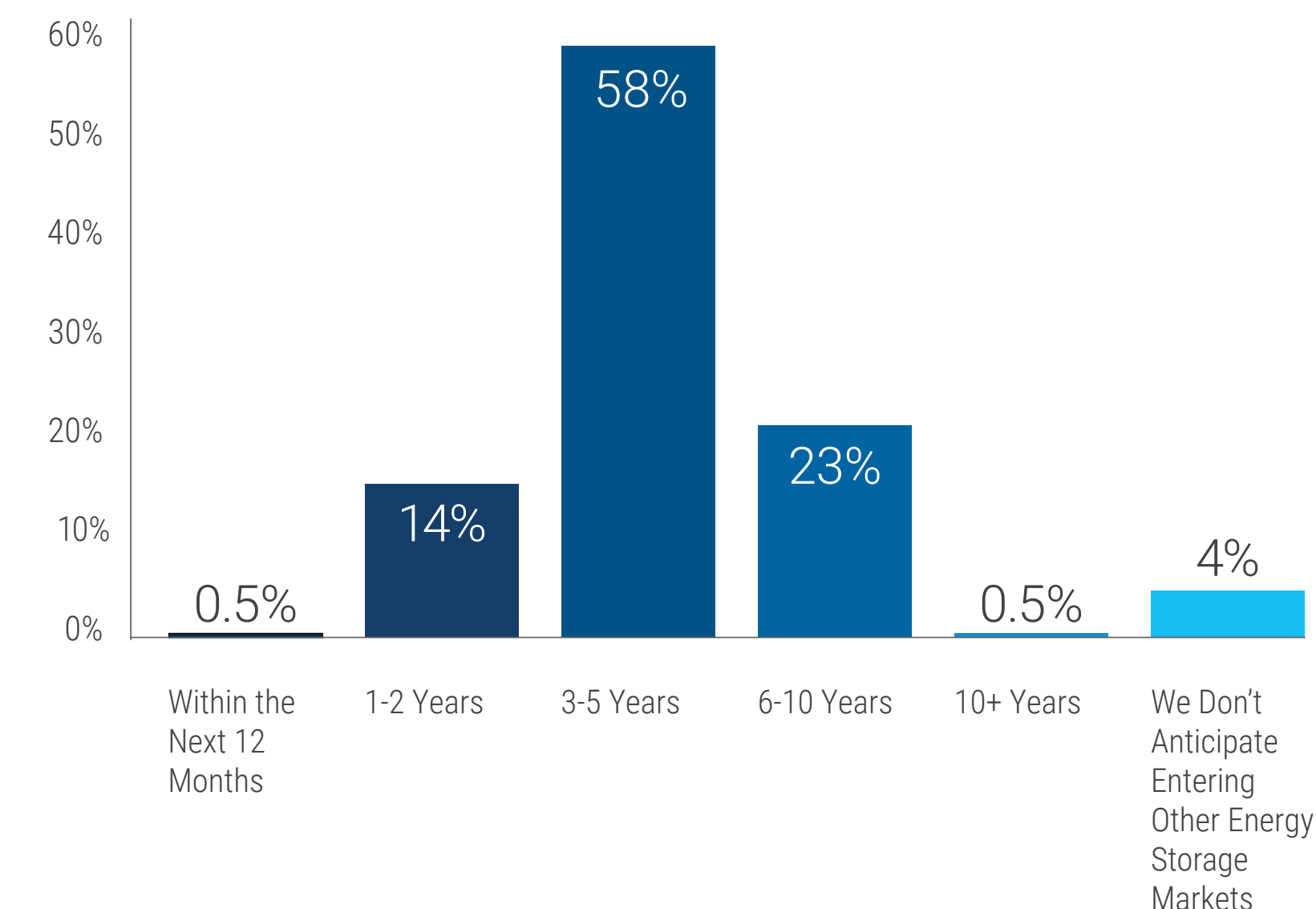
Energy Storage Companies are Primarily Building Commercial and Residential Solutions, Looking to New Markets 3-5 Years From Now

Most respondents (88%) are developing energy storage systems for commercial and industrial purposes (like office buildings). Only a third (33%) said their companies are currently developing systems for residential applications, and just a quarter of respondents are working on grid-scale systems. Along with residential ESS, the commercial and industrial market is the most likely area of expansion for companies (61% of respondents selected each). However, they expect that will be a long-term move. More than half of companies said they anticipate expansion in the next three to five years (58%), while 23% said it will likely come in six to 10 years.

What type(s) of energy storage system is your company developing? Have you considered expanding into other energy storage markets?



How soon do you anticipate entering other energy storage markets?





Some Companies are Expanding Into New Markets to Innovate and Differentiate; Others Say Opportunity Costs are Too High

Given the opportunity to explain why they are or are not expanding into new markets, respondents coalesced around a few themes. Those who said they are not expanding generally noted that expansion does not align with the larger company strategy and focus, and the opportunity costs for doing so would outweigh the benefits. For example, one respondent explained, “We are satisfied with our current energy storage solutions; the opportunity costs for changing them are very high.” Another respondent mentioned there would be “scaling concerns with capital vulnerability” if their company expanded. Meanwhile, those who are or plan to expand into new markets are doing so mainly to stay on top of trends and market demands. “[We are] waiting for innovation,” one respondent said. “The field is getting crowded, [and you] need to have a differentiating advantage.” Another respondent mentioned regulation being a driving force behind expansion.

Based on answers to the previous three questions, why have you chosen (or not) to expand your market offerings?

NOT EXPANDING: STRATEGY & COST

“Not part of our strategy”

“The company’s core focus is EV manufacturing”

“More focus on aviation applications”

“Opportunity costs”

“We are satisfied with our current energy storage solutions; the opportunity costs for changing them are very high.”

“Scaling concerns with capital vulnerability”

EXPANDING: TRENDS & INNOVATION

“Waiting for innovation. The field is getting crowded. Need to have a differentiating advantage.”

“To gear up with the market trends.”

“We are looking to expand into electric vehicle charging infrastructure and associated energy storage systems.”

“Regulation”

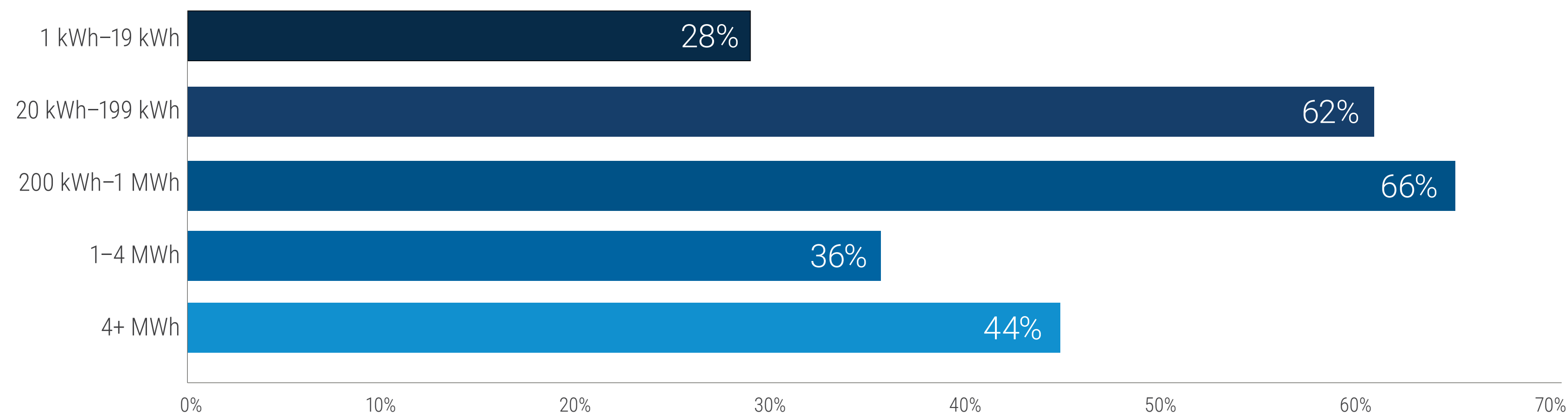


Respondents Were Most Interested in Mid-Range Energy Capacities for Their Storage Systems

Aligned with their current development of energy storage systems for commercial and industrial purposes, most respondents (66%) were interested in developing systems in the 200 kWh to 1 MWh capacity ranges. A similar number (62%) showed interest in developing slightly smaller systems in the 20 kWh to 199 kWh range.

Which **energy capacities** are you most interested in developing for your storage system?

Choose all that apply.



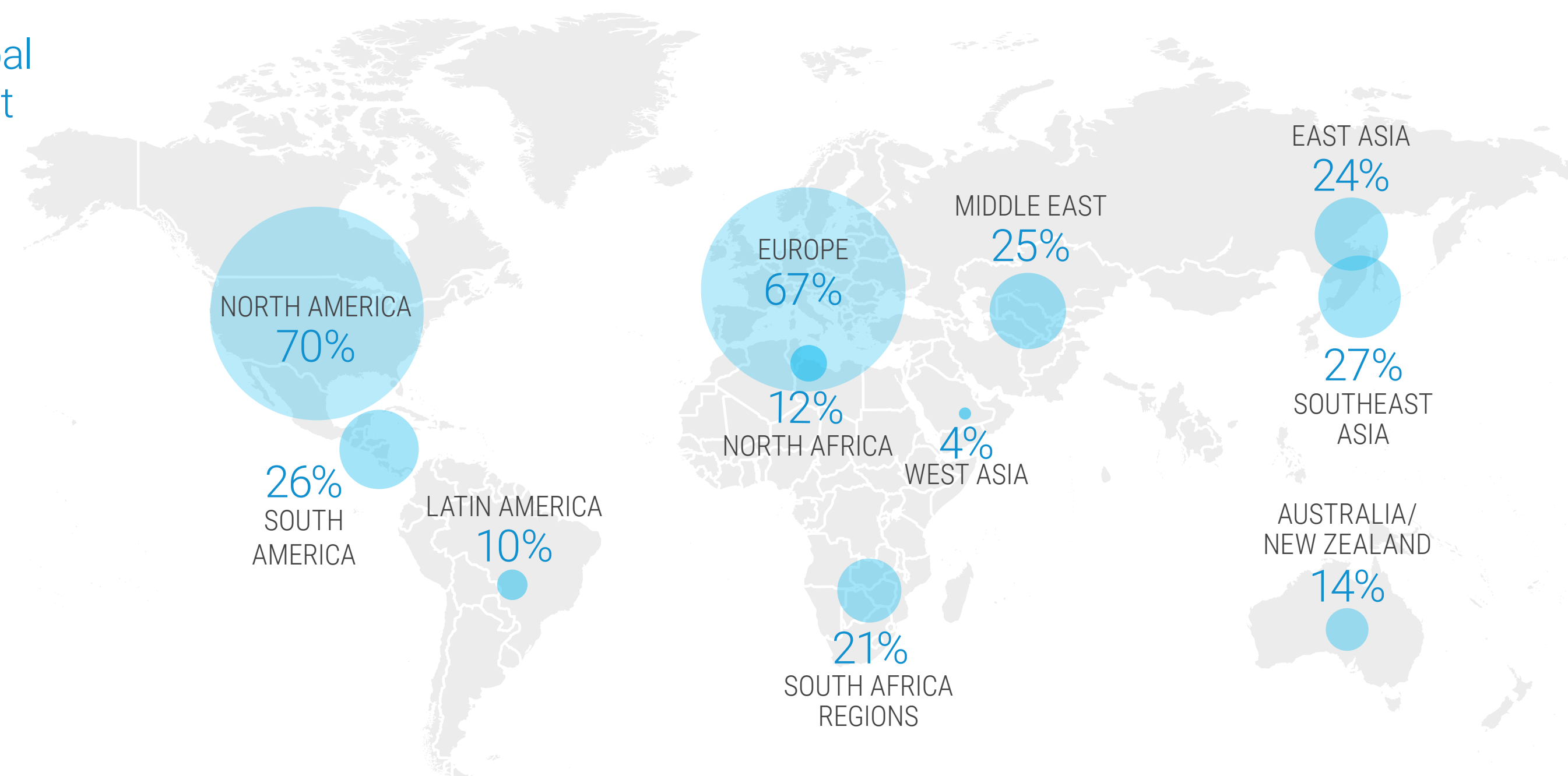


North America and Europe Expected to Have Highest Deployments of ESS in the Next Three to Five Years

Respondents anticipate countries in the western hemisphere will overtake the currently leading Asia-Pacific region in energy storage system deployment over the next half decade. North America (selected by 70% of respondents) and Europe (67%) are expected to have the most installations in the next three to five years, followed distantly by a number of growing markets – Southeast Asia (27%), South America (26%), and the Middle East (25%) – plus East Asia (24%). China has already been a strong leader in renewable energy and ESS deployment, so respondents likely expect other markets to begin catching up.

In the next three to five years, which global regions do you expect will have the **most concentrated distribution of deliveries?**

Select up to three choices.



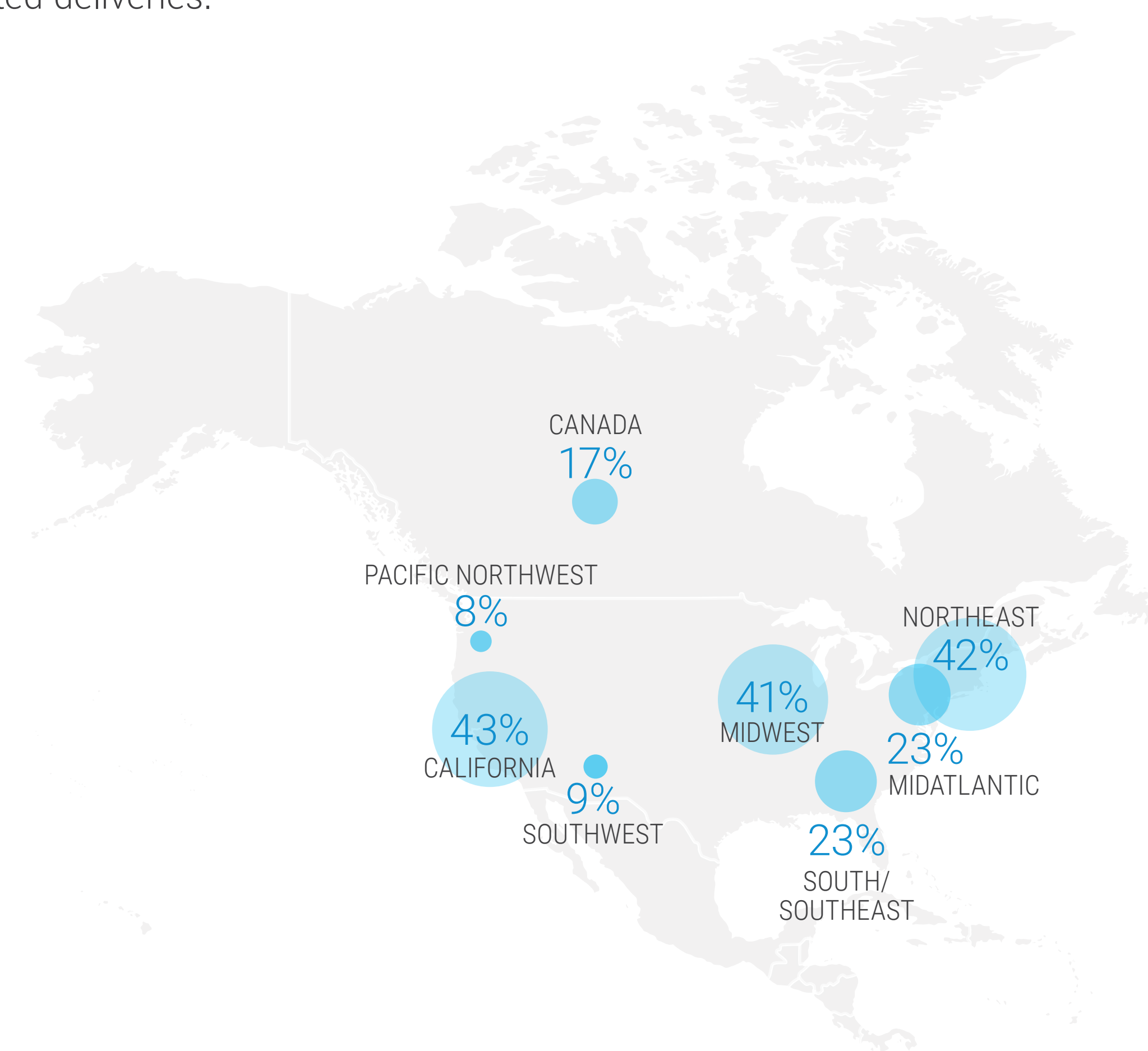


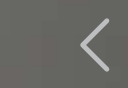
California, Northeast, and Midwest Expected to Lead Deployment Within North America

Of the respondents who selected North America as an answer to the previous question, they were in widespread agreement that California (43%), the Northeast (42%), and the Midwest (41%) will lead the region's energy storage deployment in the coming years. Respondents also expect the South and Southeast (including Texas, 23%) and the Mid-Atlantic to be areas of concentrated deliveries.

Within North America, choose the regions (up to three) where you expect to have the **most concentrated distribution of deliveries?**

(If respondent selected North America as an answer to the previous question).



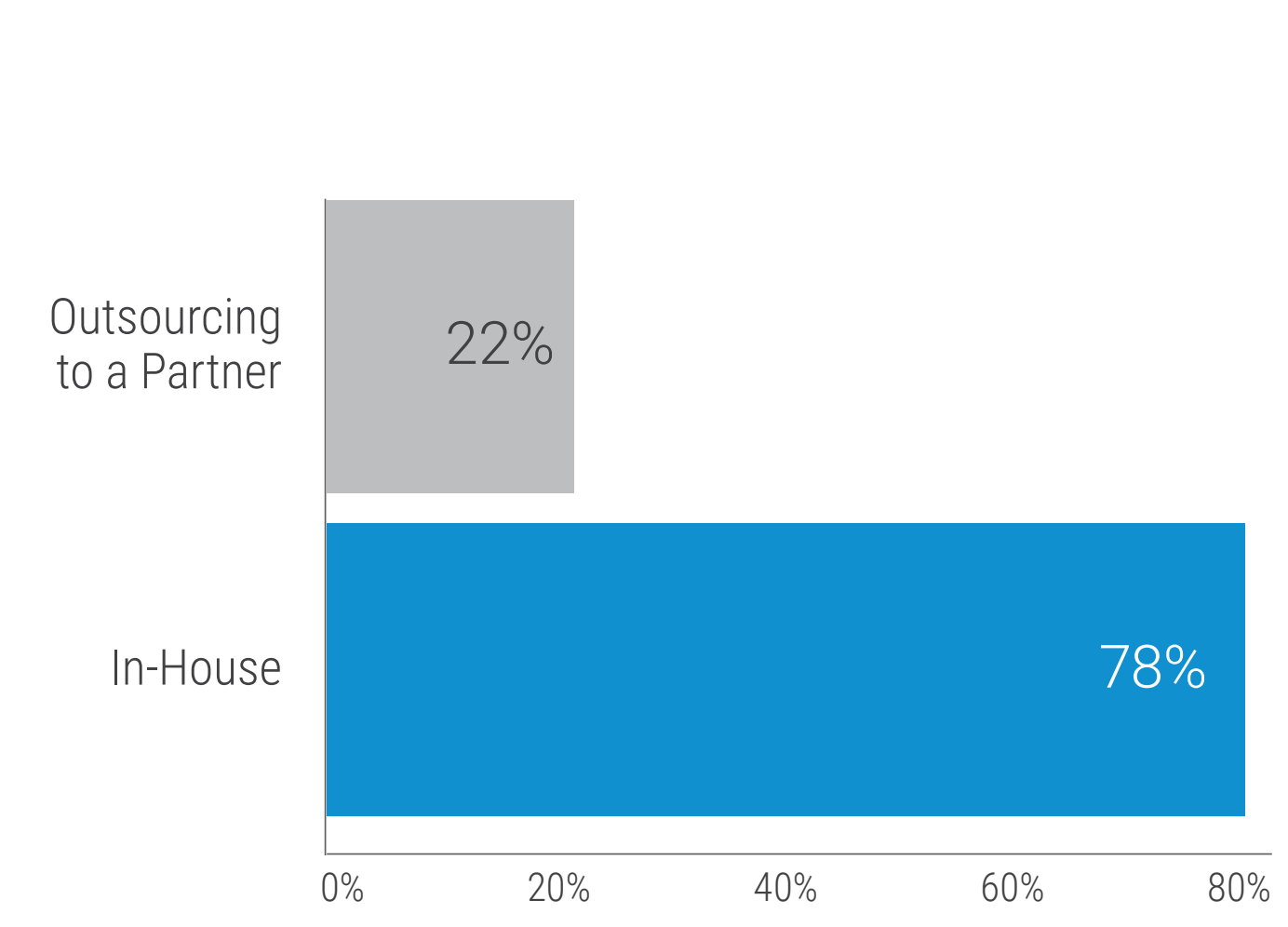


Batteries and Energy Storage Solutions

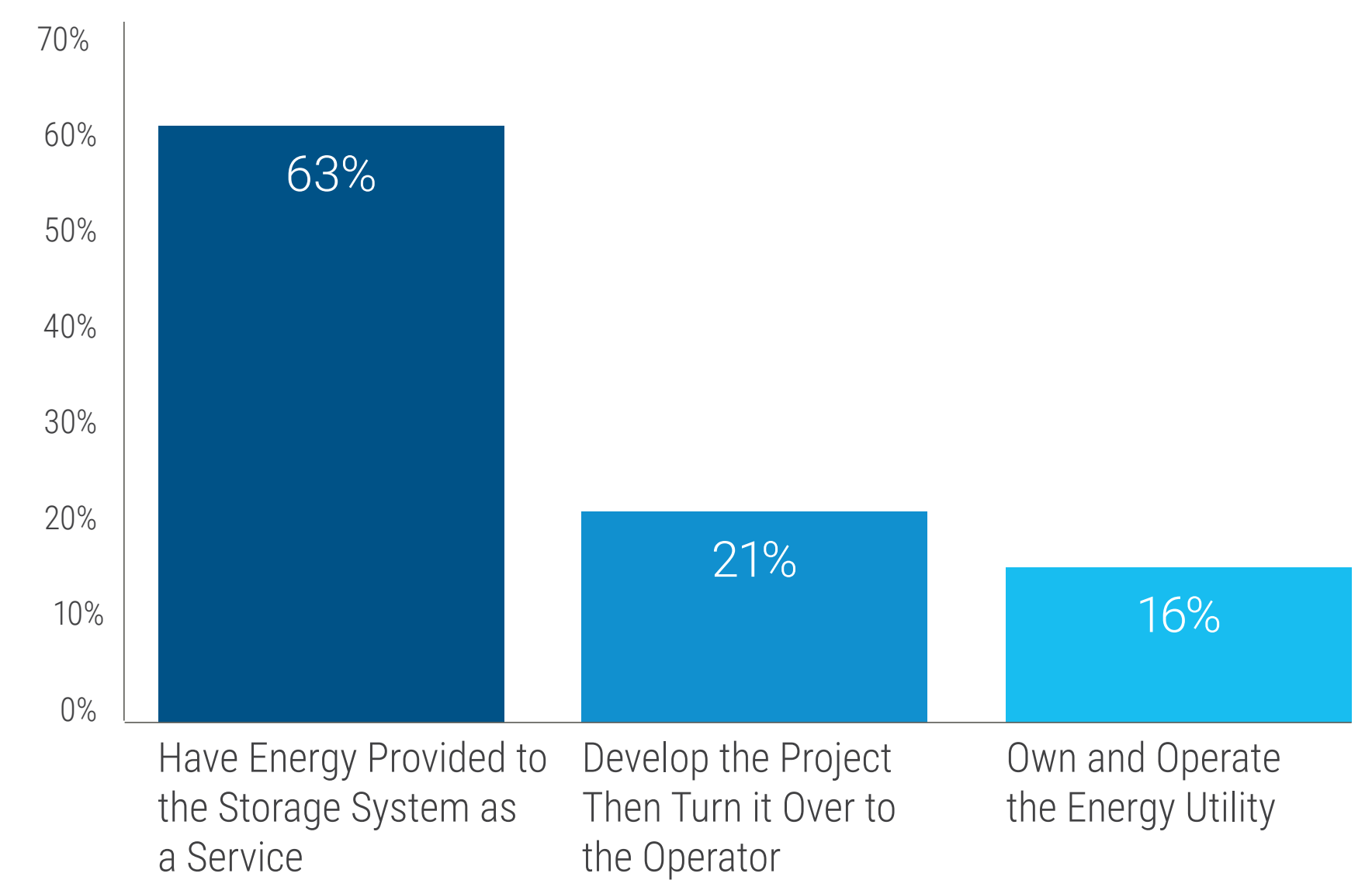
Respondents Mostly Managing Storage System Software In-House, Have Energy Provided as a Service

More than three quarters (78%) of respondents manage the software for the battery management system within their storage solution themselves, likely preferring to keep a close hand on intellectual property. However, more than six in 10 respondents (63%) plan to partner with an energy provider, like a local utility, to have energy delivered to their storage system as a service.

How are you **managing** the software for your battery management system?

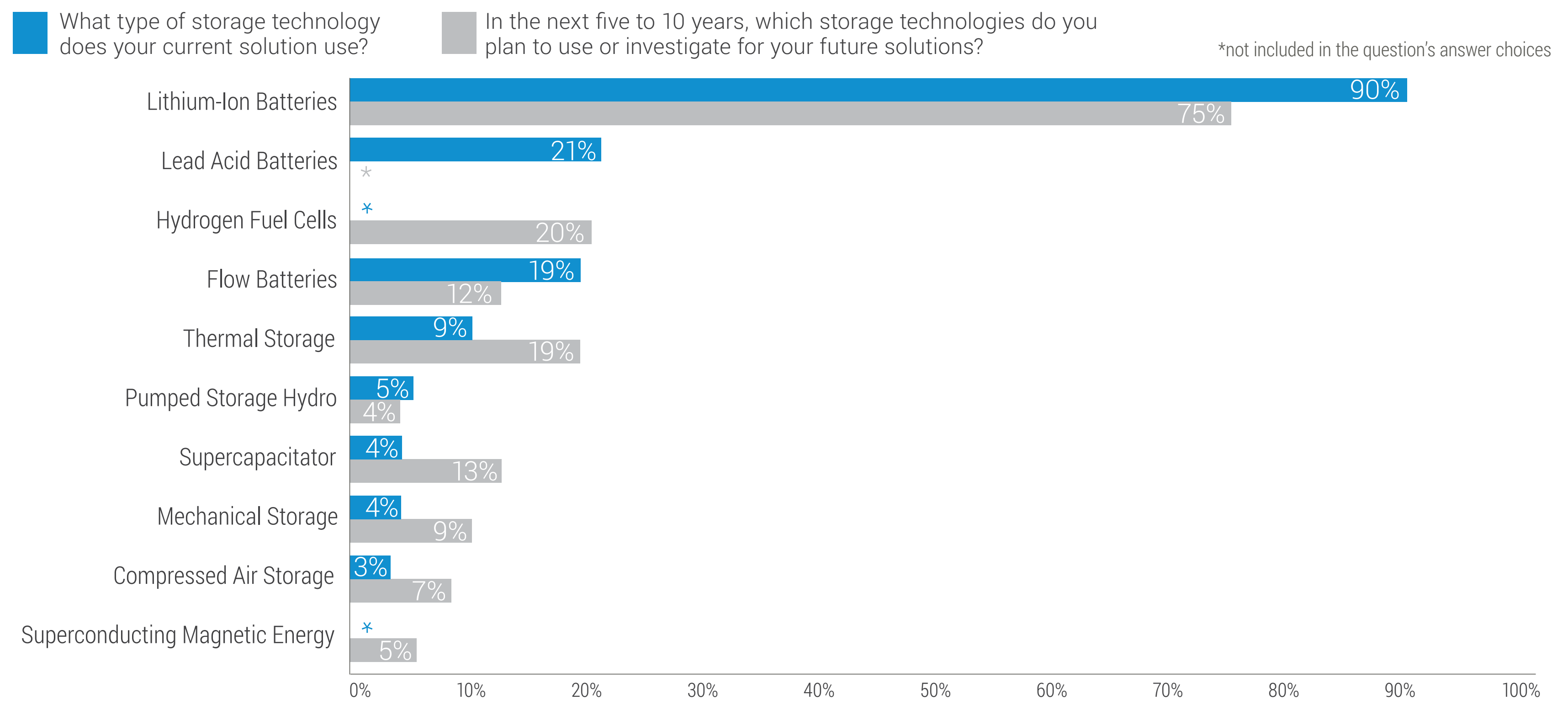


How do you plan to **deploy** your storage system?



Lithium-Ion Batteries are Overwhelmingly Popular for Current and Future Solutions

Perhaps unsurprisingly, an overwhelming majority of respondents (90%) indicated that they use lithium-ion batteries in their current energy storage solution. However, our findings show that companies intend to stick with the tried-and-true, as 75% of respondents said they plan to use lithium-ion in the next five to 10 years. Current solutions leverage other types of batteries as well, with 21% of respondents noting they use lead-acid batteries and 19% using flow batteries. Respondents showed interest in non-battery technologies for future solutions, which will help increase resiliency as the world's energy needs grow. These included hydrogen fuel cells (20%), thermal storage (19%, up from 9% for current solutions), and supercapacitors (13%, up from 4%).



Companies are Pursuing Energy Solutions for Their Power Densities, Lifespans, and Sustainability

Respondents provided details around the applications and motivations for the use of nearly all the energy storage solutions listed on the previous page. Here are a few representative responses:

Why are you interested in pursuing your selected energy solution(s)?
What use cases do you anticipate?

LITHIUM-ION BATTERY

“Lithium batteries charge faster, last longer, and have a higher power density for longer battery life in a lighter package [to] meet the most demanding [applications].”
“Lithium-ion batteries are easy to use and relatively low maintenance.”
“These [have] potential for application to grid-level energy storage systems because of their rapid response and modularization.”

FLOW BATTERY

“Flow battery technology can be used for large-scale energy storage projects, such as those for utility-scale wind and solar installations.”
“Flow batteries have a longer lifespan and are considered one of the most sustainable solutions and ideal for both residential and commercial use due to their risk-free nature.”

THERMAL STORAGE

“Thermal storage systems often provide lower capital costs in addition to lower energy use and lower energy costs.”
“From the larger demand perspective, thermal storage can be used in industrial processes that require high-temperature heat, such as metal production or chemical manufacturing.”

COMPRESSED AIR

“The uniqueness of compressed air storage is it can be utilized in recreational activities [and] also can be used to power irrigation systems in agriculture.”

HYDROGEN FUEL CELLS

“Hydrogen fuel cells can store excess renewable energy and can be used to power homes, reducing reliance on the grid.”
“Fuel cells can be used to power data centers and other high-energy consumption facilities.”

MECHANICAL STORAGE

“Mechanical storage can be used in microgrids to provide localized energy storage and distribution.”

PUMPED STORAGE

“Pumped storage hydro is the most sustainable and renewable energy solution with the lowest ecological impact.”

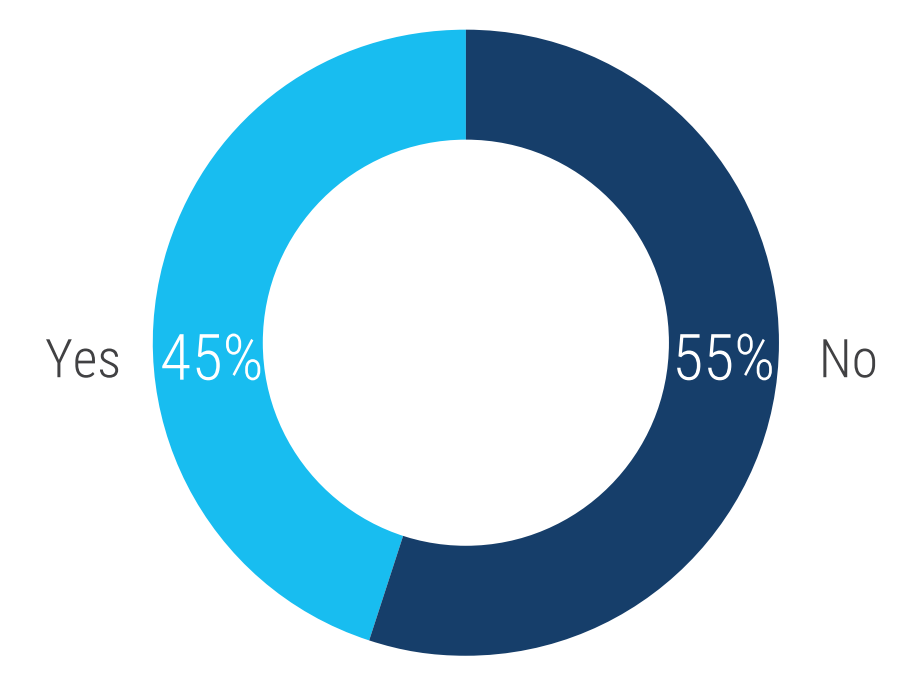
SUPERCAPACITATOR

“The supercapacitor storage solution is strong and stable.”

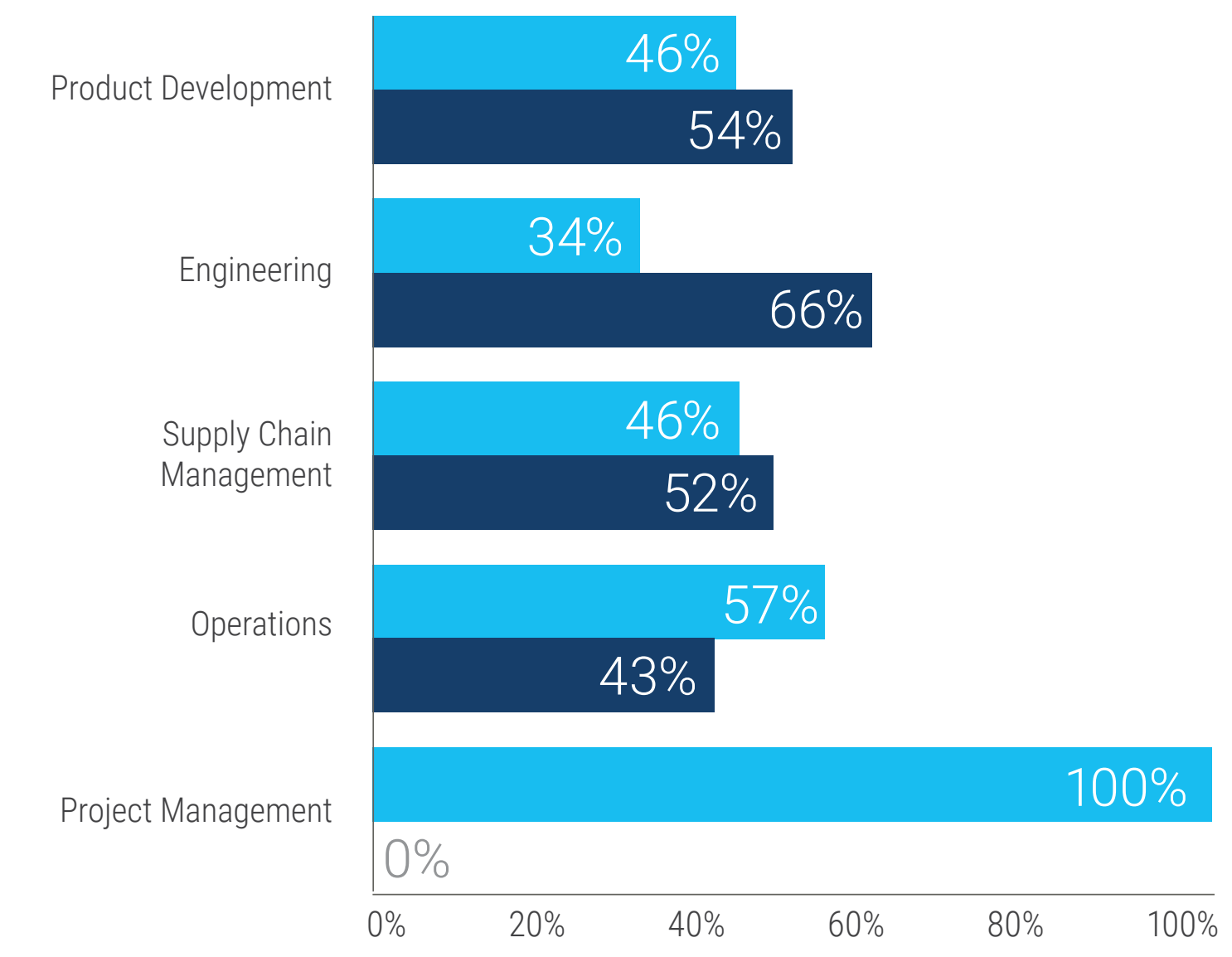
Respondents are Split on the Need for Safer Battery Chemistry, With Engineers Most Likely to Say "No"

Although innovations in lithium-ion battery chemistry have continually made the products safer over the years, there is still some concern among consumers, governments, and local regulators about fire risks. Energy storage system companies work closely with fire officials in the municipalities where systems are deployed to ensure all local regulations are met. Likely because this focus on safety is already so high, only 45% of respondents said they are actively working on safer battery chemistry, while 55% of respondents are not. Engineers were the least divided of any job category, with just 34% saying yes and 66% saying no. Of those respondents who are working on safer chemistry, they primarily noted the risk of thermal runaway and environmental impact (i.e., carbon footprint or the potential for pollution) as top concerns with their current chemistry.

Are you **actively working** on safer battery chemistry?



(BY RESPONDENT JOB CATEGORY)

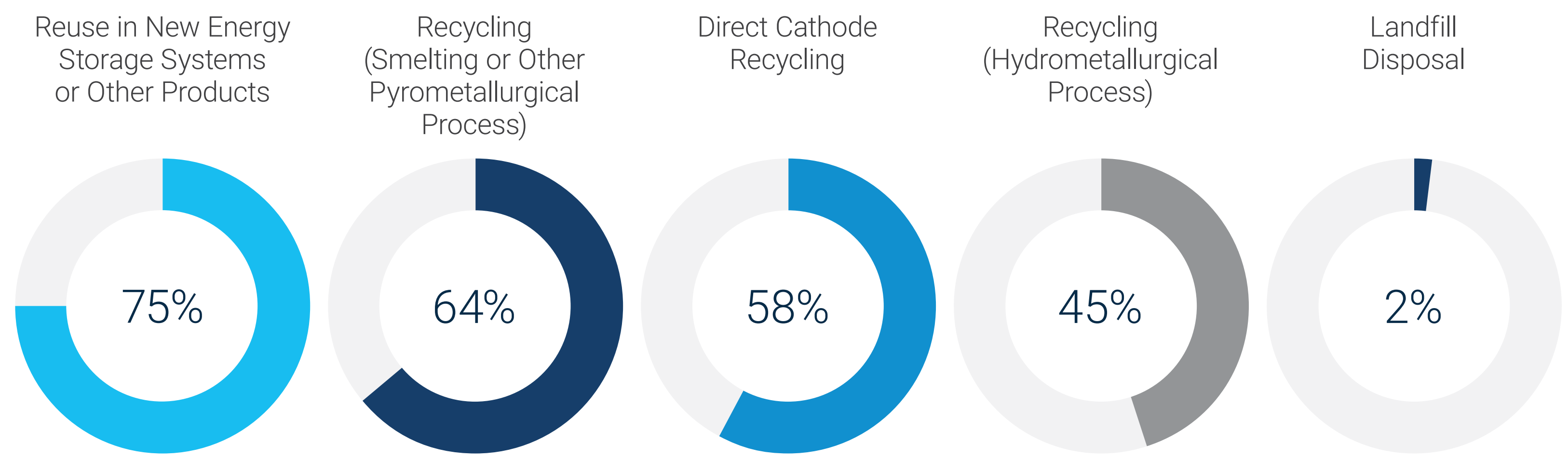


Yes No

Fewer Than 40% of Respondents Plan to Use Second-Life Batteries in Their Own Systems, But 75% Plan to Reuse Their Batteries in Other Systems

Sustainability will be a key issue for energy storage solutions companies in the years ahead, particularly as lithium-ion batteries reach the end of their lives in an ESS. However, the useful lives of batteries can often be extended in new applications. Three quarters (75%) of respondents said they plan to reuse their batteries in new storage systems or other products.

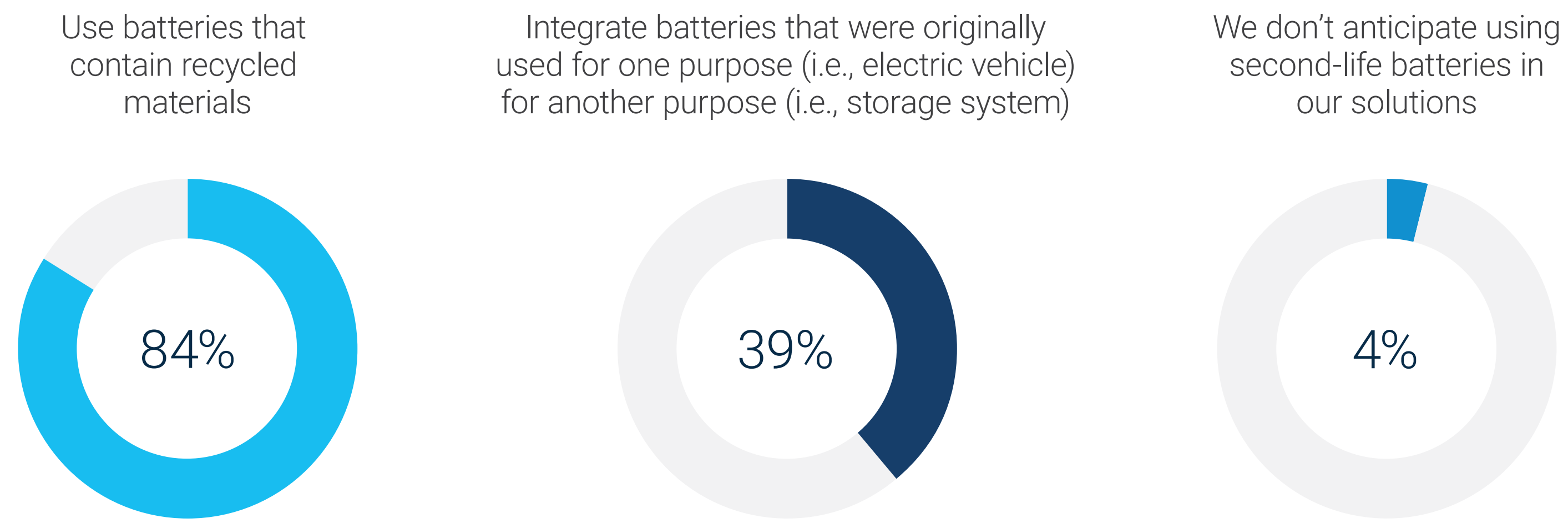
How do you plan to handle batteries from your storage systems at the **end of their life?**



Fewer Than 40% of Respondents Plan to Use Second-Life Batteries in Their Own Systems, But 75% Plan to Reuse Their Batteries in Other Systems

A bit of a contradiction was revealed when respondents were asked how they would integrate second-life batteries in their own solutions. Despite high numbers indicating they would like to reuse their batteries in other products, only 39% said they expect to integrate second-use batteries originally used for a different purpose in their energy storage systems over the next five to 10 years. Instead, 84% anticipate using batteries that contain recycled materials in the future.

How do you expect to **integrate second-use or second-life batteries** into your energy storage systems in the next five to 10 years?





Energy Storage Opportunities and Challenges

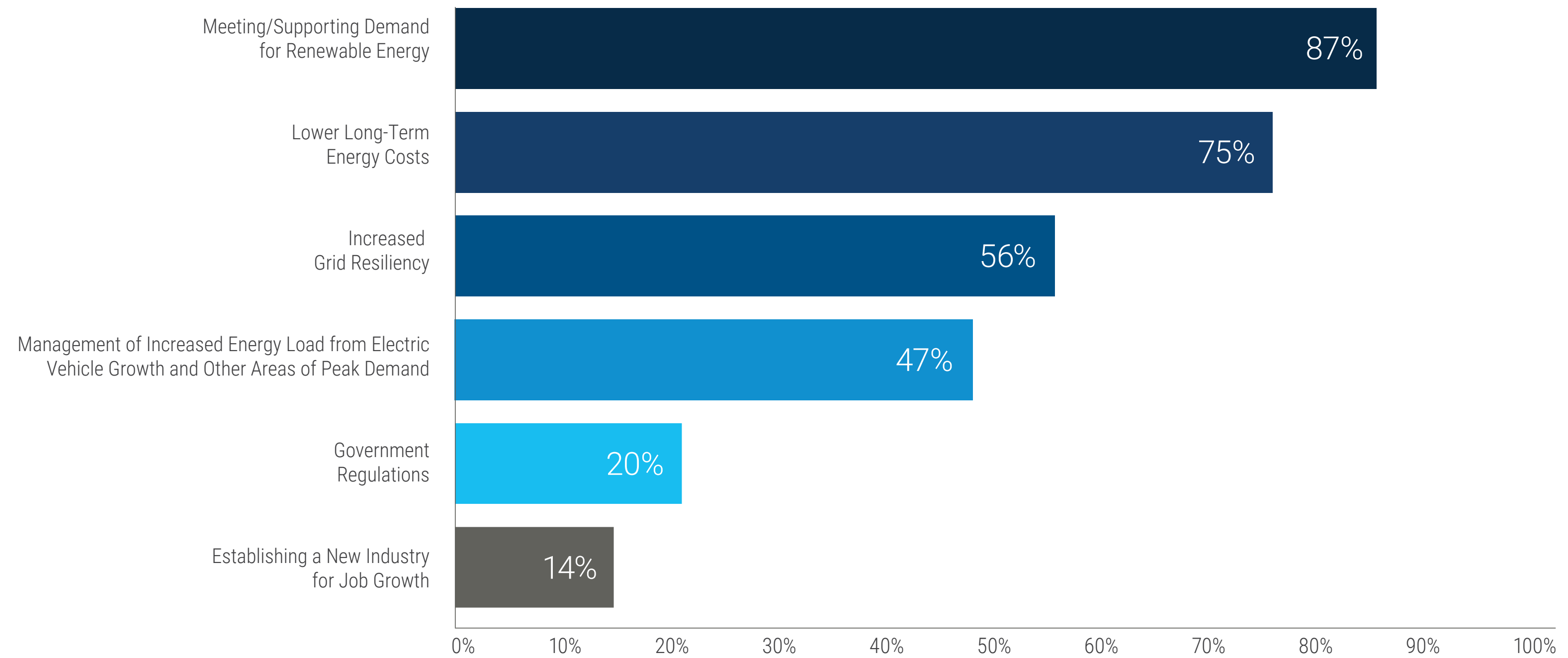




Demand for Renewable Energy and Lower Energy Costs is Driving the Development of ESS

As nations, cities, and companies ramp up their use of renewable energy sources, the need for storage systems to help manage the load on grids will be critical. An overwhelming majority (87%) of respondents said that helping meet and support demand for renewable energy is driving the development of their ESS. A desire for the lower long-term energy costs (75%) that will likely accompany the combined use of renewables and ESS, as well as a push for increased grid resiliency (56%) in a time of growing energy demand, were also key drivers.

What factors are driving the **development** of your energy storage solutions?

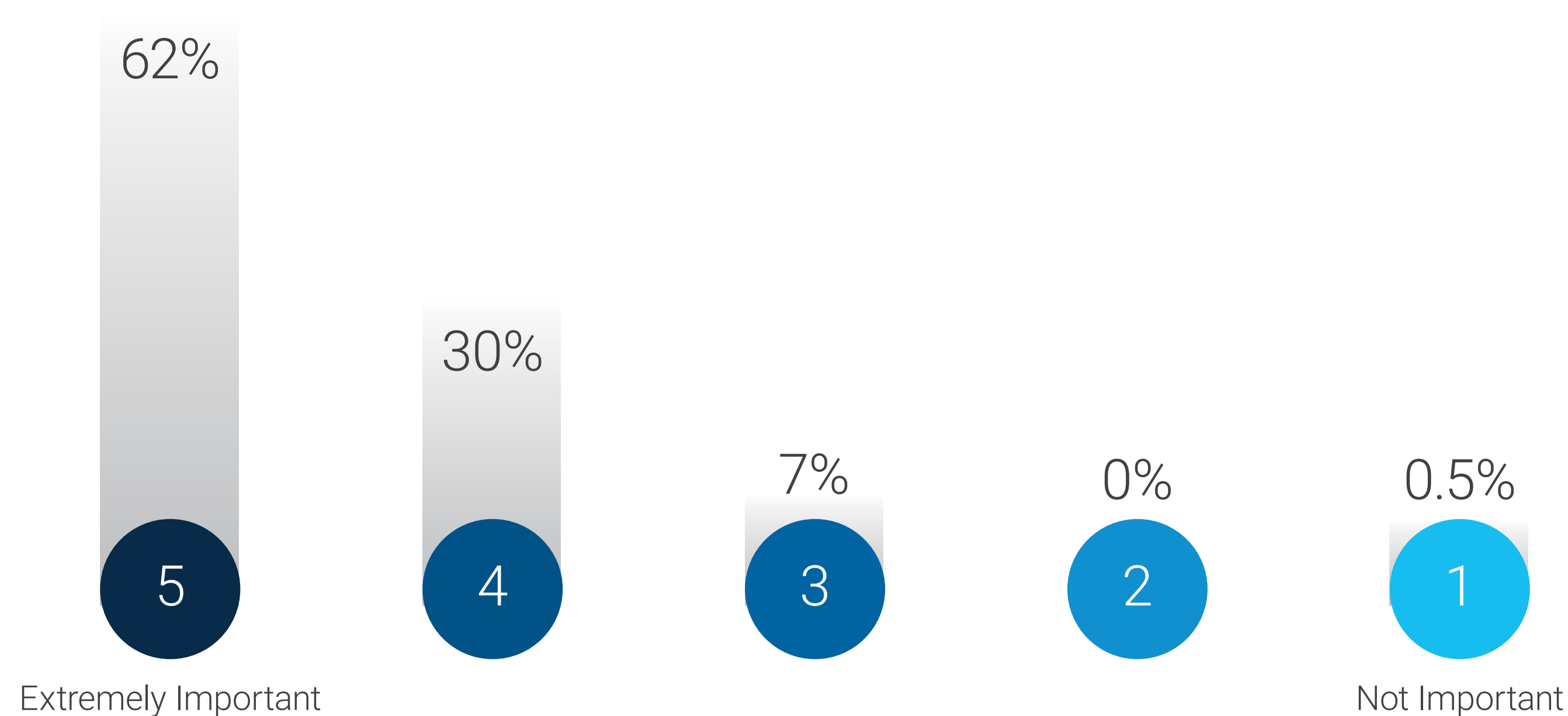




Modularity is Extremely Important for Energy Storage System Design

Modular design, or modularity, is becoming increasingly popular in the energy storage industry to make manufacturing and product technology updates simpler. On a scale of one to five – with one being “not important” and five being “extremely important” – survey respondents rated modularity an average of 4.5 in importance to the design of their energy storage system.

Based on the type of energy storage system you are developing, how important is **modularity** in the overall design on a scale from 1 to 5?

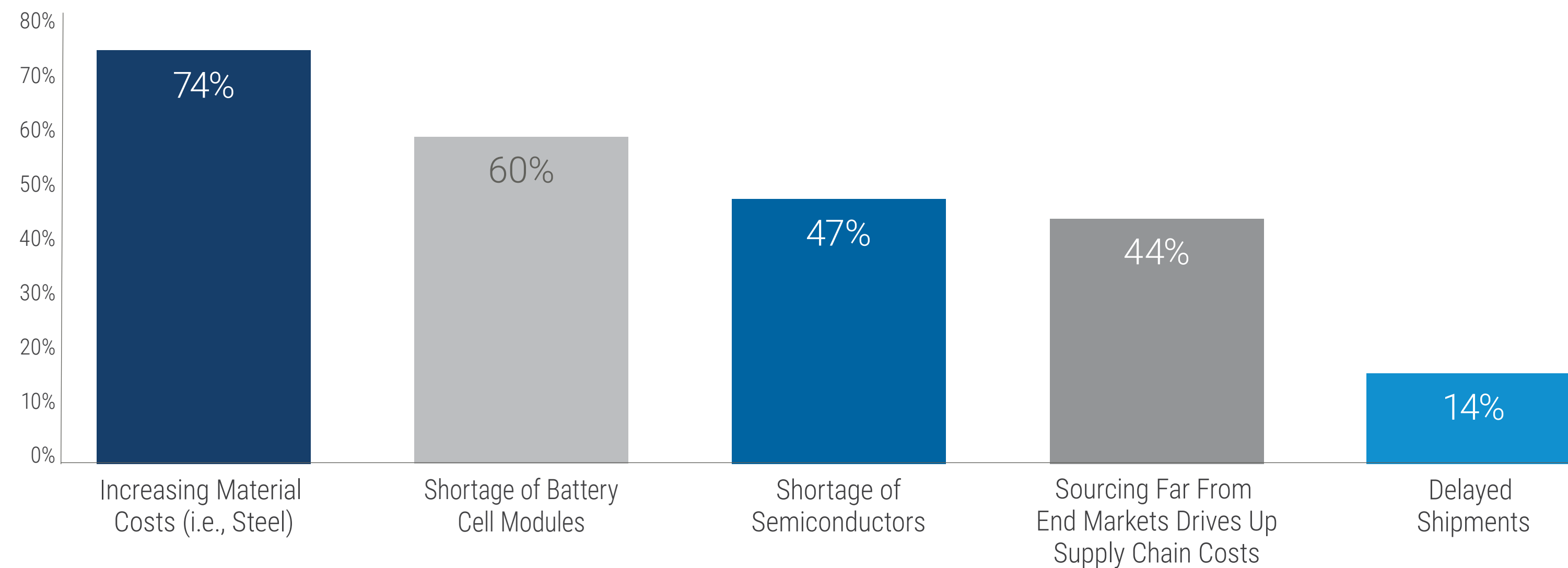




Increasing Material Costs are the Leading Energy Storage Supply Chain Issue

Nearly three quarters (74%) of respondents said increasing material costs are impacting their ability to create their desired solution. While critical materials – particularly steel for storage system frames – are becoming more expensive, companies are under pressure from governments and customers to localize their sourcing instead of procuring less expensive steel from Asia. Along with a shortage of battery cell modules (impacting 60% of respondents) caused by high demand, these supply chain issues are leading energy storage companies to seek more cost-effective manufacturing options close to their end markets.

What **supply chain issues** are impacting your company's ability to achieve your desired kWh level in your battery solution?

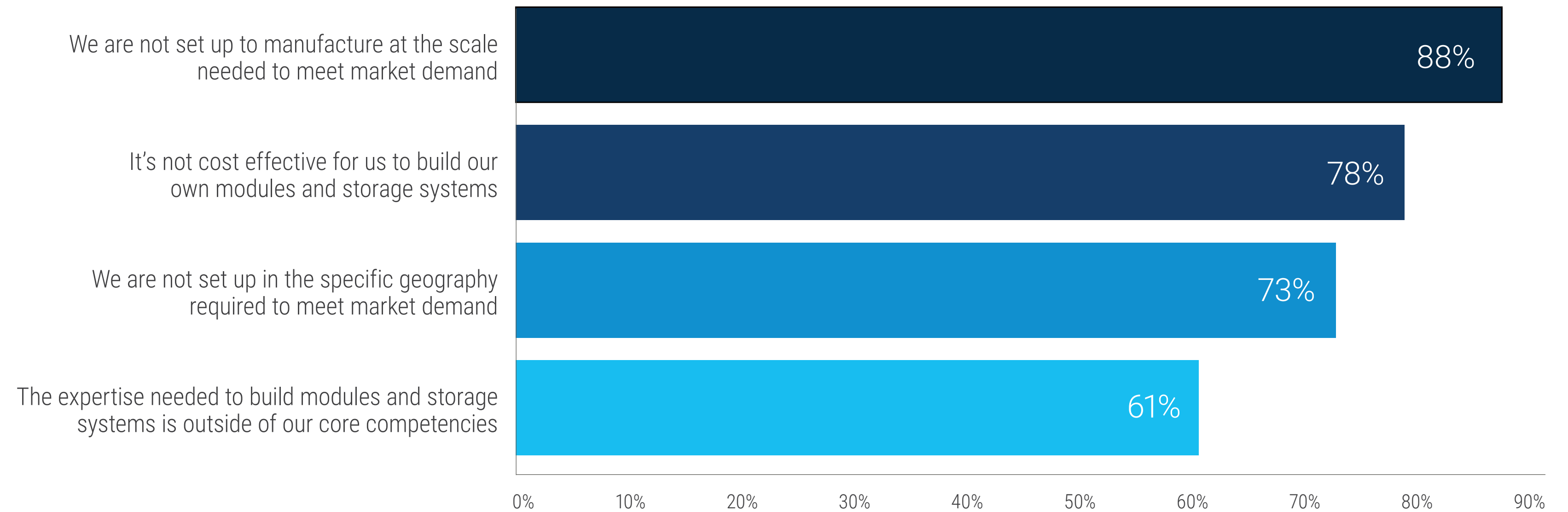




Scale, Cost, and Geography are the Top ESS Manufacturing Challenges

The rapidly growing global demand for energy, especially renewables, means the need for storage solutions will only continue to grow. Thus, 88% of respondents noted their biggest manufacturing challenge is scaling production to meet market demand. Despite many respondents indicating in a question later in this report that they do not plan to outsource manufacturing, most respondents demonstrated here that they are facing challenges that could be alleviated with partnerships. More than three quarters (78%) said here that it is not cost effective to build their own modules and storage systems, 73% said they are not set up in the right geography to meet demand, and 61% said manufacturing expertise is outside their core competencies.

What **manufacturing challenges** do you face in transforming battery cells into energy storage systems?

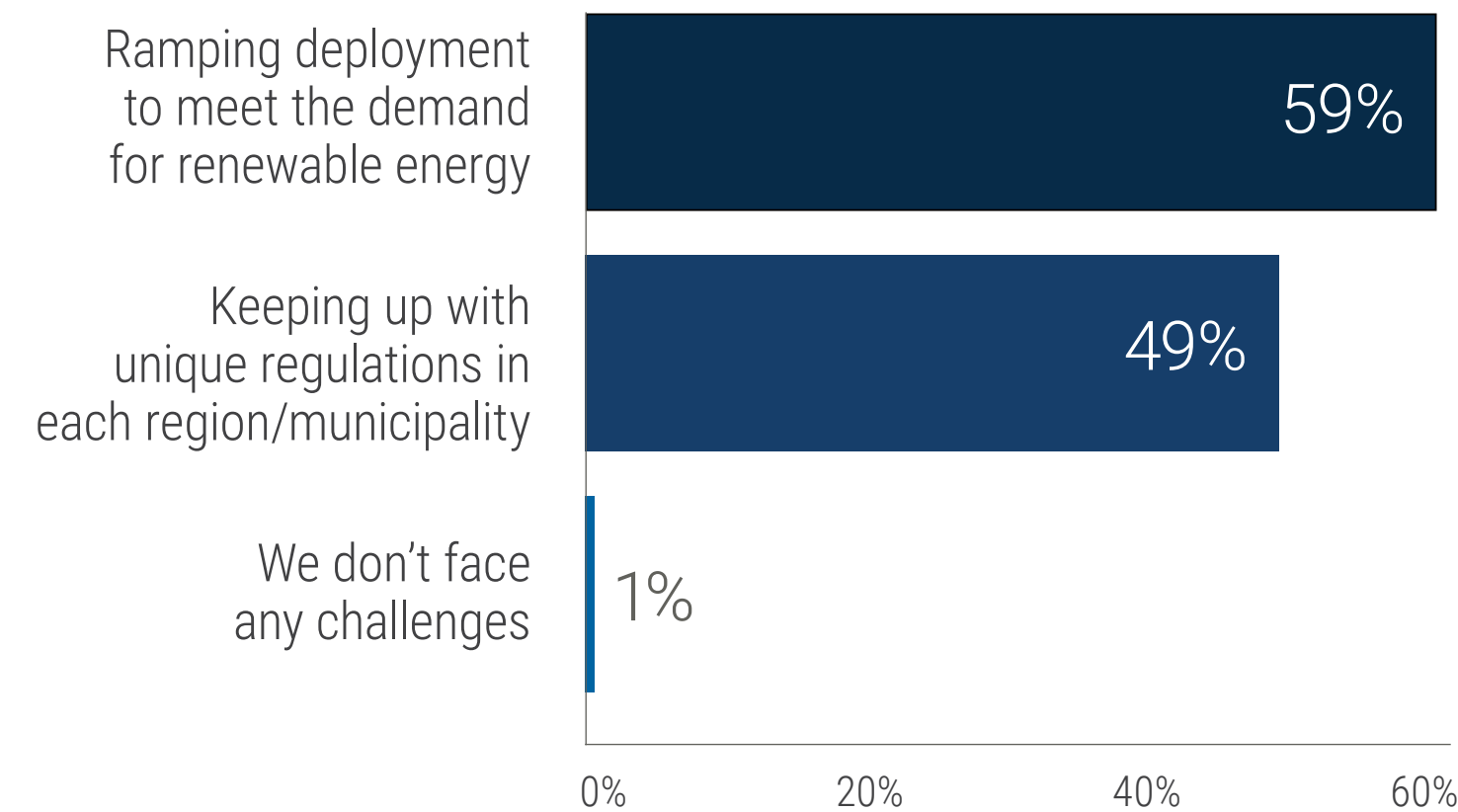




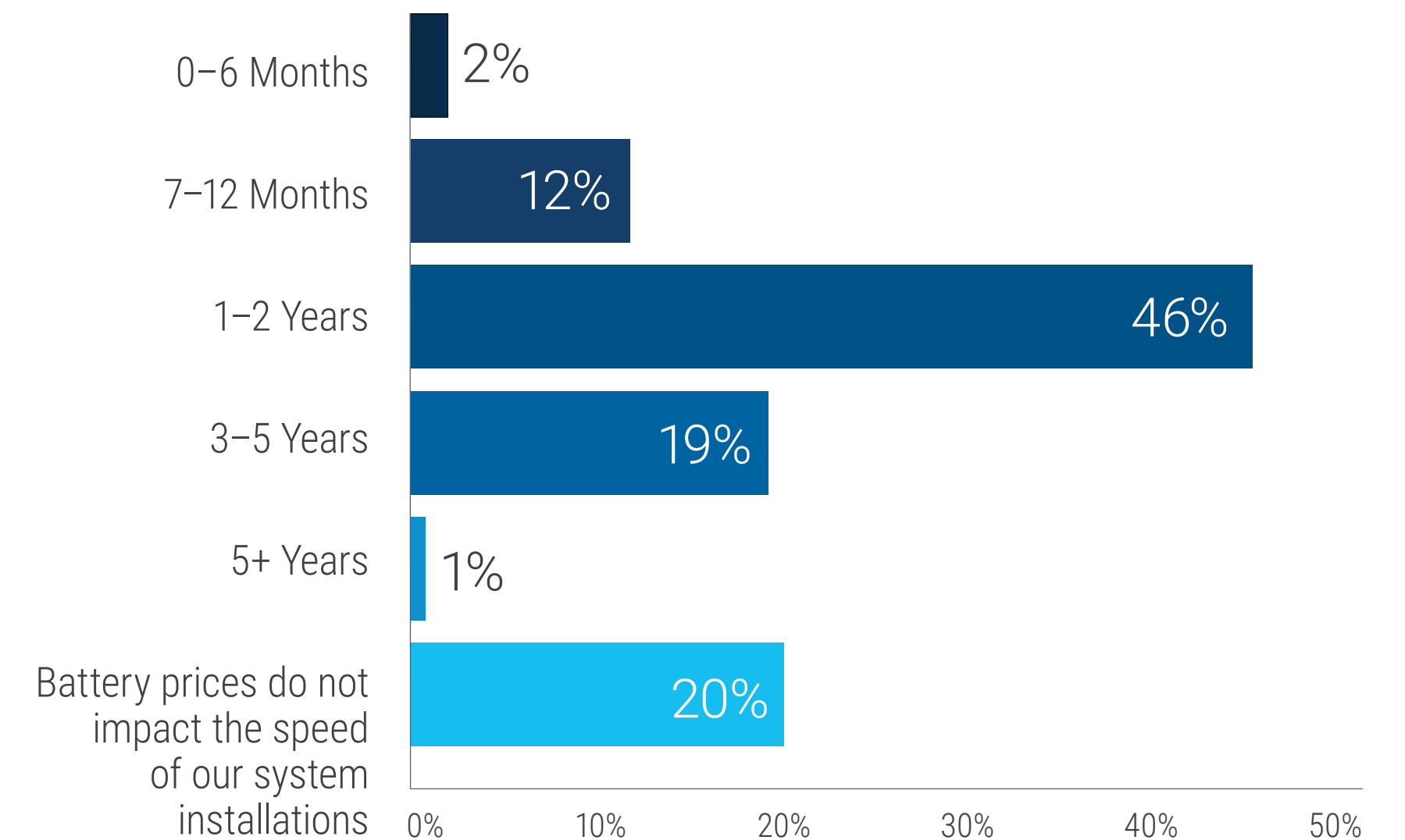
Ramping to Meet Renewable Energy Need is the Biggest Challenge to ESS Deployment, but Cheaper Batteries Could Mean Faster Installations

Similar to the challenges many respondents face in manufacturing energy storage systems, 59% said ramping to meet the growing demand for renewables in their top challenge when deploying their solutions. However, close to half (46%) indicated that a battery price 25% lower than what they typically pay could result in installations happening one to two years faster than average.

What **challenges** do you face in deploying energy storage systems?



If battery prices were **25% cheaper**, how much faster would you roll out your installations?

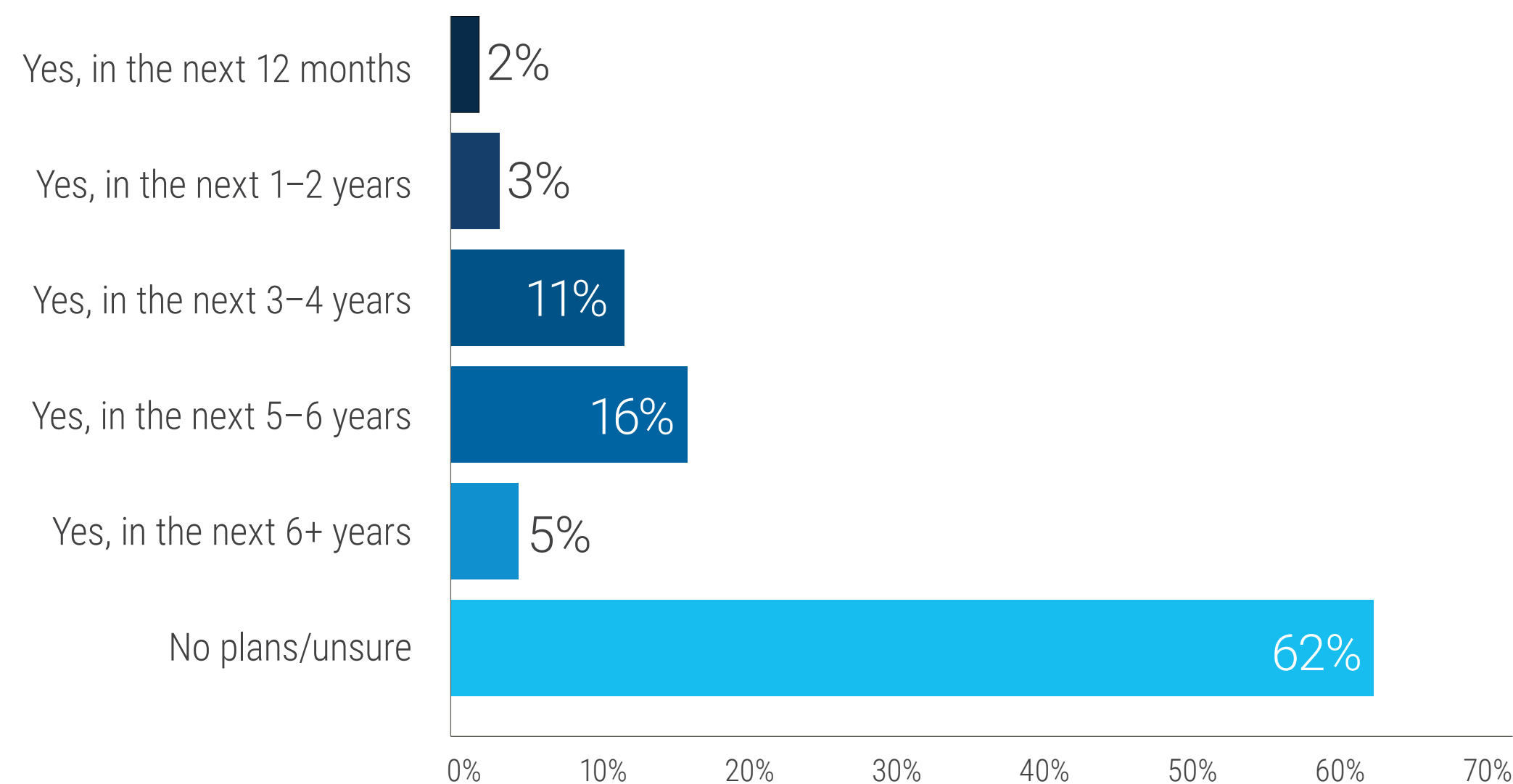




More Than a Quarter of Respondents Plan to Regionalize Manufacturing

As indicated in by respondents' answers to previous questions, distance from end markets is driving up supply chain costs and making it challenging to meet demand for many ESS companies. Thus, 27% of participants said they anticipate reshoring or regionalizing in the next three to six years. These respondents said they are most likely to reshore or regionalize the manufacturing of separators, electrodes, power electronics, and packaging and enclosures. More than six in 10 (62%) are either unsure of their plans or do not plan to move their production closer to end markets. For ESS companies who have not yet determined whether reshoring or regionalizing is in their future, manufacturing partners can help them evaluate their options and make the best business decision.

Do you plan to **reshore/regionalize** any part of your energy storage system manufacturing?



Respondents Will Most Likely Reshore/Regionalize Manufacturing of:

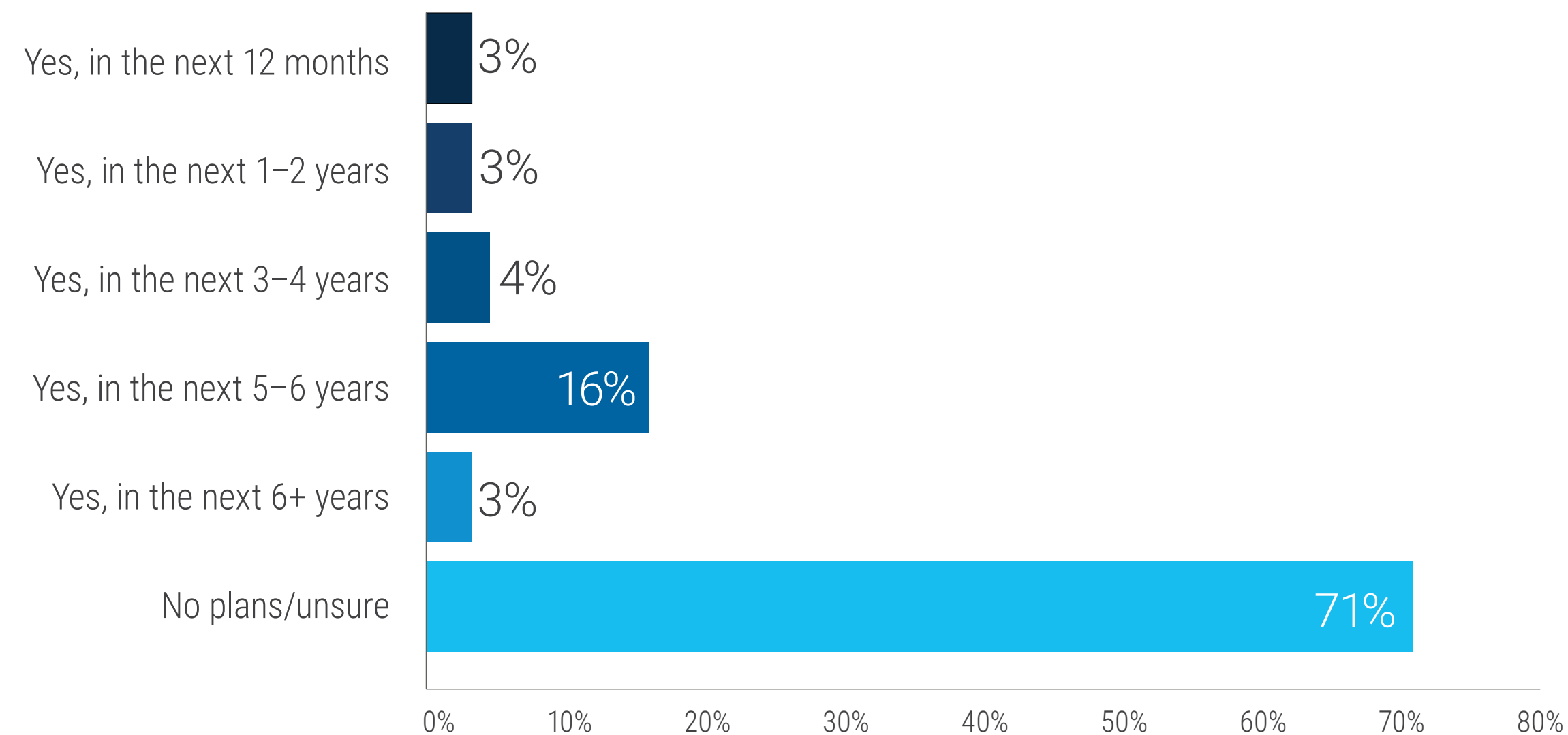
- Separators**
- Electrodes**
- Power Electronics**
- and
- Packaging & Enclosures**



One Fifth of Respondents Plan to Outsource ESS Manufacturing

Respondents generally expect their manufacturing will be kept in house for the foreseeable future, with 71% unsure of their plans or not planning to outsource at all. Manufacturing partners can work with ESS companies who are uncertain of their plans to determine how outsourcing production could bring cost and efficiency benefits. However, 20% do expect to outsource some part of their production in the next three to six years. Those who anticipate outsourcing said they plan to leverage partnerships to produce separators, electrodes (specifically to access expertise in that component), battery cases and management systems, electrolytes, power conversion systems, packaging and enclosures, and fire suppression systems. Additionally, multiple respondents mentioned outsourcing the production of battery components or materials to companies in regions with access to more resources needed for those materials and parts.

Do you have any plans to **outsource** the manufacturing of any part of your energy storage system?



Respondents Anticipate Outsourcing Manufacture of:

- Separators
- Electrodes
- Battery Cases & Management Systems
- Electrolytes
- Power Conversion Systems
- Packaging & Enclosures
- and
- Fire Suppression Systems



Survey Participants and Methodology



Goals and Methodology

RESEARCH GOAL

The purpose of this survey was to capture hard data and insights from applicable companies regarding energy storage solutions and their opinions on different technologies and their business value.

METHODOLOGY

Independent sources of manufacturing and energy storage professionals were invited to participate in the online survey. A variety of questions were asked on topics including types of solutions they currently produce, those they plan to develop, driving forces behind the development of energy storage solutions, trends in the industry, and expected future leading markets for energy storage solution deployment.

PARTICIPANTS

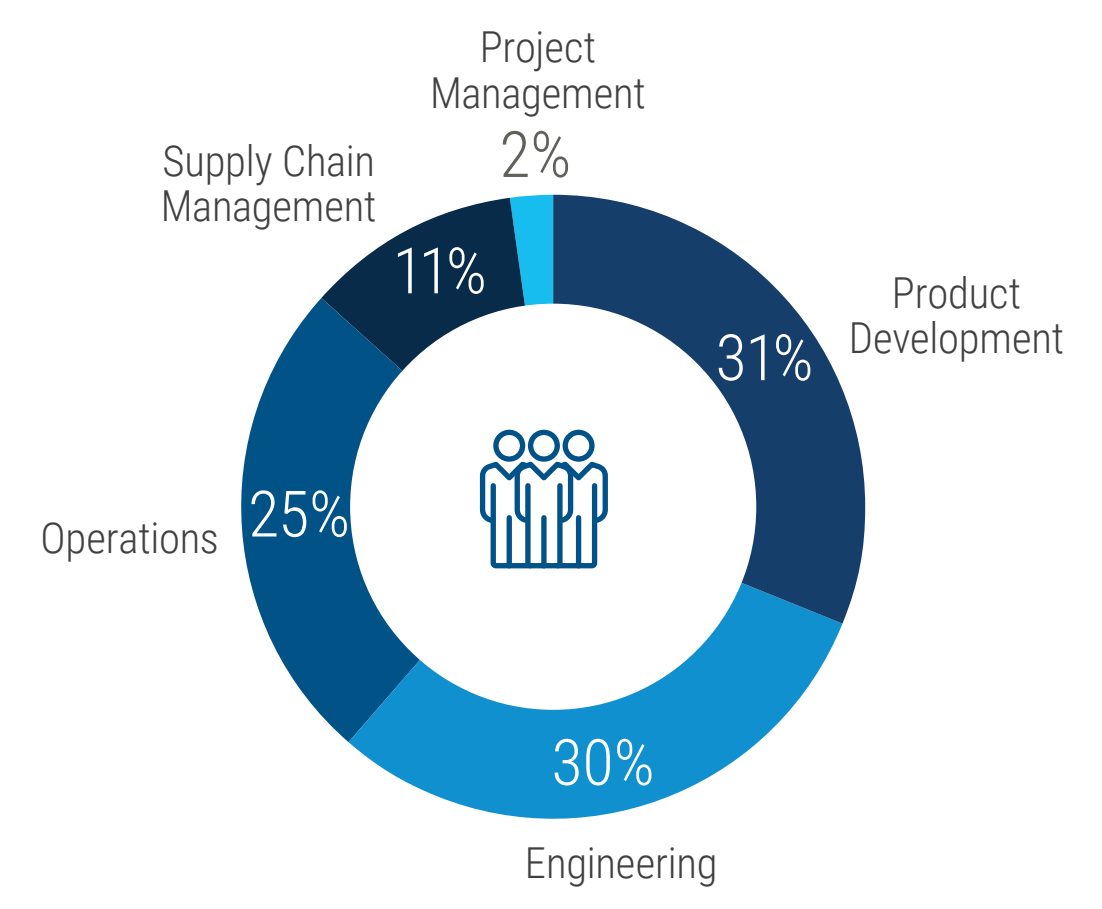
A total of 204 qualified individuals participated in the survey. All were decision makers for energy storage within engineering, operations, project management, product development, and supply chain management. The geographic scope included the Americas, Europe, the Middle East and North Africa, and Asia-Pacific.



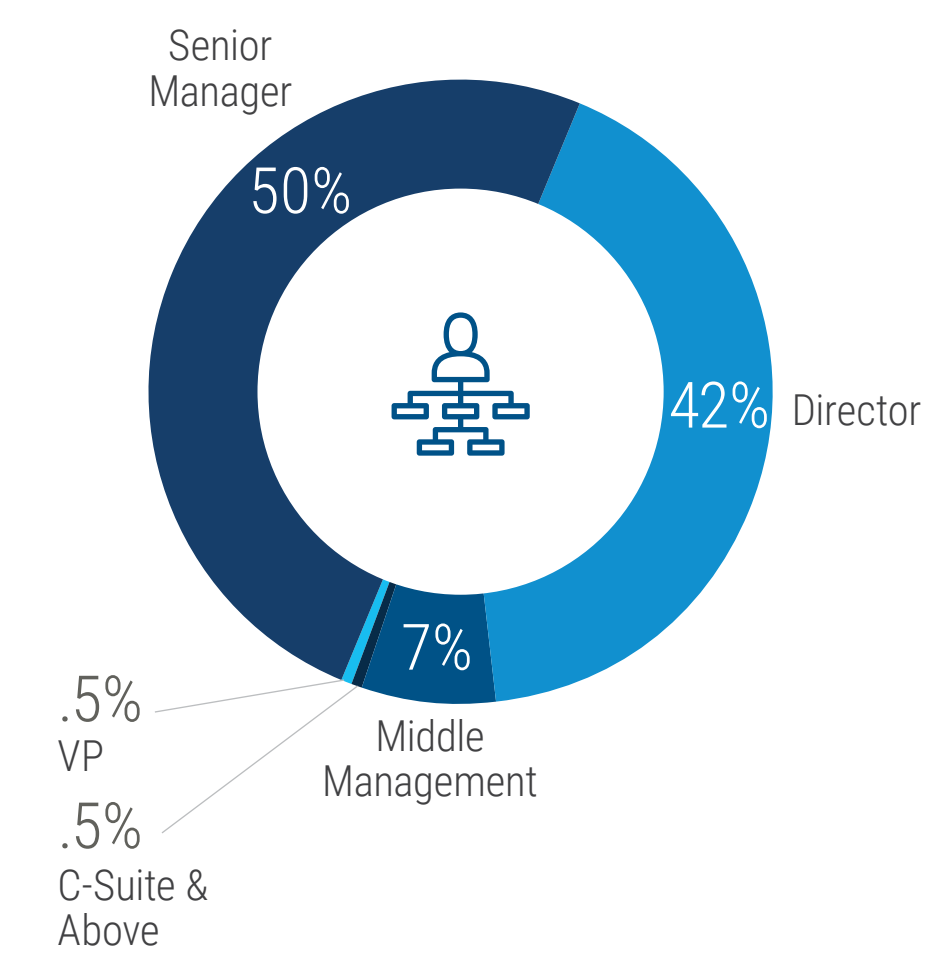


Survey Participants Respondent Profile

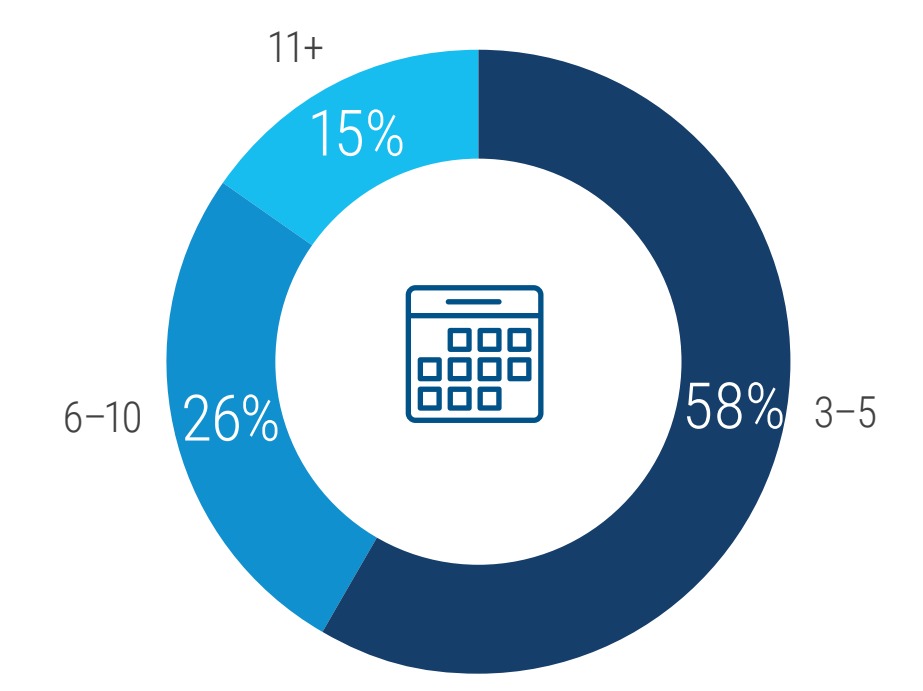
Which best describes the department you work for?



What is your level of seniority within your company?

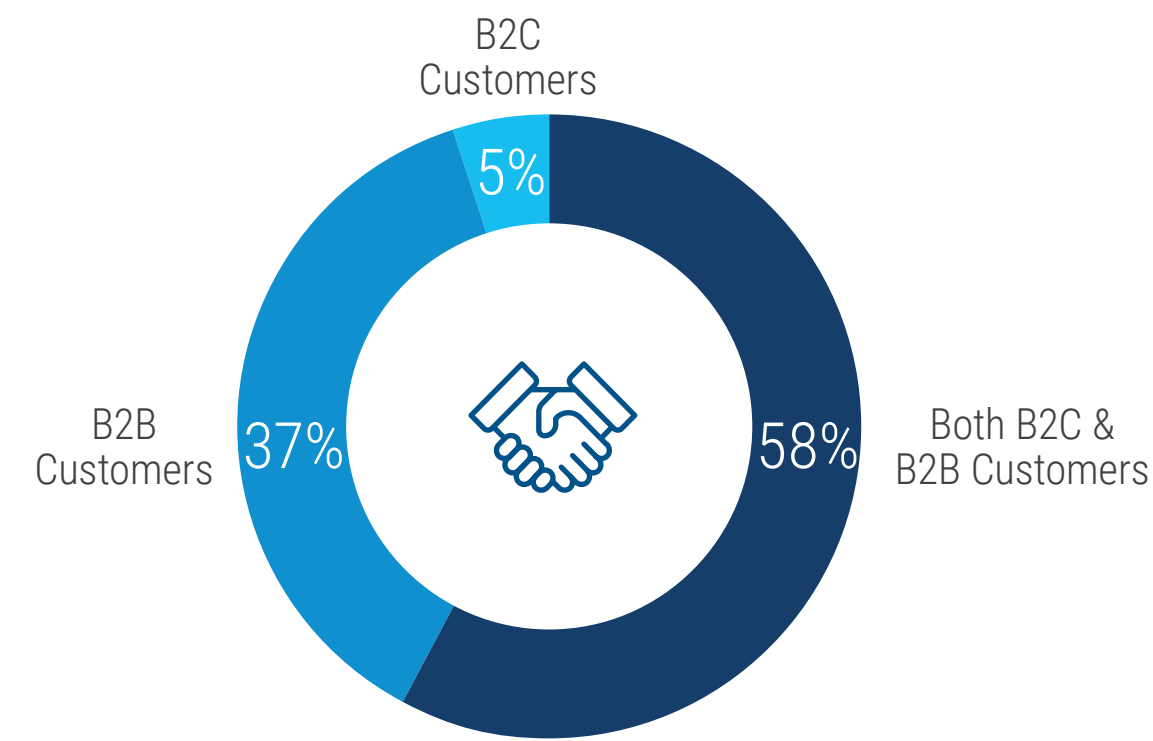


How many years of experience do you have?

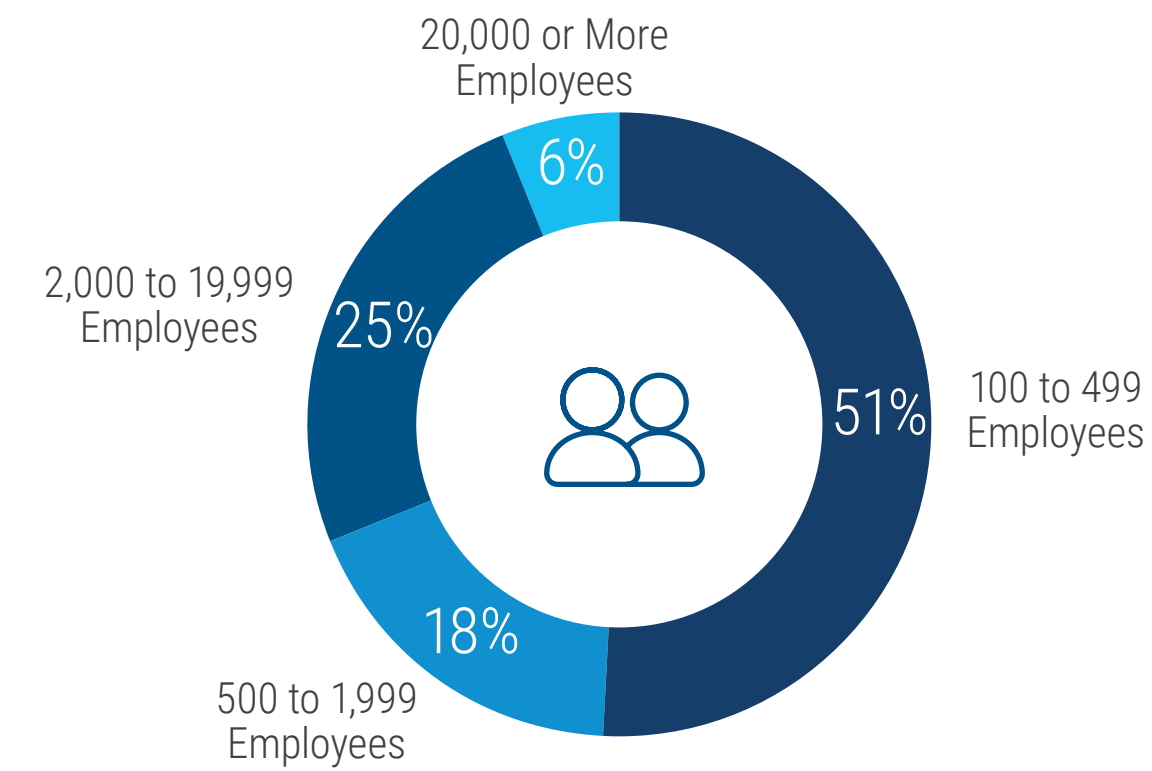


Survey Participants Company Profile

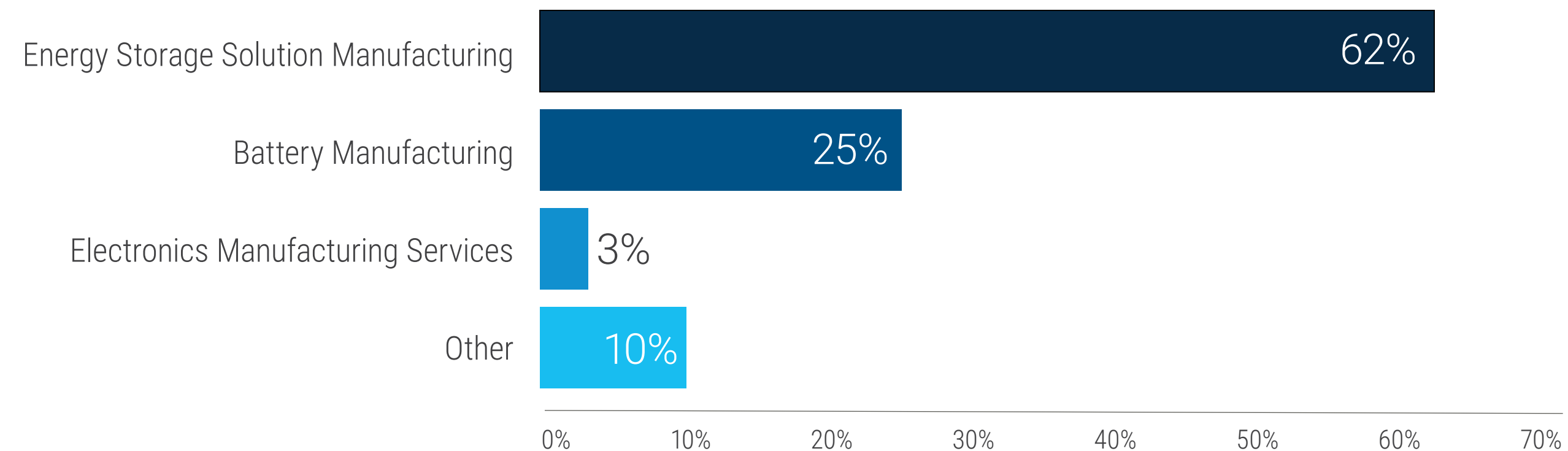
Who is your company's primary customer base?



Which best describes how many people are employed full-time by your organization in the United States?



Which specific industry in the list below best describes the company you work for?





JABIL | ENERGY STORAGE

Jabil engineers, builds, and ramps some of the most innovative and complex energy storage system (ESS) products in the world. ESS solution providers benefit from Jabil's unique combination of high-level assembly (HLA), power engineering, and global manufacturing capabilities. As a proactive solution partner, Jabil provides residential, industrial, and utility/grid-scale ESS solution providers the design and manufacturing expertise to accelerate growth globally. Jabil's market specific experience and expertise include:

- Large scale electrical and electro-mechanical products
- Dedicated supply chain teams in all key sector commodities
- Professional mechanical engineers and certified electrical engineers (up to 1000v)
- Early customer engagement through manufacturing deployment

From concept to prototype, Jabil's design teams specialize in collaborative design, development and value engineering within all ESS power ranges. Power engineering competences in design and manufacturing include hardware design and manufacturing; re-design for UL certifications; and value engineering (VAVE) and manufacturing.

With operations in over 100 sites in 30 countries, and manufacturing and supply chain experience in key geographies that include Brazil, China, Hungary, India, Italy, Mexico, Vietnam, and the United States, Jabil is uniquely positioned to help our customers succeed in the ESS market. From design and fabrication through testing and an intelligent, digital supply-chain that ensures you build in the right location at the right cost, Jabil delivers technological and innovative solutions for the ESS market — building a sustainable tomorrow, today.





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