



Environment & Economics

Without software,
the energy transition
is going nowhere

[ge.com/digital](https://www.ge.com/digital)



REUTERS

Contents

Foreword 2

Introduction 4

Software in the energy transition 5

Barriers & scale 8

Finance & markets 13

Digital tools for the energy transition 16

Workforce 18

Outlook & conclusions 20

References 21



Foreword

Make no mistake, the energy transition is here. We see it in action all around us, with every wind turbine and solar farm erected, and as coal plants give way to gas power or simply fade away. We see it, too, as battery storage, carbon capture and hydrogen as a fuel source inch their way toward maturity and mainstream adoption.

And while the goal of net zero is necessary, we must balance this future with the growing demand for available and affordable power today.

Every step towards reaching net zero adds potential fragility to the entire ecosystem. Traditional power generation wasn't built for the dexterity needed today, let alone the future.

This isn't to say we should stop or even slow our progress. Quite the opposite.

As the title of this report aptly declares: Without software, the energy transition is going nowhere. And it is not difficult to understand why. The energy transition is a multi-variate equation that only grows in complexity with every advancement.

For example, a thermal generator can burn more fuel on spinning reserve and spend more money on replacement power to make up for uncertainties, all for the sake of availability. Additionally, we see renewables not fully utilized due to unknown risk. In either case, the result is burning fuel unnecessarily, a sin in the energy transition.

These select examples highlight that what we're doing isn't working. It hasn't for some time.

And while it will take decades to modernize our physical infrastructure, software that tangibly accelerates progress is here today. Software can collect and synthesize disparate sources of data

– both internal and external – for the purpose of real-time visibility into the status of operations. It can apply AI/ML for insights and industry expertise for strategic recommendations. Software can orchestrate entire fleets to balance demand with emissions.

We commissioned Reuters Events – the world's leading media organization with a focus on the energy transition – to conduct a blind study on our behalf. This report highlights what we're already seeing: There is clear and accelerating year-over-year growth in software designed to make power, energy and materials needed for clean energy more reliable, affordable, and sustainable.

The energy transition requires big, systems-of-systems thinking.

Addressing reliability or uptime alone and at a single plant or site is not enough. Fixing a point problem with a point solution doesn't account for the enterprise-wide orchestration required to make marked gains in decarbonization.

As the report reveals, ironically, smaller organizations were more than twice as likely than their larger counterparts to choose enterprise and integrated (composable) software that allows them to select and assemble software components within an interconnected platform to meet their needs. Reuters Events analysts suggest larger enterprises have the means to create their own point solutions and therefore don't have a preference to integrated and composable solutions.

Paradoxically, nearly a third of respondents within larger enterprises said composable software was much more valuable than point solutions – a disconnect exists between their beliefs and actions.



We see another dichotomy in the results where respondents say their individual organizations are investing enough in digital transformation, while they rate the industry overall as underfunded. This could be a result of physical hardware, or infrastructure, gaining more visibility than software. This could also be explained by traditionally anemic investment in software at the organizational level, and therefore any increase in investment is seen as adequate.

Another interesting finding is that of the software use cases offered, not one strategy stood out. Much like the physical transformation needed, the tools for a digital transformation are also diverse, requiring not one solution, but many. This perhaps best underscores the need for an integrated, composable technology stack to enable faster time to value and insights.

Despite our focus on hardware and software thus far, there is yet another lever in the energy transition equation: People.

In some cases, software can run autonomously, requiring little to no human intervention except for the occasional audit or upgrade if not running in the cloud. However, the majority of software solutions require workforce adoption if outcomes are to be achieved.

For this reason, the software solution, as well as the implementation, requires industry expertise. It also requires executive sponsorship and functional leader empowerment of the workforce's use of

digital solutions. Additionally, we know that adoption is greater when the digital solution is built with the understanding of the business use cases and personas accountable for success.

All paths lead to software.

We're proud to enable the energy industry as it finds its way to net zero. We know there's no one way through this journey, but we know that all paths require software.



A handwritten signature in white ink on a blue background, reading "Linda Rae".

Linda Rae

General Manager, Power Generation & Oil and Gas
GE Digital

Introduction

The energy transition is frequently portrayed in terms of wind turbines and solar panels. Yet in reality, much of the success in society's transition to a more sustainable, low-carbon energy system will come down to bits and bytes. From the electrification of industry to virtual power plants and from demand response aggregators to vehicle-to-grid, the energy system is increasingly becoming digital.

To help quantify this transformational impact, in December 2022 Reuters Events polled professionals from a wide range of industry sectors on topics ranging from the importance of digital technologies in the energy transition to the extent of technology adoption today. In line with the makeup of the Reuters Events audience database, around two fifths of the respondents came from North America and a further 28% were from Europe.

Most of the experts polled hailed from the energy business, with 24% working in utilities, 19% in oil and gas, and 10% in clean energy-related ventures. Another 20% of respondents worked in consulting and analysis firms. Most of the respondents were senior industry figures, with 21% occupying C-suite positions and 41% working at director level or above.

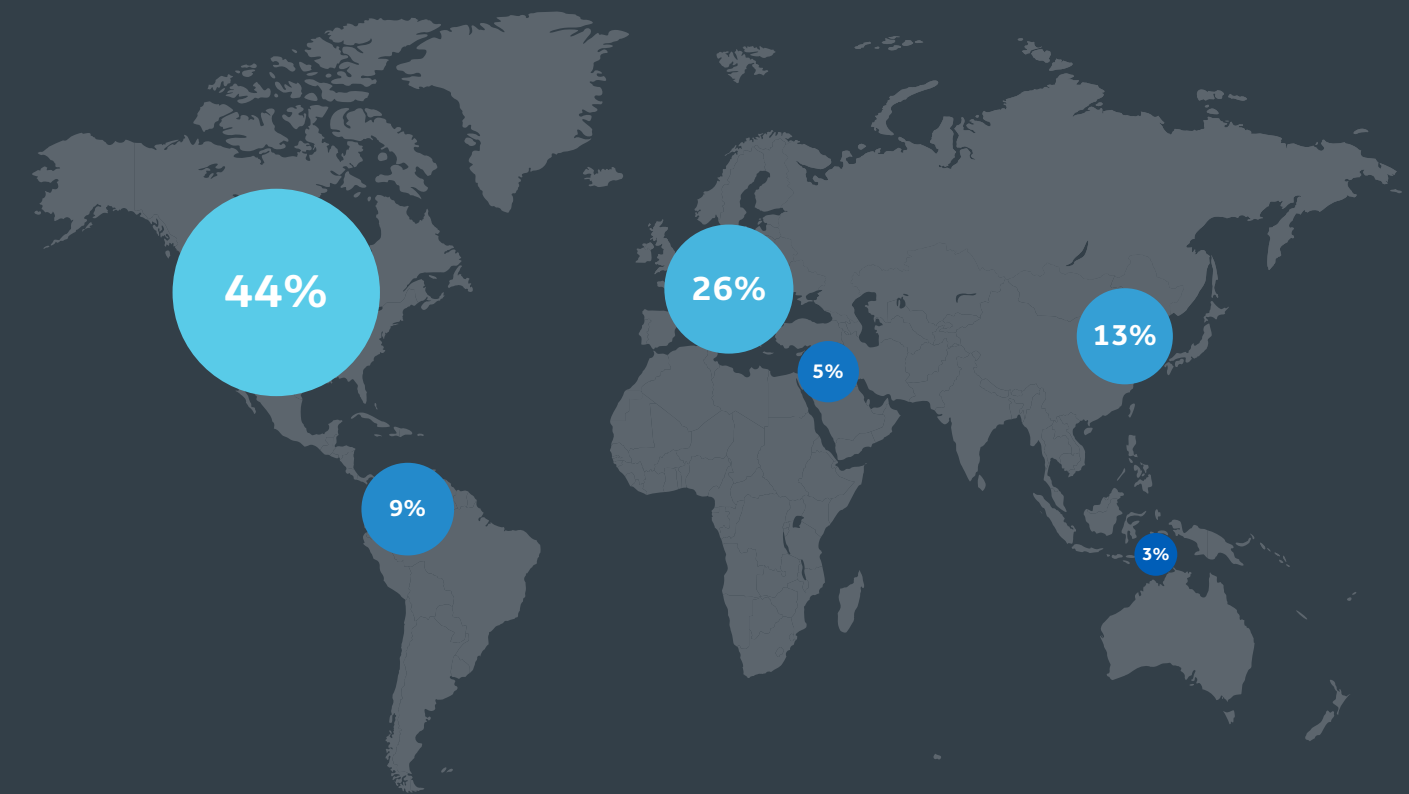
This report analyzes the main findings from the research. While every effort has been made to ensure the accuracy of the analysis, readers should be aware of the shortcomings of the research methodology, including the fact that the sample was not randomized and may be subject to self-reporting biases.

Disclaimer

This report contains general information only and Reuters Events and GE Digital are not, by means of this publication, rendering accounting, business, financial, investment, legal, tax or other professional advice or services. This publication is not a substitute for such professional advice or services, nor should it be used as a basis for any investment decision or action that may affect your business. Before making any decision or taking any action that may affect your business, you should consult a qualified professional adviser. Reuters Events and GE Digital shall not be responsible for any loss sustained by any person who relies on this publication.



Breakdown of survey respondents by location.



Software in the energy transition.

With dire warnings of global warming impacts coming almost daily on the news and climate events hitting operations and supply chains, it is hardly surprising that 86% of those surveyed saw the energy transition as a major priority for their organizations. Notably, this percentage was the same in the C-suite and ‘other executive’ segments of the sample as in the sample overall.

C-suite respondents were almost 10 percentage points more likely than the rest of the sample to view the energy transition as their top priority, rather than just a high-priority issue. This likely underscores how the transition to low-carbon operations has now become the main strategic driver of change in the energy sector, which dominated the sample.

The energy transition was more of a concern for larger organizations (1000+ employees), where

it was rated as being of high importance by 91% of respondents and the top priority by 56%—compared to 82% and 49% in small companies of 1000 employees or less. This can be interpreted as reflecting the fact that it may be harder for large organizations to achieve net-zero operations, leaving them more exposed to stakeholder concerns as the energy transition progresses.

Across the board, many of these organizations were also concerned with digital transformation. This was ranked as a high priority by 68% of the sample, and the top issue by 23%. As with the energy transition results, these figures remained fairly constant across levels of seniority but showed differences when split by organizational size.

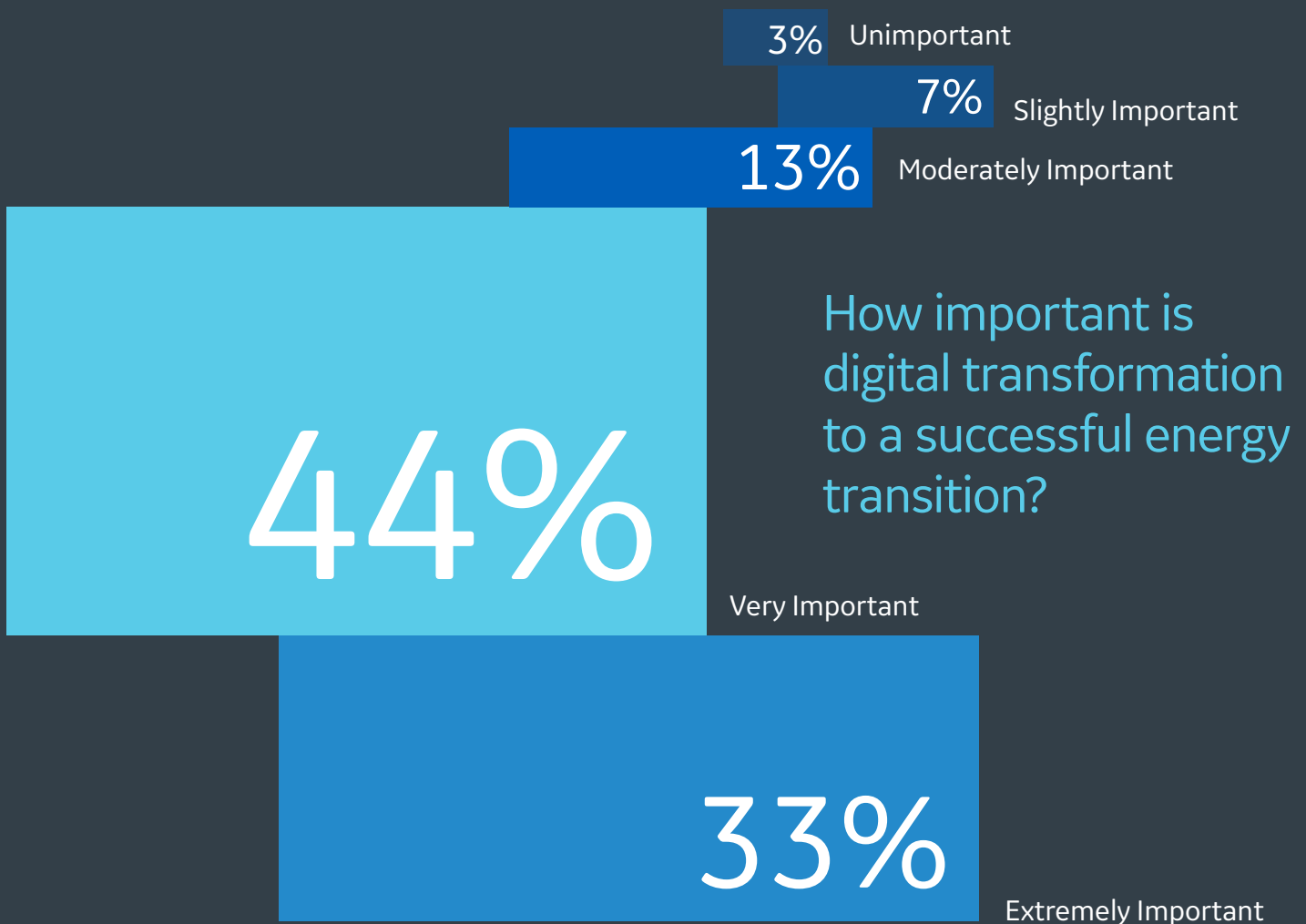


Large companies were more likely to see digital transformation as a high (80%) or top (30%) priority compared to small businesses, where the figures were 60% and 19%, respectively. One reading of this is that business agility in larger organizations may be hampered by the presence of legacy technologies and processes, necessitating a tighter focus on digital transformation.

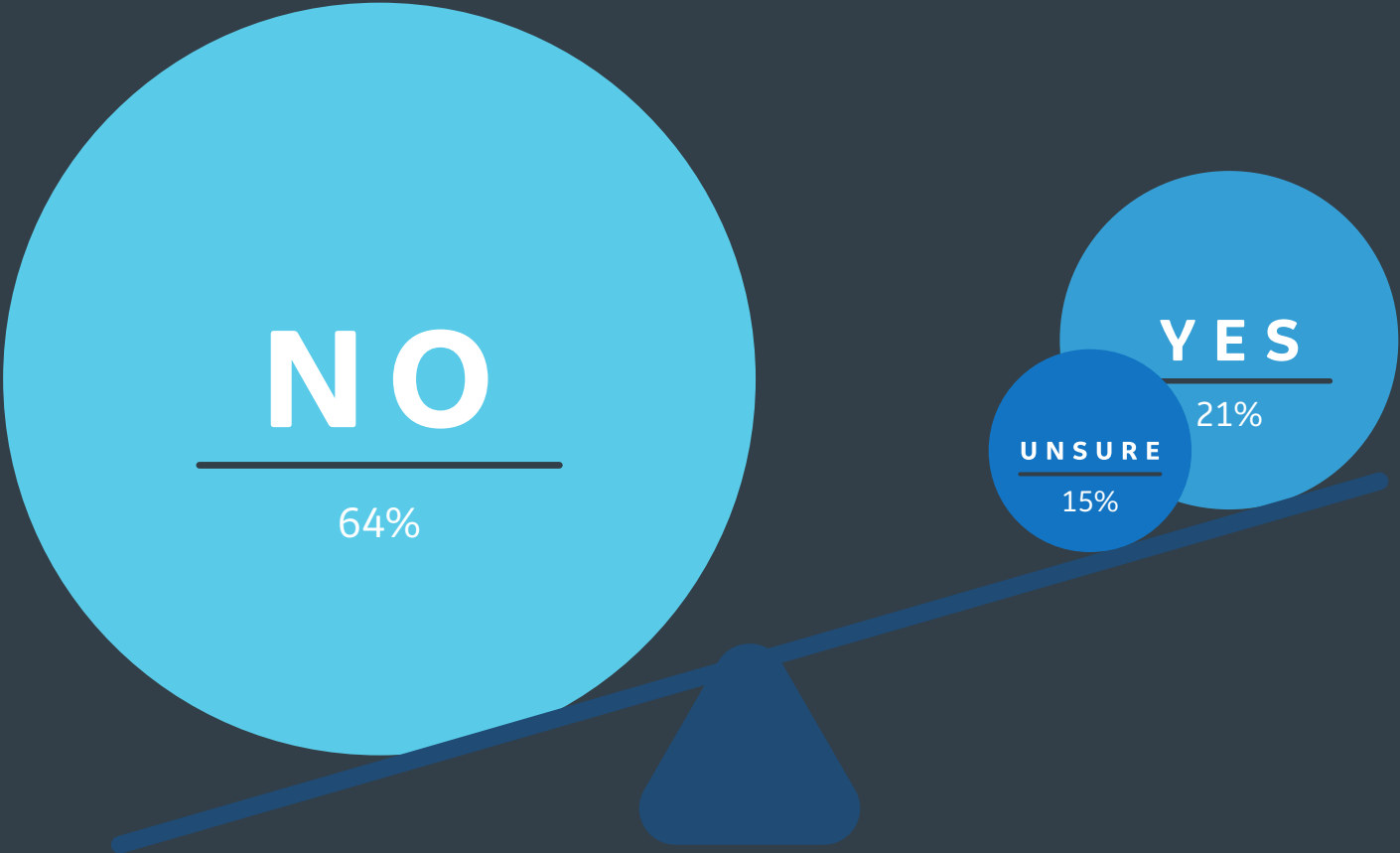
Notwithstanding this difference, there was broad agreement across the sample that digital transformation will be key for energy transition plans, with 33% rating it as 'extremely' important and 44% saying 'very'. Only 3% said digitization would not be important at all. Once again, this sentiment varied little according to seniority but was more

marked among larger organizations, where 50% of respondents said the link was very important and 37% said it was extremely so. In small companies, the figures were 41% and 30%, respectively.

The role of digitization in aiding decarbonization is further underscored by the responses to a question asking whether it would be possible to deliver the energy transition without rapidly increasing digital transformation. More than 63% of the sample said no, and a further 15% did not know. C-suite respondents were slightly less emphatic on this point, with 31% saying the energy transition would be possible without digital transformation, versus 21% overall.



Is it possible to deliver the energy transition without rapidly increasing digital transformation?



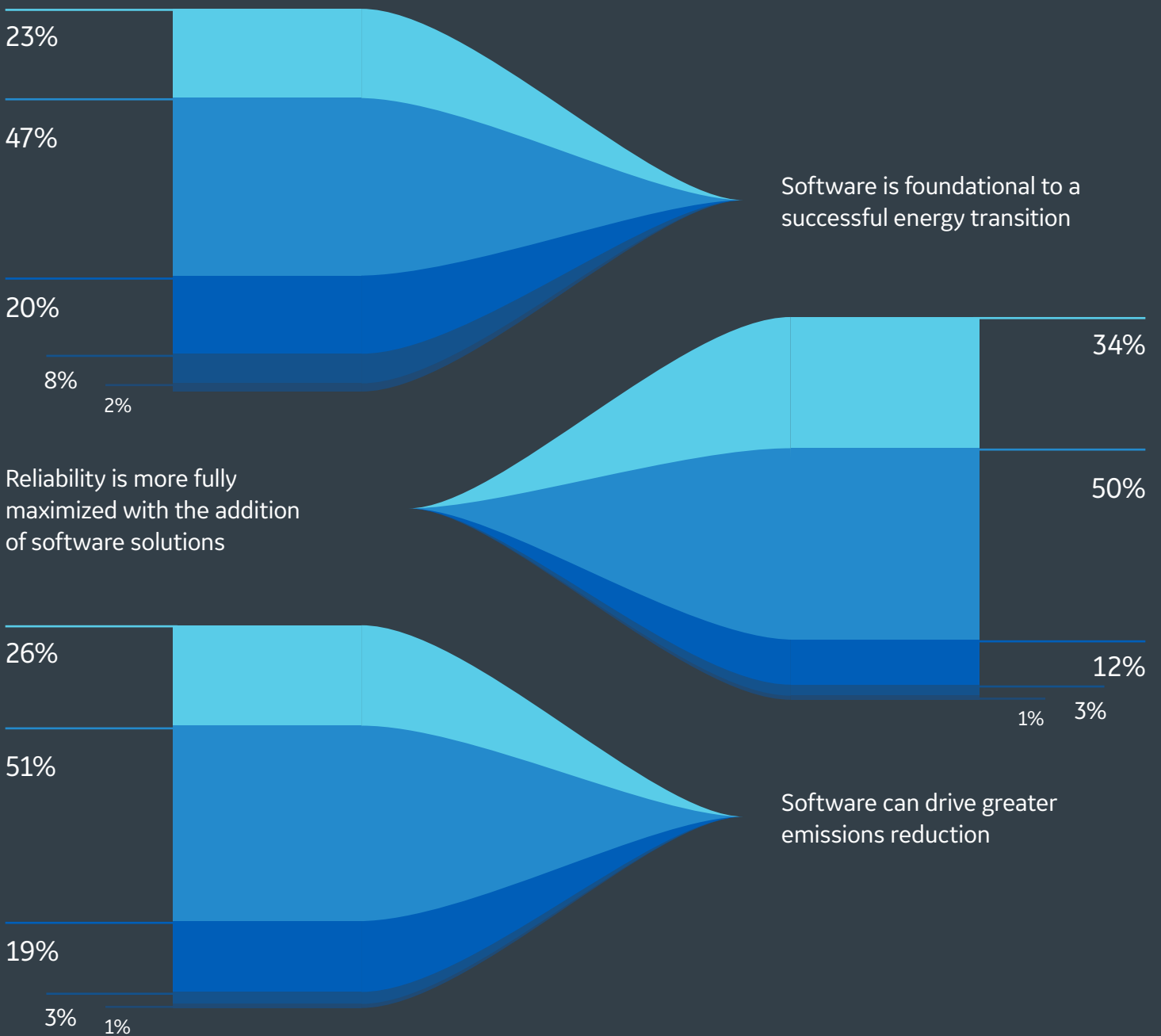
Likely as a result of the deeper decarbonization challenges facing large organizations, the larger companies in the sample were more likely than average to see digitization as indispensable for the energy transition.



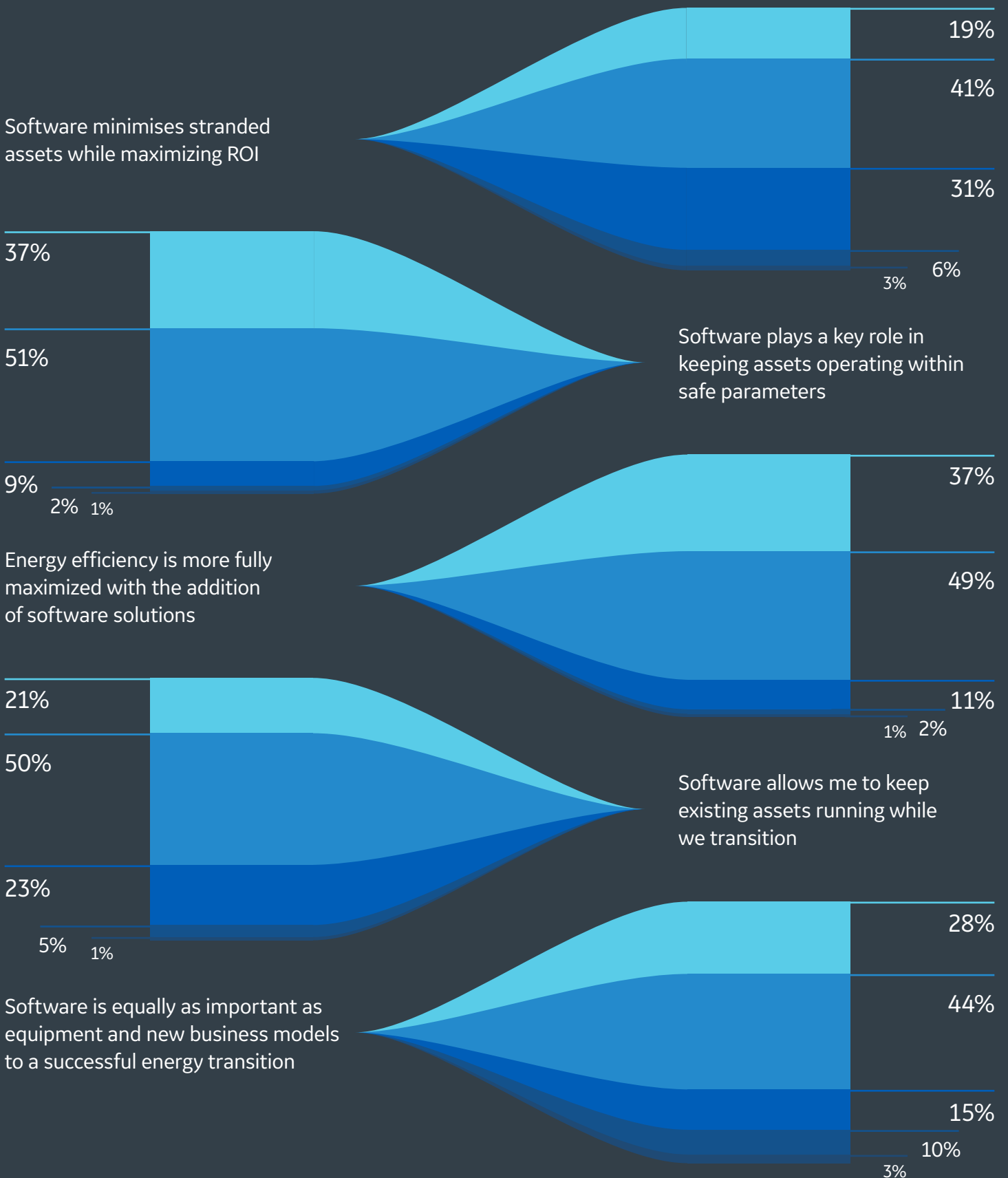
Barriers & scale

Only one in 10 respondents disagreed with the idea that digital solutions are critical to delivering their organization's decarbonization and sustainability goals. Software, in particular, was seen as foundational to a successful energy transition by 70% of respondents and 61% of CXOs.

● Strongly Agree
 ● Agree
 ● Unbiased
 ● Disagree
 ● Strongly Disagree



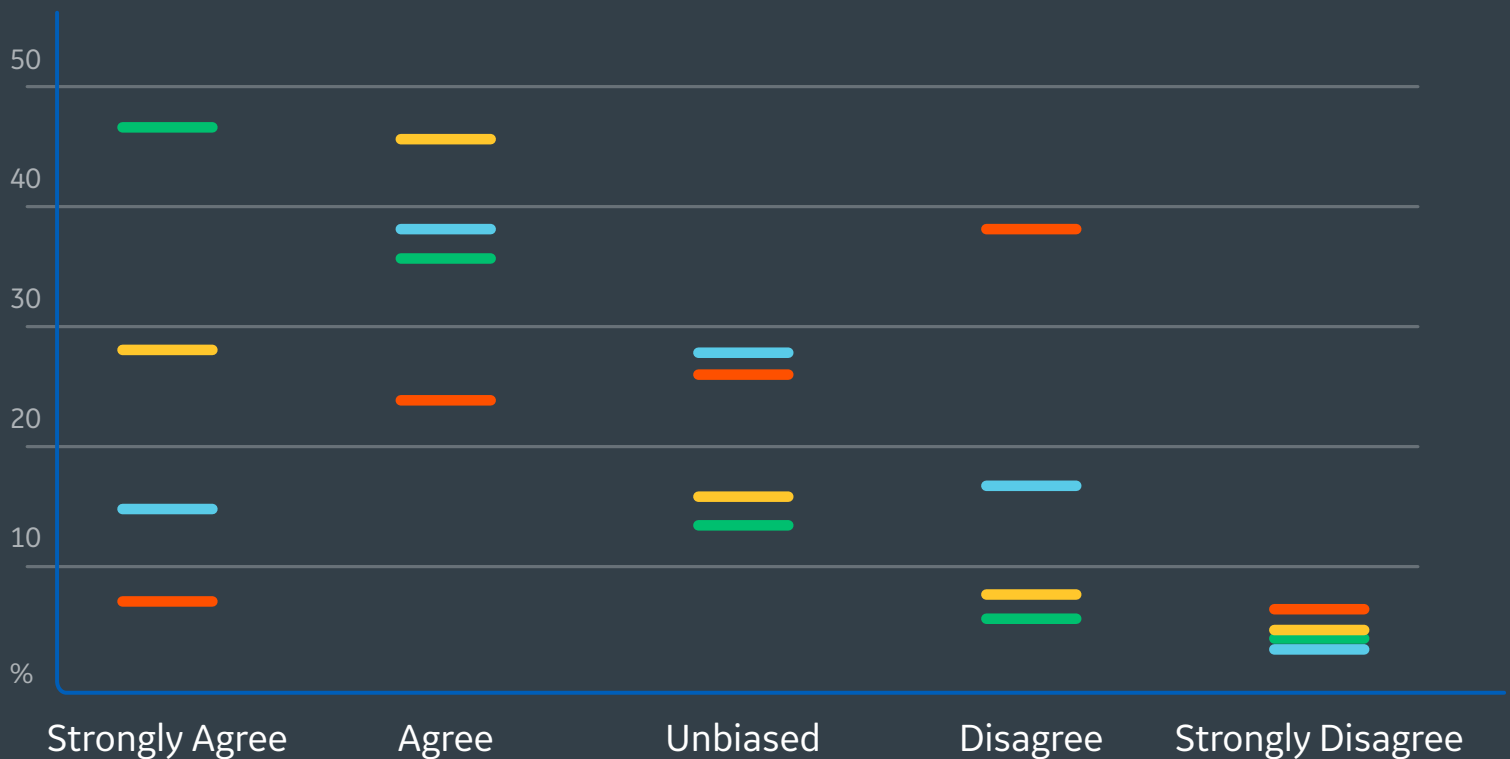
● Strongly Agree
 ● Agree
 ● Unbiased
 ● Disagree
 ● Strongly Disagree



Almost 88% of respondents (and 83% of CXOs) viewed it as key for assets to operate within safe parameters, and 84% said reliability can be maximized with software. Software can improve emissions reduction, said 77% of respondents, and can keep existing assets running while an organization transitions to low-carbon operations, according to 72%.

More than 60% of respondents also thought software could minimize the likelihood of stranded assets and improve return on investment, while 72% claimed it was just as important as equipment or new business models in achieving the energy transition. There was also overwhelming support for the notion that energy efficiency, which can often be enabled through software tools, is the logical first step for decarbonization.

- Overall industry investment in software is sufficient to deliver the energy transition
- Digital solutions are critical to delivering on my organization's decarbonization and sustainability goals
- My organization is investing enough in digital solutions to overcome the energy transition challenges we face
- Energy efficiency is the first step towards progress on decarbonization



54% believed their organizations were investing enough in digital solutions to overcome the energy transition challenges, however, only 31% affirmed that overall industry investment in software is sufficient for the mission.

Given these clear benefits, it is fortunate that 54% of respondents believed their organizations were investing enough in digital solutions to overcome the energy transition challenges they face. However, only 31% affirmed that overall industry investment in software is sufficient for the task.

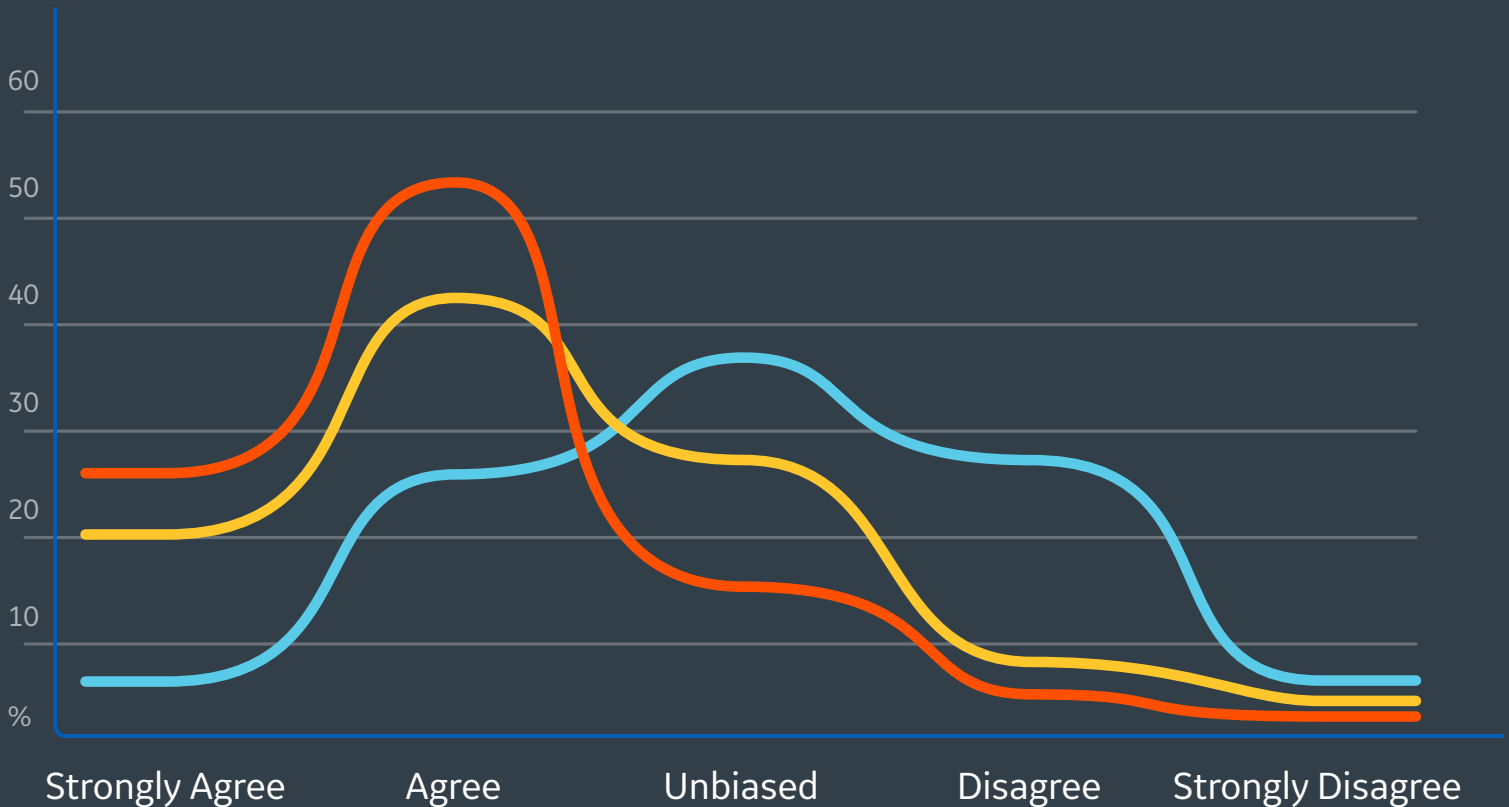
Lack of investment is just one area where lack of digitization could stymie the energy transition. At an organizational level, the biggest problems with enabling energy transition strategies through software was to do with deployment and adoption challenges, cited by 57% of CXOs and 63% of respondents overall.

Lack of available software was only a problem for 22% of CXOs and 31% overall, although having the budget to buy new systems was a concern for 46% of C-suite respondents. In line with these findings, the biggest barrier for scaling up digitization in the energy transition appears to be the need for improved business models for deployment.

This was a concern for 70% of CXOs and 75% of respondents overall. Another major problem, expressed by 67% of CXOs and 69% overall, is having a better understanding of the offerings. Perhaps related to this, 56% of CXOs complained that overly complex software is inhibiting their ability to support the energy transition.



- Barriers to digital transformation are lower than they were 5 years ago
- Software will require a lot more investment than today to scale up sufficiently
- The industry is investing enough into software today



For now, the fact that today’s abundant digital tools may be hard to deploy and use potentially explains a paradoxical finding from the research. While roughly equal proportions of the sample agreed and disagreed over whether the industry is investing enough into software today, 62% said it will require a lot more investment to scale up sufficiently.

The implication seems to be that industry leaders are resigned to spending over the odds for software tools because they know the technologies are needed for the energy transition—but they cannot be sure their organizations can leverage the gains.

At least there is a feeling, shared by four out of five respondents, that barriers to digital transformation are lower now than they were five years ago.

The organizations that tend to adopt new software and scale it most effectively are ones that create teams specially dedicated to the task, says Tracy Swartzendruber, Vice President of Marketing at GE Digital. “They appoint leads for these programs, they redirect people, they may even add staff,” she says. “A lot of times, people worry about automation—you’re going to take jobs away. In large part, that’s not the case.”



Finance & markets

Finance is an important factor in the adoption of digital energy transition tools, but by no means the most important. Among small companies, access to budget was seen as having the third-largest potential to increase software adoption within the energy and materials sectors, after improved deployment business models and a better understanding of the offerings.

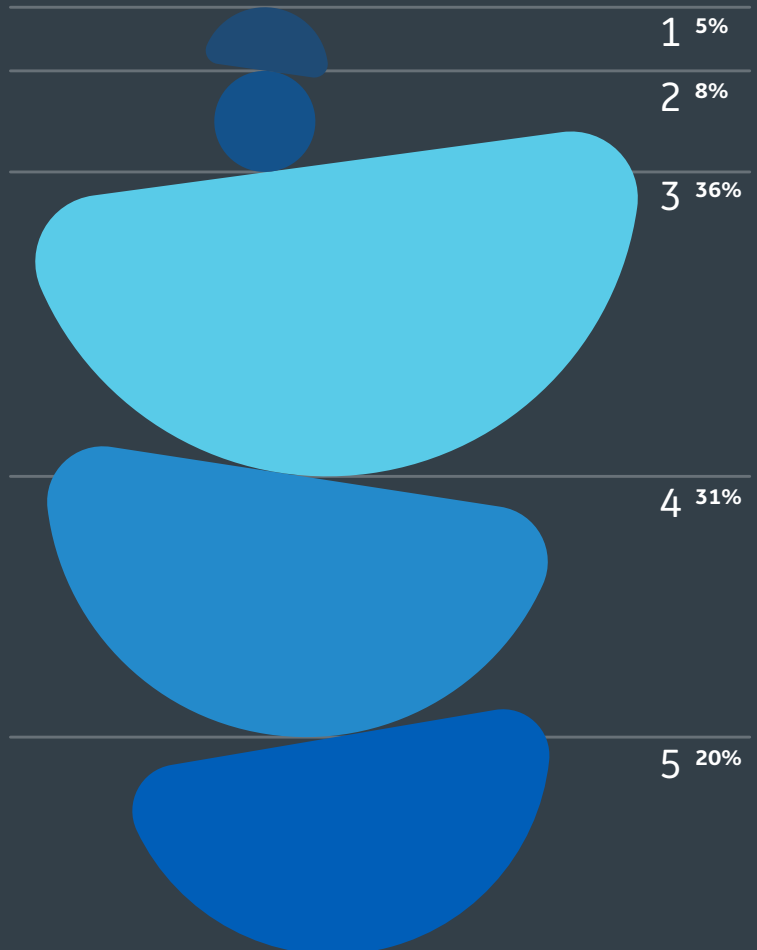
With larger businesses, the top three factors included workforce readiness, and access to budget was relegated to fourth in importance for increasing software adoption. Views on the importance of regulatory support were even more equivocal, although 56% of the overall sample still listed this as first or second in terms of potential to speed up software adoption.

In your opinion, to what degree is your organization embracing new software and software change?

On a scale of 1 to 5 (1 = Not at all, 5 = As much as possible)

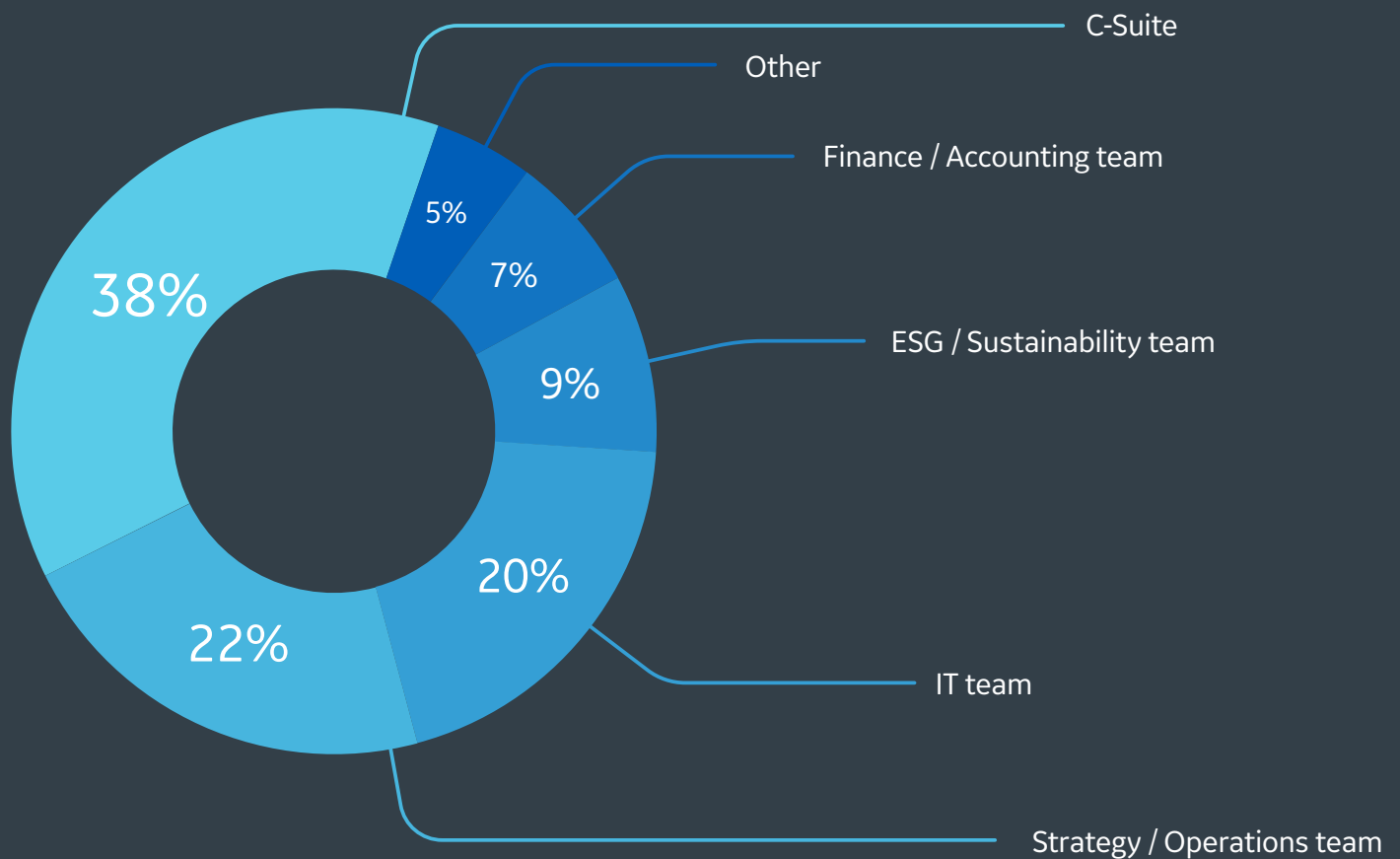
In line with the budget responses, one in five respondents (and a similar proportion of CXOs) reported their organizations were adopting new software and embracing digital change 'as much as possible' despite the current uncertain economic outlook. The pace of adoption was particularly marked among the larger companies in the sample, consistent with the idea that these businesses face more onerous energy transition challenges and need more and/or better tools to deal with the problems.

Nevertheless, 60% of respondents (and 50% of CXOs) said investors were critical to driving transformation and an important minority (48% of the main sample and 41% of CXOs) said the investment community held the most power in advancing the transition.



Notwithstanding the importance of investors, digital transformation priorities and strategy were widely seen as a task for the C-suite, as reported by 52% of CXOs and 38% of respondents overall.

Who is responsible for setting your organizational digital transformation priorities and strategy?



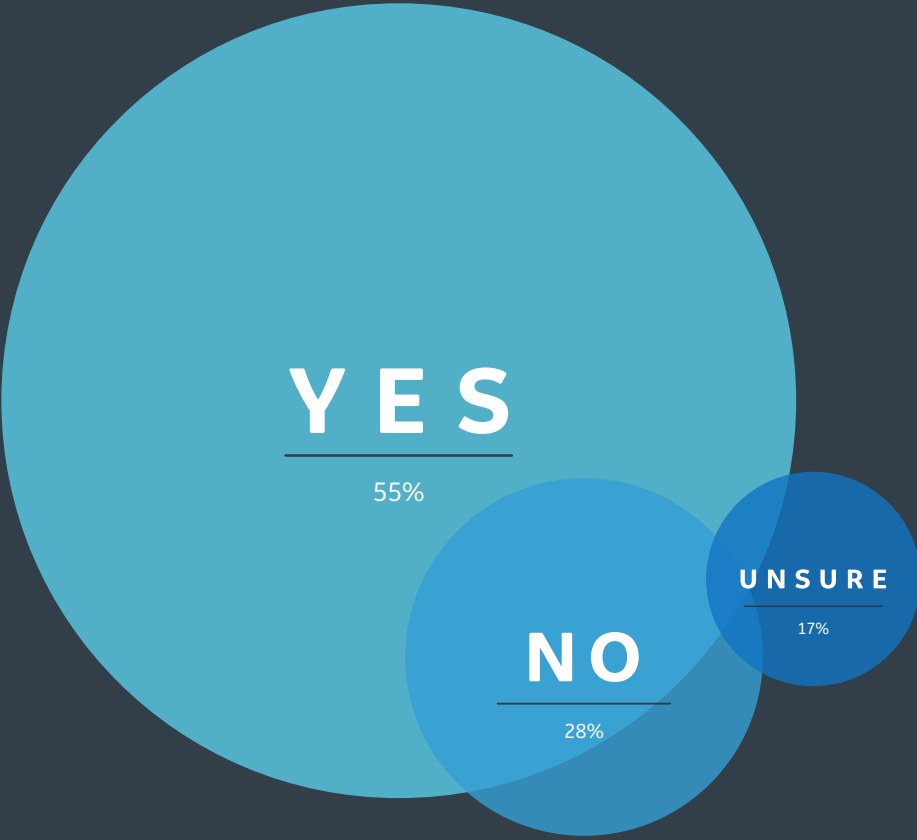
Perhaps unsurprisingly, the C-suite was slightly less likely to take on responsibility for digital transformation in large companies than in small ones (34% versus 40%), while the larger businesses were more likely to hand the job to a sustainability team (12% and 7%). CXOs were also more likely than otherwise to agree that investing in software was central to overcoming energy transition challenges, a sentiment that was shared by 63% of the sample overall.



It also seems that companies are entering commercial agreements to deploy energy transition-related digital tools, with 55% of the sample saying their business had partnered with a software provider or consultant in this space within the last 12 months. However, there was an unusual amount of discrepancy between groups within the survey on this point. While 74% of vice-president or executive vice-president respondents confirmed the existence of recent partnerships, with CXOs this level fell to just 45%.

It is unclear how these differences have arisen, beyond the possibility that the lower of the two grades has more detailed knowledge of contracts and may have referred to agreements that were beyond the scope of the C-suite. Overall, the research indicates there is significant appetite and few financial barriers to investing in digital tools to help accelerate the energy transition, although it appears deployment remains a challenge.

Has your company partnered with a software provider or consultant in this space in the last 12 months?

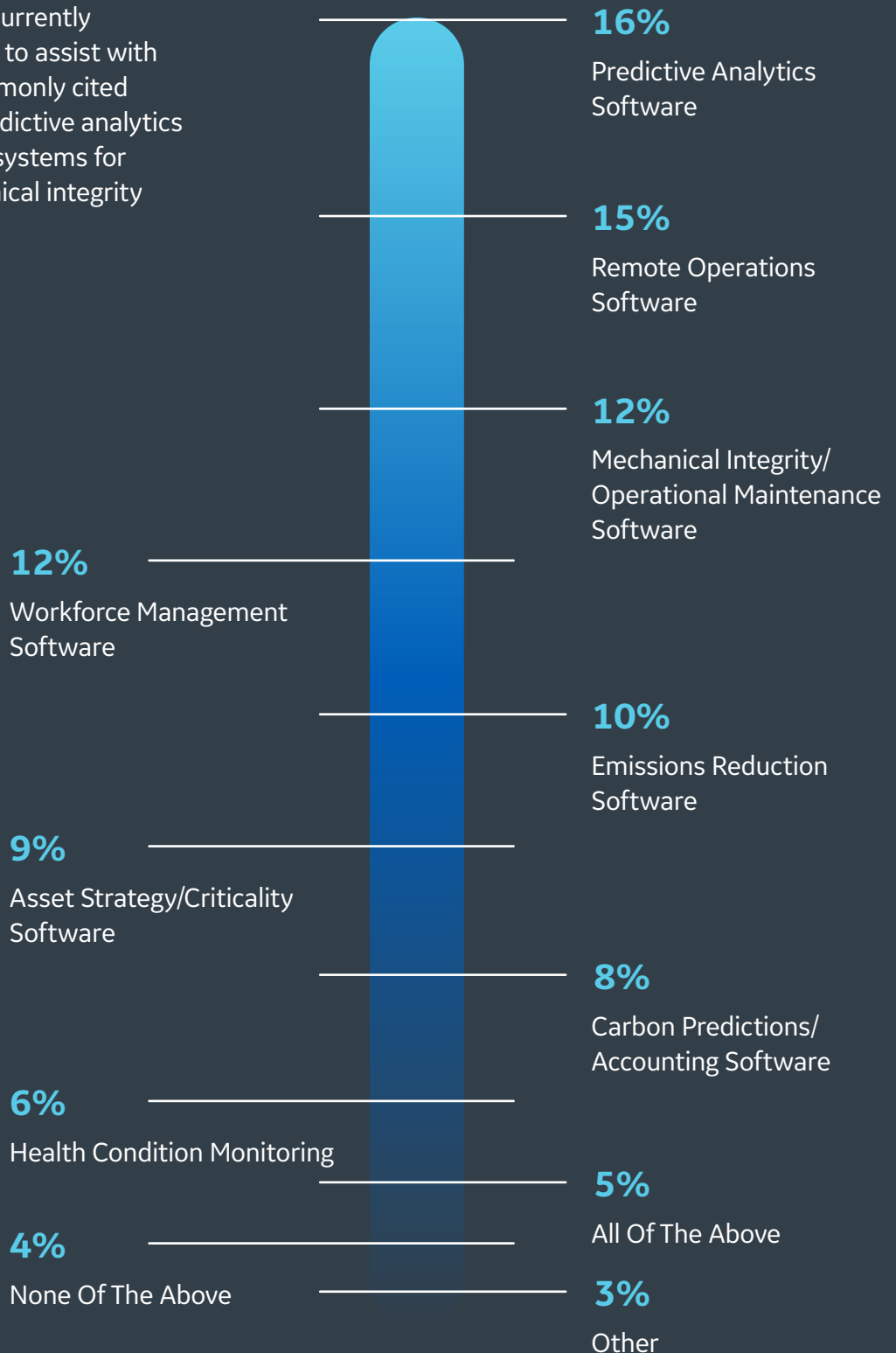


Digital tools for the energy transition

The survey revealed companies are currently pursuing a wide range of digital tools to assist with the energy transition. The most commonly cited types of software were those for predictive analytics and remote operations, followed by systems for workforce management and mechanical integrity and operational maintenance.

One in 10 respondents said their companies were also looking into software for emissions reduction, criticality and carbon accounting. Carbon emissions reporting and management software was said to be a high priority for 32% of the sample, and of moderate importance for a further 24%.

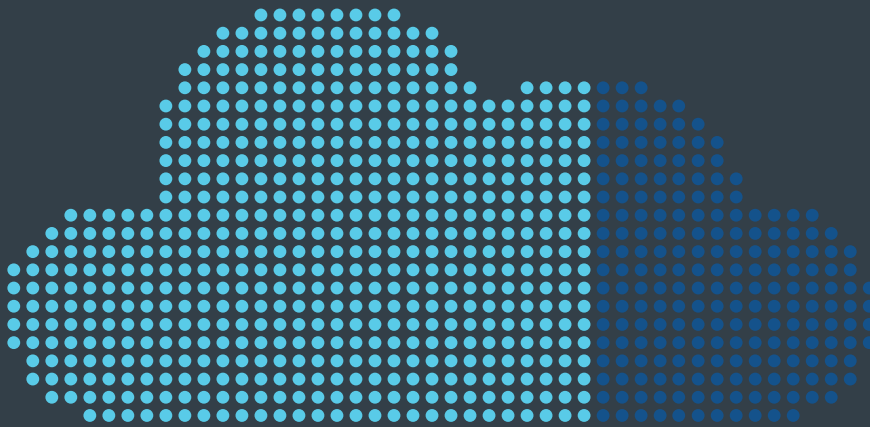
However, these results are strongly dependent on company size, with 73% of large businesses rating the software as having high or moderate priority and only 46% of small firms ranking it thus. There also appeared to be a significant discrepancy in the priority of this kind of software between members of the C-suite and those directly below.



Although the proportion of CXOs and vice and executive vice presidents regarding emissions software as high priority was the same, at 28%, among the former only 17% regarded it as of moderate importance, compared to 30% in the second group. Also, 19% of C-suite respondents said emissions reporting was not a priority at all for the business, compared to 12% at the vice president and executive vice president level.

Beyond these findings, there was remarkable consistency of opinion regarding other aspects of the technology stack for energy transition applications. The majority of businesses polled (71%) said they were completely or somewhat committed to a cloud-first strategy, with only 8% staying clear of the cloud and 7% claiming not to know.

Extent of cloud-first strategy adoption.



71%

Are completely or somewhat committed to a cloud-first strategy

The level of cloud adoption was greater in larger companies, with 78% completely or somewhat embracing cloud-first (compared to 67% among small firms) and only 2% of the bigger businesses dispensing with cloud-based approaches altogether (versus 12%). Similarly, all companies tended to prefer a mix of enterprise and site-specific systems, albeit with a bias towards the former.

Perhaps surprisingly, though, small companies were more than twice as likely than large ones to choose enterprise-only software (13% compared to 6%), possibly hinting at larger organizations' increased potential for in-house, bespoke system development.

Finally, respondents tended to view composable software, which allows enterprises to swap and pair blocks of code at will, as equally (44%) or more (42%) more valuable than point solutions.

This was particularly the case in large companies, where 31% of respondents said composable software was much more valuable than point solutions, versus 2% that said the opposite. This finding likely reflects a notion that the value of point solutions diminishes with company size as more and more of them may be needed to cover different use cases, creating management and infrastructure inefficiencies.



Workforce

Notwithstanding the deployment issues noted elsewhere in the research, respondents had a positive view of the contribution that digital tools could make to their workforces. Three out of five respondents agreed that their organization currently has a workforce that is capable of delivering digital transformation objectives, and 75% said software could help their workforces deal with challenges.

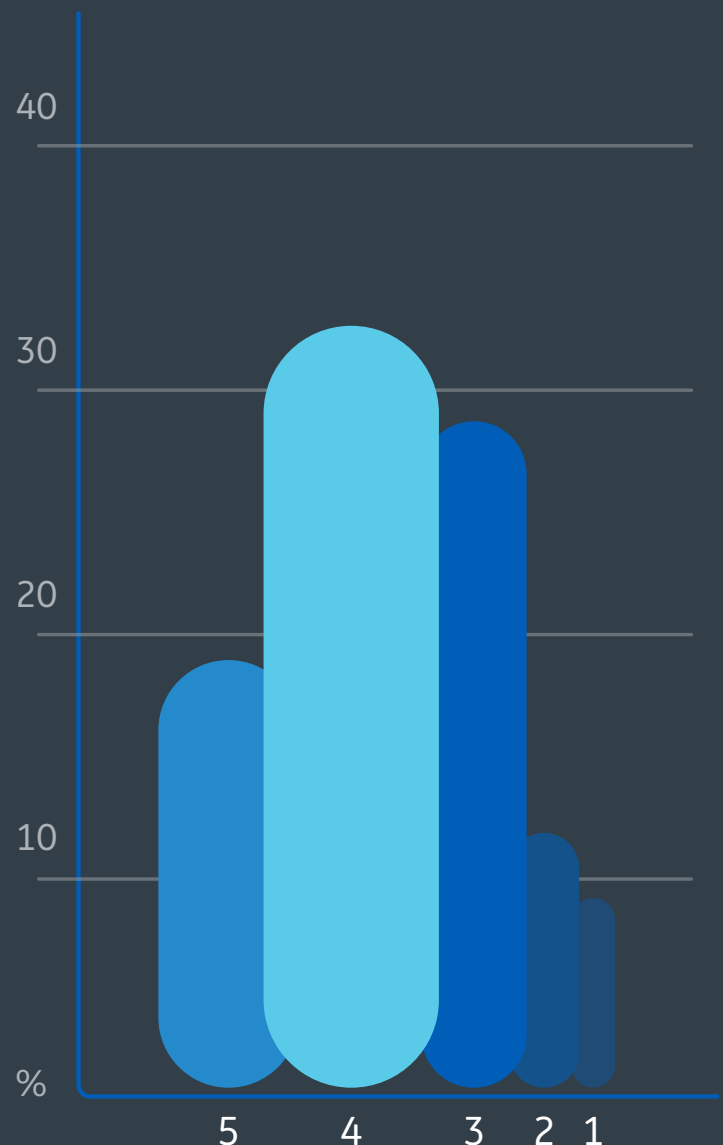
Perhaps the most obvious workforce application for digital technologies is in remote monitoring and access, where 88% of respondents agreed there could be improvements in safety and efficiency. Larger companies were generally more bullish on all these points, with 62% claiming to have a digital transformation-ready workforce, 83% saying software could ease their pressure and 94% valuing the safety and efficiency of remote monitoring and access.

Attitudes towards remote monitoring and access tools have likely been colored by the impact of the COVID-19 pandemic on working practices. The imposition of remote working practices appears to have had a net positive effect on the organizations polled, with 49% of respondents rating the impact at four or five on a five-point scale where the upper bound represents 'extremely positively.'

The imposition of remote working practices appears to have had a net positive effect on the organizations polled, with 49% of respondents rating the impact at four or higher.

How much has remote working affecting your organization positively?

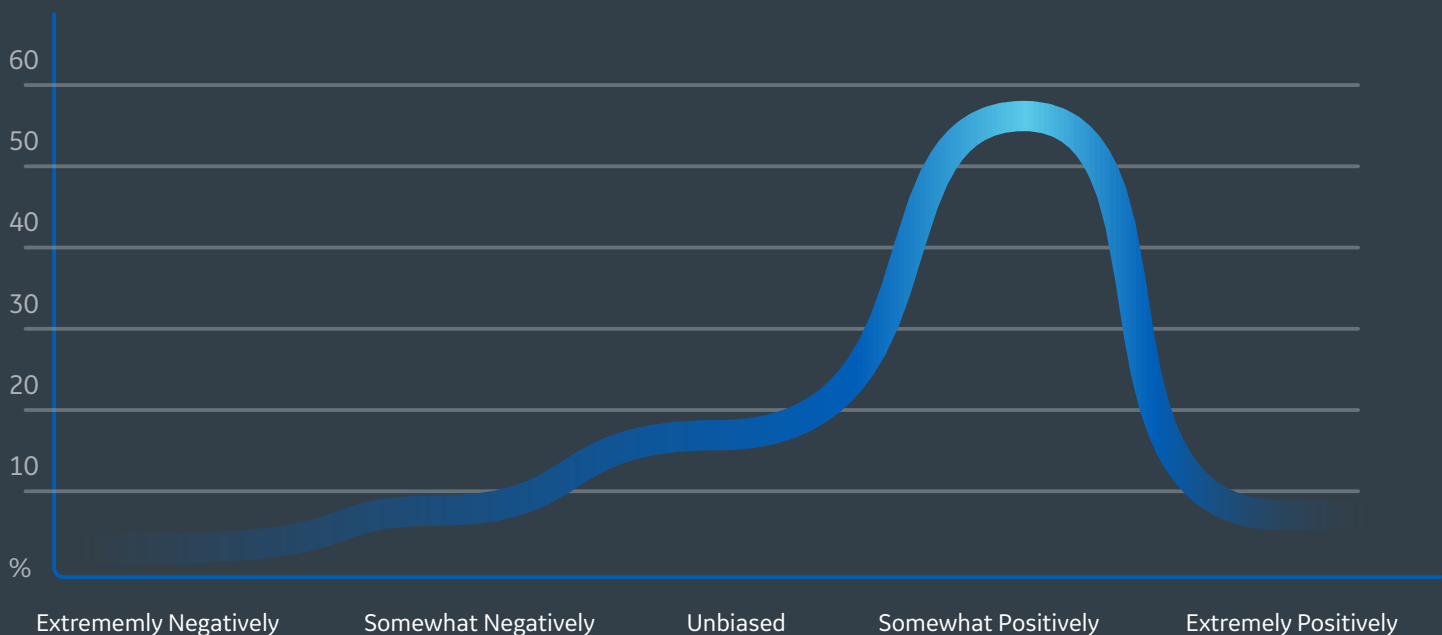
On a scale of 1 to 5 (1 = Not at all, 5 = Extremely)



Among large companies, the proportion was 55%, 10 percentage points higher than for small businesses in the sample. In contrast, only 2% of respondents said remote working had affected their organization extremely negatively. In the C-suite, 35% of respondents reported no negative impacts at all from remote working. Although this was not covered in the study, it is widely acknowledged that the success of many if not all remote working schemes has been down to digital tools.

Office-based platforms such as video-conferencing saw a surge in uptake during the pandemic, but in the energy sector there has also been an increase in adoption of more complex systems, such as visual processing software for remote cameras. The outlook for digitization in the energy industry remains bright, according to the responses to another question in the survey.

How positively or negatively will automation and artificial intelligence affect the energy and materials workforce?



When asked whether automation and artificial intelligence will affect workforces positively or negatively in the energy and materials sectors, the sentiment was overwhelmingly positive. Across the whole sample, 73% of respondents viewed these tools as having a somewhat or extremely positive impact. This belief was strongest in larger companies, where the percentage was 83%, compared to 66% for smaller businesses.

Meanwhile, only 2% of respondents forecast an extremely negative impact for automation and artificial intelligence. This tallies with the experience to date with these technologies, which tends to show they result in increased productivity, efficiency and safety, freeing up workers from doing routine or risky tasks and allowing them to focus on more value-added work.



Outlook & conclusions

The most obvious message to emerge from this research is that companies large and small – and their leaders – have a powerful ally in software when it comes to enabling an energy transition to low-carbon operations. This transition is generally seen as a major corporate priority in 2023, in line with dominant policy trends and stakeholder attitudes. And for most of those polled, delivering the energy transition simply is not possible without software.

More than advanced hardware, this transformation will be about software, which will make asset-intensive industry more efficient, and provide visibility and insights to orchestrate energy and pave the way for more renewables to come online. Underscoring this, digital transformation is more often seen as a C-suite or strategy team mission than one that can be devolved to functions such as finance.

Consequently, most companies surveyed are investing in technology to help their organizations carry out the energy transition, although there is still a feeling that more can be done. Increased investment is just one part of the puzzle, however, with respondents pointing to deployment and adoption challenges as the main frustration in scaling the use of digital technologies.

Other notable challenges included poor workforce readiness for digital tools and a lack of understanding of the need for new systems. This points to people, rather than dollars, acting as the main brake on the scale-up of digital tools. For the IT industry, the implication is that software solutions should be accessible and usable. This is not rocket science: from smartphones to internet search, the history of technology is filled with instances of improved usability leading to enhanced adoption.



Beyond this simple finding, the research bears the following pointers for technology selection:

Reach for the cloud and fly

While many energy companies have been relative laggards in cloud adoption, the proportion of organizations now embracing a cloud-first strategy means cloud-based applications will have a clear advantage in the market.

The world wants enterprise software and industry expertise

Most companies will look to mix and match enterprise systems with site-specific software, but there is a general tendency to prefer the former – even among smaller businesses.

There is no killer app

A range of digital tools will be required to enable the energy transition. What is important is that applications can work together in a composable way, with high levels of integration.

Overall, what is clear is that the time is now ripe for organizations to move past point solutions and into enterprise programs that can gain real results and scale to the levels required for society to achieve its decarbonization goals.

References

- ¹ Dane White, ProcessMaker, November 10, 2021: Why composability is the single most important requirement in software. Available at <https://www.processmaker.com/blog/why-composability-is-the-single-most-important-requirement-in-software/>.



Adopting digital technology is critical to achieving your decarbonization and sustainability goals. Read more thought leadership from GE Digital.

LEARN MORE

About GE Digital

GE Digital, an integral part of GE Vernova's portfolio of energy businesses, is a \$1 billion software business putting data to work to accelerate a new era of energy. GE Digital has pioneered technologies like Industrial AI and Digital Twins to serve industries that matter for decarbonization like energy, manufacturing, aviation. Our software drives insights customers need to transform how they create, orchestrate, and consume energy. Over 20,000 customers world-wide use our software to fuel productivity and reliable operations while reducing costs and carbon for a more sustainable world. For more information, visit www.ge.com/digital. GE Vernova, a dynamic accelerator comprised of our Power, Renewable Energy, Digital and Energy Financial Services businesses, focused on supporting customers' transformations during the global energy transition.

Talk to a GE Digital expert about digital solutions that can advance your transition and transformation goals.

[Contact us](#)

Contact Information

1-800-433-2682

gedigital@ge.com

www.ge.com/digital

© 2023 General Electric Company – All rights reserved.

GE Digital reserves the right to make changes in specifications and features shown herein, or discontinue the product described at any time without notice or obligation. Contact your GE Digital representative for the most current information. GE and the GE Monogram, are trademarks of General Electric Company. GE Digital, a division of General Electric Company.

