

2023 Energy Transformation Readiness Study

Survey-based insights into
energy sector digitalization
through open source

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2023 Energy Transformation Readiness Study

76% of energy stakeholders surveyed **have a clear strategic plan for digitalization** and have it already implemented.



51% of energy stakeholders see IT and OT on the way to convergence in their organizations.

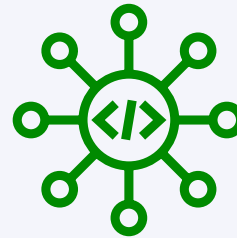


Digitalization plays a critical role in decarbonization by enabling smart home energy management, EV charging, & improved demand response.

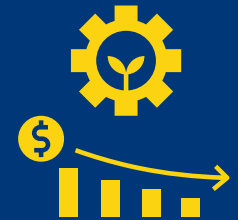


A lack of preparedness for digitalization can result in **penalties, fines, or regulatory actions** due to energy service violations.

64% of energy stakeholders report that they use more **open source software (OSS)** than closed source.



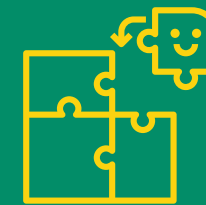
Cost reduction and transition speedup are the most popular benefits of OSS in the energy sector.



Flexibility is the most promising feature of OSS for energy stakeholders.



Performance, support, and security are the main barriers to OSS adoption in the energy sector.



OSS reduces grid complexity by enabling the integration and management of distributed energy resources (DERs) and easing application development.



Energy industry consensus is key to increasing OSS adoption.

89% of energy stakeholders agree or strongly agree that they have the **skills needed to address digitalization needs.**



Half of the organizations believe that training programs should cover software and OSS skills.



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Foreword

When Linux Foundation Research was newly formed, one of the first conversations I had was with the late founder of LF Energy, Dr. Shuli Goodman. Shuli needed data to inform her efforts to increase multi-stakeholder collaboration at the intersection of open source software (OSS) and the energy sector. She and LF Energy community members understood that to meet climate targets, there would be a need for a rapid digitalization of the world's energy infrastructure and that much of the digitization effort would rely heavily on OSS. But what were the gaps? What was the level of readiness among energy organizations and professionals where open source was concerned? And did the community have the necessary resources in terms of training to succeed in their digitalization efforts?

We set out to design a study that would help to answer these and many other questions, involving numerous organizations, members of the LF Energy board, academic partners, and colleagues across the Linux Foundation. We planted the seeds of the study at a workshop led by LF Training & Certification GM and SVP Clyde Seepersad at Energy Thought Summit in Austin during the early half of 2022 and set to work designing a survey, which, after much input, had its launch in December 2022.

More than a year after my initial conversation about this project, I'm delighted that the results of a truly community-wide research collaboration are in. And while it is with a heavy heart that Shuli is not with us to see them, I know she would be excited about the insights that they reveal across regions.

At the Linux Foundation, we recognize that OSS is a catalyst for digital transformation in the energy sector, and we are committed to advancing its adoption. OSS is built on the principles of collaboration and community, and it is uniquely suited to meet the complex and rapidly evolving needs of the energy sector, in particular, the need to both establish and integrate renewable energy sources and better balance overall energy supply and demand. By harnessing the power of OSS, the energy sector can transform the way that energy is generated, distributed, and consumed and accelerate the transformation to a decarbonized future.

While the energy sector is at a crossroads, facing unprecedented challenges, there are exciting developments in the industry and new pathways forward to support decarbonization targets and the time-bound United Nations Sustainable Development Goals (SDGs), particularly SDG 7, Affordable and Clean Energy, and SDG 14, Climate Action. To meet these challenges, we require leadership, bold decision-making, and broad-based support from stakeholders, including regulators, enterprises, governments, and across civil society. We are grateful to Dr. Shuli Goodman for her vision and leadership, and we are committed to carrying forward her legacy. Please join us in our effort.

Hilary Carter,
SVP Research and Communications,
The Linux Foundation

Introduction

The energy sector is undergoing a significant transformation due to the increasing adoption of distributed energy resources (DERs), the electrification of energy consumption and the urgent need to address climate change. DERs, such as solar panels, wind turbines, and energy storage systems, are changing the way energy is produced, consumed, and distributed, leading to a more decentralized, dynamic, and less predictable energy system. At the same time, the threat of climate change is driving the shift toward a more sustainable, low-carbon energy future. One of the ways to battle climate change is through further electrification in areas such as mobility and heating. This, in turn, puts pressure on energy operators. New challenges and opportunities are ahead for energy companies, policymakers, and consumers alike as they work to manage the growing complexity of the energy system and undertake the transition to a more sustainable energy future.

The solution to this overarching problem can be envisioned through the use of open source software (OSS) within the wider process of digitalization. OSS is increasingly being adopted by organizations in the energy sector due to its numerous benefits. One key advantage of OSS is that it is often free or low-cost to use and distribute, which can help reduce costs and increase innovation. OSS tends to be highly adaptable, enabling enterprises to customize software to their unique needs and specifications. Additionally, OSS frequently has a large user and developer community that contributes to its growth and improvement, fostering a more inclusive and collaborative approach to software

development. This strong community might lead to quicker innovation, better quality software, and more reliable security. OSS can also assist businesses in avoiding vendor lock-in and retaining more control over their IT infrastructure.

This research intends to provide actionable insights stemming from the state of digital transformation readiness among energy stakeholders and the identification of existing gaps in educational tooling. With these insights, we aim to create greater awareness of the state of transformation readiness, suggest best practices, and influence both contributions to and the adoption of open source technology stacks vital to achieving climate targets.

Research Overview

We conducted a worldwide online survey to collect insights about the transformation readiness of energy stakeholders. Data collection for the survey took place in 2022 Q4. We received 441 valid responses, which are the basis for the analysis presented in this report. The survey included questions in the following areas: demographics, the current state of digitalization, benefits of digitalization, the current state of open source uptake, governance, benefits and barriers of OSS, skill demand, outsourcing, and training. We also incorporated insights from subject matter experts, whose contributions are referenced throughout the study. For more information about this research approach and participants' demographics, see the Methodology section.

Digitalization

Digitalization in the energy sector refers to the use of digital technologies to improve the efficiency, reliability, and sustainability of energy systems. It involves the integration of automation, the Internet of Things, data analytics, and (cloud) computing into various aspects of the energy value chain, including generation, transmission, distribution, and consumption. Throughout this report, we often use the term “grid,” which refers to the network of transmission lines, substations, transformers, and other elements that play a role in delivering energy to homes and businesses. One of the most important aspects of digital transformation is the “smart grid,” a grid boosted with digital technology that allows two-way communication between utilities and consumers while “sensing” along the transmission lines.

The traditional energy sector model is characterized by a centralized, top-down, one-way approach to energy production and distribution. Typically, a small number of large energy companies control the majority of energy production and distribution and are often reliant on nonrenewable fossil fuels. The energy is generated at large power plants and then transmitted over long distances through transmission and distribution networks before reaching consumers. This traditional system is often inflexible and inefficient, with energy losses occurring during transmission and distribution with little or no opportunities for energy storage. Consequently, consumers have limited opportunities, if any, to produce and store energy. Households are unable to effectively track their consumption to reduce energy waste.

The grid transformation driven by digitalization has the potential to transform the energy sector in many ways and, most importantly, help to integrate renewable energy sources into the grid more effectively. For example, advanced sensors and control systems can help to manage the variability of wind and solar power, enabling greater penetration of renewable energy sources.

Digital technologies can help to optimize the operation of the grid, reducing waste and improving the efficiency of the system. For instance, smart grids can use real-time data to balance supply and demand, reducing the need for fossil fuel-based peaker plants, which are power plants generally only running when demand is high. Digitalization can further help efforts of mitigating the impacts of new load growth from electrification of transportation and heat. Some digital technologies can also help to improve energy efficiency in buildings and industrial processes. For example, smart building systems can optimize heating, cooling, and lighting, reducing energy waste and lowering carbon emissions. However, new technologies are not enough, and therefore a wider digitalization initiative must include strategies for best practices in measurement and other standards.

THE CURRENT STATE OF DIGITALIZATION IN THE ENERGY SECTOR

Organizations are on the path toward digital transformation

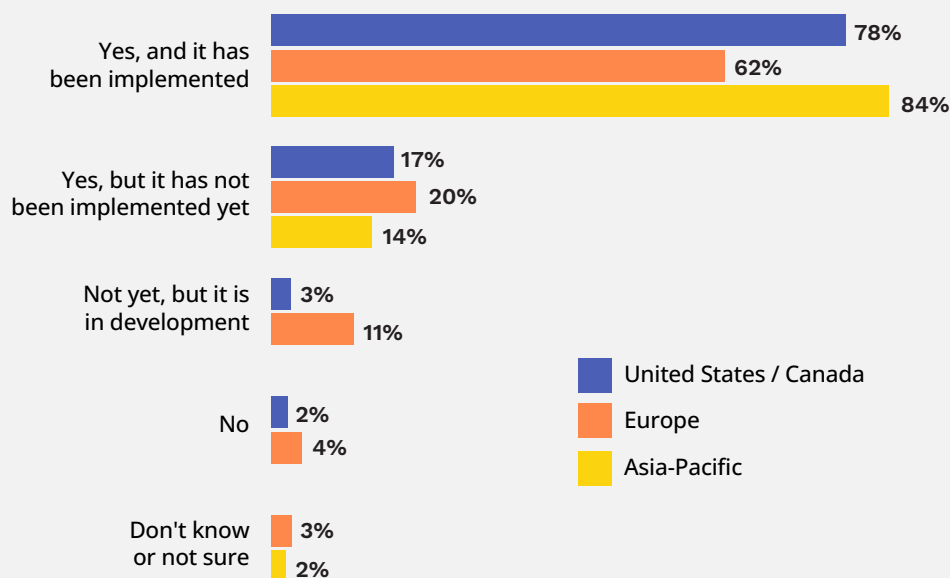
First, the survey set out to investigate the current state of digital transformation specific to the energy sector. One of the ways our survey conceptualized digitalization efforts was through companies’ intention to develop a digitalization plan. A digitalization plan is crucial for digital transformation, as it encapsulates an organization’s commitment to change. We also asked about whether the organizations employ a chief data officer (CDO) or have this role covered in other ways. Having a CDO within the organization indicates a strong effort to leverage the potential of data in the changing world of the energy sector. Although a digitalization plan and a CDO show that the organization takes digital transformation seriously, we also sought out whether organizations are on the path toward a truly systematic change by

converging their information technology (IT) and operational technology (OT) processes. Where respondents see a convergence of the two in their organizations, it can be implied that their organizations are on the verge of transforming to their deepest layers. This is an approach and effort that decarbonization goals will require from the energy sector.

Most organizations surveyed have a clear strategic plan for digitalization and have already implemented it. However, there are regional differences where a smaller percentage of organizations in Europe have implemented a strategic plan. These findings correlate with the answers on CDOs, where a lower proportion of European-based organizations have a CDO compared to North America and Asia-Pacific. On a more systemic level, around half of the respondents see IT and OT on the way to convergence in their organizations. This finding shows that digital transformation within organizations is not as clear as can be seen in previous measurements. Organizations are on the path toward digital transformation, but there is still a way to go. We describe the key findings in more detail below.

FIGURE 1
STRATEGIC PLAN FOR DIGITALIZATION ACROSS REGIONS

Does your organization have a clear strategic plan for digitalization? segmented by In which region does your organization have its primary headquarters?



MOST ORGANIZATIONS HAVE ALREADY IMPLEMENTED A DIGITALIZATION PLAN

A strategic plan can indicate that an organization is taking a proactive approach to adapt to the changing environment of the energy sector and articulating digitalization's benefits. In total, 76% (TABLE A19) of organizations surveyed have a clear strategic plan for digitalization and have implemented it already.

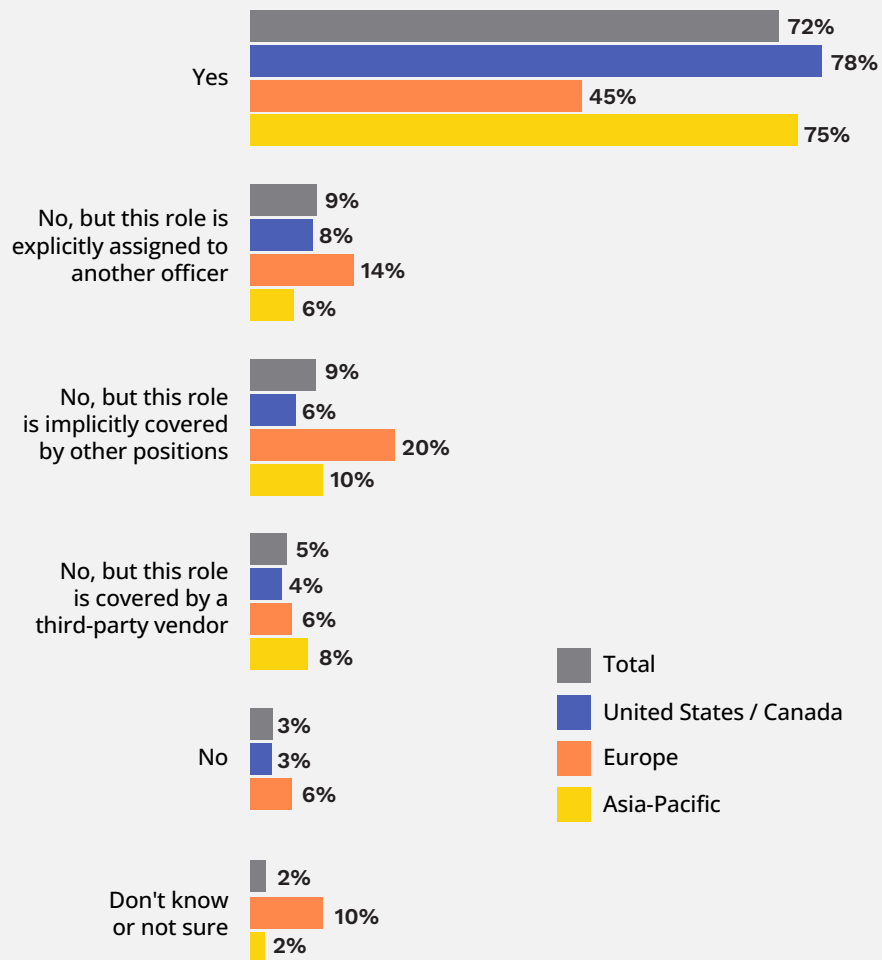
FIGURE 1 shows that there are regional differences in how strategic planning for digitalization is being pursued. 62% of organizations in Europe have digitalization plans implemented, whereas in North America the percentage is 78%, and in Asia-Pacific, it is 84%. Another 31% of European organizations are in the preparation stage: They have a plan, but it has not been implemented yet, or the plan is currently being developed.

Overall, 93% of organizations have a clear strategic plan comprising 76% who have implemented this plan and 17% who are in the process of implementing it (TABLE A19). This suggests that most organizations are taking digitalization very seriously.

2022 Transformation Readiness Survey, Q18, sample size = 428.

FIGURE 2
ROLE OF CHIEF DATA OFFICE ACROSS REGIONS

Does your organization have a chief data officer? segmented by In which region does your organization have its primary headquarters?



2022 Transformation Readiness Survey, Q19, sample size = 428.

MOST ORGANIZATIONS HAVE A CDO OR HAVE THIS ROLE COVERED

As the energy sector undertakes a significant digital transformation, it becomes more and more data-intensive due to the vast amounts of data being generated from various sources, such as smart meters and sensors of the grid. To gain value from such data, organizations must have a clear strategy and a dedicated team to oversee data management and analytics. At this point, the role of the CDO becomes crucial.

FIGURE 2 shows that in total, 95% of organizations have a CDO or have this role covered. The state of CDOs in Europe again shows that European organizations are in the early stages of digitalization where dedicated, functional roles and titles are concerned. 45% of European organizations have a CDO, compared to values above 70% for the other two regions. This might be due to data analyst skills missing and being outsourced in the sector, as will be later discussed in this report.

In terms of digitalization preparedness, 23% of North American organizations report they fit into the top quartile of digital preparedness (TABLE A22). This contrasts with 35% of European and 42% of Asia-Pacific-based organizations who report being in this top quartile.

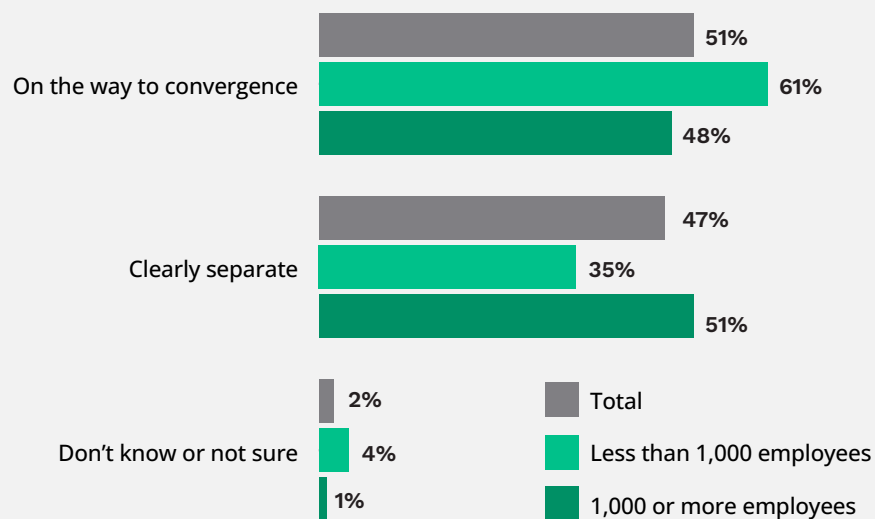
A MORE SYSTEMATIC DIGITAL TRANSFORMATION IS STILL UNDERWAY IN HALF OF THE ORGANIZATIONS

The convergence of IT and OT can indicate digitalization at a deep level. IT is the use of computing technology to manage and process information, while OT refers to the technology that monitors and controls physical processes, such as energy generation and distribution.

Traditionally, IT and OT have been separate domains with their own tools, systems, and processes. This is mainly due to a security concern to protect physical operations from external

manipulation. However, with the increasing use of digital technologies in the energy sector, there is a growing need to integrate these two domains to enable more effective data management and decision-making.

FIGURE 3
IT AND OT CONVERGENCE ACROSS COMPANY SIZE
 How do you see the intersection of information technologies (IT) and operational technologies (OT) in your organization?
segmented by Please estimate how many employees the organization you work for has worldwide.



As shown in **FIGURE 3**, 51% of respondents see IT and OT on the way to convergence in their organizations, and 47% of respondents see the two technologies as clearly separate in their workplace. The reason half of the organizations still separate the two processes might be due to security concerns in the energy sector. Another reason might be company size. The perception that they are on the way to convergence is more common in smaller companies (**FIGURE 3**).

BENEFITS OF DIGITALIZATION IN THE ENERGY SECTOR
 Respondents confirm that digitalization plays a key role in decarbonization

In this section, we queried what benefits organizations see in the digitalization of the energy sector. We asked specifically what role digitalization plays in decarbonization, where options included the enabling features of digitalization and its facilitating characteristics. We explored whether digitalization can enable new services, business models, and new automation specifications as well as collaboration among operators and stakeholders. We investigated whether digital transformation has the ability to unlock flexibility and facilitate interoperability. We were interested in what features of digitalization are the most important to energy stakeholders. We also examined the other side of the coin to see what consequences a lack of preparedness for digitalization can have on the energy sector.

Respondents see a lot of value in digitalization and confirm that it enables new services to customers. An example of this is smart home energy management, for which demand is increasing as households are seeking ways to monitor and lower their energy consumption. Organizations further confirmed that digitalization enables new automation specifications, such as automating demand response. A lack of preparedness can pose challenges in competitiveness, limiting the ability of the organizations to maintain a role in the market. The specific benefits and challenges we observed from the survey are explored below.

2022 Transformation Readiness Survey, Q28, sample size = 441.

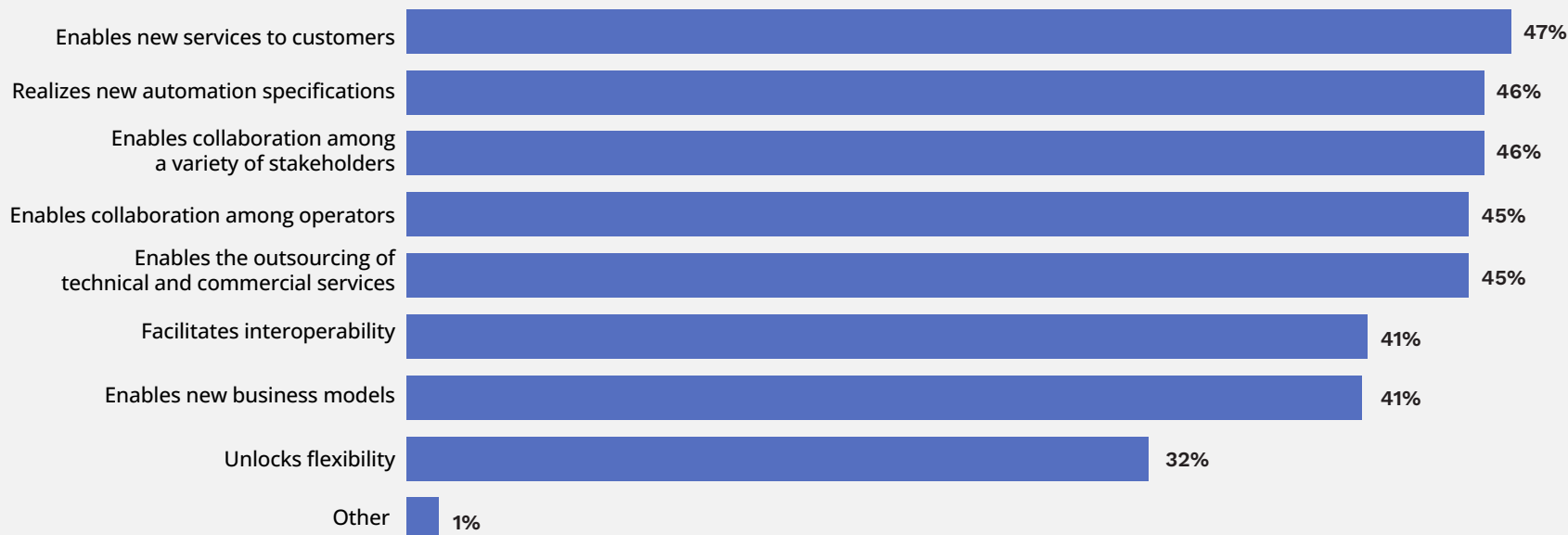
DIGITALIZATION ENABLES COLLABORATION AND NEW SERVICES AND FEATURES

FIGURE 4 shows that 47% of respondents believe that digitalization enables new services to customers. Examples include smart home energy management, EV charging, and renewable energy sharing and storage, enabling consumers to manage their energy consumption more effectively, reduce their carbon footprint, and participate in the transition to a low-carbon energy system.

46% of respondents believe that digitalization realizes new automation specifications. Such specifications may include optimizing the integration of renewable energy sources, improving energy efficiency by the automation of energy management systems, reducing energy waste by automating demand response, and predictive maintenance.

Almost half of the respondents also believe digitalization enables collaboration among stakeholders and among operators. By

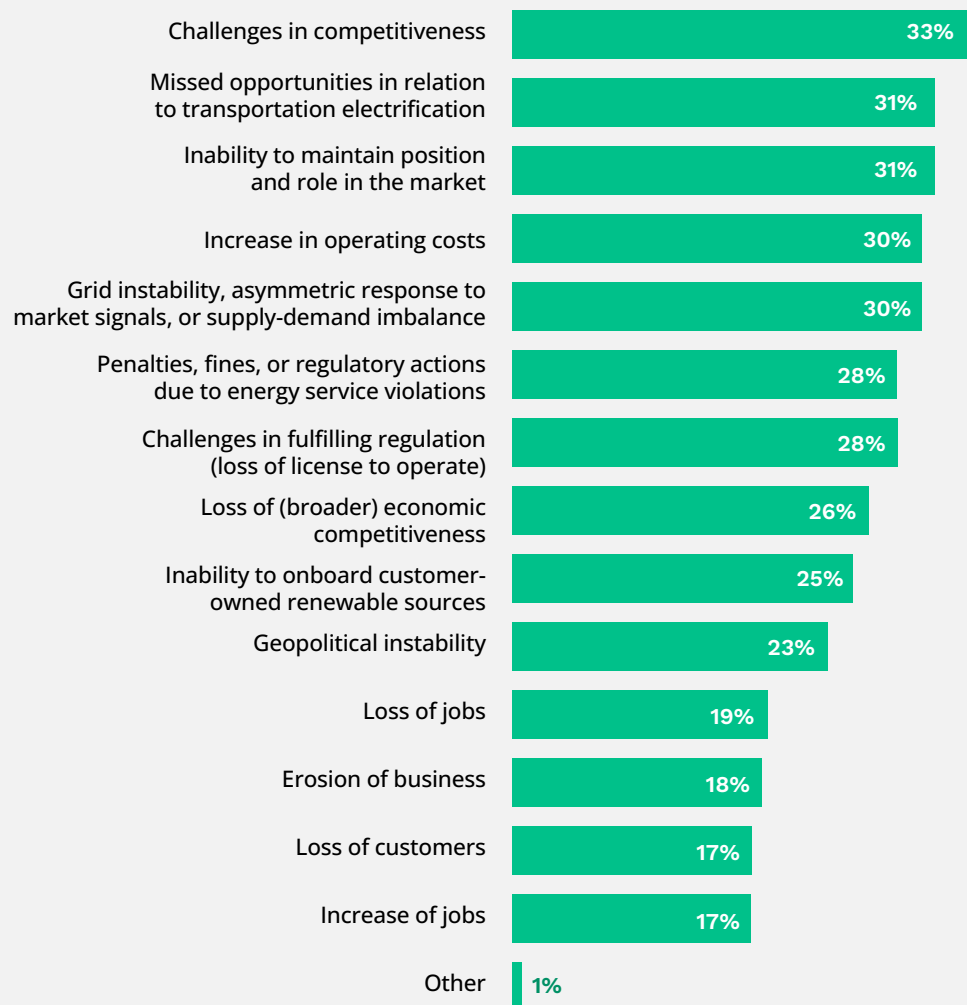
FIGURE 4
ROLE OF DIGITALIZATION IN DECARBONIZATION
 In your view, what role does digitalization (the application of software and data) play in the decarbonization of the energy sector?



2022 Transformation Readiness Survey, Q17, sample size = 441, valid cases = 441, total mentions = 1,514.

FIGURE 5
LACK OF PREPAREDNESS FOR DIGITALIZATION

What consequences do you expect for a lack of preparedness for digitalization in the energy sector?



leveraging digital technologies, organizations in the energy sector can collaborate effectively with other stakeholders, drive innovation, and achieve their decarbonization goals.

A LACK OF PREPAREDNESS CAN BRING MANY CHALLENGES TO THE ENERGY SECTOR

A lack of preparedness for digitalization can have a variety of consequences, including issues related to competitiveness. A third of respondents expect challenges in competitiveness for a lack of preparedness in the energy sector. **FIGURE 5** shows that 31% of respondents see missed opportunities in relation to transportation electrification, and 31% see an inability to maintain position in the market.

Many consequences reflect overarching challenges to decarbonization. For instance, a quarter of respondents see the inability to onboard customer-owned renewable sources as a main consequence. In the U.S. utility sector, a lack of preparedness might be also correlated with negative regulatory relationships. This confirms that penalties, fines, or regulatory actions due to energy service violations are also seen as a consequence of a lack of preparedness for digitalization.

Digitalization is simply inevitable as all things get electrified and decarbonized. Most new DERs are unpredictable by nature and to be integrated within the grid, energy stakeholders need new digital capabilities.

“If we are not able to keep up with digitalization, we will slow down the transition to a more sustainable society and potentially even limit economic growth.”

—JONAS VAN DEN BOGAARD, DIGITAL STRATEGY LEAD FOR OPEN SOURCE, ALLIANDER

2022 Transformation Readiness Survey, Q34, sample size = 436, valid cases = 436, total mentions = 1,555.

Open Source Software

Utilities will no longer have total control over energy systems when centralized power generation is replaced by DERs. Because of the industry's fragmentation, not all power production, transmission, and distribution technologies are compatible, making interoperability crucial for integrating the large range of DERs that are going online. A single organization cannot create the necessary technologies alone. The outdated "black box" methods and closed source energy industry software cannot be used in this new era because they could result in different measurement standards and different utility evaluation criteria. Open source prevents conflicting standards while ensuring the interoperability and compatibility of systems by ensuring vendor neutrality and collaborative development.¹

By offering affordable, reliable, and adaptable solutions, OSS plays a crucial part in the transformation of the energy sector. OSS can assist in addressing the difficulties associated with controlling the growing complexity of the modern grid and integrating DERs. Open source solutions can make it possible to monitor and manage DERs in real time, communicate data easily with various devices and programs, and create new services and applications. In addition, the creation of new energy management tools and services that empower customers to actively lower their energy use and carbon impact is made possible by OSS.

There are various ways that the energy sector can use OSS. Organizations can use open source solutions that are already available and modify them to suit their unique requirements. Multiple open source solutions are in the early adoption phase at LF Energy. For instance, operators can create applications able to perform dynamic power flow simulations and security analyses on the network with an open source library, PowSyBl.² Organizations can also assist in the creation of OSS by joining open source communities and submitting code, instructions, and bug reports. Additionally,

businesses can develop their own OSS and distribute it to the general public, which can encourage creativity and accelerate the development of new solutions. Finally, organizations can encourage the use of OSS in the energy industry by promoting its advantages and fostering stakeholder cooperation and knowledge sharing.

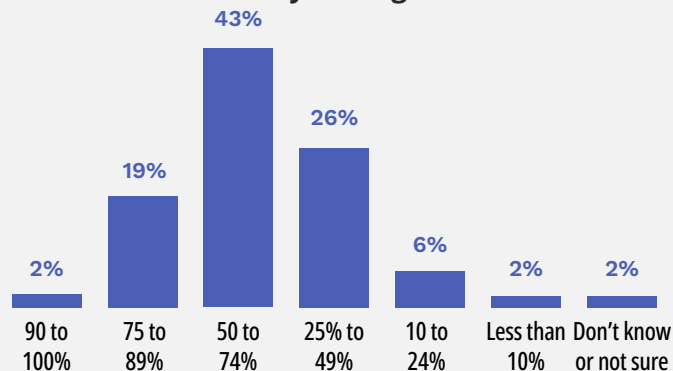
THE CURRENT STATE OF OSS IN THE ENERGY SECTOR

Energy stakeholders are keen to use OSS

In this section, we aimed to understand whether organizations are already using OSS for their work or are planning to. We conceptualized this by asking what percentage of software they use is open source and what their stage of open source readiness is. We also examined whether organizations in the energy sector are familiar with concepts such as an open source program office (OSPO) and OSS governance. We further investigated the current stage of OSS governance in the energy industry.

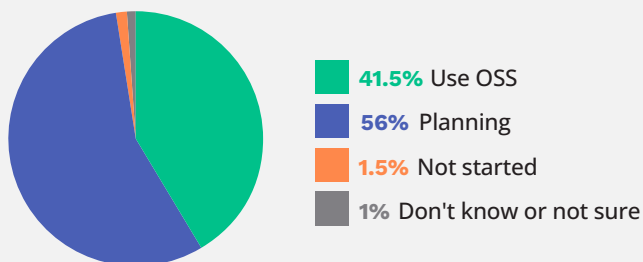
The use of OSS is pervasive, with close to two-thirds of organizations responding that more than half of the software they use is open source. Almost all organizations are keen to use OSS, with many of them already using it and another significant proportion planning to. Only a small percentage of respondents were not aware of what an OSPO is. In terms of OSS governance, most respondents understand that governance regulates the interaction of open source community participants. The adoption of OSS in the energy sector is growing, driven by the need for greater flexibility, interoperability, and innovation.

FIGURE 6
OSS USE IN ORGANIZATIONS
 What percentage of OSS can be typically found in most software used in your organization?



2022 Transformation Readiness Survey, Q33, sample size = 416. (filtered by Q22 to exclude respondents not familiar or slightly familiar with OSS in their organization)

FIGURE 7
OSS READINESS
 What is your organization's current open source software (OSS) readiness?



2022 Transformation Readiness Survey, Q29, sample size = 416. (filtered by Q22 to exclude respondents not familiar or slightly familiar with OSS in their organization)

OSS USE IS WIDESPREAD IN THE ENERGY SECTOR

64% of organizations report that 50 to 100% of the software they use is OSS as shown in **FIGURE 6**. This is consistent with how OSS is often perceived as software that “is everywhere but not visible.” Most modern IT stacks cannot go without OSS; therefore, open source is crucial for the IT systems within the energy sector. A lot of small libraries are used, but there are examples of open source software being incorporated in large projects. Some grid operators, such as Alliander, also use energy sector specific OSS (e.g. [OpenSTEEF](#)).

As OSS often requires technical capability, some energy sector operators are ahead of others. More traditional grid operators still rely on vendors for their software solutions. As the digital lead for open source at Alliander points out, Alliander is one of the frontrunners in open source use among grid operators and has an OSPO. Others in Europe are open to taking up OSS, and while OSPOs are increasingly being formed, they are still not common.

We received further insight into the U.S. utility sector from a subject matter expert. There is a considerable amount of open source use, either on the server side or elsewhere in the stack. However, there are still a lot of closed source software stacks used.

MOST ORGANIZATIONS HAVE OSS ON THEIR PLAN

FIGURE 7 indicates that almost all organizations already use OSS or are planning to do so (98%). Organizations are ready to use OSS and understand the benefits it can bring, such as cost savings, flexibility, interoperability, innovation, security, and sustainability.

The 40% of energy organizations that use OSS do not simply make use of it but are also equipped with an OSPO and / or security team as shown in **TABLE A32**. OSS often requires a higher level of technical expertise than closed source software.

OSPOs have great business value and come in all shapes and forms.³ **TABLE A30** shows that 66% of respondents understand the

role of an OSPO (that it manages development and contributions to software both within and outside the organization). Only a few respondents (7%) did not know what an OSPO is.

GOVERNANCE IN EUROPE IS IN EARLIER STAGES

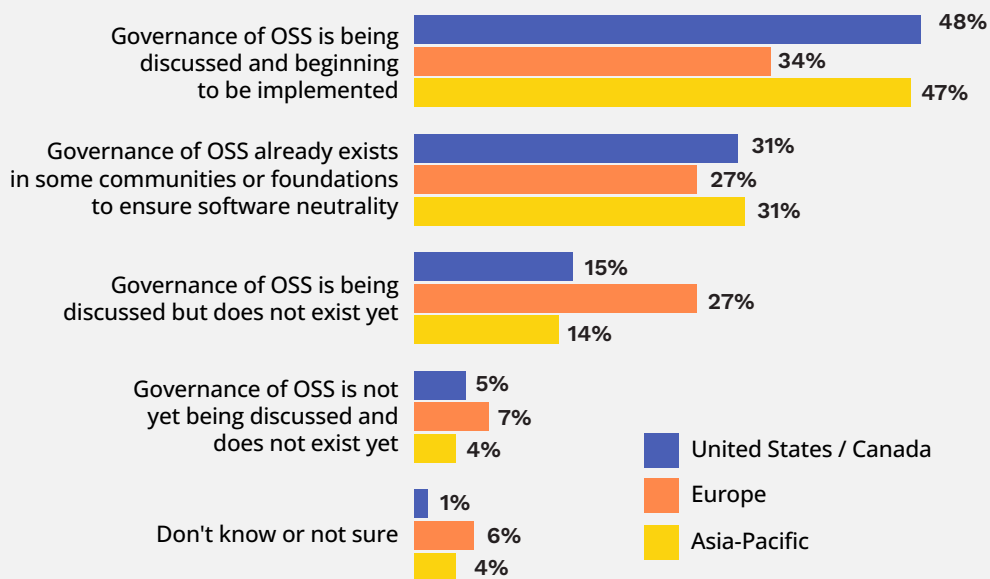
OSS governance is important for ensuring compliance, managing risk and intellectual property, facilitating collaboration, and maintaining the organization’s reputation in the open source community. Governance helps to ensure that the organization is using OSS in a responsible and sustainable manner.

Most organizations understand the importance of OSS governance. **TABLE A27** shows that 56% agree that governance regulates the interaction of OSS community participants, and 55% agree that governance leads to innovation and commercialization.

FIGURE 8 shows that respondents in North America and Asia-Pacific (48% and 47%, respectively) believe that governance of OSS is being discussed and beginning to be implemented. In Europe, fewer respondents believe the same, and a higher percentage say that governance is being discussed but does not exist yet. Subject matter experts confirmed that as the technology industry is stronger in North America than in Europe, there is a delay in open source uptake and OSPO formation.

FIGURE 8
STATE OF OSS GOVERNANCE

What is the current state of governance for OSS in the energy industry? segmented by In which region does your organization have its primary headquarters?



2022 Transformation Readiness Survey, Q25, sample size = 428.

BENEFITS AND CHALLENGES OF OSS

OSS brings many benefits to the energy sector, but there are barriers to full adoption

A large part of the sample is a strong believer in OSS (66%), and the remaining is partially unconvinced (34%), as shown in **TABLE A24**. This further confirms that organizations are keen on OSS if belief can be translated into actual use. We explored the advantages attributed to OSS behind the strong belief in this section. The questions we asked were all intended to provide a picture of what benefits OSS can bring to energy stakeholders and what are its most promising features. We also intended to investigate the factors that are influencing which OSS library or package an organization chooses for their work. As there is still no full adoption of OSS in the energy sector, it is important to understand why this might be; therefore, the survey also explored the main barriers to OSS use. As OSS will be crucial for grid transformation and decarbonization, LF Energy is committed to improving OSS adoption. We sought out an answer from the energy stakeholders about what would be the key to this improvement.

Cost reduction and transition speedup are the most popular benefits of OSS. Flexibility is the most promising feature. The quality of source code influences OSS library choice the most in North America, but the

size of the user community seems to be a more important factor in Europe. Performance, support, and security are the main barriers to adoption. Industry consensus is key to improving OSS adoption.

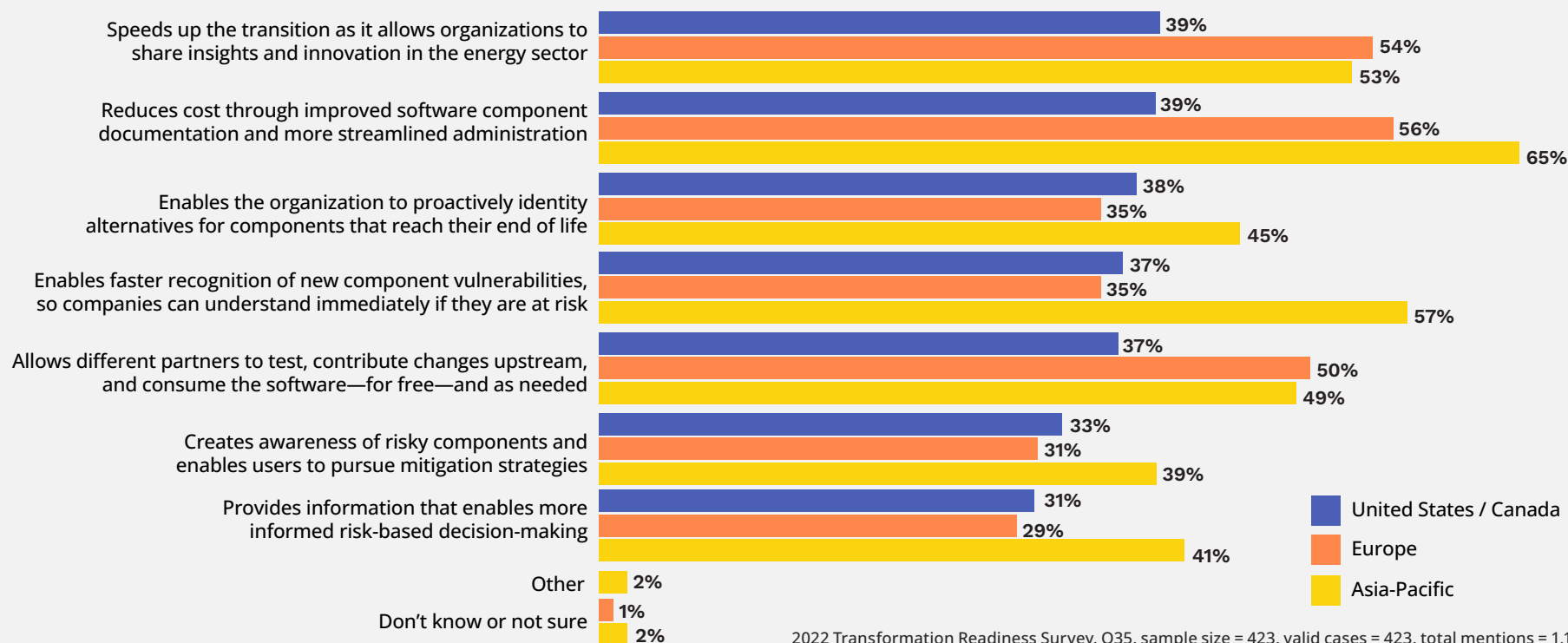
COST REDUCTION AND TRANSITION SPEEDUP ARE THE MAIN BENEFITS OSS BRINGS TO THE ENERGY SECTOR

North American organizations are overall less passionate about OSS benefits compared to other regions, but this might be due to underrepresentation in Europe and Asia-Pacific. This can be

seen in **FIGURE 9**, where a smaller percentage of North American respondents selected the options. According to our subject matter experts, the reason might be that the energy infrastructure in Europe is perceived as public money, and open source provides the opportunity of “giving back.” Although there is an appetite for OSS in the U.S. energy sector, it is not evangelized. OSS has to demonstrate product-market fit to spark willingness to adopt it. This finding is consistent with the more “romantic” perception of OSS in Europe, as reported in our Europe Spotlight Research.⁴

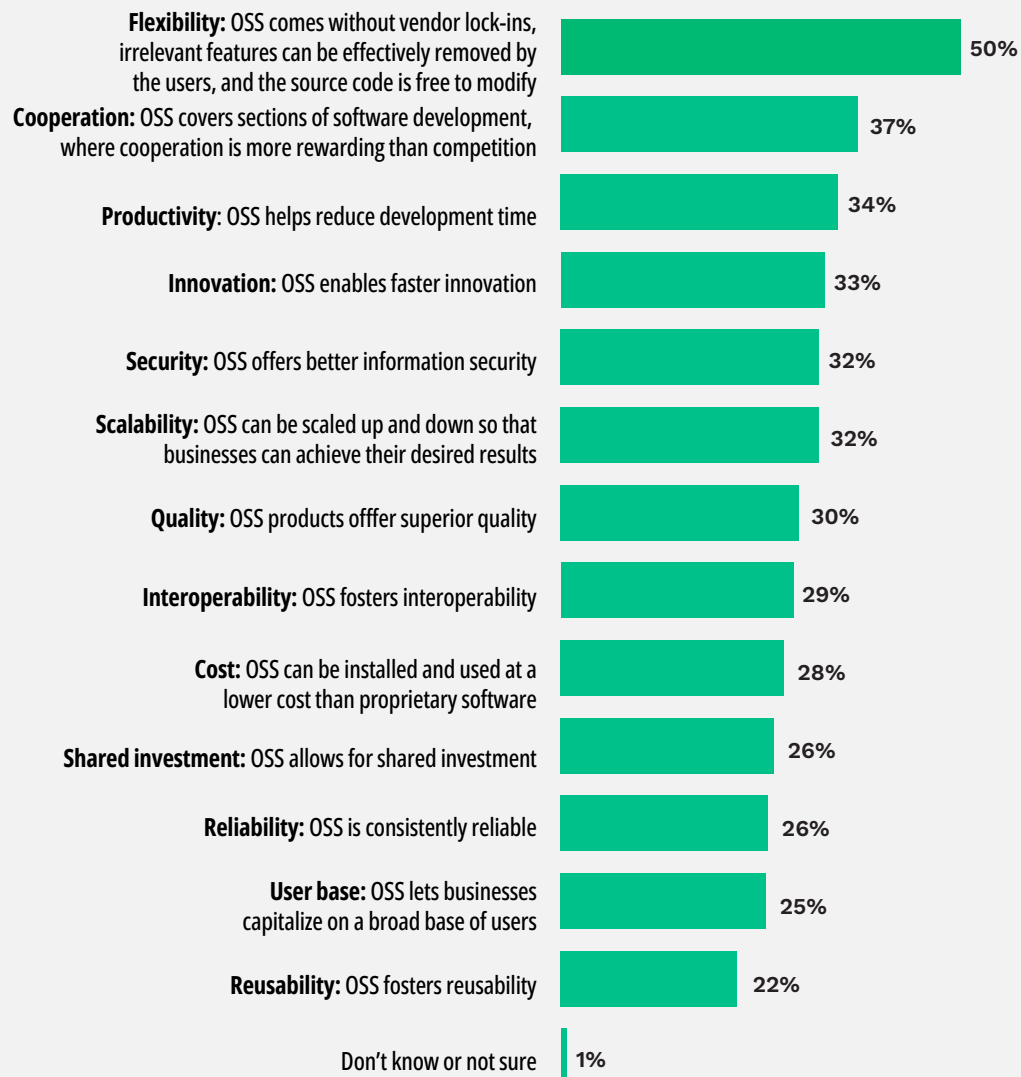
FIGURE 9
OSS BENEFITS ACROSS REGIONS

In your opinion, what benefits will OSS bring to companies in the energy sector?
segmented by In which region does your organization have its primary headquarters?



2022 Transformation Readiness Survey, Q35, sample size = 423, valid cases = 423, total mentions = 1,150.

FIGURE 10
PROMISING FEATURES OF OSS
 For your organization, what are the most promising features of OSS?



2022 Transformation Readiness Survey, Q30, sample size = 416, valid cases = 416, total mentions = 1,679.

FIGURE 9 also shows that many organizations believe that OSS reduces cost through improved software component documentation and more streamlined administration: 39% in North America, 56% in Europe, and 65% in Asia-Pacific. OSS is typically available at no cost or at a lower cost than closed source software. This can help energy companies save money on software licensing fees and reduce their overall IT expenses.

Transition speedup is also greatly valued by organizations, as OSS is often developed by a large community of developers who can collaborate and contribute to the software’s development. OSS brings further benefits for organizations, such as the identification of alternatives and component vulnerabilities, collaboration, mitigation strategies, and the provision of information.

FLEXIBILITY IS THE MOST PROMISING FEATURE OF OSS FOR ENERGY STAKEHOLDERS

Flexibility is the most promising feature of OSS shown in **FIGURE 10**, with 50% of respondents selecting this feature. OSS is often more flexible and customizable than closed source software. Energy companies can modify the code to meet their specific needs and integrate it with other software systems. Cooperation is important as a feature of OSS for 37% of respondents. For 32% of respondents, security is one of the most promising features of OSS. This paints a diverse picture of stakeholders’ opinions on OSS security, as will be later shown.

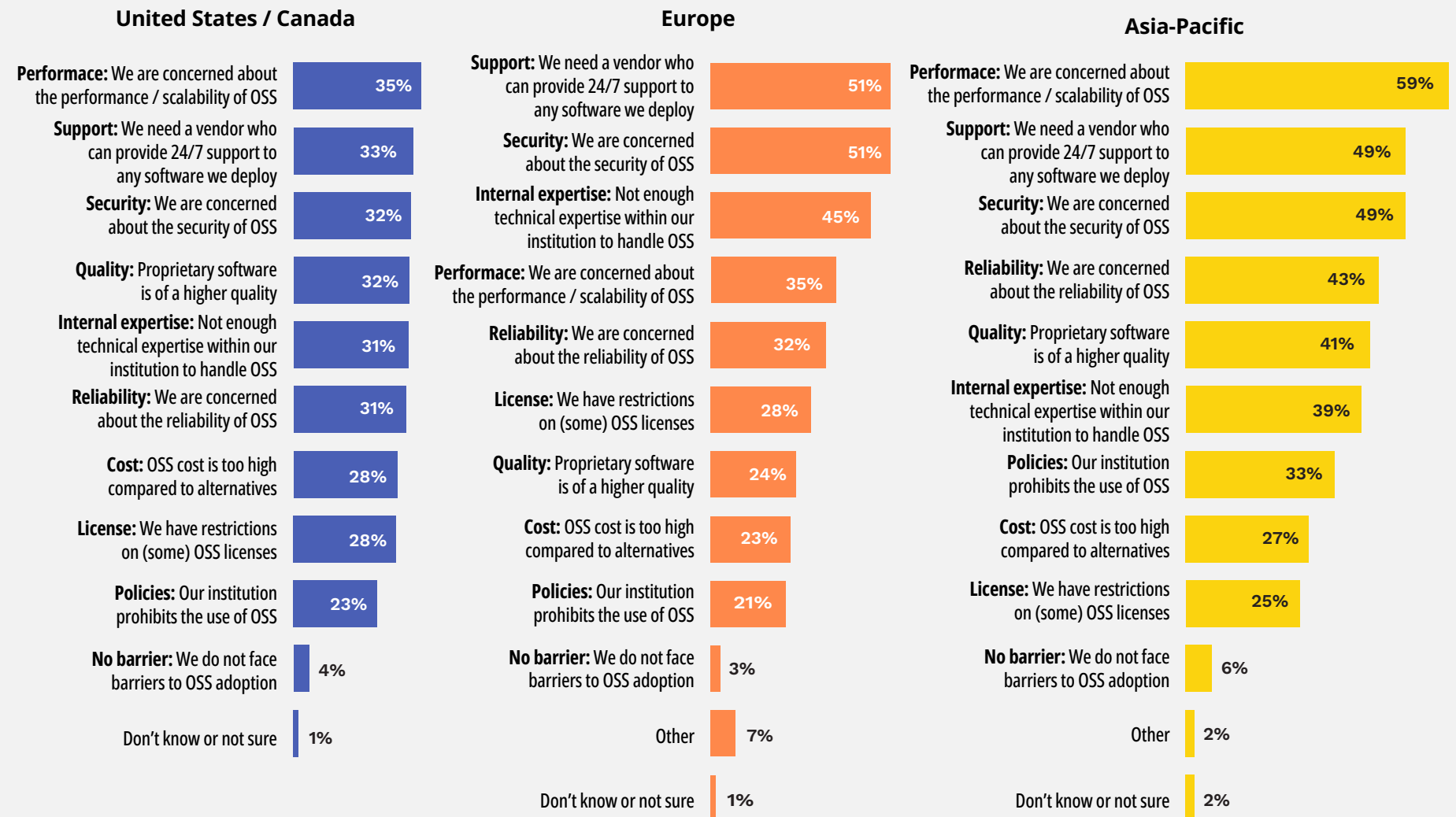
OSS is designed to be interoperable with other software systems, enabling energy companies to integrate different systems and data sources more easily. **TABLE A29** shows that 18% of organizations always use OSS to address interoperability issues, and 46% use it very often.

In terms of what factors organizations consider when choosing specific OSS packages and libraries, we found that the quality of source code influences OSS package / library choice in North America and Asia-Pacific, whereas community / third party support is most important to respondents in Europe (see **TABLE A36**).

FIGURE 11

MAIN BARRIERS TO ADOPTION OF OSS

What are the main barriers to OSS adoption in your organization? *segmented by*
In which region does your organization have its primary headquarters?



2022 Transformation Readiness Survey, Q31, sample size = 428, valid cases = 428, total mentions = 1,633.

PERFORMANCE, SUPPORT, AND SECURITY ARE THE MAIN BARRIERS TO ADOPTION

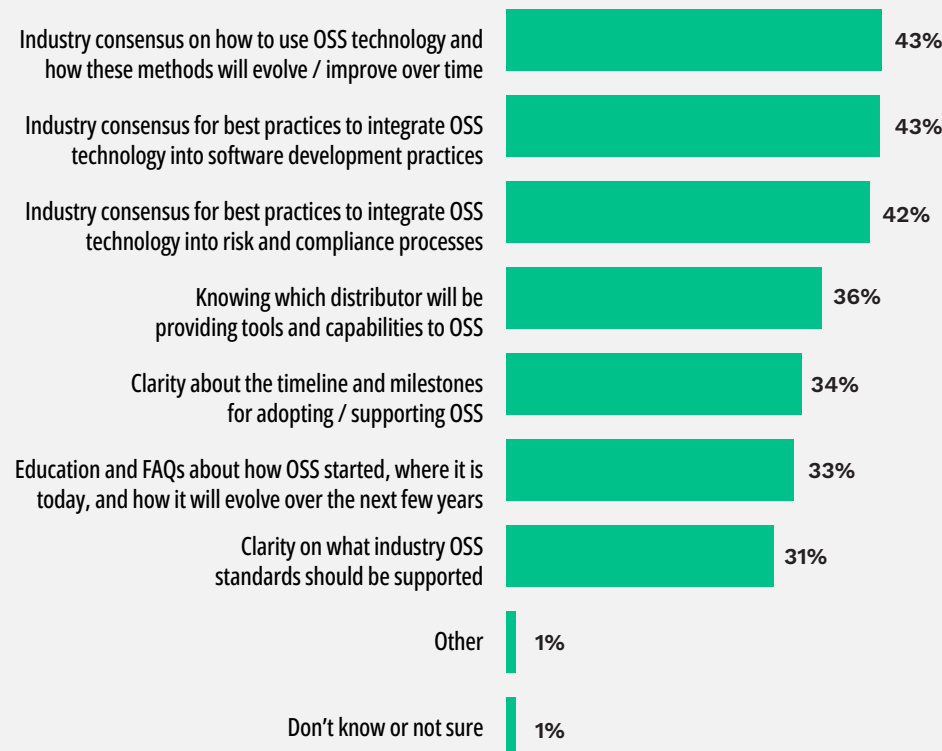
As seen in **FIGURE 11**, performance, support, and security are the main barriers to OSS adoption worldwide. But other factors are almost equally as important, such as quality, internal expertise, and reliability. In Europe, support, security, and internal expertise were

mentioned by close to half of the organizations. For organizations in Asia-Pacific, performance, support, and security were top priorities.

The area of security deserves special attention when we are discussing the context of the energy sector. The subject matter experts we consulted confirm that security is crucial, as grid operators need to adhere to regulations while providing vital infrastructure. Therefore, the security aspect is extremely important when choosing software. However, experts point out that security is examined in all types of software, including closed source software. According to one expert, it is not about open source being less secure or more secure than closed source software. Any software must be secure for energy sector uptake, be it open or closed source.

FIGURE 12
FACTORS THAT WOULD IMPROVE OSS ADOPTION

What would improve the energy sector’s adoption of OSS?



INDUSTRY CONSENSUS IS KEY TO IMPROVING OSS ADOPTION

Industry consensus is crucial for adoption, as can be seen in **FIGURE 12**. We found that multiple types of industry consensus are important, such as consensus on how to use OSS technology and how these methods will evolve / improve over time (43%). There also needs to be consensus for best practices to integrate OSS technology into software development practices (43%). Industry consensus for best practices to integrate OSS technology into risk and compliance processes (42%) also came up high on the list.

Another interesting finding that came up during subject matter expert discussions was related to the procurement process. As one of our experts pointed out, there is a build or buy decision for organizations. Those who pursue the “buy” route could have a procurement process where there is a knowledge gap on what software solutions are available, and so open source gets underrepresented. In Europe, this also becomes a regulatory issue since the procurement process is regulated or semi-regulated for energy sector companies. As procurement is a slowly changing process, people overseeing the procurement decisions might not have the technical expertise necessary. As a result, OSS adoption can suffer the consequences.

2022 Transformation Readiness Survey, Q36, sample Size = 436, valid cases = 436, total mentions = 1,151.

Knowledge Gap

The range of skills needed has changed because of digital transformation and the move toward decarbonization in the energy sector. There is a growing need for individuals with digital skills such as data analysis, cybersecurity, and software development, even while conventional skills such as engineering and technical competence are still crucial. Professionals knowledgeable in energy efficiency techniques and renewable energy technology are also in greater demand. With the need to collaborate across teams and stakeholders to address complex challenges, communication and collaboration skills are increasingly becoming more and more crucial for professionals working in the energy sector. To drive change and adjust to the changing industry landscape, there is also a need for experts who can think strategically and innovate.

Having a digitally adept workforce is essential for the energy sector to thrive in today's rapidly evolving digital landscape. It is critical to implementing digital technologies, making data-driven decisions, optimizing energy systems to reduce waste, and improving customer experience. Therefore, investing in the digital skills of the workforce is crucial to the success of the energy sector. Skills can be leveraged for grid transformation in energy sector organizations in several ways. Organizations in the energy sector can provide training programs for their employees to improve their digital technology skills, enabling them to be ready and adept for the ongoing transformation of the sector. Online courses and certifications can also be an effective way to learn new skills and technologies, especially those related to OSS through the global online communities and foundations. Organizations can also hire or outsource new talent with specialized skills in areas such as data analytics, software development, and cybersecurity to support their digital transformation efforts.

EXTENT OF KNOWLEDGE GAP

The knowledge gap in the energy sector is moderate

In this section, we aimed to discover the extent to which the community is knowledgeable of education, training, and HR development programs around grid digitalization and transformation. This was also a good occasion to learn what core competencies are needed to develop to fill this potential gap. We also asked respondents how confident they are that their organizations have the skills required to address their digitalization needs. To get a closer picture, we also asked how difficult they find it to fill positions related to software. We also needed to know what skills organizations demand and whether these are outsourced or internally solved.

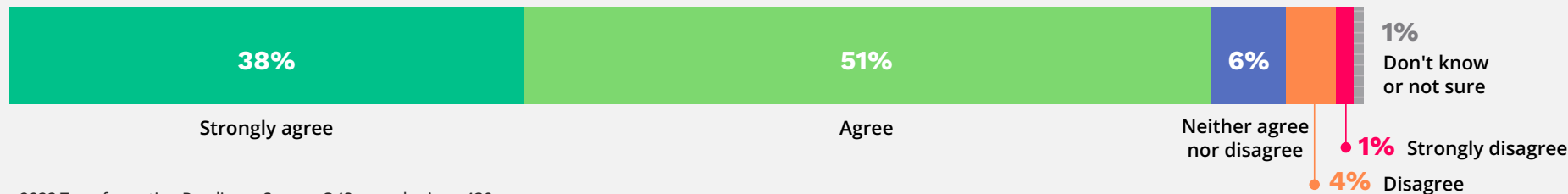
Most organizations agree or strongly agree that they have the skills needed to address digitalization needs. More than half of organizations in North America say that it is easy to fill positions in software and programming, but far fewer organizations feel this way in Europe and in Asia-Pacific. Data analyst, architect, and software developer competencies are the most in-demand skills, and these are the competencies that organizations most often outsource.

MOST ORGANIZATIONS ARE OPTIMISTIC ABOUT THE SKILLS NEEDED TO ADDRESS THEIR DIGITALIZATION NEEDS

Energy sector companies have deep knowledge and expertise in their field, which can be leveraged to drive digital transformation initiatives that are tailored to the industry's specific needs and challenges. Organizations are optimistic, as can be seen in **FIGURE 13**. 89% of organizations agree or strongly agree that they have the skills needed to address digitalization needs. This finding suggests that companies in the energy sector have the ability

FIGURE 13
KNOWLEDGE GAP TO ADDRESS DIGITALIZATION NEEDS

To what extent do you agree or disagree with the following statement:
My organization has the skills needed to address its digitalization needs.



2022 Transformation Readiness Survey, Q42, sample size = 430.

to effectively implement digital technologies and solutions to drive innovation, improve efficiency, and optimize operations for decarbonization.

As we also aimed to get a better picture of how difficult it is for organizations to hire talent, **TABLE A45** shows the state of filling positions in software and programming positions. A total of 56% of organizations in North America say that it is easy or very easy to fill positions in software and programming, compared to 28% of organizations in Europe and 41% in Asia-Pacific. For 6% of North American organizations, it is difficult or very difficult, compared to 27% and 18% in Europe and Asia-Pacific, respectively.

THE MOST NEEDED SKILLS ARE RELATED TO DATA AND SOFTWARE

Data analyst, architect, and software developer competencies are the most in-demand skills for the organizations surveyed. **FIGURE 14** shows that in total, 54% of organizations need data analysts, and 50% need software developers. Data and software skills can play a crucial

role in transforming the energy sector to drive decarbonization by enabling more efficient, cleaner, and smarter energy systems.

Organizations most often outsource data and software skills. **TABLE A42** shows that 38% of organizations outsource data analysts, 32% outsource software developers, and 30% outsource data architects.

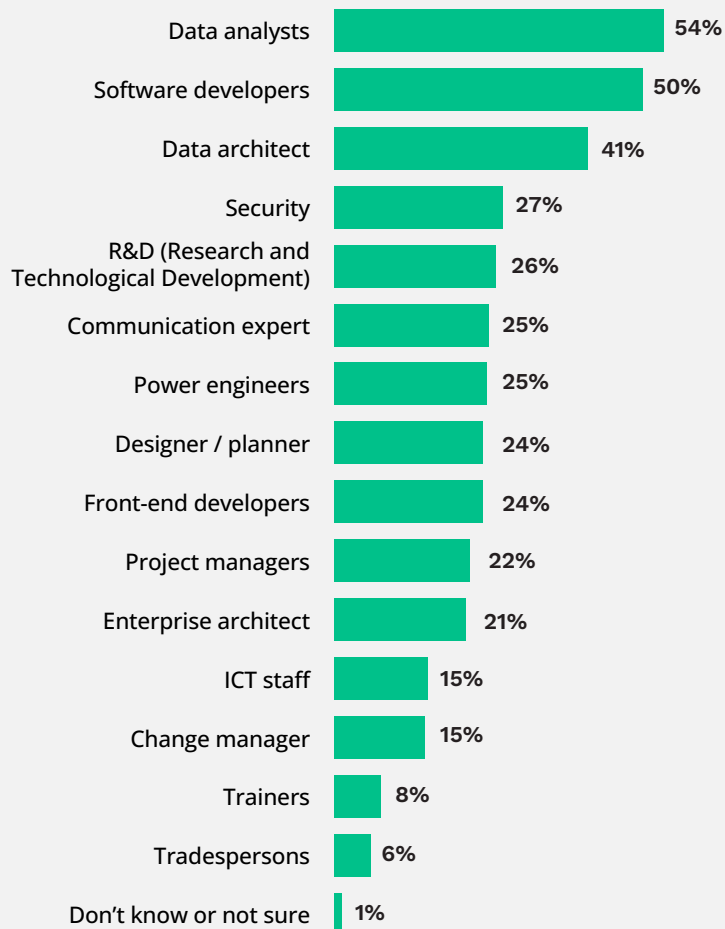
TRAINING

Organizations in the energy sector are seeking to improve their employees' digital technology skills

In this section, we aimed to focus on training to better understand the potential ways of upskilling the energy sector's workforce. We explored what actions organizations are taking to improve their employees' digital technology skills. We also examined different training approaches such as on-the-job or online training. It is also important to know where training should

FIGURE 14
SKILLS NEEDED BY THE INTERNAL WORKFORCE

Which competencies best represent the skills needed by your internal workforce?



2022 Transformation Readiness Survey, Q37, sample size = 435, valid cases = 435, total mentions = 1,674.

happen, be it within or outside the organization. We investigated what type of skills organizations are keen to include in their training programs, and we also explored the role of soft skills in the energy sector.

Most organizations focus on improving the development process and adopting best practices, while training happens parallel to these actions. This means that organizations realize the importance of not just training but improving the working environment by revising their internal processes. We found that organizations see value in both on-the-job and online training but would prefer training within their organization, including from their internal upskilled workforce. Training outside the industry is still important nonetheless. In terms of what skills should be trained, half of the organizations believe that software and OSS skills should be covered in training programs. Soft skills are also deemed important by organizations for digital transformation.

MOST ORGANIZATIONS FOCUS ON IMPROVING THE DEVELOPMENT PROCESSES

FIGURE 15 shows that more than half of the organizations surveyed (55%) improve development processes to boost their employees' digital skills. This shows that organizations are aware of actions besides training that can help their workforce advance. 43% of respondents selected the adoption of best practices as one of the actions taken by their organization, such as agile working and collaboration best practices.

TABLE A51 shows that there are various approaches to training, and organizations see value in both on-the-job and online training.

In terms of the source of the training, TABLE A52 shows that 38% of respondents would prefer that the source of training is within the industry, and another 25% would like training to come from an internal retrained workforce. 31% would prefer training from other industry sectors.

A LARGE NUMBER OF ORGANIZATIONS SAY OSS SKILLS SHOULD BE COVERED IN THEIR TRAINING PROGRAMS

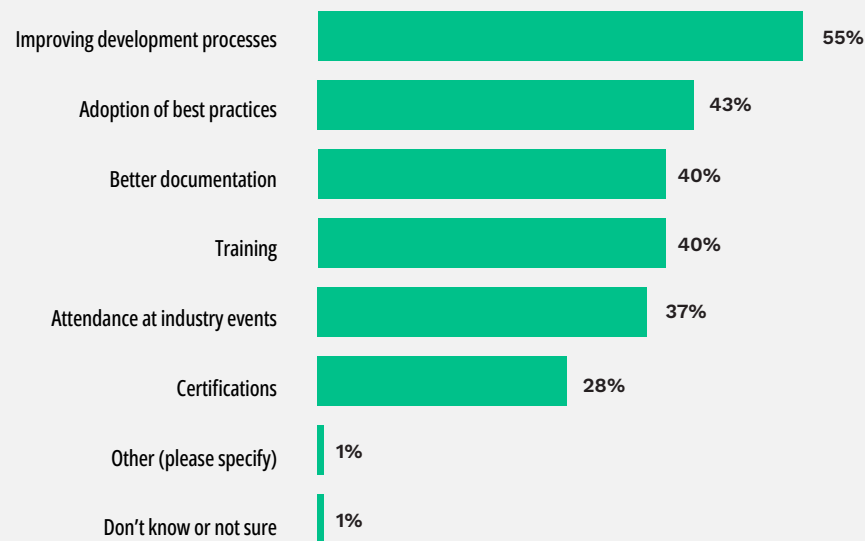
According to [FIGURE 16](#), nearly half of the organizations surveyed believe that software and OSS skills should be covered in training programs. The most popular skills to be covered in training programs are software development and software analytics skills. Through training, employees could feel safer and more supported when developing or simply using OSS.

Organizations would like to see data skills in their training programs but to a lesser degree than software skills. This might be due to already-in-place solutions for outsourcing data skills.

Soft skills are also important for digital transformation. Collaboration among stakeholders requires communication skills. [TABLE A50](#) shows that 36% of organizations believe that communication should be included in their training programs. Project management is also crucial for strategies to be implemented. Similarly, 36% of respondents believe that project management skills are also valuable skills that their employees should be trained for.

FIGURE 15
ACTIONS TO IMPROVE EMPLOYEE'S DIGITAL TECHNOLOGY SKILLS

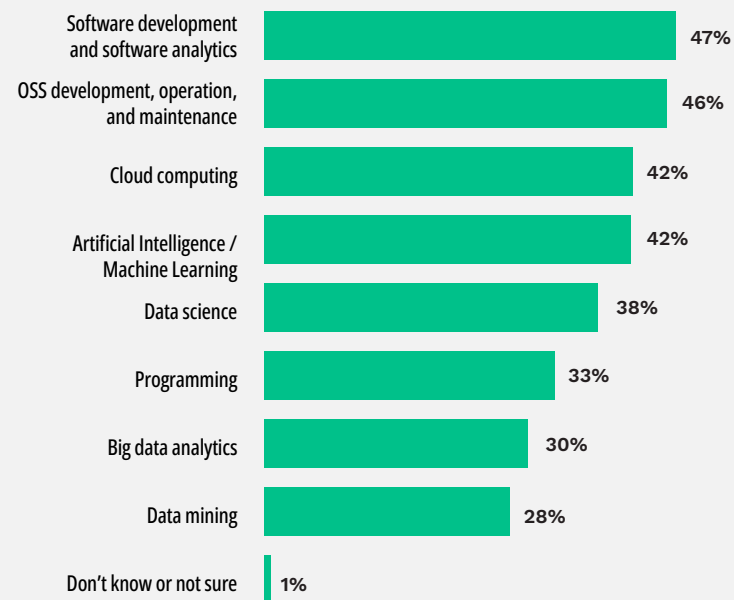
What actions is your organization taking to improve employee digital technology skills?



2022 Transformation Readiness Survey, Q43, sample size = 430, valid cases = 430, total mentions = 1,053.

FIGURE 16
SKILLS TO BE COVERED IN TRAINING PROGRAMS

What digital skills should be covered in your organization's training programs?



2022 Transformation Readiness Survey, Q44, sample size 430, valid cases = 430, total mentions = 1,317.

Conclusions

The importance of digitalization and being data-driven

This research showed that energy stakeholders are consciously paving their way to grid transformation and decarbonization. We showed that most organizations have a digitalization plan in place and find the transition to data-intensive processes important. At the same time, organizations clearly understand the benefits gained from digitalization and its impact on decarbonization, which include the enablement of new services for customers, facilitating more automation, and supporting higher levels of collaboration with stakeholders and operators. However, a systematic change of digitalization in the energy sector is still underway, as the IT and OT processes are still separate in around half of the organizations surveyed. Nonetheless, organizations realize the benefits of digitalization and the role it plays in decarbonization. A lack of digital preparedness is also a challenge that many organizations are aware of.

A data-driven approach can bring many benefits for businesses in today's world. This is especially true for organizations in the energy sector as they transition from the traditional model to a more dynamic and sustainable energy chain. Businesses can rely on data to make better decisions, as their choices are based on evidence rather than intuition. This can result in better insights into customer behavior, market trends, and their own operations. Using data to optimize processes improves efficiency, which is a crucial point in the energy sector as organizations try to reduce energy waste. In addition, data enables energy efficiency to appear on the customer's side since smart home systems can help simplify, reduce, and manage energy consumption on the household level. This also paves the way to innovation and to finding new ways to develop products and services that consumers

appreciate. Data can also reduce risk since organizations can analyze information that can facilitate the development of best practices and risk mitigation. Being data-driven can give energy sector businesses a competitive advantage in today's data-rich environment. By using data to make informed decisions, optimize their operations, and improve the customer experience, businesses can increase efficiency, competitiveness, and innovation, while reducing risk.

OSPOs are key to OSS adoption and to addressing governance compliance

Energy companies are keen to use OSS, as most of them are planning to or are already using it for their work. As open source use is best supported by an OSPO and / or security team, it is reassuring to see stakeholders understanding the role of an OSPO and OSS governance. Although there are benefits of OSS that are most popular among stakeholders, such as transition speedup and cost reduction, they realize the vast array of advantages OSS can bring to the energy sector. Flexibility was the most cited promising feature of OSS, showing that organizations are keen to build their own software for their specific needs. As performance, support, and security came up as the most important concerns for the organizations surveyed, the OSS community will need to convince energy stakeholders of open source's ability to meet or even surpass the level of closed source software regarding these areas.

Training is a viable solution to addressing the digitalization knowledge gap

There is a knowledge gap when it comes to digital skills; however, it is moderate and differs across regions. Most organizations are

generally optimistic about the skills they have to meet digitalization goals. Where there are gaps in skills, data and software skills are the most sought after. These skills are often outsourced in the sector. Organizations have not only considered training to improve their employees' skills but are also improving their development processes and adopting best practices. This suggests that organizations are taking a holistic view when strategizing how to upskill their employees. Organizations see value in both on-the-job and online training but prefer if training is sourced from within their organizations. Stakeholders are keen to include software and OSS skills as well as soft skills, such as communication and project management.

Open source is vital to addressing today's energy sector needs

OSS provides tools and technologies that enable the development and deployment of clean energy solutions. As most OSS is developed in a collaborative environment, energy stakeholders can contribute from around the world, which leads to faster innovation and the creation of better solutions. From a sustainable future perspective, transparency and accountability are crucial, and so OSS becomes an evident solution to ensure clean energy solutions are deployed in a responsible and sustainable way. OSS has been widely recognized for its ability to create interoperable systems. This is not different in the energy sector, where multiple technologies are needed to be integrated into the grid. As OSS is highly customizable, energy stakeholders can tailor software to their specific needs, allowing local solutions to a worldwide collaboration effort. Overall, OSS can play an important role in helping the energy industry achieve decarbonization by enabling faster innovation, reducing costs, increasing transparency, improving interoperability, and providing flexibility and delivering customization options.

Methodology

About this study

From a research perspective, we aimed to eliminate sample bias and ensure high data quality. We addressed eliminating sample bias by sourcing 89% of the usable sample from a third-party panel provider and the remaining 11% from Linux Foundation Members.

We addressed data quality through extensive screening criteria to ensure that respondents had sufficient familiarity and professional experience to answer questions accurately on behalf of the organization they worked for.

The worldwide survey conducted by Linux Foundation Energy and Linux Foundation Research was designed to gather insights on the current trends and challenges related to digitalization, OSS use, and related skills in the energy sector. The survey was conducted in 2022 Q4 and was promoted through various channels, including social media, the Linux Foundation, Linux.com websites, and the Linux Foundation Newsletter.

The final sample size analyzed was a maximum of 441 respondents. The margin of error for the survey data is $\pm 4.7\%$ at a 95% confidence level. Not all percentages will add to 100% due to rounding.

For more details about the screening criteria used and access to the survey dataset, see <http://www.data.world/thelinuxfoundation>.

How missing data is handled

Although respondents are required to answer nearly all questions in the survey (the only exceptions are the open-ended questions), there are times when a respondent is unable to answer a question because it is outside the scope of their role or experience. For this reason, we frequently add a “Don’t know or not sure” (DKNS) response to the list of responses for a question. However, this creates a conundrum regarding how to deal with DKNS responses.

One approach is to treat it just like any other response. In this way, report readers can see the percentage of respondents that answered DKNS. The advantage of this approach is that it reports back the exact distribution of the data collected. The challenge with this approach is that it distorts the distribution of valid responses—those responses where respondents could answer the question.

Some of the analyses in this report excluded the DKNS. This can be done because the data missing can either be classified as missing at random (MAR) or missing completely at random (MCAR). Excluding DKNS data from a question does not change the distribution of data (counts) for the other responses, but it does change the size of the denominator used to calculate the percent of responses across the remaining responses. This has the effect of proportionally increasing the percentage values of the remaining responses relative to the number of DKNS responses. The number of valid cases is adjusted accordingly. Where we have elected to exclude DKNS data, a careful examination of the footnote for the figure will enable the reader to determine the number of DKNS responses based on the difference between the sample size (DKNS inclusive) and valid cases (DKNS excluded).

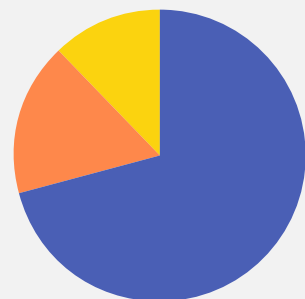
Demographics

FIGURE 17 presents a combination of employee and organizational demographics. This was a worldwide study, with 71% of organization headquarters located in North America, 17% in Europe, and 12% in Asia-Pacific countries. Company size data (number of employees) in the second panel was originally collected across 7 size categories (**TABLE A15**). We aggregated and then recoded this data into two categories: 1 to 999 employees (71%), and 1,000 or more employees (29%). The third panel classifies the role of the respondent and shows that 81% of respondents were in leadership positions within

their organizations, and 19% were in non-leadership positions. The fourth panel in **FIGURE 17** shows the distribution of organization types in the energy sector. It is important to note that this was a “select all that apply” question. A total of 39% of our sample selected “energy aggregator,” but most of them also chose other energy sector categories. More traditional categories, such as generation, transmission, and distribution, are part of the answer choices but we also included more modern categories of the energy sector, such as flexibility services, congestion management, and EV mobility. Other categories include oversight or regulating bodies, academic divisions, and commercial or industrial consumers.

FIGURE 17
SELECTED DEMOGRAPHICS OF THE 2022
TRANSFORMATION READINESS SURVEY

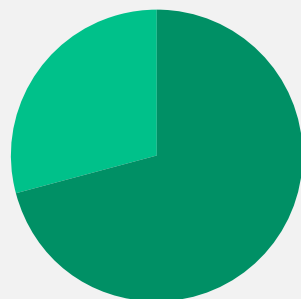
Organization’s region



71% United States / Canada
17% Europe
12% Asia-Pacific

2022 Transformation Readiness Survey, Q8, sample size = 428

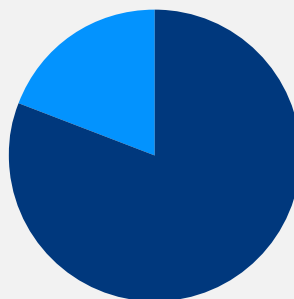
Organization’s size



71% 1,000 or more
29% Less than 1,000

2022 Transformation Readiness Survey, Q15, sample size = 441

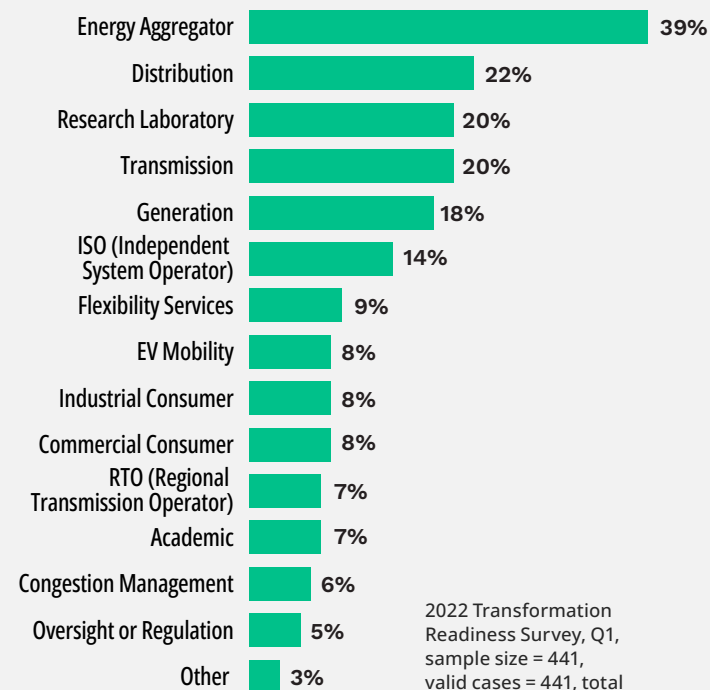
Respondent’s Leadership Position



81% Leadership position
19% Non-leadership position

2022 Transformation Readiness Survey, Q13, sample size = 441

Organization’s energy sector category



2022 Transformation Readiness Survey, Q1, sample size = 441, valid cases = 441, total mentions = 856

Appendix

This Appendix includes a frequency table for every question in the survey and selected crosstabs referenced in the report. The “count” column shows how many respondents selected a particular response. The “percentage” column shows the ratio of those respondents answering a response to the number of respondents available to answer the response. For a complete PDF of the survey instrument, see <http://www.data.world/thelinuxfoundation>. This Appendix includes 54 tables, numbered A1 through A54.

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT	PERCENTAGE
A1	Q1: Which of the following energy sectors are you currently employed in? (select all that apply)		
	Generation	81	18%
	Transmission	86	20%
	Distribution	96	22%
	Oversight or Regulation	21	5%
	Academic	30	7%
	Research Laboratory	90	20%
	EV Mobility	37	8%
	Energy Aggregator	172	39%
	Flexibility Services	38	9%
	ISO (Independent System Operator)	63	14%
	RTO (Regional Transmission Operator)	31	7%
	Congestion Management	26	6%
	Commercial Consumer	35	8%
	Industrial Consumer	37	8%
	None of the above	0	0%
	Other (please specify)	13	3%
	Total	441	
A2	Q2: How familiar are you with your organization's transition to distributed energy using digital technologies? (select one)		
	Don't know or not sure	0	0%
	Not familiar at all	0	0%
	Slightly familiar	0	0%
	Familiar	80	18%
	Very familiar	165	37%
	Extremely familiar	196	44%
	Total	441	

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT	PERCENTAGE
A3	Q3: Which of the following responses best describes you? (select one)		
	Don't know or not sure	0	0%
	I'm just lines of code	0	0%
	I'm a real person	441	100%
	I'm a bot	0	0%
	I just want to mess with the researchers	0	0%
	Total	441	
A4	Q4: How old are you? (select one)		
	Prefer not to answer	0	0%
	Under 18 years old	0	0%
	18 to 24 years old	3	1%
	25 to 44 years old	304	69%
	45 to 64 years old	133	30%
	65 or older	1	0%
	Total	441	
A5	Q5: What statement best describes your current employment situation? (select one)		
	None of the above	0	0%
	Student full time or part time	0	0%
	Employed full time	425	96%
	Employed part time	7	2%
	Self-employed full or part time	9	2%
	Unemployed but looking for work	0	0%
	Unemployed and not currently looking for work	0	0%
	Retired	0	0%
	Total	441	
A6	Q6: Professionally, which area best describes your field of competence? (select one)		
	Other (please specify)	6	1%
	Academia / Education	9	2%
	Business Analysis	10	2%
	Data Science / Research	82	19%
	Design	13	3%
	Developer / Software Engineer	171	39%

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT	PERCENTAGE
	Finance / Accounting	24	5%
	Operations / Support	40	9%
	Product / Delivery Management	7	2%
	Sales / Marketing	15	3%
	Senior / Executive Management	59	13%
	Systems Administration	5	1%
	Total	441	
A7	Q7: How do you identify yourself? (select all that apply)		
	Woman	58	13%
	Man	382	87%
	Non-binary	0	0%
	Prefer not to answer	0	0%
	Other (please specify)	2	0%
	Total	441	
A8	Q8: In which region does your organization have its primary headquarters? (select one)		
	Other (please specify)	1	0.2%
	North America (Canada / U.S.)	306	69.4%
	Mexico, Central America, and the Caribbean	2	0.5%
	South America	5	1.1%
	Europe (eastern & western, excluding Russia)	71	16.1%
	Middle East	2	0.5%
	North Africa	1	0.2%
	West and Central Africa	2	0.5%
	Eastern and Southern Africa	0	0.0%
	Asia-Pacific (except China, India, Japan, Russia, & Australia / New Zealand)	14	3.2%
	China	1	0.2%
	India	32	7.3%
	Japan	0	0.0%
	Russia	0	0.0%
	Australia / New Zealand	4	0.9%
	Total	441	

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT	PERCENTAGE
A9	Q8: In which region does your organization have its primary headquarters? (select one) (grouped)		
	U.S. / Canada	313	71%
	Europe	76	17%
	Asia-Pacific	51	12%
	Total	440	
A10	Q9: In which region do you live? (select one)		
	Other (please specify)	1	0.2%
	North America (Canada / U.S.)	303	68.7%
	Mexico, Central America, and the Caribbean	3	0.7%
	South America	5	1.1%
	Europe (eastern & western, excluding Russia)	69	15.6%
	Middle East	0	0.0%
	North Africa	0	0.0%
	West and Central Africa	1	0.2%
	Eastern and Southern Africa	0	0.0%
	Asia-Pacific (except China, India, Japan, Russia, & Australia / New Zealand)	14	3.2%
	China	0	0.0%
	India	41	9.3%
	Japan	0	0.0%
	Russia	0	0.0%
	Australia / New Zealand	4	0.9%
	Total	441	
A11	Q10: What is the highest level of formal education that you have completed? (select one)		
	Prefer not to answer	0	0%
	Less than secondary (high) school	0	0%
	Secondary (high) school graduate or equivalent	4	1%
	Some college, no-degree vocational / trade program or apprenticeship	5	1%
	Bachelor's degree	67	15%
	Master's degree	318	72%
	Doctorate (e.g., Ph.D., M.D., J.D.) or another advanced degree	47	11%
	Total	441	

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT	PERCENTAGE
A12	Q11: What were the main disciplinary fields of your education? (select all that apply)		
	Applied Science / Engineering	212	48%
	Arts / Humanities / Social Sciences	24	5%
	Commerce / Business	79	18%
	Computer Science	240	54%
	Education	24	5%
	Law	8	2%
	Medicine / Nursing	15	3%
	Science / Life Science	59	13%
	Other (please specify)	5	1%
	Total	441	
A13	Q12: Which of the following best describes the organization you work for? (select one)		
	Don't know or not sure	0	0%
	Government-owned organization	47	11%
	Privately-owned / Investor-owned organization	387	88%
	Non-profit organization	7	2%
	Total	441	
A14	Q13: What is your position in the organization you work for? (select one)		
	Other (please specify)	5	1%
	Developer / Contributor	75	17%
	Manager	59	13%
	Director	88	20%
	VP	115	26%
	C-Level / C-Suite	93	21%
	Consultant	6	1%
	Total	441	
A15	Q14: Which of the following best describes your organization's industry? (select one)		
	Other (please specify)	1	0.2%
	Agriculture	1	0.2%
	Automotive	9	2.0%

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT	PERCENTAGE
	Business Services (accounting, management consulting, legal, etc.)	6	1.4%
	Consumer Packaged Goods	0	0.0%
	Construction / Engineering	12	2.7%
	Education (K-12 / Primary / Secondary)	1	0.2%
	Education (College / University)	7	1.6%
	Financial Services (Banking / Insurance / Securities)	6	1.4%
	Government (Federal / National)	5	1.1%
	Government (State / Local)	3	0.7%
	Health Care	3	0.7%
	Hospitality	0	0.0%
	Information Technology (IT vendor, service provider, or manufacturer)	75	17.0%
	Life Sciences (biotech, pharmaceuticals, etc.)	11	2.5%
	Manufacturing (discrete or process)	7	1.6%
	Media (broadcast communications, entertainment, publishing, website, social networking, etc.)	3	0.7%
	Mining, Oil & Gas	26	5.9%
	Retail, Wholesale, & eCommerce	8	1.8%
	Telecommunications / Internet Service Provider (ISP) / Web Hosting	3	0.7%
	Transportation & Logistics (other than Automotive)	2	0.5%
	Utilities / Energy	252	57.1%
	Total	441	
A16	Q15: Please estimate how many employees the organization you work for has worldwide. (select one)		
	Don't know or not sure	0	0%
	10 or less	8	2%
	11 to 49	7	2%
	50 to 249	19	4%
	250 to 999	92	21%
	1,000 to 9,999	227	51%
	10,000 to 19,999	66	15%
	20,000 or more	22	5%
	Total	441	

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT	PERCENTAGE
A17	Q16: When talking about digital transformation preparedness, what perspective can you speak for? (select one)		
	Other (please specify)	0	0%
	I can speak for the entire company or organization that I work for	279	63%
	I can only speak for the department I work for within the company or organization	124	28%
	I work across multiple organizations and can speak for what I see in the industry	32	7%
	I can speak only for myself	6	1%
	Total	441	
A18	Q17: In your view, what role does digitalization (the application of software and data) play in the decarbonization of the energy sector? (select all that apply)		
	Don't know or not sure	1	0%
	Unlocks flexibility	139	32%
	Realizes new automation specifications	202	46%
	Enables collaboration among operators	199	45%
	Enables collaboration among a variety of stakeholders	202	46%
	Enables new business models	179	41%
	Enables new services to customers	207	47%
	Enables the outsourcing of technical and commercial services	199	45%
	Facilitates interoperability	180	41%
	Other (please specify)	6	1%
	Total	441	
A19	Q18: Does your organization have a clear strategic plan for digitalization? (select one)		
	Don't know or not sure	3	1%
	No	11	2%
	Not yet, but it is in development	17	4%
	Yes, but it has not been implemented yet	75	17%
	Yes, and it has been implemented	335	76%
	Total	441	
A20	Q19: Does your organization have a Chief Data Officer? (select one)		
	Don't know or not sure	9	2%
	No	14	3%

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT		PERCENTAGE
	No, but this role is implicitly covered by other positions	38		9%
	No, but this role is explicitly assigned to another Officer	44		10%
	No, but this role is covered by a third-party vendor	21		5%
	Yes	315		71%
	Total	441		
A21	Q20: In your opinion, where does your organization rank in terms of digitalization preparedness among the organizations in your sector? (select one)			
	Don't know or not sure	5		1%
	Top 25%	120		27%
	Between the bottom 25% and the top 25%	201		46%
	Between the bottom 5% and the bottom 25%	111		25%
	Bottom 5%	4		1%
	Total	441		
A22	Q20: In your opinion, where does your organization rank in terms of digitalization preparedness among the organizations in your sector? (select one) segmented by Q8: In which region does your organization have its primary headquarters? (select one)			
		U.S. / Canada	Europe	Asia-Pacific
	Top 25%	23%	35%	42%
	Between the bottom 25% and the top 25%	45%	46%	54%
	Bottom 25%	31%	19%	4%
A23	Q21: Which of the following statements reflect your personal thoughts on open source software (OSS)? (select all that apply)			
	Don't know or not sure	1		0%
	OSS is only good for academic developments	107		24%
	OSS is simply defined as a permissive IP license that enables shared investment and leveraged development	179		41%
	OSS covers only the non-competitive portion of the development	93		21%
	OSS seems the right way to go, but diving into it seems risky for individual companies	139		32%
	OSS enables shared investment that speeds up affordable development, but I don't understand how companies profit	179		41%
	OSS enables shared investment that speeds up affordable development, and companies still can profit from overlaying diff	289		66%
	None of the above	5		1%
	Total	441		

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT	PERCENTAGE
A24	Q21: Which of the following statements reflect your personal thoughts on open source software (OSS)? (select all that apply) (grouped)		
	Strong believer	289	66%
	(Partially) unconvinced	152	34%
	Total	441	
A25	Q22: How familiar are you with how OSS is being used in your organization? (select one)		
	Don't know or not sure	2	0%
	Not familiar at all	4	1%
	Slightly familiar	19	4%
	Familiar	69	16%
	Very familiar	178	40%
	Extremely familiar	169	38%
	Total	441	
A26	Q23: How familiar are you with the OSS governance in your organization? (select one)		
	Don't know or not sure	1	0%
	Not familiar at all	9	2%
	Slightly familiar	22	5%
	Familiar	61	14%
	Very familiar	193	44%
	Extremely familiar	155	35%
	Total	441	
A27	Q24: Which of the following statements reflect your organization's beliefs about open source governance? (select all that apply)		
	Don't know or not sure	12	3%
	Governance regulates the interaction of OSS community participants	246	56%
	Governance protects interoperability	172	39%
	Governance enables joint investment	154	35%
	Governance leads to innovation and commercialization	242	55%
	Other (please specify)	1	0%
	Total	441	

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT	PERCENTAGE
A28	Q25: What is the current state of governance for OSS in the energy industry? (select one)		
	Don't know or not sure	12	3%
	Governance of OSS is not yet being discussed and does not exist yet	24	5%
	Governance of OSS is being discussed but does not exist yet	75	17%
	Governance of OSS is being discussed and beginning to be implemented	200	45%
	Governance of OSS already exists in some communities or foundations to ensure software neutrality	130	29%
	Total	441	
A29	Q26: How much does your organization use OSS to address system interoperability? (select one)		
	Don't know or not sure	5	1%
	Always	81	18%
	Very often	201	46%
	Sometimes	115	26%
	Rarely	35	8%
	Never	4	1%
	Total	441	
A30	Q27: Which of the following statements reflect your understanding of the role of an Open Source Program Office (OSPO)? (select all that apply)		
	Don't know or not sure	7	2%
	I do not know what the role of an OSPO is	30	7%
	An OSPO manages the relationship between the organization and the open source ecosystem	204	46%
	An OSPO manages development and contributions to software both within and outside of our organization to ensure the comp	289	66%
	The IP Office can easily take on the role of OSPO	140	32%
	There is no need for an OSPO, as the organization's developers directly manage the OSS components	64	15%
	Total	441	
A31	Q28: How do you see the intersection of Information Technologies (IT) and Operational Technologies (OT) in your organization? (select one)		
	Don't know or not sure	8	2%
	Clearly separate	206	47%
	On the way to convergence	227	51%
	Total	441	

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT	PERCENTAGE
A32	Q29: What is your organization's current open source software (OSS) readiness? (select one)		
	Don't know or not sure	11	2%
	We have not started to address OSS	13	3%
	We are planning how to address OSS	67	15%
	We are planning to use OSS within the next 6 months	86	20%
	We are planning to use OSS within the next 6-12 months	61	14%
	We are planning to use OSS within the next 12-24 months	28	6%
	We already use OSS and have an Open Source Program Office (OSPO)	58	13%
	We already use OSS and have a security team monitoring upstream OSS projects for vulnerabilities	57	13%
	We already use OSS and have both an OSPO and security team monitoring upstream OSS projects for vulnerabilities	60	14%
	Total	441	
A33	Q30: For your organization, what are the most promising features of OSS? (select all that apply)		
	Don't know or not sure	7	2%
	Shared investment: OSS allows for shared investment	117	27%
	Cost: OSS can be installed and used at a lower cost than proprietary software	120	27%
	Quality: OSS products offer superior quality	125	28%
	User base: OSS lets businesses capitalize on a broad base of users	109	25%
	Reusability: OSS fosters reusability	97	22%
	Interoperability: OSS fosters interoperability	129	29%
	Innovation: OSS enables faster innovation	144	33%
	Productivity: OSS helps reduce development time	150	34%
	Security: OSS offers better information security	136	31%
	Cooperation: OSS covers sections of software development where cooperation is more rewarding than competition	159	36%
	Reliability: OSS is consistently reliable	111	25%
	Flexibility: OSS comes without vendor lock-ins, irrelevant features can be effectively removed by the users, and the source code is free to modify	211	48%
	Scalability: OSS can be scaled up and down so that businesses can achieve their desired results	142	32%
	Total	441	

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT	PERCENTAGE
A34	Q31: What are the main barriers to OSS adoption in your organization? (select all that apply)		
	Don't know or not sure	8	2%
	Quality: Proprietary software is of a higher quality	139	32%
	Policies: Our institution prohibits the use of OSS	103	23%
	Cost: OSS cost is too high compared to alternatives	118	27%
	Internal expertise: Not enough technical expertise within our institution to handle OSS	153	35%
	Support: We need a vendor who can provide 24/7 support to any software we deploy	162	37%
	Reliability: We are concerned about the reliability of OSS	142	32%
	Security: We are concerned about the security of OSS	164	37%
	Performance: We are concerned about the performance / scalability of OSS	165	37%
	License: We have restrictions on (some) OSS licenses	121	27%
	No barrier: We do not face barriers to OSS adoption	20	5%
	Other (please specify)	7	2%
	Total	441	
A35	Q32: Which factors influence your organization's decision to use a particular OSS software package or library? (select all that apply)		
	Don't know or not sure	10	2%
	History of the project	75	17%
	Programming language used in the code	142	32%
	Quality of the source code	210	48%
	Community's activity and engagement	157	36%
	Number of maintainers / contributors	154	35%
	Size of the user community	137	31%
	Community / third-party support	129	29%
	Frequency of release cycle	97	22%
	Operating system dependencies	125	28%
	Lack of an equivalent proprietary software	86	20%
	Security	128	29%
	Performance	107	24%
	Reliability	79	18%
	OSS license of the software	54	12%
	Other (please specify)	1	0%
	Total	441	

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT		PERCENTAGE
A36	Q32: Which factors influence your organization's decision to use a particular OSS software package or library? (select all that apply) segmented by Q8: In which region does your organization have its primary headquarters? (select one)			
		U.S. / Canada	Europe	Asia-Pacific
	Quality of the source code	48%	41%	53%
	Number of maintainers / contributors	33%	35%	37%
	Community's activity and engagement	33%	39%	49%
	Programming language used in the code	28%	41%	41%
	Community / third-party support	27%	39%	27%
	Security	26%	34%	31%
	Size of the user community	26%	44%	51%
	Operating system dependencies	24%	34%	47%
	Performance	21%	30%	37%
	Frequency of release cycle	20%	30%	25%
	Lack of an equivalent proprietary software	20%	18%	22%
	Reliability	14%	25%	27%
	History of the project	13%	25%	24%
	OSS license of the software	8%	30%	18%
	Don't know or not sure	2%	3%	4%
	Other (please specify)	0%	1%	0%
	Total	441		
A37	Q33: What percentage of OSS can be typically found in most software used in your organization? (select one)			
	Don't know or not sure	15		3%
	less than 10%	15		3%
	10% to 24%	28		6%
	25% to 49%	115		26%
	50% to 74%	180		41%
	75% to 89%	79		18%
	90% to 100%	9		2%
	Total	441		

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT	PERCENTAGE
A38	Q34: What consequences do you expect for lack of preparedness for digitalization in the energy sector? (select all that apply)		
	Don't know or not sure	2	0%
	Erosion of business	79	18%
	Loss of jobs	81	19%
	Increase of jobs	75	17%
	Challenges in fulfilling regulation (loss of license to operate)	120	28%
	Challenges in competitiveness	146	33%
	Loss of customers	76	17%
	Inability to onboard customer-owned renewable sources	108	25%
	Missed opportunities in relation to transportation electrification	134	31%
	Increase in operating costs	130	30%
	Grid instability, asymmetric response to market signals, or supply-demand imbalance	130	30%
	Inability to maintain position and role in the market	134	31%
	Geopolitical instability	100	23%
	Loss of (broader) economic competitiveness	113	26%
	Penalties, fines, or regulatory actions due to energy service violations	124	28%
	Other (please specify)	3	1%
	Total	441	
A39	Q35: In your opinion, what benefits will OSS bring to companies in the energy sector? (select all that apply)		
	Don't know or not sure	3	1%
	Provides information that enables more informed risk-based decision-making	140	32%
	Enables faster recognition of new component vulnerabilities, so companies can understand immediately if they are at risk	173	40%
	Allows different partners to test, contribute changes upstream, and consume the software—for free—and as needed	174	40%
	Enables the organization to proactively identify alternatives for components that reach their end-of-life	165	38%
	Creates awareness of risky components and enables users to pursue mitigation strategies	146	33%
	Reduces cost through improved software component documentation and more streamlined administration	199	46%
	Speeds up the transition as it allows organizations to share insights and innovation in the energy sector	192	44%
	Other (please specify)	2	0%
	Total	436	

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT	PERCENTAGE
A40	Q36: What would improve the energy sector's adoption of OSS? (select all that apply)		
	Don't know or not sure	5	1%
	Industry consensus for best practices to integrate OSS technology into software development practices	187	43%
	Industry consensus for best practices to integrate OSS technology into risk and compliance processes	182	42%
	Industry consensus on how to use OSS technology and how these methods will evolve / improve over time	188	43%
	Knowing which distributor will be providing tools and capabilities to OSS	158	36%
	Clarity on what industry OSS standards should be supported	134	31%
	Clarity about the timeline and milestones for adopting / supporting OSS	148	34%
	Education and FAQs about how OSS started, where it is today, and how it will evolve over the next few years	144	33%
	Other (please specify)	5	1%
	Total	436	
A41	Q37: Which competencies best represent the skills needed by your internal workforce? (select all that apply)		
	Don't know or not sure	5	1%
	Change manager	64	15%
	Communication expert	109	25%
	Data analysts	233	54%
	Data architect	179	41%
	Designer / planner	105	24%
	Software developers	218	50%
	Enterprise architect	93	21%
	Front-end developers	105	24%
	ICT staff	66	15%
	Power engineers	108	25%
	Project managers	96	22%
	R&D (Research and Technological Development)	114	26%
	Security	119	27%
	Tradespersons	26	6%
	Trainers	33	8%
	Other (please specify)	1	0%
	Total	435	

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT	PERCENTAGE
A42	Q38: Which skills / competencies are outsourced in your organization? (select all that apply)		
	Don't know or not sure	12	3%
	Our organization does not outsource skills/competencies	64	15%
	Change manager	73	17%
	Communication expert	93	21%
	Data analysts	164	38%
	Data architect	132	30%
	Designer / planner	104	24%
	Software developers	141	32%
	Enterprise architect	79	18%
	Front-end developers	70	16%
	ICT staff	52	12%
	Power engineers	72	17%
	Project managers	67	15%
	R&D (Research and Technological Development)	74	17%
	Security	68	16%
	Tradespersons	26	6%
	Trainers	33	8%
	Other (please specify)	1	0%
	Total	435	
A43	Q39: What types of vendors do you outsource these skills / competencies to? (select all that apply)		
	Don't know or not sure	4	1%
	Cloud service providers	165	46%
	Communications companies	164	46%
	Consultants	139	39%
	Networking companies	177	50%
	System integrators	96	27%
	Other (please specify)	5	1%
	Total	357	

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT		PERCENTAGE
A44	Q40: How difficult is it for your organization to fill positions in software and programming? (select one)			
	Don't know or not sure	4		1%
	Extremely difficult	11		3%
	Difficult	39		9%
	Moderate	164		38%
	Easy	124		29%
	Very easy	90		21%
	Total	432		
A45	Q40: How difficult is it for your organization to fill positions in software and programming? (select one) segmented by Q8: In which region does your organization have its primary headquarters? (select one)			
		U.S. / Canada	Europe	Asia-Pacific
	Easy / very easy	56%	28%	41%
	Moderate	38%	43%	37%
	Extremely difficult / difficult	6%	27%	18%
A46	Q41: What are the main obstacles to reskilling / upskilling the workforce for your energy business? (select all that apply)			
	Don't know or not sure	7		2%
	Difficulty in identifying which skills employees have, which skills they need, and how to fill the gaps (performance map	162		38%
	Training offer is not practical	105		24%
	Training offer does not connect with the job requirements	152		35%
	Lack of time for training	160		37%
	Costs of training	149		34%
	Peer pressure	91		21%
	Quick and continuous change of technical skills needs	140		32%
	Lack of goals	70		16%
	Resistance of the workforce due to fear of failure, fear of losing status, or job security	124		29%
	Resistance of the workforce due to a wrong perception of the training	53		12%
	Other (please specify)	0		0%
	Total	432		

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT	PERCENTAGE
A47	Q42: To what extent do you agree or disagree with the following statement: My organization has the skills needed to address its digitalization needs. (select one)		
	Don't know or not sure	3	1%
	Strongly disagree	6	1%
	Disagree	16	4%
	Neither agree nor disagree	24	6%
	Agree	218	51%
	Strongly agree	163	38%
	Total	430	
A48	Q43: What actions is your organization taking to improve employee digital technology skills? (select all that apply)		
	Don't know or not sure	6	1%
	Adoption of best practices	184	43%
	Attendance at industry events	161	37%
	Better documentation	170	40%
	Certifications	122	28%
	Improving development processes	237	55%
	Training	170	40%
	Other (please specify)	3	1%
	Total	430	
A49	Q44: What digital skills should be covered in your organization's training programs? (select all that apply)		
	Don't know or not sure	5	1%
	Data science	163	38%
	Big data analytics	129	30%
	Artificial Intelligence / Machine Learning	179	42%
	Data mining	120	28%
	Software development and software analytics	201	47%
	Programming	142	33%
	OSS development, operation, and maintenance	197	46%
	Cloud computing	180	42%
	Other (please specify)	1	0%
	Total	430	

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT	PERCENTAGE
A50	Q45: What soft skills should be covered in your organization's training programs? (select all that apply)		
	Don't know or not sure	6	1%
	Project management	156	36%
	Leadership	136	32%
	Team working / collaboration	146	34%
	Lateral thinking	119	28%
	Communication	154	36%
	Learning agility	151	35%
	Change management	116	27%
	Cross-functionality	121	28%
	Interdisciplinarity	126	29%
	Social awareness (interest in and understanding of social responsibility)	154	36%
	Other (please specify)	1	0%
	Total	430	
A51	Q46: Which of the following approaches to training are appropriate for training at your organization? (select all that apply)		
	Don't know or not sure	2	0%
	Online courses	151	35%
	E-learning platforms	187	43%
	Self-directed learning	171	40%
	MOOCs	101	23%
	Open source learning platforms	176	41%
	On-the-job courses / seminars	191	44%
	On-the-job practical experience	185	43%
	Blended learning	112	26%
	Mentoring / coach	88	20%
	Other (please specify)	0	0%
	Total	430	

TABLE	QUESTIONS AND ANSWER CHOICES	COUNT	PERCENTAGE
A52	Q47: In your opinion, which source of training should support most of the acquisition of knowledge skills / competencies by the current and future workforce? (select one)		
	Other (please specify)	8	2%
	School / academic education	21	5%
	Training from within the same industry	162	38%
	Training from other industry sectors	132	31%
	Training from internal re-trained upskilled workforce	107	25%
	Total	430	
A53	Q48: What are the technical and business priorities for your organization that other entities (in your industry) should be aware of? (select all that apply)		
	Don't know or not sure	7	2%
	Need to transform customer's experience (increasing satisfaction while decreasing cost to serve)	157	37%
	Need to reduce operating costs and increase competitiveness by building agile, forward-thinking, and lean organizations	180	42%
	Intelligent automation can help remove barriers between information systems and negate the need for additional staff while still enabling commercial growth	193	45%
	Mitigation of aging infrastructure and workforce through the introduction of intelligent automation and new technologies	185	43%
	Innovation needs related to climate change and sustainability	146	34%
	Ensure regulatory compliance and risk management	119	28%
	Need to create future operating models in the face of the dramatic change in the industry	160	37%
	Enhancing cybersecurity	126	29%
	Other (please specify)	0	0%
	Total	430	

Endnotes

- 1 Source: "LF Energy is Accelerating the Energy Transition through Open-Source Technology," Climate Tech Review, April 2023, Accessible at: <https://climatetechreview.com/lf-energy-is-accelerating-the-energy-transition-through-open-source-technology>
- 2 More information at: <https://www.lfenergy.org/projects/powsybl>
- 3 Source: The Business Value of the OSPO Report, The Linux Foundation, March 2023
- 4 Source: World of Open Source Europe Spotlight Report, The Linux Foundation, September 2022

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LF ENERGY

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