The future of the energy workforce

An IEEE Power & Energy Society – Kearney collaborative study

IEEE PES Power & Energy Society®

KEARNEY

Understanding the challenges, dynamics, and skills that will define those who will engineer the world's clean energy future

Executive summary

Across every corner of the world, the need to address the threat and risks posed by climate change is forcing an epic energy transition and evolution unprecedented in history. The power industry must develop scalable solutions, identify the most promising technologies, and upgrade existing infrastructure, while modernizing crucial areas of the energy system. At the same time, the industry must navigate difficult economics, competing political interests, governmental mandates and timetables, rising concerns over energy affordability, and fickle public will and support.

As difficult as the reality of this transition is and will be, there remains an even more defining challenge which we must meet: the need for a climate change-focused energy workforce.

The transition to clean energy will not happen in absence of a modern energy workforce; it will depend on it. The defining question is this: How will companies, educational institutions, and government agencies educate, recruit, and train this workforce of engineers while meeting the world's burgeoning energy needs and demands?

To answer this question, we've identified the broad trends that will have the most consequential impact:

1. **Overcoming a looming talent shortage.** With growing investments and policy initiatives aimed at enhancing power infrastructure to address climate change, the world will need between 450,000 and 1.5 million more power engineers by 2030 to design, implement, and operate the new infrastructure. That's potentially more than double the size of today's workforce.

2. **The impact of emerging disruptive technologies.** Technologies such as AI and machine learning, the Internet of Things, smart grids, and digital twins have widespread potential in power generation and management.

3. **Expanding the pipeline of engineers.** Industry leaders increasingly agree on the opportunity to diversify beyond electrical engineers (about 50 percent of engineers in the power workforce today). For instance, more mechanical engineers are needed. Additionally, women constitute only 23 percent of the engineering workforce.

4. **Electricity demand is rising steeply.** Between the expansion of electrification for vehicles, indoor cooling, data center requirements, and population growth, it is estimated that energy demand will increase by more than 50 percent, on average, by 2040, with the sharpest increases in India (239 percent), Mexico (99 percent), and China (97 percent). Between now and 2030, renewables such as solar, wind, and biopower will account for the biggest percentage gains in capacity.

5. **Global investment in clean energy systems, generation, and infrastructure is historic.** In 2022, there were more people employed in low-emissions power generation and grids than in traditional fossil fuel supply.

6. **Need for a more skilled workforce.** Up to 40 percent of industry executives believe that an insufficiently skilled workforce, coupled with the competition for talent that is skilled appropriately, will represent one of the greatest challenges in filling engineering positions over the next five to 10 years.

7. **Curricula are misaligned.** Current educational curricula and training programs are not keeping pace with the increasing demand for engineers with diverse multidisciplinary skills and digital expertise. For instance, executives still consider project management an increasingly essential skill.

8. **The power industry has an image problem.** University professors interviewed worldwide claimed more students are opting for careers in IT and technology. To compete, the power industry needs to cultivate a more appealing image with students.

9. **Talent retention is a concern.** Almost half of all power engineers have either changed jobs within their company, moved to another employer, or left the industry in the past three years. Additionally, about 15 percent of the power engineering workforce plan to retire in the next decade.

10. **Power companies, industry associations, and universities must act with urgency to help cultivate a new generation of engineers to meet these challenges.** See the recommendations section for details on specific targeted actions.

This report, a joint study by Kearney and the IEEE Power & Energy Society (PES), explores these trends to understand their implications for the world's engineering workforce over the next decade. As part of this study, we assess future workforce needs and expectations and probe the gaps between workforce demand and supply.

What is clear, based on our analysis, is that the energy industry will not be able to mitigate the global effects of climate change, let alone lead the world through this clean energy transition, unless it is able to develop, train, and compete effectively for the best and the brightest among our workforce.

The transition to clean energy will not happen in absence of a modern energy workforce; it will depend on it.

The present engineering workforce: key survey insights

It will take a legion of engineers with the right capabilities to power the energy transition. The industry today is falling woefully short: the workforce is too small, the pipeline too thin, and the capabilities not fully in place.

As the threat of climate change grows and the need for global action increases, the global demand for a new army of differently trained engineers, who will build and manage these energy systems, will also increase. To understand what engineers the world will need in the future, it is important to understand the present composition and background of engineers. To that end, the IEEE PES–Kearney survey of engineers highlights the nature of this workforce today, and how much this vital sector will need to evolve over the coming years and decades.

Engineers are concentrated in a few disciplines

According to the IEEE PES–Kearney survey of more than 700 engineers, about 50 percent of engineers working in the power industry today are electrical engineers. Another nearly 30 percent are evenly divided between mechanical and chemical engineering.[1]

While many engineers work across multiple sectors, the largest percentage have experience in renewable power generation (45 percent) and fossil-fuel-based generation (36 percent).

[1] These breakdowns, along with our other demographic findings, are representative, as corroborated in our many interviews with industry executives and leaders.

A clear gender gap[2]

The power industry is predominantly male, accounting for 77 percent of the workforce. Women constitute 23 percent of the engineering workforce. Nonbinary respondents represented less than 1 percent of the workforce. The highest percentage of female engineers are in North America (28 percent); the lowest proportion of women in the industry are in Asia and the Middle East (see figure 1).

Overall, about 76 percent of the workforce surveyed hold technical positions ranging from junior engineer and senior engineer to engineering manager and director-engineer. The remaining 24 percent hold management roles ranging from individual contributor and manager/supervisor to senior manager and director.

The power industry is predominantly male, accounting for 77 percent of the workforce. Women constitute 23 percent of the engineering workforce.

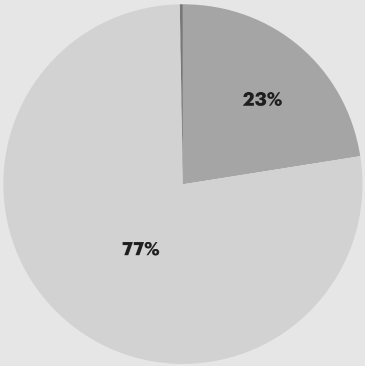
[2] In this report, we define gender as an individual's personal or social identity.

Figure 1

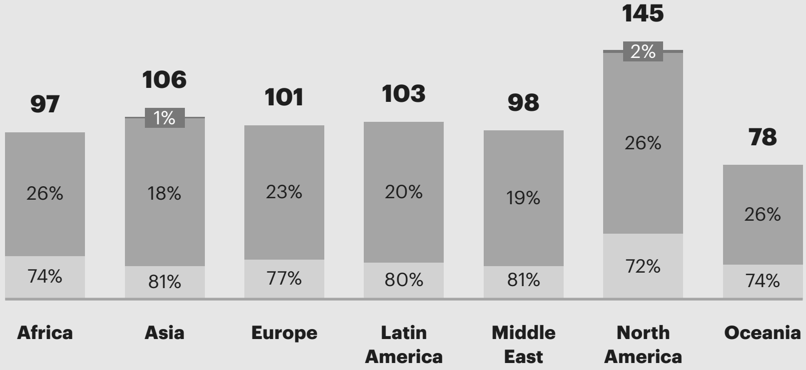
Females make up 23% of the power industry with the highest representation in the North America region and the nuclear power generation sector

Gender breakdown of survey participants

Overall gender breakdown[1]



Gender breakdown by region



Male Female Nonbinary

N = 727

[1] The question was optional and the % represents the total respondents who answered (n = 727).
Note: percentages may not resolve due to rounding.
Source: 2024 IEEE PES–Kearney Survey

In terms of position, there are fewer women on the technical ladder than on the management ladder (see figure 2):

— Of the respondents on the technical ladder, only 22 percent are female, with the smallest representation at the engineering director level (16 percent).

— Of the respondents on the management ladder, 25 percent are female, with the smallest representation, again, at the director level (19 percent).

Clearly, women on the technical ladder are dropping out at senior levels.

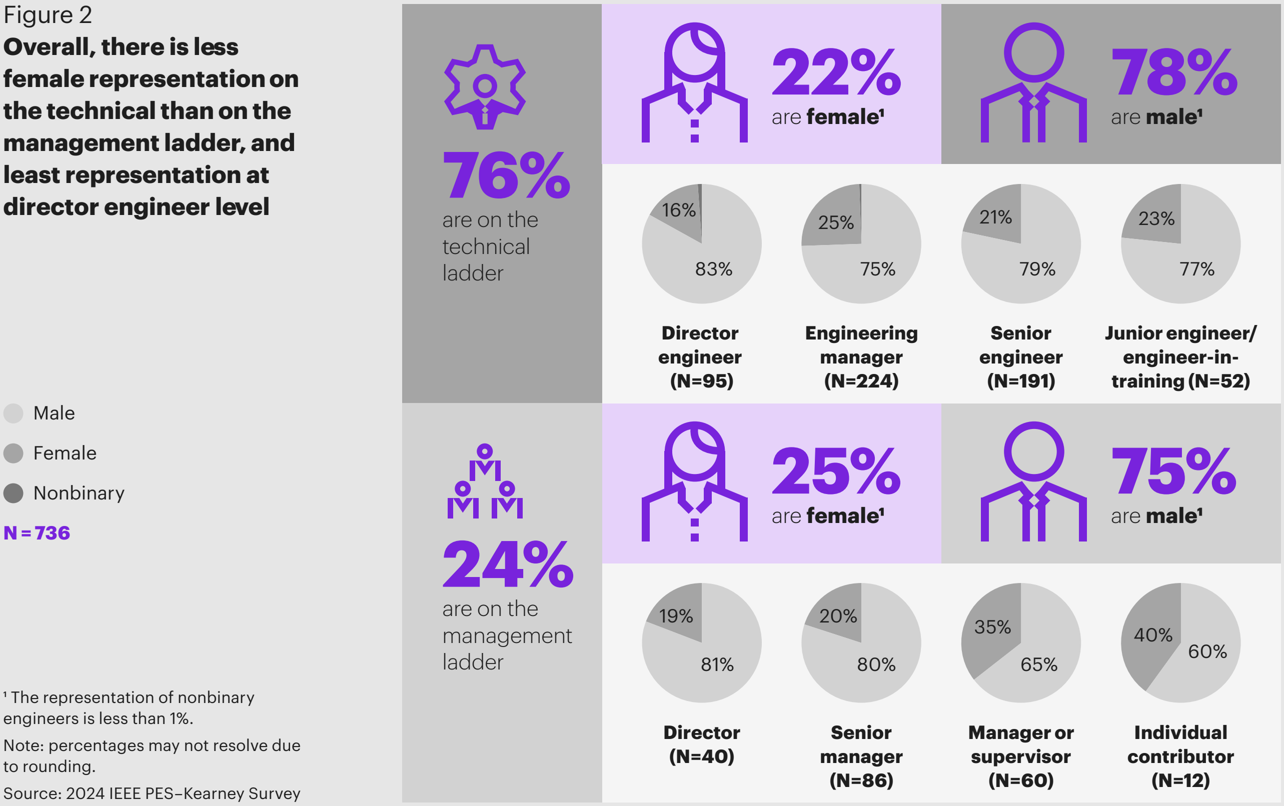
Need to expand ethnic diversity

Whites/Caucasians account for the largest proportion of power engineers, at 38 percent of the workforce. Asians and Pacific Islanders constitute the next-largest share, at 23 percent.

Geographically, North America's power workforce is 73 percent White/Caucasian, 6 percent Black/African American, 7 percent Hispanic/Latino, and 5 percent Asian and Pacific Islander. This breakdown indicates there is room for more diversity, especially for Black/African Americans. Attracting diverse talent is an important way to expand the talent pool, in North America and elsewhere.

The ethnic diversity in the Middle East's power industry workforce is a function of that region's dependence on a large expatriate workforce. Sixty-nine percent of the region's engineers migrated there for better job prospects. Asians and Pacific Islanders represent about half the region's power engineers, and 12 percent of engineers are Caucasian. Just under 20 percent of the workforce is homegrown.

Figure 2
Overall, there is less female representation on the technical than on the management ladder, and least representation at director engineer level



[1] The representation of nonbinary engineers is less than 1%.

Note: percentages may not resolve due to rounding.

Source: 2024 IEEE PES–Kearney Survey

Impact of retirement

About 15 percent of the power engineering workforce plan to retire in the next decade—a slightly higher percentage than what executives estimated (10 percent). In addition, more retirees are moving into part-time consulting roles, a trend that will continue to grow over the next 10 years. However, there's a material gap between the demand for part-time work opportunities and the current supply: 39 percent of engineers seek to transition to part-time work, whereas only 25 percent of employers offer that option.

About 15 percent of the power engineering workforce plan to retire in the next decade—a slightly higher percentage than what executives estimated.

A looming talent shortage

The global power industry is wrestling with significant supply and demand challenges against a backdrop of structural labor issues and more extreme weather events.

The world's power industry is at a pivotal moment.

Electricity demand, in advanced and emerging economies, is rising.[3] At the same time, the energy supply base is undergoing transformation, as governments further their commitment to renewable energy sources. Compounding the supply/demand challenge is the growing frequency of extreme weather events, which requires a more robust, reliable, and resilient power infrastructure.

As if these challenges weren't significant enough, structural shifts in the workforce and the current composition of the engineering workforce are converging to create a significant talent shortfall in the very types of workers needed now more than ever: engineers.

How significant is the problem? By 2030, the world will need between 450,000 and 1.5 million more power engineers to design, implement, and operate the very power systems that are not only crucial to the clean energy transition that is under way, but to meet exploding global energy demands.

What is shaping this looming talent shortage isn't just one factor, however. The following section will explore each of these economic, market, and technological forces that will impact the demand for the very engineers who will be entrusted to build the energy system of the future.

Evolving energy demand and supply

Electricity demand worldwide is rising steeply. Between the demands of electrified vehicles and other motors, indoor cooling, data center requirements, and sheer population growth, it is estimated that energy demand will increase by more than 50 percent, on average, by 2040, with the sharpest increases coming in India (239 percent), Mexico (99 percent), and China (97 percent).

Between now and 2030, renewables such as solar, wind, and biopower will account for the biggest percentage gains in energy capacity (see figure 3 on page 8). Solar capacity will more than triple, wind will double, and biopower will grow by nearly half. This reapportionment of capacity will lead to more variable and cyclic load profiles. In addition, power systems will become more decentralized and complex.

Emerging nations, already the biggest users of coal, will account for 92 percent of coal capacity by 2030. Their share of nuclear capacity will also grow considerably (from 38 percent to 53 percent of total capacity), offsetting nuclear's declining share in advanced economies.

[3] In this report, unless otherwise noted, the terms "advanced economies" and "emerging economies" reflect the countries our survey respondents and interviewees come from. Advanced economies include Australia and New Zealand ("Oceania"), Canada, Germany, the UK, and the US; emerging economies include Brazil, China, India, Mexico, and South Africa.

Figure 3

Electricity supply will be driven by low emissions sources, driving increasingly variable and cyclic load profiles and decentralized, higher-complexity systems

Global power plant capacities (MW)

Advanced economies[1] | Advanced economies[2]

		Total asset capacity 2023 (MW)			Change in capacity	Total asset capacity 2030 (MW)		
Conventional sources	Gas	35%	65%	1,087K	+17%	42%	58%	1,269K
	Coal	85%	15%	1,761K	+7%	92%	8%	1,883K
	Nuclear	38%	62%	188K	+23%	53%	47%	231K
	Hydro	75%	25%	723K	+9%	77%	23%	786K
	Oil	64%	36%	138K	-6%	66%	34%	129K
Alternative sources	Solar PV	68%	32%	1,035K	+202%	70%	30%	3,130K
	Wind	64%	36%	795K	+99%	68%	32%	1,584K
	Biopower	67%	33%	114K	+46%	71%	29%	165K
	Geothermal	28%	72%	7K	+24%	32%	68%	9K

[1] Advanced economies include the US, the UK, Canada, Australia, Germany, Netherlands, New Zealand.

[2] Emerging economies include Brazil, Mexico, China, India, South Africa, UAE, Saudi Arabia, Nigeria, Kenya.

Sources: GlobalData Power Capacity & Generation database; Kearney analysis

Historic levels of energy investment

Bold pledges and ambitious climate targets in advanced as well as emerging countries have prompted generous policy packages and funding mechanisms, such as the US Inflation Reduction Act, the EU REPowerEU plan, China's 14th Five-Year Plan, and India's renewable energy targets.

From 2019 through 2023, average global annual investment in the sector grew by a compound annual growth rate (CAGR) of 6.4 percent, reaching $1.4 trillion (see figure 4 on page 9). Investment was concentrated in renewable power, grid infrastructure and storage, end-use renewables, and electrification for buildings and transportation. Looking ahead, annual global energy investment is estimated to grow by another 3 percent to 14 percent by 2030, depending on how quickly policies are implemented.

This range is reflected in the three investment scenarios developed by the IEA: the Stated Policies Scenario (STEPS), which represents expected investment based on the latest policy settings in effect; the Announced Pledges Scenario (APS), which assumes all announced national energy and climate pledges are met in full and on time; and the Net Zero Emissions by 2050 Scenario (NZE), the investment needed for all countries to reach net zero (limiting global warming to 1.5 degrees Celsius) by 2050.

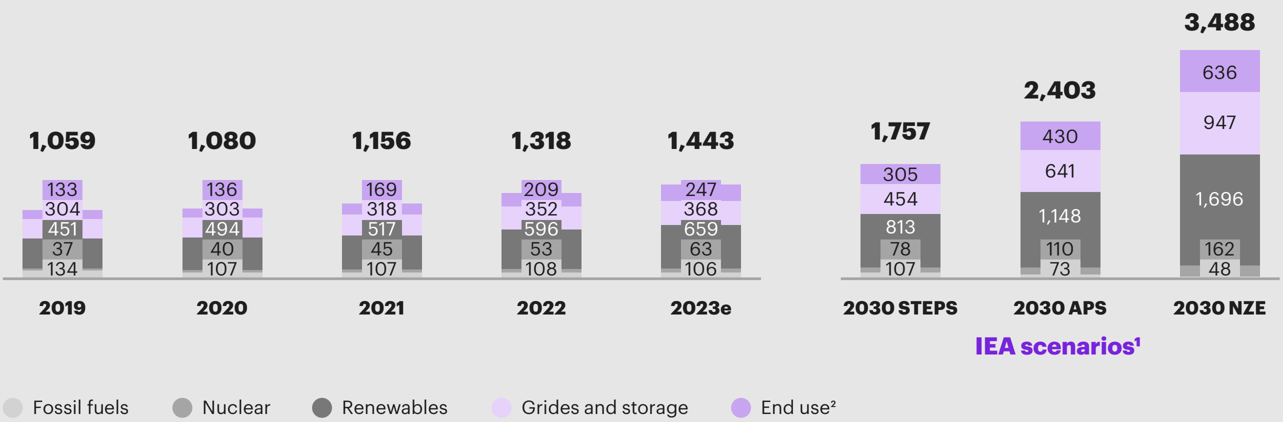
Why does this matter? The level of investment undertaken will directly impact the number of engineers, and the overall size of the energy workforce, required globally to help design, build, and implement these new and cleaner energy systems.

Figure 4

Power sector investments have been growing at an unprecedented rate, but still lack the desired momentum to reach net-zero targets

Global average annual investments in power sector by category, 2019–2030e[1]

(All values in $ billion)



[1] IEA's definitions of energy investment scenarios – STEPS: Expected investment based on the latest policy settings in effect; APS: Assumes all announced national energy and climate pledges are met in full and on time; NZE: limits global warming to 1.5 degrees Celsius by 2050

[2] The end use category may include direct use of renewables for heating, cooling, or industrial processes and electrification.

Note: numbers may not resolve due to rounding.

Sources: IEA World Energy Investment 2023; Kearney analysis

The changing nature of the power-sector workforce

Global investment in clean energy systems, generation, and infrastructure is causing a historic transformation in the composition of the world's energy workforce. In 2022, for example, there were more people employed in low-emissions power generation and grids than in traditional fossil fuel supply. In the four years ending in 2022, employment in the power industry grew 3.5 percent; in contrast, employment in the fossil fuel supply sector shrank by 1.1 percent.

As of 2022, the power industry employed 12.5 million people in power generation jobs and 8 million in grids and storage, according to the IEA. Power generation projects are a major driver of employment growth; roughly 60 percent of power generation jobs are in building new facilities. Jobs in "clean" energy—those in solar, wind, hydro, and nuclear—represent about 9.4 million, or more than 75 percent, of those 12.5 million power generation jobs. Solar PV accounts for 3.9 million jobs, the majority among key power generation technologies (see figure 5 on page 10).

Geographically, China, with 6.7 million power employees, is far and away the biggest power-sector employer, accounting for one-third of the total global workforce. This dominance stems from China's leading role in solar panel manufacturing. India, in second place, is quickly catching up. With the growing number of clean power generation installations—in particular, major solar and wind projects in emerging economies such as China and India—explosive employment growth in that sector is expected to continue.

Figure 5

Green jobs represent a major share of power sector employment today

Employment breakdown in the power industry, 2019–2022

[1] Fossil fuel supply includes oil, coal, and gas supply; power industry includes low-emissions and fossil fuel-based generation and grids and storage.

Sources: IEA World Energy Employment 2023; Kearney analysis

Changing national energy policies

In the United States, a combined $217 billion in tax credits and grants is expected to create more than 5 million jobs by 2030. Europe, with an aggregate $172 billion in loans and grants, will see more than 3.5 million new jobs. Canada and Australia, allocating $46.7 billion and $20 billion respectively, will see more than 1 million and 600,000 jobs created respectively. In total, nearly $456 billion in commitments will yield more than 10 million new jobs by 2030.

Emerging economies are also investing aggressively in power infrastructure through loans, tax incentives, public–private funding mechanisms, and direct subsidies. China's investment alone ($455 billion) equals that of advanced economies combined and is expected to generate more than 6.6 million jobs. India has committed $200 billion, which will produce more than 3.5 million jobs by the next decade. Brazil, with the most aggressive target for renewable generation—81 percent of its power by 2029—is investing $100 billion (via competitive bidding in power purchase agreements) and expects to create more than 7.5 million new jobs.

Emerging power infrastructure and digital technologies, driven by decarbonization mandates and technological advancement, are revolutionizing the industry.

The effect of future technology

Emerging power infrastructure and digital technologies, driven by decarbonization mandates and technological advancement, are revolutionizing the industry. Smart grids, along with renewable energy solutions such as bladeless wind turbines, SMRs, and advanced energy storage solutions, are enhancing grid efficiency and reliability. Technologies such as the Internet of Things (IoT), AI, and digital twins are enabling real-time monitoring, predictive maintenance, and optimized energy management. Distributed energy resources, electrification, and grid edge innovations are driving sustainability and resilience, while paving the way for a cleaner and more efficient energy future.

In aggregate, the new power infrastructure technologies are fueling a shift from the traditional centralized, one-way, and stable power grid to a modern decentralized, bidirectional, and intermittent power value chain.

Many legacy companies and new entrants have already introduced new infrastructure and digital technologies across the power value chain (see figure 6 on page 12).

Consider the following examples:

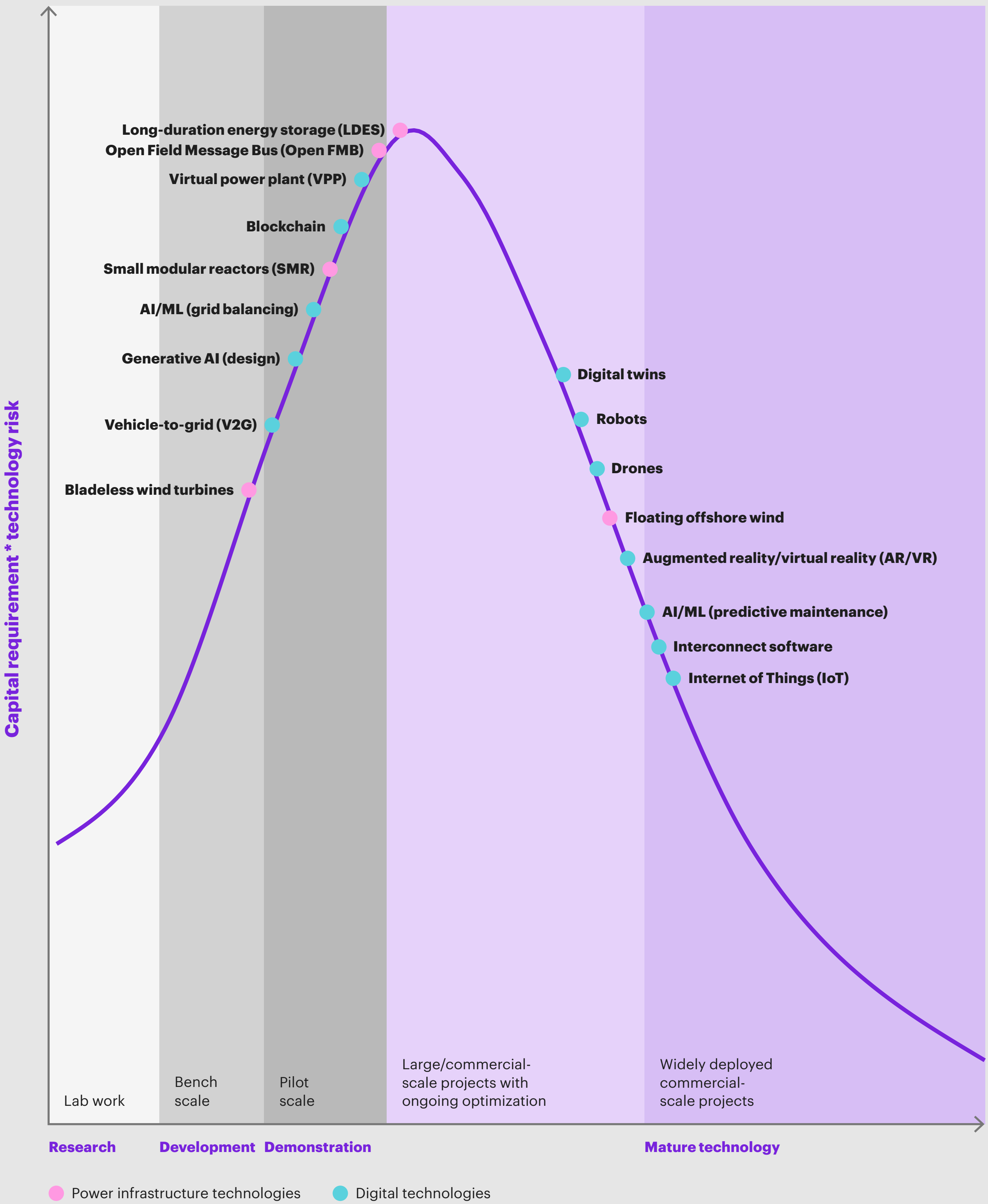
— **In development:** BASF is testing Aeromine Technologies' bladeless wind turbines at its manufacturing plant in Michigan. Aeromine's stationary and silent unit generates round-the-clock energy in any weather and takes 10 percent of the roof space needed by solar panels.

— **In the demonstration stage:** Nuscale recently certified its first SMR design for the US market. Each power module in this advanced light-water SMR can generate 50 megawatts of emissions-free electricity. The first module is expected to be operational by 2029 with full plant operation the following year.

— **Already commercialized:** Duke Energy recently extended its digital twins technology from its nuclear facilities to its hydro and fossil fuel plants.

Figure 6
Across the power value chain, new technologies have different maturity levels, indicating greater pace required for upskilling and reskilling engineers than in the past

Maturity curve for high-impact power technologies
(Non-exhaustive)



Note: AI/ML is artificial intelligence/machine learning.
Sources: ENTSO-e; Kearney analysis

The role of digital technologies

Digital technologies will be instrumental to the changing power system in two ways: in meeting the demands of increasingly complex power systems, and in enhancing productivity to mitigate the labor market constraints most countries face. Complexity will be a fixture of the new energy environment, and the world's future energy workforce will need to be trained across an array of digital technologies, such as:

— **Virtual power plants (VPPs).** A network of decentralized power units monitored through a central control room, VPPs maximize energy use and efficiency. As the market for distributed energy resources grows, we expect VPPs to become the preferred option for energy deployment. A handful of VPPs are already in operation in several countries. In the US, ERCOT launched two VPPs in 2023, and a Pacific Northwest VPP aims to deliver up to 100 megawatts by 2025.[4]

— **AI, machine learning, and digital twins.** These technologies can carry considerable weight in a wide range of functions. AI enhances big data capabilities, supporting the expansion of smart grids and the massive volumes of data they generate. Along with machine learning, AI can vastly improve supply and demand forecasting accuracy and predictive maintenance scheduling. With digital twins, power companies can create near-exact 2D and 3D models for construction and maintenance projects. They not only accelerate their development, but they also make projects safer.

— **Drones and robots.** These technologies deliver cost savings, enhance safety, and increase accuracy in evaluating asset conditions. Drones can be used to map plants, carry out inspections, and collect real-time data, including in high-voltage areas. Robots can be used to inspect power networks and boiler tubes, and to navigate high-radiation areas.

The impressive array of digital technologies will also revolutionize every step in the power engineering value chain. From design, planning, and sourcing to construction and operations and maintenance, the world's engineers will be required to adopt an array of these digital skills technologies to build and manage all aspects of future energy systems vital to electrification and addressing climate change.

How important will such digital technologies and skills prove to be? According to our survey, up to 40 percent of industry executives believe that an insufficiently skilled workforce, coupled with the competition for talent that is skilled appropriately, will represent one the greatest challenges in filling engineering positions over the next five to 10 years.

Wanted: twice as many power engineers by 2030

Given the impact of the aforementioned dynamics across the energy sector, coupled with the demand for new skills and skill sets, and the need to reach net zero spurred on by historic levels of investment, it is estimated that the power engineering workforce will need to grow massively by 2030—most likely by more than double.

Why such a massive increase? Consider the effect of three levels of investment in the energy sector, and the growth in the power engineers that will be required under each scenario:

— **Scenario 1:** The most conservative estimate, captured in the IEA's STEPS, projects the need for up to 450,000 more engineers, or a 61 percent increase over the 2023 workforce size.

— **Scenario 2:** A mid-range level of investment (the IEA's APS) projects 900,000 more engineers, or a 117 percent increase over 2023.

— **Scenario 3:** The most ambitious level of investment (the IEA's NZE Scenario) foresees the need for up to 1.5 million more engineers, or a 208 percent increase over 2023.

[4] ERCOT is the Electric Reliability Council of Texas (US), the state entity providing power generation transmission, distribution, and end use to large customers and residential customers.

[5] IEA's definitions of energy investment scenarios – STEPS: expected investment based on the latest policy settings in effect; APS: assumes all announced national energy and climate pledges are met in full and on time; NZE: limits global warming to 1.5 degrees Celsius by 2050

Exploring the impact of technology on the future energy workforce: key survey insights

How effective will the emerging technologies be in solving or mitigating the enormous challenges the industry faces? According to survey respondents, both executives and engineers believe the technologies will have a sizeable impact over the next five to 10 years on the power sector (see figure 7).

Among the moderate to high-impact digital technologies, AI (including generative AI) and machine learning are already in commercial use; several organizations that participated in our study depend on them to predict parts failure and improve operational efficiencies. The use of these technologies is expected to grow.

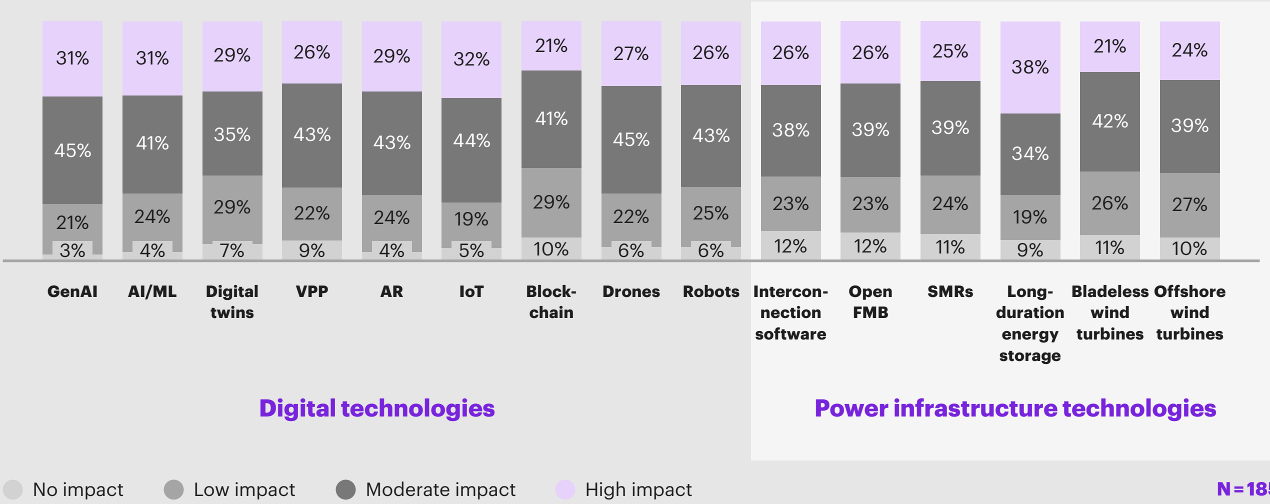
Of the six key infrastructure technologies, energy storage was, not surprisingly, rated "highest impact." Long-duration storage is pivotal to the future of the industry as the sector increasingly skews toward renewables. Storage gives electricity shelf life—a capability essential for the intermittent energy sources that comprise renewables. It is a vital hedge against supply risk and energy insecurity, providing flexibility in the face of weather variances.

Figure 7

Most executives believe digital technology will have a high to moderate impact on the power sector, but will need to prepare for the impact of a broad technology set

Preliminary

Executives' perception of most impactful technologies



Notes: AI/ML is artificial intelligence/machine learning. VPP is virtual power plants. AR is augmented reality. IoT is Internet of Things. Percentages may not resolve due to rounding.

Sources: 2024 IEEE PES-Kearney Survey

Investing in new technology

Our survey of power engineers and executives highlights the promise of emerging technologies over the next five to 10 years, and how willing industry employers may be to invest in this crucial engineering workforce (see figure 8 on page 16). Specifically, engineers proved to be slightly more optimistic than executives about the potential impact of new technologies. However, these engineers rated employers' willingness to invest in these emergent and disruptive technologies below its potential impact.

Interestingly, executives and engineers rate AI and energy storage as the most high-impact emerging technologies in digital as well as infrastructure technologies. The biggest disparities between perceived impact and willingness to invest occur with generative AI and robots (in digital) and offshore wind turbines, SMR technology, and bladeless wind turbines (in infrastructure). This is likely because of the capital intensity of such technologies, as well as their lack of maturity.

Executives and engineers rate AI and energy storage as the most high-impact emerging technologies in digital as well as infrastructure technologies.

The global attitudinal divide

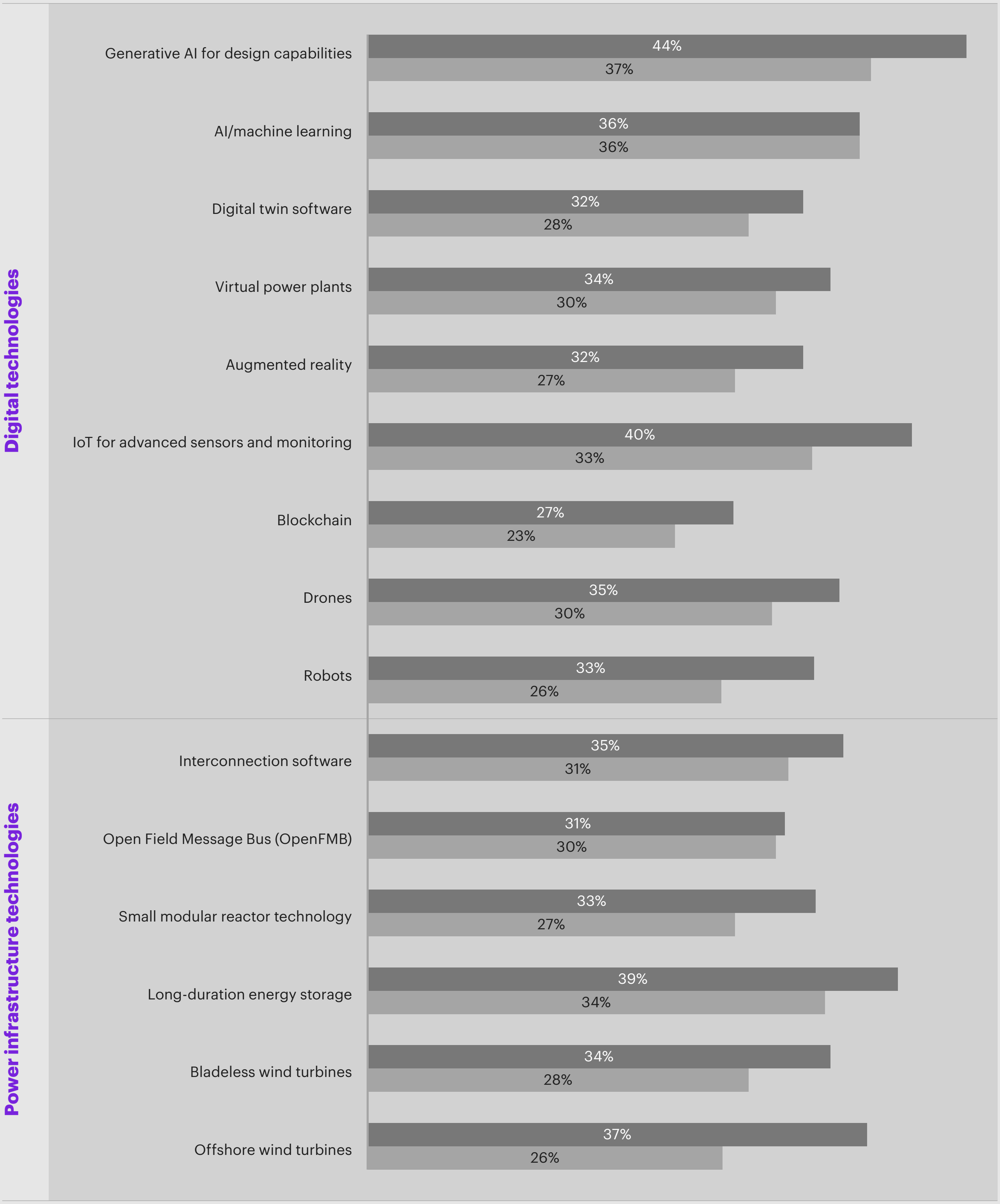
When it comes to perceptions about the impact of new technologies, we uncovered a marked difference in attitudes, intentions, and actions between professionals in advanced and emerging economies. Even across emerging economies we spotted differences in sentiment.

Our survey data reveals that among advanced economies, North American executives are the least optimistic about, and the least willing to invest in, emerging technologies (see figure 9 on page 17 and figure 10 on page 18). This sentiment aligns with the insights we gathered from our interviews with US executives, who are concerned about regulatory restrictions and the potential consequences of adopting new, relatively unproven technologies in critical infrastructure. They attribute the sluggish adoption of digital technologies to the intricacies of the nation's utility regulatory model, one heavily influenced by policy dynamics that are subject to change based on each jurisdiction's governing body.

European executives perceive that new technologies will have greater impact than their peers in North America and Oceania. This explains their greater appetite for investing in these technologies. Europe is the developed world's leader in investment in electrification and clean energy, thanks to favorable policies.

Figure 8
Engineers are slightly more optimistic than executives about the potential impact of new technologies

Executives' perception of most impactful technologies



% workers who believe the technology will have "high impact" in the next 5–10 years
% workers who believe their employer will be "very willing" to invest in the technology

N=709

Source: 2024 IEEE PES-Kearney Survey

Figure 9

Executives from emerging economies tend to be more optimistic about the impact of digital technologies than their counterparts in the rest of the world

Skill set	North America	Latin America	Asia	Middle East	Africa	Europe	Oceania
Generative AI for design capabilities	13%	21%	41%	23%	52%	35%	36%
AI/machine learning	23%	29%	45%	23%	40%	27%	28%
Digital twin software	37%	21%	28%	27%	28%	42%	20%
Virtual power plants	13%	29%	34%	27%	32%	31%	16%
Augmented reality	13%	21%	34%	35%	40%	35%	28%
IoT for advanced sensors and monitoring	27%	29%	45%	50%	24%	19%	28%
Blockchain	10%	13%	24%	35%	24%	19%	20%
Drones	23%	33%	21%	19%	32%	35%	28%
Robots	17%	33%	34%	12%	32%	42%	16%

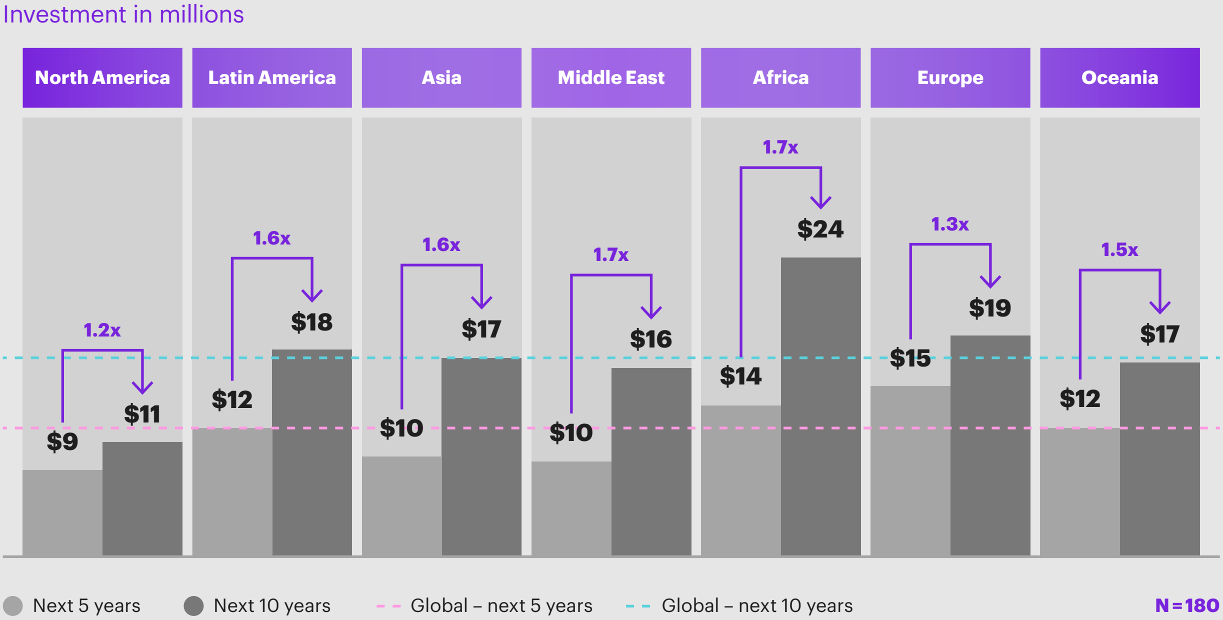
● % executives that believe that the technology will have "high impact" in the next 5–10 years

N = 184

Source: 2024 IEEE PES-Kearney Survey

Figure 10

Executives from North America intend to invest the least in emerging digital technologies over the next 5–10 years



Source: 2024 IEEE PES-Kearney Survey

Executives in emerging economies, especially Asia and Africa, show more optimism about, as well as greater willingness to invest in, digital technologies such as AI/machine learning over the next five to 10 years than their counterparts in more advanced regions. Executives worldwide are especially interested in the technologies' ability to perform predictive analytics, unlock operational efficiencies, and enable proactive decision-making. They recognize that robots and drones are valuable for improving safety for field crews, especially in equipment inspection. In India, for example, they are widely used to conduct chimney inspections and test pipeline gauges in coal generation plants and inspect solar panels and transmission and distribution assets.

Amid these differences, respondents across the globe share one common sentiment about digital technologies: concerns about data overload. Knowing how to fully utilize the massive volumes of data generated remains a huge challenge. An Indian executive we spoke with estimates that only 20 percent of data collected today is currently being used to draw meaningful insights. As a German executive argued, consolidating and scaling data for human interpretation is vital for preventing data overload. In cases where the volume of data becomes too overwhelming for humans to manage, machine or software assistance may be necessary. This executive also underscored the importance of sound data governance, which should address quality, availability, and responsibilities for data accessibility.

Understanding global views on artificial intelligence

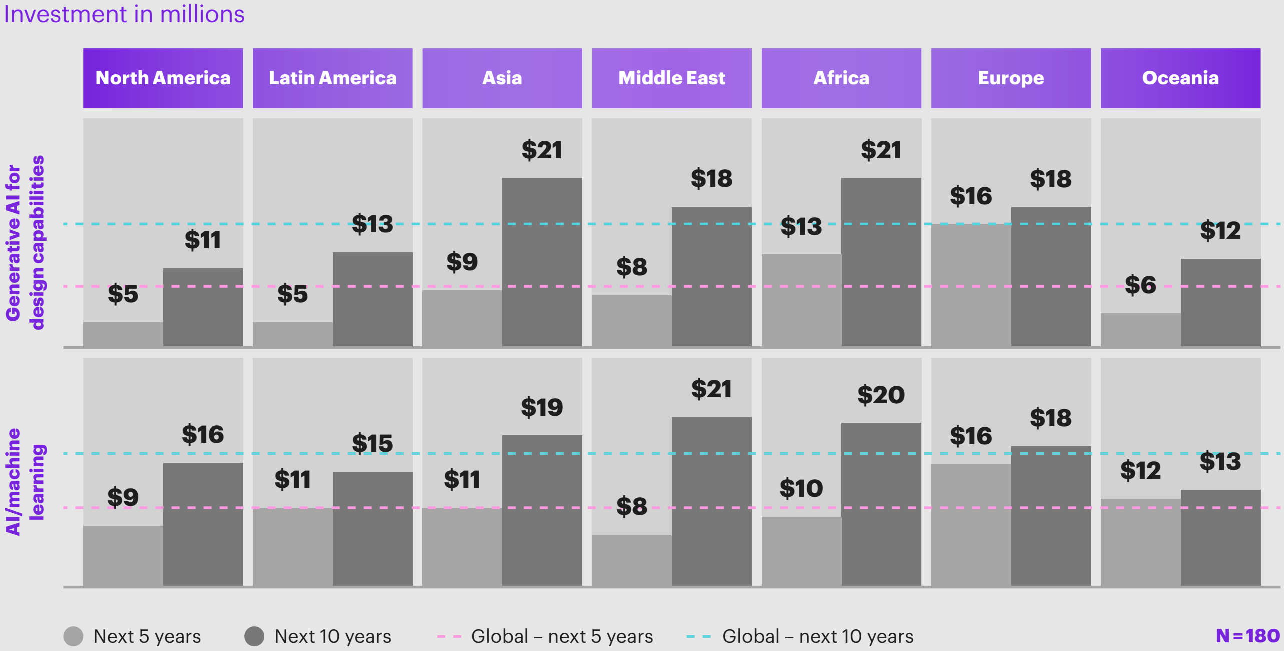
AI is a hot topic among power executives, especially in India, where it is already being implemented. The strong investment interest in generative AI and AI/machine learning in emerging economies reflects the region's optimism about the potential of these technologies.

According to the Indian executives interviewed, big data analytics and AI are already being used to optimize operations and streamline costs. Thermal and renewable plant operators have either invested in or plan to invest in AI/machine learning technology in the near term. Current users, for example, rely on AI/machine learning for several applications, including yield optimization, predictive maintenance, and operations efficiency improvement.

Among executives in certain advanced economies, including in Europe, we saw the same optimism; a German executive mentioned potential applications of generative AI tools such as ChatGPT, including AI-assisted responses to regulatory questions that engineers may have.

Conversely, some executives in advanced economies are more skeptical about AI's practical implementation. They are less willing to invest in generative AI and AI/ML capabilities in the short term than the global average (see figure 11). Based on interviews, multiple US executives expressed an incomplete understanding of the practical implementation of AI tools in the power industry. Despite rapid advances in broader AI technologies, executives believe that the full potential of generative AI and AI more broadly is still theoretical and limited by regulatory constraints, especially in the power industry.

Figure 11
AI is a hot topic among power executives, especially in Asia where it is already being implemented



Source: 2024 IEEE PES-Kearney Survey

Understanding how asset age impacts views on technology investment

The enthusiasm power executives in emerging economies have for adopting new technologies also has much to do with the younger age of their conventional assets: 25 years, on average, versus 37 years for those of advanced economies.

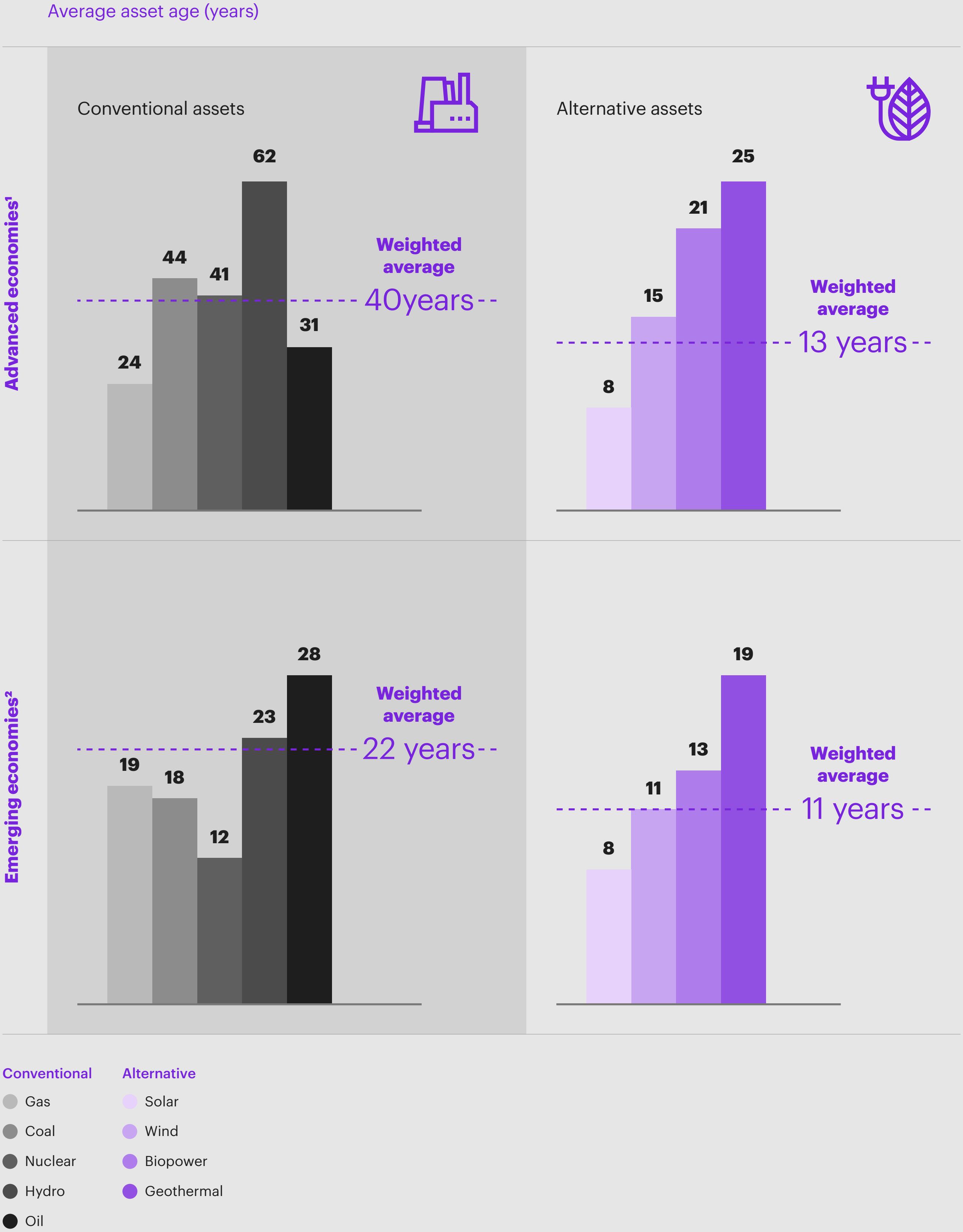
In advanced economies, the age gap is much greater between conventional and alternative sources. In some cases (for example, Germany and the United States), conventional assets are more than twice as old (see figure 12 on page 21).

In emerging economies, both conventional and alternative assets are younger, and the age gap between the two types of power sources is narrower as a result of the recent push to develop renewables.

Countries whose power assets are younger are more willing to invest in digital technologies than countries with older assets, for two main reasons. Investing in younger assets with a longer lifespan produces a higher return. The older a plant, the closer it is to retirement, so the payback may not be worthwhile. Newer power plants, even conventional ones (for example, coal plants in India), are by design more compatible with modern control systems. It's easier to integrate digital technologies into newer assets, making them more cost competitive and more worthy of investment.

Countries whose power assets are younger are more willing to invest in digital technologies than countries with older assets.

Figure 12
Emerging economies have far younger conventional power plants while the average ages for green power plants are close to those of advanced economies



[1] Advanced economies include the US, Canada, the UK, Germany, Netherlands, Australia, New Zealand.
[2] Emerging economies include China, India, Saudi Arabia, UAE, Qatar, Brazil, Mexico, South Africa, Nigeria, Kenya.
Sources: S&P Capital IQ – SNL platform; Kearney analysis

Understanding which skill sets will matter: key survey insights

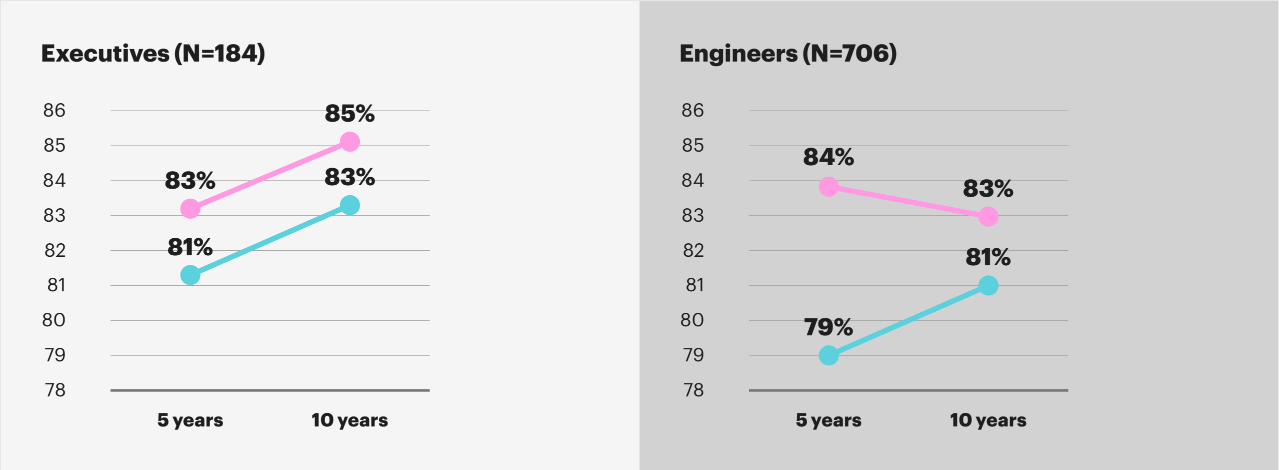
Based on our survey of industry executives, there is a clear expectation that both foundational skill sets and emerging skill sets will be equally important over the next five to 10 years. In contrast, engineers' views differ somewhat across the industry.

In the next five years, 81 percent of executive respondents rated emerging skill sets important as compared to 79 percent of engineers. In the next 10 years, 83 percent of executives rated emerging skill sets important, versus 81 percent of engineers (see figure 13). For foundational skill sets, the difference between the two respondent groups was slightly less pronounced over the next five to 10 years. Executives maintain that the importance of foundational skill sets will increase, albeit slightly, whereas engineers believe the importance of foundational skills will decline slightly.

Figure 13

In the next 5–10 years, emerging skill sets will be equally important as foundational skill sets—more so than engineers expect

% respondents who believe a skill set is "important"[1]



[1] Includes responses "very important" and "somewhat important"

Source: 2024 IEEE PES-Kearney Survey

Within foundational skill sets, executives place a slightly higher value on technical proficiency, project management, and interdisciplinary skills than engineers. Executives place a slightly higher value on all emerging skill sets than engineers do—in particular, on AI, augmented reality, and cybersecurity (see figure 14).

The survey findings also corroborate the findings from our executive interviews. Specifically, engineers will need a broader, multidisciplinary knowledge base that includes the ability to analyze big data, leverage more IT and software engineering principles, and make decisions involving strategic, commercial, and economic considerations. As executive interviews emphasize, as the industry changes, future engineers will also need a more dynamic set of skills, one that emphasizes cross-disciplinary experiences, teamwork, and communication, and that equips them to think strategically and creatively.

Future engineers will also need a more dynamic set of skills, one that emphasizes cross-disciplinary experiences, teamwork, and communication.

Figure 14
Executives place a slightly higher value on all emerging skill sets than engineers do

Skill set importance breakdown[1]

	Skill set	Executives (N=184) In 5 years	Executives (N=184) In 10 years	Engineers (N=706) In 5 years	Engineers (N=706) In 10 years
Foundational skill sets	Technical proficiency	87%	88%	89%	84%
	Project management	80%	85%	86%	82%
	System or product design	80%	85%	80%	80%
	Data analytics	84%	83%	83%	84%
	Communication	83%	84%	84%	85%
	Interdisciplinary skills	84%	85%	82%	84%
Emerging skill sets	AI/machine learning	79%	87%	79%	82%
	Big data analytics	86%	83%	83%	85%
	Cybersecurity	89%	85%	83%	85%
	Programming and coding	77%	83%	79%	78%
	Augmented reality	76%	79%	71%	73%

Importance to executives   Importance to engineers

[1] Includes responses "very important" and "somewhat important"
Source: 2024 IEEE PES-Kearney Survey

Views on the most sought-after skill sets

Despite their attitudinal divide over investments in the new technologies, executives in both advanced and emerging economies believe that the skill sets associated with new power technologies will be as important as the foundational skill sets over the next five to 10 years. This common view emerged in our survey as well as our interviews.

Globally, executives still consider technical proficiency a valuable foundational skill. But project management is fast becoming an essential for long-term success. This is in large part due to the accelerated pace of renewable power projects. Such projects require a high degree of skill to implement successfully, on time and on budget. Moreover, project management is not limited to new projects; engineers are expected to be adept at execution, regardless of where in the power value chain they play. For example, engineers in equipment design and production must be able to anticipate manufacturing challenges, while those in utility operations and maintenance must be able to consider end-to-end systems and processes and manage electricity output and customer demand effectively.

According to a renewable-power executive in India, project management skills are a "game changer" in elevating his company's competitiveness. Strong project management capabilities help the company reduce project risk, more readily obtaining land approvals and construction permits, and, overall, be more agile. Together, these capabilities give the company significant advantage in securing solar land parcels ahead of competitors.

Similarly, African executives rank technical proficiency and project management the highest out of executives from all the regions. The ability to implement development plans and apply non-technical perspectives (for example, on strategy or the environment) is crucial, as a South African executive explained. But she was quick to point out that such skills are not emphasized in engineering degree programs.

In Latin America, executives put a high value on technical proficiency and project management skills in both the short and the long term. However, our interviewees noted the lack of project management capabilities and a limited understanding of systems among the up-and-coming workforce. They attribute this to a "simplification" of the engineering degree, which has equipped students with operational skills but not the ability to innovate, develop new technologies, and implement them.

For the near and long term, the executives we surveyed consider interdisciplinary skills somewhat more important than engineers do. Furthermore, executives pointed to the need for engineers to have a broader knowledge base beyond their domain-specific knowledge. Engineers will need to be conversant in product management, in everything from end-consumer offerings such as smart meters to energy management software. They will also need to be well-versed in economics, telecommunications (as the use of IoT sensors grows), and database management and analysis (because of the voluminous data that interconnected systems are generating).

In Europe, 89 percent of executives believe big data analytics to be one of the most important skills in the short term. German executives we interviewed noted that this skill should be nurtured beginning in grade school. They also believe that electrical engineers' education must be broader; many executives, across all the countries in our study, feel that power engineers increasingly need to have IT and software engineering expertise.

In North America, we are already seeing new preferences in engineering hires, including graduates with dual degrees in IT and electrical engineering (also called "bridge engineers"). An understanding of AI/machine learning and their underlying algorithms is becoming table stakes as the nature of the power engineer's job shifts from field work to overseeing the code and control systems that perform the same operations and maintenance tasks.

In the Middle East, about 96 percent of respondents consider that programming and coding will be important in the next 10 years; 88 percent of respondents say that AI/machine learning will likewise be important over that period. An executive in Lebanon noted that his company is contending with a scarcity of data science and IT skills. Demand for engineers who can bridge the knowledge gap between power engineering and data analytics is booming. However, he acknowledged that current engineering school curricula haven't adapted to equip engineering graduates with the necessary data science toolkit.

Among the executives we interviewed in emerging economies, there is widespread consensus that demand for power engineers with expertise in AI/machine learning and data analytics is growing. One executive in India characterized AI/machine learning skills as "increasingly essential rather than optional" for power engineers. "Incorporating AI/ML in engineering school curricula will be beneficial for the future workforce," he said. One Brazilian executive told us that engineering schools are augmenting their data and analytics curriculum and reducing practical and operational studies.

From some global executives, however, we heard that engineers are over-relying on data analytics systems, and that as a result, they now lack critical judgment and an understanding of the processes and procedures underpinning the technology. "Data sense" is a competency that still needs to be developed among junior engineers; they need to be able to apply a critical lens to the outputs that technology generates for them.

Just as important is how to foster a data-driven mindset. With big-data competency becoming table stakes, executives want to know how to ingrain a data-driven mindset within their organization (see Adani case study on page 16). Moreover, while technological development is attracting new engineers to data and analytics areas, engineers must be able to use the new technologies to advantage—so that the technologies enhance their capabilities rather than replace the engineers altogether.

Given the increase in digitalization and data collection, cybersecurity is becoming top of mind for executives globally, with more than 80 percent in North and Latin America and about 90 percent in the rest of the world seeing it as a key skill needed by power engineers in the next decade. A South African executive echoed the importance of cybersecurity, reinforcing the need for enhanced IT and software skills among power engineers. In practice, universities are integrating cybersecurity awareness into their curricula, while we heard from US and German executives that they are investing in building internal capability to manage and recover from cyberattacks.

"Data sense" is a competency that still needs to be developed among junior engineers.

Adani case study: Digital skill-building (and culture change) through a center of excellence

Adani Power Limited (APL) is India's leading private thermal power producer, with a generation capacity of 15 GW. As part of the Adani Group, it is committed to the conglomerate's principles of "nation building" and "growth with goodness" to enable sustainable growth, value creation, and a credible sustainability footprint.

In early 2022, external pressures—decarbonization, decentralized power generation, supply chain disruptions, and regulatory pressures, along with changing consumer preferences—were making those principles seem more elusive than ever. Unwavering in their ambition to sustain the company's leadership position, APL executives saw digital technologies as the answer.

Defining the vision and the strategy

APL launched Project Beacon to integrate data and analytics throughout operations. The initiative was designed to drive generation performance improvement, and more broadly, to foster a culture of continuous improvement and innovation across the organization.

Recognizing the value of dedicated centers of excellence for thought leadership, best practices, and value creation, APL leaders set up its Analytics Center of Excellence (ACoE), one of the few examples in the industry. As a first step, leaders aligned the center's vision and objectives with the company's overarching goals—operational excellence, best-in-class safety, and fostering a proactive decision-making culture—which in turn align with ADL Group's broader principles.

Building the teams

Leaders selected high-performing engineers (based on a skill level assessment) and grouped them into cross-functional squads made up of business, technical, data science, and systems integration experts. Over a six-month period, squad members received training on advanced analytics, culminating in experiential bootcamps and hackathon sprints for developing use cases. This stage of the project paved the way for establishing the company's hybrid analytics organization—a central analytics team designed to work with functional experts on the ground.

Brainstorming comprehensive applications

ACoE squads brainstormed more than 50 analytics use cases that could be applicable across APL's core operations as well as its support functions. These use cases ran the gamut, from developing a machine learning-based combustion optimization model to improving boiler efficiency to using image processing (via monitoring cameras) for improving safety practices.

By standing up the ACoE, Adani ultimately drove improvements across many facets of its operations, while developing the capabilities of 40+ engineers. Beyond achieving its stated aims, APL's ACoE proved to be a source of inspiration and best practices for digitalization in Adani Group's other companies.

Takeaways

APL's journey offers three important lessons for power companies embarking on analytics and digital training.

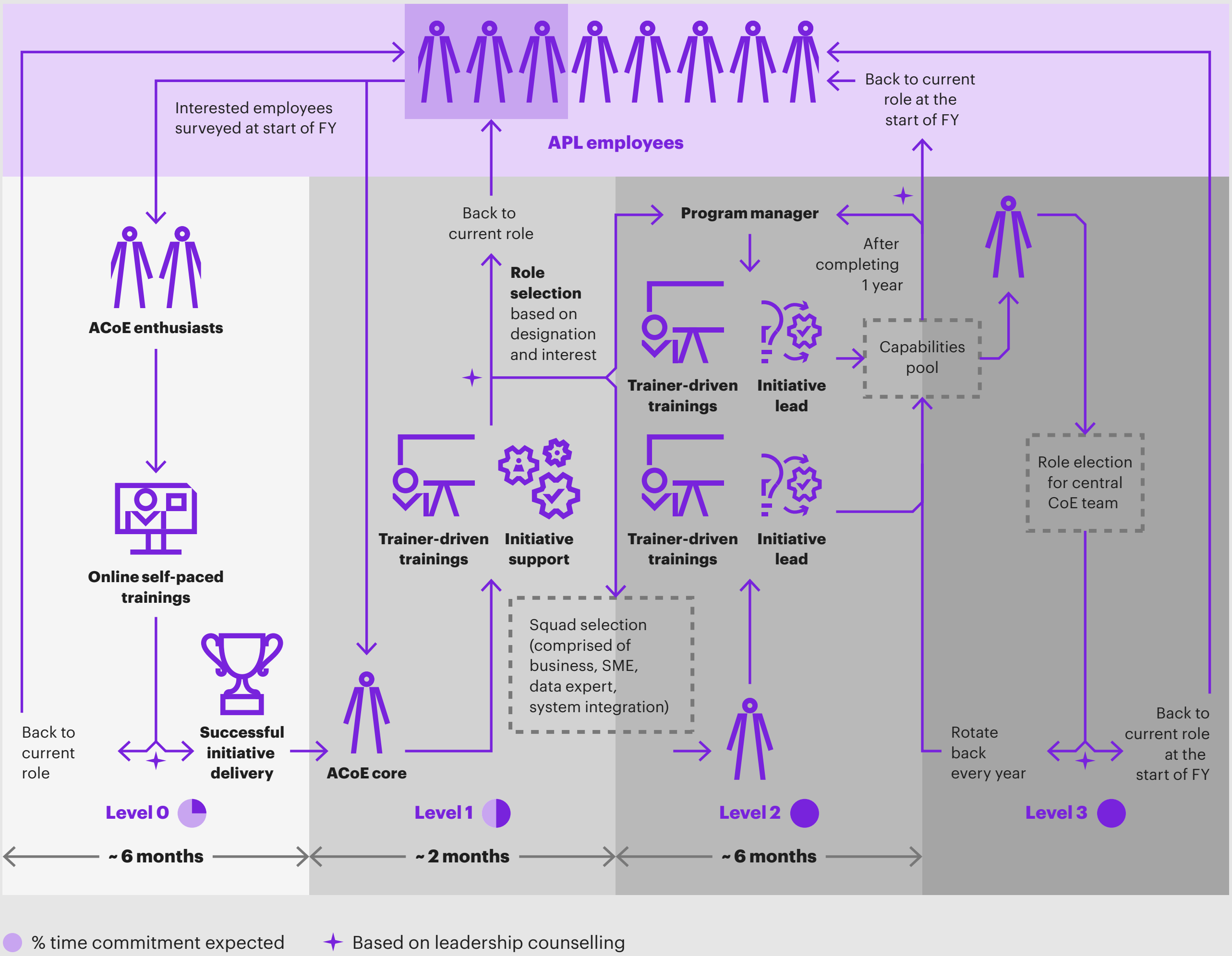
— **Digital technologies have game-changing potential.** Adopting analytics, and digital more broadly, is more than a straightforward technology exercise. Companies need to think big—and think broad. Understand that real-time data has immense potential as a source of valuable insights across the power value chain. Beyond O&M improvement, use cases can include such wide-ranging efforts as bird and wildlife protection, vegetation management, and even power-theft detection.

— **Involving employees in cutting-edge technologies is a winning talent move.** Fostering a culture of digitalization and analytics can set firms apart as an employer of choice. As our survey showed, the limited opportunities for creative problem-solving is a key reason power engineers leave their jobs. Look to digital technologies to provide such opportunities; they can boost employee morale and engagement, bolster retention—and enhance attraction efforts.

— **Digital technologies help embed a culture of operational excellence and continuous improvement.** By fostering a mindset of innovation and experimentation—while acknowledging that not all solutions will succeed—companies can truly enable the full potential of digital tools and analytics and facilitate agile and proactive ways of working.

Figure
ACoE capability build at Adani Power involves level-based learning pathways with opportunity to contribute within and outside ACoE

Adani Power ACoE capability build



ACoE by the numbers
(As reported in APL Annual Report 2022–2023)

40+ number of employees chosen for setting up CoE

200+ number of analytics enthusiasts involved

10+ number of squads in ACoE at two super-critical fossil assets

30+ members in the expert network for deepening analytics

1,500+ hours of training conducted (online/offline)

8 sessions of "Harnessing the Power of Analytics" groupwide showcase of actual analytics use cases

Source: Adani Power Limited, Adani Power Limited Annual Report 2022-2023

Foundational skills remain paramount for the workforce

It's worth noting that although engineers throughout the world place greater importance on emerging skills in the long term (in 10 years), engineers in most regions hold foundational skill sets important both in the short term (within five years) and the long term. The only exceptions were engineers in the Middle East and Africa, who rated emerging skills slightly more important in both the short and the long term.

Globally, engineers also believe technical proficiency and project management skills to be important in the next five years, while communication and interdisciplinary skills are considered slightly more important in the long term by respondents across most regions.

In comparison, a smaller percentage of engineers in North America place high importance on foundational skill sets than do their global counterparts. This difference is especially pronounced in the skill area of system or product design. Technical proficiency, communication, and interdisciplinary skills rank as the top skill sets for the next five years, whereas communication ranks as the top skill in the long term.

In Europe too, technical proficiency is the most important skill in the short term, while communication and interdisciplinary skills emerge as top skills in 10 years. Engineers in Oceania believe that most foundational skill sets will be important and won't change significantly over the next five to 10 years.

In Asia, more engineers expect technical proficiency and project management to be important in the short term, and data analytics, communication, and interdisciplinary skills to become important in the long term. Data analytics ranks as a top foundational skill set in 10 years, in line with most executives' views.

In Africa, there is similar emphasis on technical proficiency and project management skills in the short term, and on communication and interdisciplinary skills in the long term. Communication ranks as the top foundational skill set in 10 years—a view that reflects executives' expectation that project coordination requires a high degree of collaboration.

Finally, Middle East engineers believe that most foundational skill sets will be important and that their importance won't change significantly over the next five to 10 years.

Global workforce views on emerging skills

Engineers worldwide are recognizing the importance of AI/machine learning skills, big data analytics, and cybersecurity in the long term. Among North American engineers surveyed, a smaller percentage place high importance on emerging skills than their global counterparts—just as they did with foundational skills, thus indicating a neutral sentiment. While there is a disparity between engineers and executives globally in how they rate emerging technology skill sets, it is more pronounced in North America. In contrast, engineers in Europe and Oceania believe that most emerging skill sets will be important and that their importance won't change significantly in the next five to 10 years.

In comparison, in emerging economies, more engineers believe that AI/machine learning and big data analytics will be important skills in the short term, and that cybersecurity, programming and coding, and augmented reality will be important skills over the long term. In Latin America, for example, more engineers believe that most emerging skills will be important and won't change significantly in five to 10 years—except AI/machine learning, which they ranked as the top skill in the next decade. In the Middle East, engineers surveyed believe that most emerging skill sets will be important and that their importance won't change significantly in the next five to 10 years.

Training and retention: the challenges faced

The typical training life cycle for power engineers begins with a formal education in engineering, followed by internship opportunities and graduate engineering trainee programs in the first few years of employment. Most professional training happens on the job, through formal rotational programs or even through external training programs provided by OEM suppliers.

Other training comes in the form of in-house workshops, online courses, mentorship programs, and attendance at industry conferences. As they gain experience, engineers might enroll in continuing education programs or obtain industry certifications to stay up to date on the latest advancements. Throughout their careers, engineers might also receive training on specific technologies or projects as needed and tap into education resources provided by industry associations. Knowledge transfer initiatives are crucial for passing retiring engineers' expertise onto younger generations. A few companies in the power industry are starting to offer "bridge programs" that facilitate the transfer of senior or retiring engineers' valuable knowledge and experience.

For foundational skill-building, engineers may undergo specialized training in such areas as power systems, controls and automation, grid management, and renewable power (for example, SMRs, solar inverters/modules). Moreover, according to executives worldwide, as power systems grow more complex, engineers will need additional training to augment their electrical engineering expertise—including proficiency in reactive power, network balancing, disturbance analysis, and managing increasing data volumes.

For emerging skill-building, some companies provide in-house rotation programs to develop digital skills such as data analytics and AI/machine learning competency. Executives told us that they have taken responsibility for training their employees in advanced topics as technology evolves. Addressing skill shortages (and the lack of qualified engineers in the market) is top-of-mind for many executives, and in advanced economies such as Germany, many companies are conducting their own internal training programs. This, of course, requires a significant investment.

The challenge for the industry at this crucial juncture is how to best ensure workers are properly trained for the future, and that the talent supply meets demand in both the new and conventional power fields.

Rethinking future workforce training

In our survey, we asked executives how they rate the various training methods—in-house, external, and self-guided. Power executives consider external training, on-the-job training, and mentorship programs the most effective ways to train and upskill engineers (see figure 15). Many engineers today are trained through online courses, attendance at industry conferences, certification programs, and educational resources—methods that fewer executives consider effective.

In our interviews, executives expressed the need for modern, innovative training methods. For example, an executive from Panama claimed that to succeed over the long term, companies need to adopt more digital tools. This interviewee noted that social media platforms such as TikTok have been handy for training even senior engineers.

A Germany-based multinational utility has an in-house group that provides specialized training, according to a company executive. The training includes "war room" games and scenario-based exercises such as responses to cyberattacks that involve cross-functional teams.

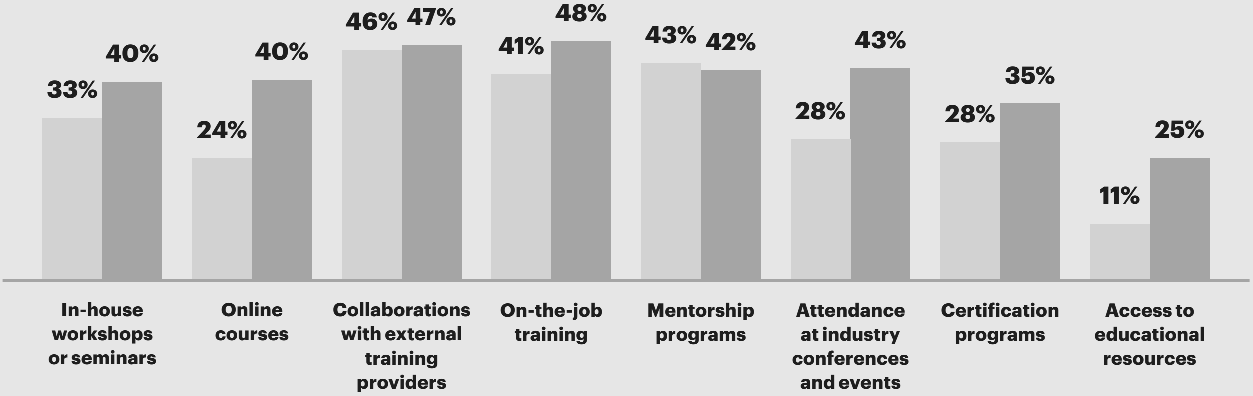
For some executives, training can do double duty. It may also serve as a way to motivate engineers. One Lebanese executive explained that setting up an internal training academy was a strategy his company used to break the monotony of repetitive work and allow engineers to expand their knowledge. The academy offered a wide range of courses in such areas as air conditioning, electric vehicles, solar PV systems, and AI-based algorithms.

What do engineers think about the current training methods? Surprisingly, the vast majority—83 percent worldwide—consider them adequate. And 83 percent also consider their existing training sufficient for helping them adopt emerging technologies.

Figure 15

Power executives consider external training, on-the-job training, and mentorship programs the most effective ways to train and upskill engineers

Effectiveness of training methods



Techniques leaders believe will be effective in helping with adoption (% executives that selected method within top three choices)

How engineers are currently being trained

Workforce N = 706
Executives N = 184

Note: 4% of engineers stated that their employer does not offer any of the training methods.
Source: 2024 IEEE PES-Kearney Survey

Retaining and attracting talent

Attrition has become a widespread concern in the power industry. Retention, especially of younger engineers, is crucial for ensuring a talent pipeline that's up to the formidable challenges companies—and the industry—face in a growing, energy-transitioning world.

According to our survey, almost half of all power engineers have either changed jobs within their company, moved to another employer, or left the industry altogether within the past three years (since 2021). Excluding retirees, some 26 percent of power engineers have either left their employer (22 percent) or have left the industry entirely (4 percent).

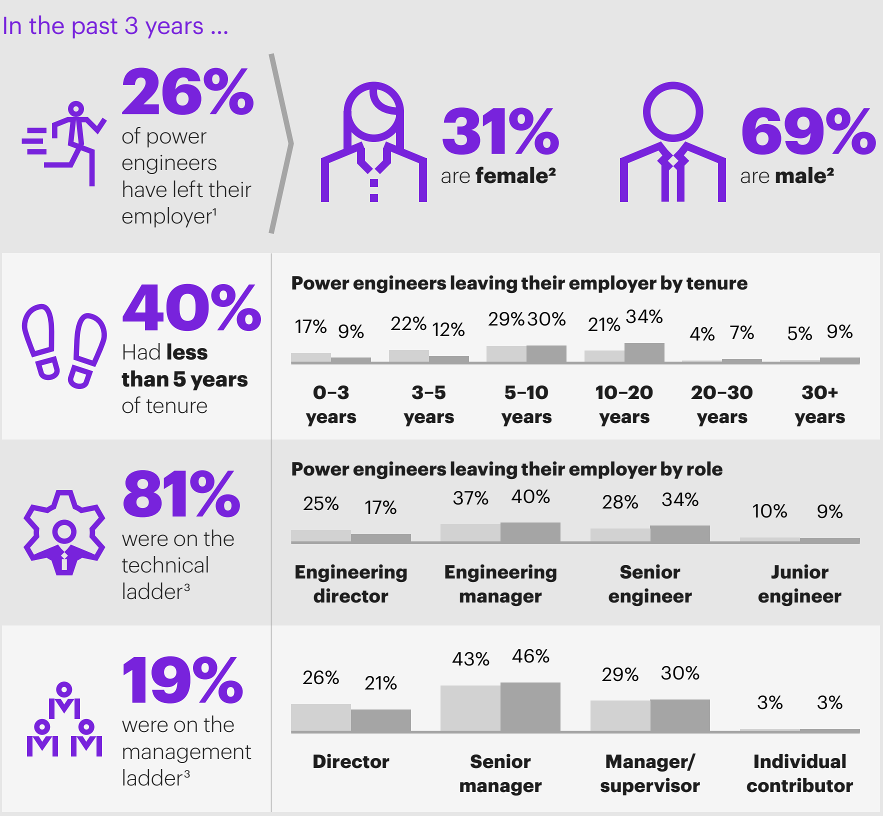
Among those who have either changed employers or left the industry, burnout and the lack of stimulating work tied as the top two reasons (each garnered 29 percent of such respondents). Difficulty in making a lateral transition was next, cited by 27 percent of respondents who departed.

Since 2021, 19 percent of power engineers transitioned to a new role at the same employer. Of those, 13 percent moved into a managerial or non-engineering role, while the remainder—87 percent—transitioned within an engineering role. Of the engineers who changed roles at the same employer, nearly three-quarters of them switched because of burnout, the lack of collaborative work, or the lack of creative problem-solving opportunities.

More than a third who left their employer were female engineers or engineers with fewer than five years of experience (see figure 16). Females represent 31 percent of departures, but, as noted earlier, only 23 percent of the total engineering workforce. Engineers with five years or less years of experience accounted for 40 percent of the departures. Eighty-one percent of engineers who left their employer or the industry were on the technical ladder—which suggests that better opportunities were available to them elsewhere, especially the 65 percent in middle management positions (senior engineering managers and senior engineers).

Figure 16
Female-identifying engineers and engineers with less than 5 years of experience are most likely to leave their employer

% engineers leaving employers
% total respondents
N = 184



¹ Retirees have been excluded.
² Compared to overall representation of 23% female, 76% male
³ Compared to overall representation of 74% technical ladder and 26% management ladder
Source: 2024 IEEE PES-Kearney Survey

According to executives interviewed, the sweet spot of talent retention is mid-career: engineers in their mid-30s to mid-40s. Those in this age bracket are most "captive": that is, settled, with a young family and probably a mortgage, and therefore less likely to relocate. This age range corresponds to a tenure of 10 to 20 years—and a lower job-moving rate (21 percent) compared to engineers with less than 10 years' experience.

Retaining talent: global differences

The most job-switching activity over the three-year period (2021–2024) occurred in companies in emerging economies. As was the case globally, burnout and unstimulating work and limited opportunities to problem-solve were the primary reasons. Executives in emerging economies noted that the intense competition for engineering talent in part explains the greater job-switching, as a growing number of independent power providers enter those markets.

The greater job stability in advanced economies (especially in Europe) is partly due to the more captive nature of their workforce. North America was the only region in which compensation figured among the top three reasons for attrition.

Two interesting outliers among the top reasons for leaving were lack of a signing bonus, cited by Middle East respondents, and minimal wellness perks (for example, allowances for workout classes), cited by Oceania respondents.

The regional differences, although certainly relevant, are overshadowed by the commonalities in key reasons for exiting—and highlight the intensifying need for better retention strategies.

Retaining talent: sector differences

By sector, those with current or prior experience in nuclear power generation underwent the most job movement. The key reason for leaving was lack of stimulating work (38 percent of respondents). The high rate of attrition (58 percent) is consistent with what we know anecdotally from executives. It is also alarming: this sector's vulnerability to talent loss means the industry may well lose a new generation of engineers.

What do engineers value?

The employee value proposition (EVP) is one of the most challenging issues in retaining and training of engineers. A comprehensive and compelling EVP addresses six essential dimensions to attract, retain, and engage talent:

— **The nature of the work.** Is it interesting, engaging, and sufficiently collaborative? Does it offer a sense of ownership and autonomy?

— **Purpose and meaning.** Does the work allow for a personal connection to the company's mission and values? Does the work give a sense that one is making a difference?

— **Culture and relationships.** Is there trust in leadership? Is there confidence that one's voice is being heard? Does the company provide positive interactions and a positive work environment?

— **Work–life integration.** Does the company offer flexible working models? Is there the possibility of work–life balance? How about autonomy over one's own schedule?

— **Compensation and benefits.** Are these competitive? Does the company offer adequate performance incentives and rewards to encourage retention?

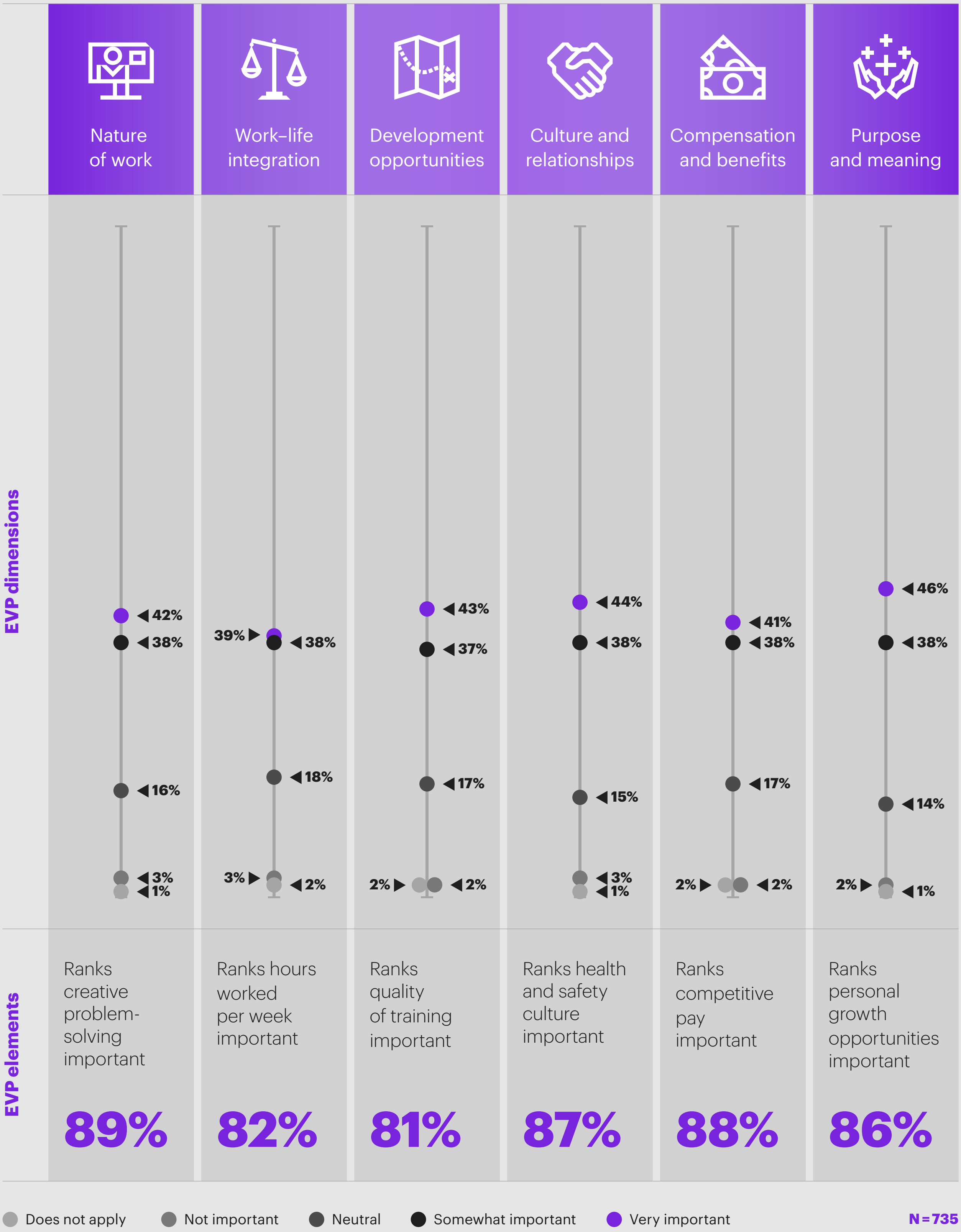
— **Development opportunities.** Does the company provide ongoing learning and development opportunities and well-defined, attractive career paths?

Our survey explored views of engineers on the six EVP dimensions and their component elements (see figure 17 on page 33). Of the six dimensions, power engineers rated "purpose and meaning" most important; 84 percent of respondents view it as "somewhat" or "very important." The individual EVP elements that were ranked most important were problem-solving opportunities (89 percent of respondents), competitive pay (88 percent), health-and-safety culture (87 percent), and personal growth opportunities (86 percent). These results clearly indicate where employers ought to focus their talent attraction and retention efforts.

Figure 17

The power engineer workforce rated purpose and meaning, culture and relationships, and development opportunities as the most important dimensions

Workforce employee value proposition



Note: Important includes % workforce that believes dimension/element is "very important" and "somewhat important."

Source: 2024 IEEE PES-Kearney Survey

Young engineers (those with fewer than 10 years of experience) consider all EVP dimensions to be important. Specifically, more than 80 percent value every dimension highly, which suggests they seek a holistic career experience, but they value purpose and meaning the most (about 84 percent of respondents) (see figure 18). More tenured engineers (those with more than 20 years of experience) also value purpose and meaning the most (about 86 percent), and work–life balance the least (64 percent of respondents).

More than 80 percent [of young engineers] value every dimension highly, which suggests they seek a holistic career experience.

Figure 18
Young engineers consider all EVP dimensions to be important

Employee value proposition dimension importance by tenure

EVP dimension	Nature of work	Work–life integration	Development opportunities	Culture and relationships	Compensation and benefits	Purpose and meaning
0–3 years	42% 37%	39% 39%	44% 37%	47% 36%	47% 36%	48% 36%
3–5 years	44% 39%	44% 39%	49% 37%	50% 35%	47% 37%	50% 39%
5–10 years	45% 38%	40% 41%	44% 39%	46% 39%	42% 40%	46% 39%
10–20 years	40% 39%	38% 39%	42% 37%	43% 37%	38% 40%	41% 39%
20–30 years	40% 36%	37% 37%	40% 37%	48% 36%	44% 33%	50% 37%
30+ years	33% 36%	25% 32%	35% 32%	41% 33%	36% 31%	51% 34%

% workforce that believe dimension is very important
% workforce that believe dimension is somewhat important
% workforce that believe dimension is not important/neutral

N = 735

Source: 2024 IEEE PES-Kearney Survey

In terms of the most important elements, creative problem-solving opportunities, competitive pay, and opportunities for personal growth had strong appeal across all tenure brackets (see figure 19). In comparison, younger engineers (those with less than 10 years of experience) put more importance on flexible work models and quality of training than did more tenured engineers (those with 20 or more years of experience) (83 percent vs. 77 percent).

For young engineers, creative problem-solving, the opportunity to work collaboratively, development opportunities (for example, quality of training), competitive pay, and the number of hours worked per week were all important. More tenured engineers place the highest value on creative problem-solving and collaborative work environments and much less importance on development opportunities and work–life integration.

In contrast, interviews of executives suggested that job stability no longer carries the weight it once did, as engineers today seek more challenging roles and projects. Executives also noted that engineering firms may have a competitive advantage over traditional utilities precisely because of the unique project opportunities and accelerated growth and career development that they can offer.

What counts in the employee value proposition differs little between genders, although those who identify as female tend to value company culture and mentorship and leadership support more than those who identify as male (see figure 20 on page 36).

Within the individual EVP elements, we found that women place greater importance on work and task variability and the ability to swap or change shifts or rotation schedules. They also put greater importance on lateral transitions, DEI programs, sick leave policies—but less importance on company mission and values—as compared to men.

Figure 19

Creative problem-solving opportunities, competitive pay, and opportunities for personal growth had strong appeal across all tenure brackets

Employee value proposition top element importance by tenure

Most important EVP element	Extent of creative problem-solving and innovation opportunities	Hours worked per week	Quality of training	Health and safety culture	Competitive pay	Opportunities for personal growth
0–3 years	69% 24%	40% 46%	51% 36%	56% 28%	67% 22%	57% 32%
3–5 years	65% 26%	42% 42%	55% 36%	61% 27%	63% 31%	50% 45%
5–10 years	56% 36%	37% 44%	47% 37%	55% 32%	52% 36%	48% 40%
10–20 years	38% 48%	44% 40%	44% 32%	45% 42%	43% 45%	44% 37%
20–30 years	47% 36%	36% 38%	48% 38%	64% 29%	59% 24%	61% 27%
30+ years	64% 29%	28% 40%	43% 39%	60% 28%	65% 29%	64% 21%

% workforce that believe element is very important

% workforce that believe element is somewhat important

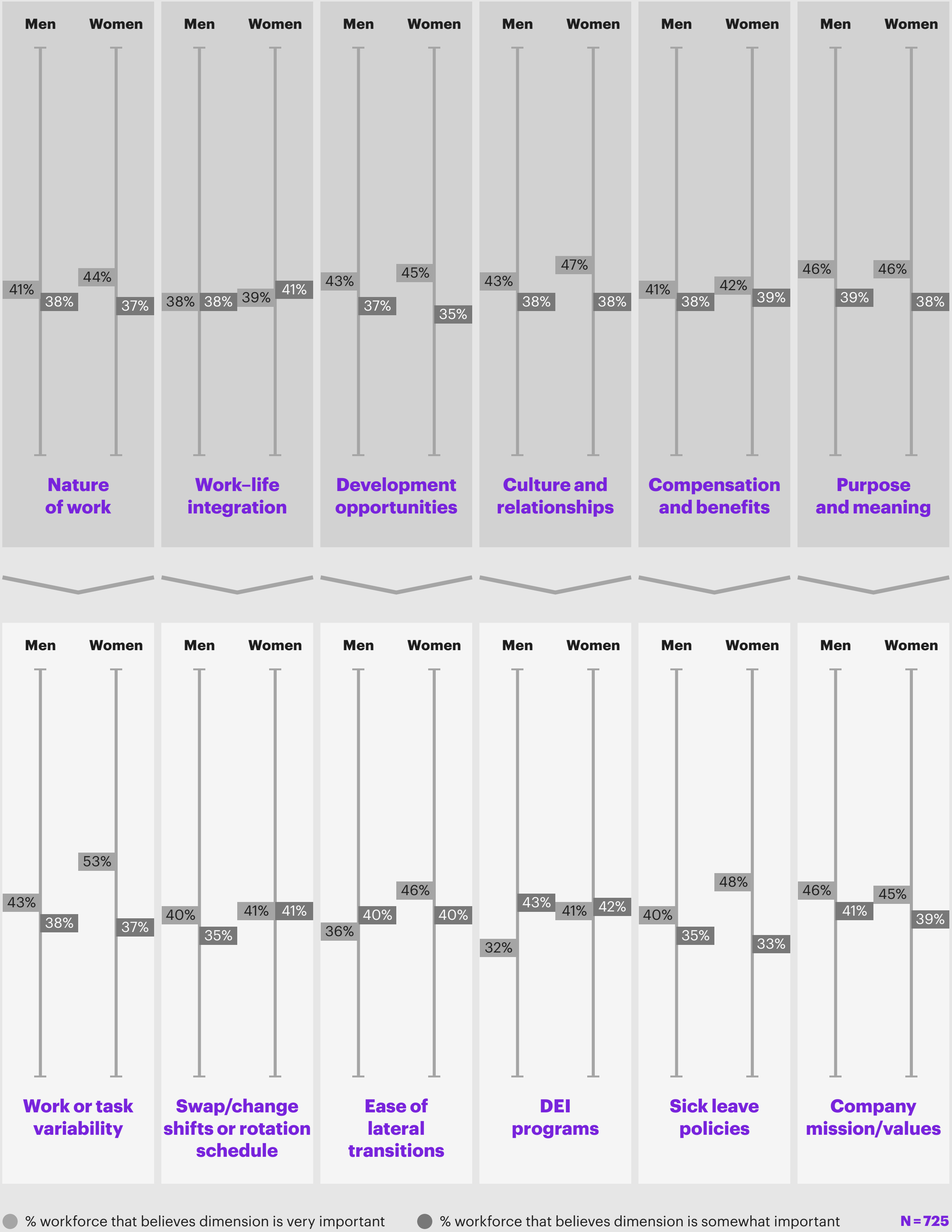
% workforce that believe element is not important/neutral

N = 735

Source: 2024 IEEE PES-Kearney Survey

Figure 20
What counts in the employee value proposition differs little between genders

Employee value proposition importance by gender[1]



[1] Nonbinary respondents are not represented due to small sample size, n=2.
Source: 2024 IEEE PES-Kearney Survey

Executives underscored the significance of the EVP elements that are crucial to female engineers. One Indian executive observed that remote locations and the scarcity of female field engineers are obstacles to attracting more women. This executive aims to draw more female engineers to the company by launching an all-female pilot site, which would give women more direct leadership support and mentorship opportunities. A North American executive highlighted a major barrier companies face in attracting more women to the industry, despite their efforts: the lack of diversity in leadership ranks. This situation is in part the result of less flexible policies, particularly for women returning from maternity leave.

Regionally, when considering overall EVP dimensions, North American engineers value purpose and meaning (85 percent of them) more than work–life integration (68 percent) (see figure 21). Similarly, in Europe, purpose is considered most important, and work–life integration least important. In Oceania, all EVP dimensions are valued highly, with slightly less importance placed on development opportunities and culture and relationships.

Among the emerging economies, Middle Eastern, African, and Latin American engineers value all EVP dimensions highly; 80 percent or more consider all EVP dimensions important.

Within the highest-ranked EVP elements, engineers across nearly every region highly rated the importance of creative problem-solving, a health and safety culture, opportunities for personal growth, and competitive pay. Quality of training mattered less to engineers in Europe (68 percent) as compared to other regions; number of hours worked per week mattered least to European (73 percent) and Asian (79 percent) engineers.

Figure 21

Purpose and meaning was considered most important by both North American and European engineers

Employee value proposition dimension importance by tenure

EVP dimension	Nature of work	Work–life integration	Development opportunities	Culture and relationships	Compensation and benefits	Purpose and meaning
North America	36% 36%	32% 36%	41% 35%	42% 37%	39% 35%	47% 38%
Latin America	45% 39%	41% 42%	50% 35%	47% 38%	47% 38%	51% 36%
Asia	41% 39%	36% 37%	41% 36%	42% 38%	38% 39%	42% 40%
Middle East	49% 36%	44% 41%	46% 37%	44% 42%	44% 41%	47% 38%
Africa	53% 30%	49% 33%	57% 30%	56% 28%	52% 33%	55% 32%
Europe	31% 42%	28% 42%	29% 42%	35% 41%	30% 43%	34% 42%
Oceania	41% 41%	37% 44%	38% 41%	39% 42%	37% 41%	42% 42%

% workforce that believe element is very important
% workforce that believe element is somewhat important
% workforce that believe element is not important/neutral

N = 735

Source: 2024 IEEE PES-Kearney Survey

In contrast, Middle East engineers rated their employers best on EVP dimensions, while employers in North America, Europe, and Asia fared the worst (see figure 22). Middle East engineers gave their employers the highest ratings in culture and relationships. In Latin America, Africa, and Oceania, employers performed moderately across all dimensions.

As for the most strongly rated EVP elements, engineers in four of the seven regions we surveyed rated their employers highly (>80 percent strong or moderately strong) in creative problem-solving opportunities. North America, Asia, and Europe were the exceptions, suggesting there is a considerable opportunity for improvement, given that it is one of the most valued EVP elements by engineers everywhere. North America performed the worst in competitive pay and personal growth opportunities, compared to other regions.

Middle East engineers rated their employers best on EVP dimensions, while employers in North America, Europe, and Asia fared the worst.

Figure 22
Middle East engineers rated their employers best on EVP dimensions, while employers in North America, Europe, and Asia fared the worst

Workforce rating of employer – overall EVP dimension rating by region

EVP dimension	Nature of work	Work–life integration	Development opportunities	Culture and relationships	Compensation and benefits	Purpose and meaning
North America	30% 36%	27% 38%	25% 34%	29% 41%	23% 35%	30% 41%
Latin America	35% 43%	37% 39%	37% 37%	39% 40%	35% 40%	41% 38%
Asia	33% 40%	30% 36%	32% 37%	31% 40%	30% 38%	32% 41%
Middle East	43% 40%	40% 42%	42% 41%	41% 44%	42% 41%	44% 39%
Africa	41% 39%	37% 36%	40% 37%	41% 42%	33% 38%	40% 41%
Europe	26% 44%	25% 44%	24% 41%	31% 40%	26% 41%	28% 44%
Oceania	36% 45%	35% 41%	34% 44%	36% 43%	34% 43%	34% 44%

% workforce that rate dimension as strong
% workforce that rate dimension as moderately strong
% workforce that rate dimension as weak/very weak

N = 721

Source: 2024 IEEE PES-Kearney Survey

North American employers were also rated among the lowest in quality of training and number of hours worked. As one North American executive observed, the pressure to reduce operational and maintenance costs could be squeezing training resources, and thus might explain the poor performance.

Asian employers were rated highly on work elements such as collaborative work opportunities and task variability. But they performed the worst in work–life integration; only 66 percent rated this dimension strong overall. The lowest element rating was in additional childcare support; only 56 percent rated it strong.

In the Middle East, employers earned high ratings across most of the elements within compensation and benefits, which are tangibly higher than in other regions.

For most of the EVP dimensions, interviews of executives suggest that this group has a fairly accurate perception of what engineers value most. And they largely share those values. Executives place a higher value on job security, the annual bonus structure, and quality of training. Best practices in retention, according to executives, include bonuses and incentives tied to career milestones or tenure. These practices motivate employees from both a professional growth and a monetary standpoint (see figure 23 on page 40).

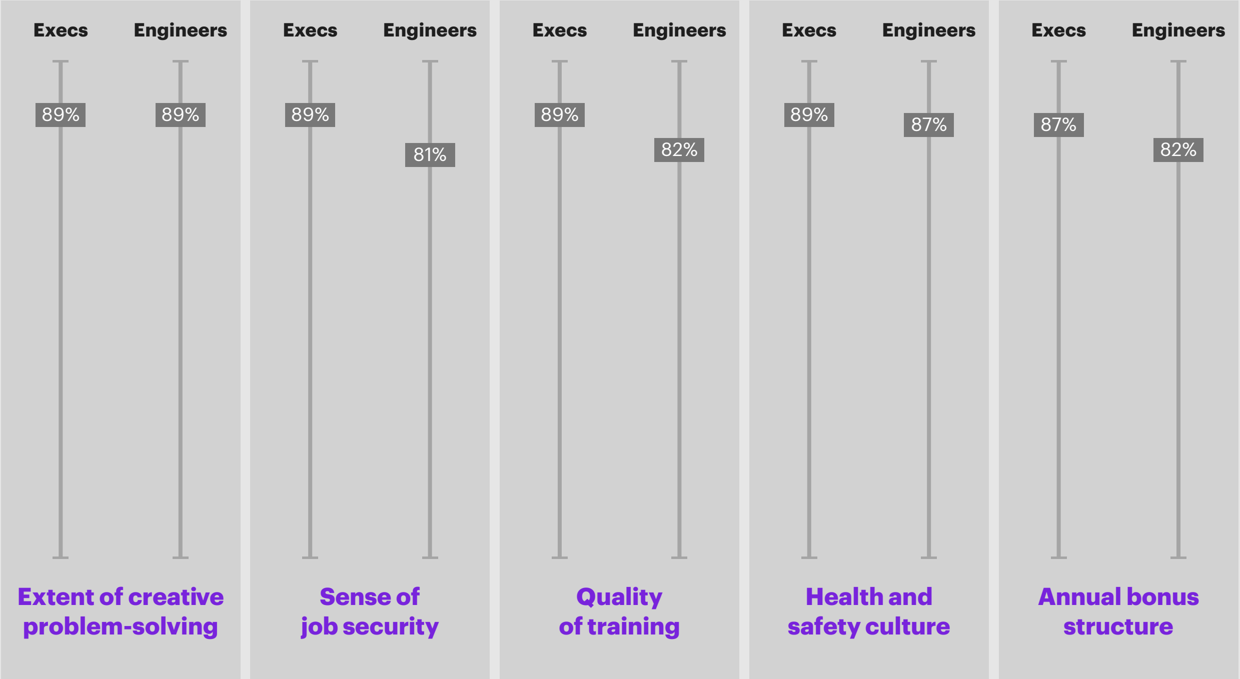
Executives echoed engineers' view that providing purpose and meaning are more important today for attracting and retaining talent than ever before. In fact, the opportunity to work on the energy transition is a more powerful EVP attractor than competitive pay. As a basic retention strategy, companies can raise awareness about power engineering's impact on climate and promote the ways in which various roles are contributing to the transition to renewables. Interestingly, competitive pay, along with company mission and values, showed the greatest disparity in ratings between executives and engineers.

Competitive pay, along with company mission and values, showed the greatest disparity in ratings between executives and engineers.

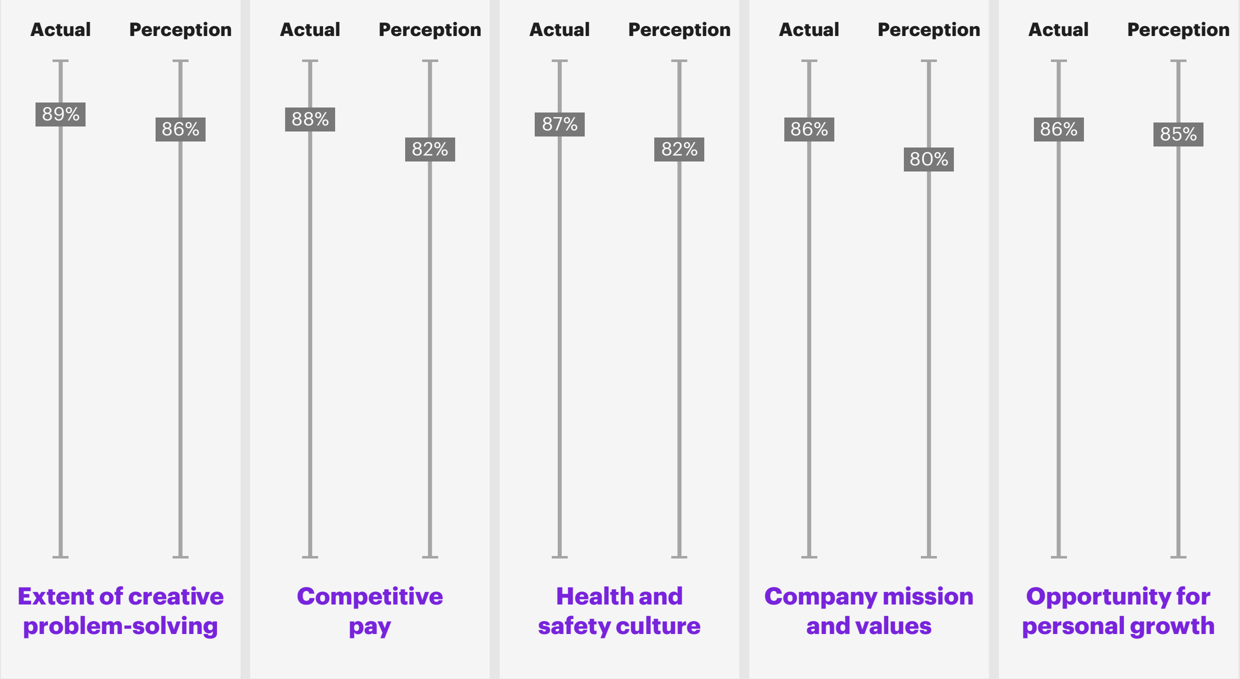
Figure 23

Executives have a fairly accurate perception of what engineers consider important for most EVP dimensions and largely hold the same values

Top 5 most important EVP dimensions for leadership and relative importance for engineers[1]



Top 5 most important EVP dimensions for engineers and leadership's perception of importance to engineers



N = 735, workforce
N = 185, executives

[1] Includes responses "very important" and "somewhat important"
Source: 2024 IEEE PES-Kearney Survey

The importance of early actions

Throughout the world, efforts have been intensifying to increase STEM enrollments and graduates. In the United States, for example, the number of STEM degrees (including bachelor's, master's, and doctorates) conferred in the past decade doubled, to 612,000 in 2021. Employment in STEM occupations reached 10.4 million in 2022. However, the majority of STEM degrees were in IT, computer, or software-related fields. In 2022, there were four-and-a-half times as many computer programmers (147,000) as there were power engineers (32,000).

In fact, university professors interviewed across the world as part of this study pointed to stagnating class sizes in core power engineering programs. More students, they claim, are opting for careers in IT and technology, lured by the tech industry's more glamorous image and higher pay packages. Industry executives we interviewed concurred. They recognize that the power sector has an image problem: young talent view it as archaic and stodgy. Compounding the problem is a shortage of incoming students, thanks to competition for talent from these other industries. To attract more young people to the field—and compete more effectively for talent—the power industry needs to cultivate a more appealing image.

As our findings confirm, there is growing consensus among industry leaders about the opportunity to diversify beyond electrical engineers. For instance, more mechanical engineers are needed for wind farm projects, battery technology development (specifically regarding heat transfer issues), and SMRs as these technologies gain momentum. There is also growing demand for industrial engineers who have a comprehensive understanding of end-to-end power systems. Some executives even see an opportunity to attract civil engineers to the electrical sector. They advocate engaging engineers earlier in their education (whether at the secondary or university level) to promote power engineering opportunities.

Redoubling efforts to retain early- to mid-career engineers

About 68 percent of engineers who left their employer in the past three years had fewer than 10 years of tenure. The reasons for such attrition, according to our survey, are consistent across regions and sectors: burnout, the lack of stimulating work, difficulty in transitioning laterally, and limited opportunities for creative problem-solving.

Based on executive interviews, there is a consensus view that greater investment in education and professional development is needed to fortify the bench of capable professionals. And executives around the world recognize that their engineers value the opportunity to work on new technologies and across different business functions.

When it comes to retaining young talent, some executives believe companies need to think differently about training requirements to facilitate lateral job movement and variety in job roles. For example, a South African executive interviewed proposes reducing accreditation time requirements for engineers, which could facilitate engineers' mobility across different technologies—from thermal to solar to nuclear.

While the preference for job movement is lower among engineers with 10 or more years of experience, executives globally favor increasing retention efforts geared toward mid-career professionals. Although they are the most captive employee segment, retention efforts help reinforce long-term workforce stability and expertise retention. And while retention measures naturally vary, several best practices emerged from our executive interviews: offering modern facilities, rest days, training opportunities, appropriate renumeration, and a healthy culture—including engaged leadership.

Preserving retiree relationships to safeguard institutional knowledge

A broad view held across executives is that engaging retirees can be an effective means of knowledge transfer until the future talent pipeline can be fortified. Some propose hiring retirees on a project basis. Others suggest incentivizing long-tenured engineers—especially those working in conventional power systems, where the expertise is at risk of fading away—by offering them part-time job opportunities post-retirement. A North American executive explained that his company already offers part-time work arrangements to retirees and transitions them to consulting roles. A Brazilian executive suggested that postponing the national retirement age would ensure an adequate engineering talent supply, and that by retaining the older generation of engineers, companies could also ensure workforce quality.

Engaging retirees can be an effective means of knowledge transfer until the future talent pipeline can be fortified.

Recommendations

Power companies, industry groups, and universities all have a role to play in cultivating a new generation of engineers equipped to meet the formidable challenges the power industry faces today and in the next decade.

As the world moves forward in planning and implementing the new clean-energy power systems, industry stakeholders must act, both independently and collectively, to shore up the talent pipeline. Without an adequate—and adequately trained—workforce, the ambitions for the energy transition cannot be realized in the targeted net-zero timeline. Industry players must expand the traditional power engineering skill set to incorporate the new systems and emerging digital technologies. More importantly, they must act with urgency to reduce workforce attrition and attract new and diverse talent, while also ensuring they retain and maintain the expertise of current engineers.

Given the variety of insights derived across this research, it is evident that ensuring the world has a sufficient and well-trained engineering workforce will require a series of targeted actions. Specifically, the research leads to the following series of recommendations:

Power companies can:

- Reframe technology as a means of mitigating the supply constraints in the engineering workforce and partner with start-ups to accelerate technology adoption.
- Establish centers of excellence to build a foundation through which technology can be rapidly deployed companywide.
- Ramp up internal training programs focused on digital technology to upskill their engineers.
- Build a diverse talent pool and craft a compelling EVP focused on development and growth to retain and attract new engineers.
- Establish policies and programs that tap into the growing pool of retiring engineers who can contribute their knowledge and experience on a part-time consulting or project basis.

Industry associations can:

— Expand offerings geared toward engineers outside of the traditional power disciplines (for example, mechanical, industrial, and civil engineering).

— Develop training programs focused on digital and emerging technologies—including cross-disciplinary skill sets—that can be easily rolled out by companies of different sizes and from different industry sectors.

— Act as an information conduit to ensure best practices and industry needs are disseminated across all major stakeholders—companies, start-ups, universities, and others.

Universities can:

— Work with government to increase program sizes for power engineering disciplines.

— Increase research programs in emerging areas of R&D focus, notably renewables, grid technology, and EV infrastructure.

— Elevate the student learning experience and accelerate workforce readiness by providing more practical work opportunities—including partnering with industry on emerging technology projects.

The energy transition calls for power engineers to demonstrate a broader, more versatile skill set and an engineering mindset that thrives on problem solving and innovation. It promises more stimulating, more meaningful work. By promoting the opportunities and the possibilities, the power industry can reverse current workforce trends and compete effectively for the best and the brightest—the next generation that will lead the way to a new energy landscape.

Power companies, industry groups, and universities all have a role to play in cultivating a new generation of engineers.

Appendix: study methodology

Primary research

Scope

Primary data for this study was collected through surveys and interviews of power industry stakeholders throughout the world.

- We conducted global surveys of power industry executives and the power engineering workforce, achieving a significant sample of 187 industry executives and 736 engineers.
- To supplement our executive survey findings, we conducted interviews with 27 executives from power generation, transmission and distribution, engineering services, and electrical equipment companies of various sizes.
- We conducted two additional interviews with public university officials in Canada and India.

Our surveys drew respondents from 37 countries. To simplify the analysis, we classified these 37 countries regionally, as follows:

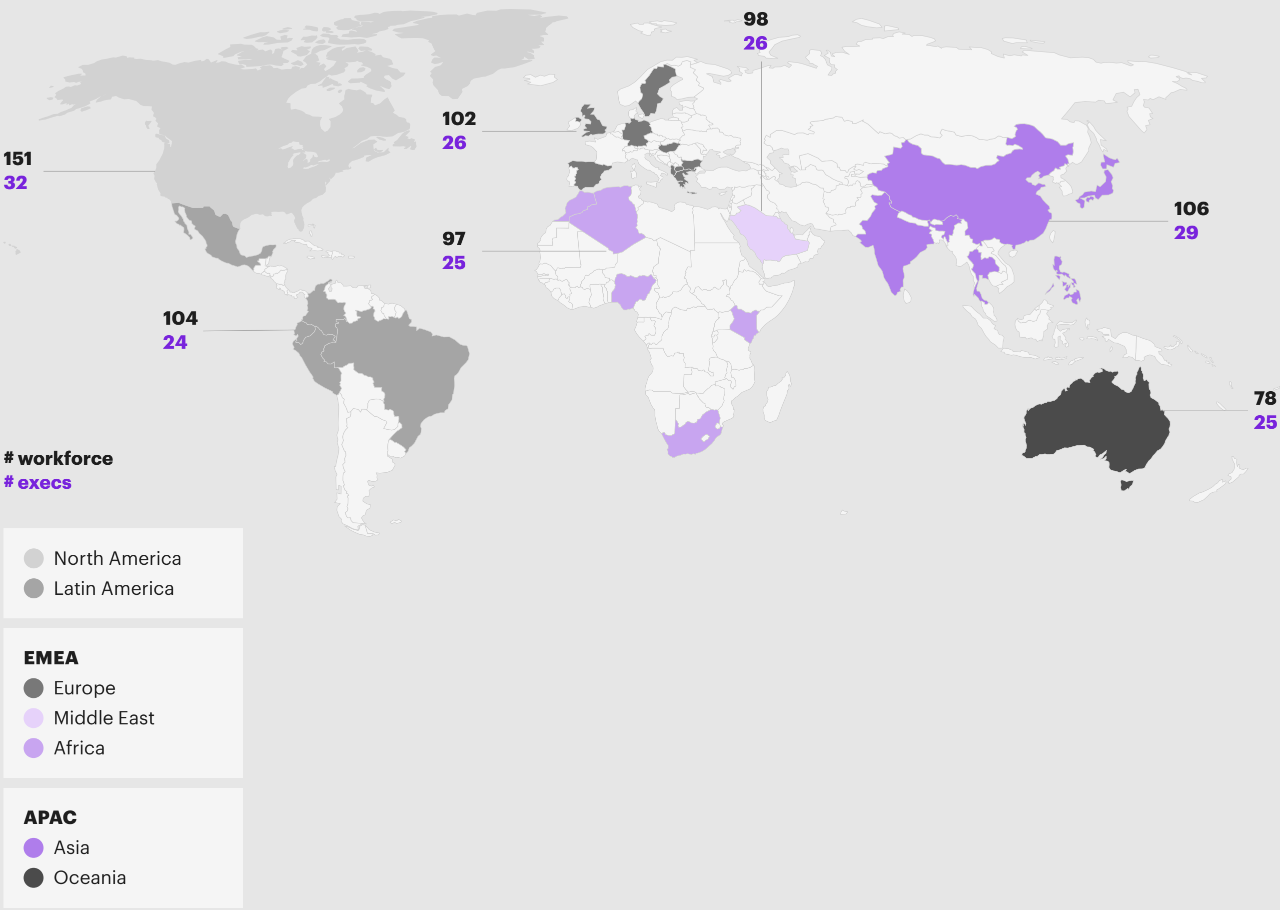
- **Africa:** Algeria, Kenya, Morocco, Nigeria, South Africa
- **Asia:** China, India, Japan, Malaysia, Philippines, Singapore, Thailand
- **Europe:** Austria, Germany, Greece, Netherlands, Portugal, Serbia, Spain, Sweden, United Kingdom
- **Latin America:** Brazil, Colombia, Ecuador, El Salvador, Honduras, Mexico, Peru
- **Middle East:** Bahrain, Palestinian territories, Qatar, Saudi Arabia, United Arab Emirates
- **North America:** Canada, United States
- **Oceania:** Australia, New Zealand

In our workforce sample, North America had the largest representation (21 percent), while Oceania had the smallest (11 percent). All other regions fell within the average representation of our sample set of 14 percent, indicating a balanced sample size across regions. In our executive sample, the average representation of each region was also 14 percent. North America had the largest representation (17 percent), and Africa and Oceania the smallest (13 percent), also indicating a well-represented sample (see figure A on page 46 for the geographic distribution of survey respondents).

Figure A

Primary data was collected globally through surveys and interviews, and represented responses from 38 countries

Survey data representation



Executive interviews

Region	# executive interviews
North America	14
Latin American	3
Europe, Middle East, Africa (EMEA)	5
Asia Pacific (APAC)	5
Total	27

Executives were interviewed from a range of organizations, including:

— Generation, transmission, and distribution utilities

— Equipment manufacturers

— Engineering consulting firms

— Energy transition start-ups

Source: 2024 IEEE PES-Kearney Survey

Our survey sample of both the workforce and the executives can be deemed well-balanced when compared with the IEEE Power & Energy Society membership base, which breaks down as follows: 42 percent from North America; 6 percent from Latin America; 14 percent from Europe, the Middle East, and Africa; and 37 percent from Asia Pacific.

To add context to the survey findings, we interviewed more than two dozen executives in Brazil, Germany, India, Lebanon, Pakistan, Panama, South Africa, and the United States. These executives have leadership responsibility across various domains within the power industry, including power system design, generation, transmission, and distribution, and utility and engineering services. The selection of interviewees was jointly facilitated by Kearney and IEEE PES, and the identity of all interviewees was anonymized.

Study design

Both the workforce and executive survey questionnaires were structured with a general screening and characterization section to ensure appropriate sample selection. This structure also allowed us to characterize responses based on professional attributes (for example, current employment, career track, role and level of responsibility, and current domain of employment), as well as demographic attributes (for instance, gender, ethnicity).

Following the screening section, the workforce survey questionnaire was designed to gain insights on retirement expectations, previous industry experience, the current and future employee value proposition, and optimism about emerging technologies. We also sought to identify potential skill gaps and areas where additional training or specialization may be needed.

Similarly, the survey questionnaire for executives was designed to gain insights on investment in new technologies, expected industry talent needs, and attraction and retention trends. We also wanted to understand how companies could sustain productivity and operational performance over the coming five to 10 years.

The survey questions consisted of yes/no and multiple-choice questions, along with sentiment rankings on a four- to six-point spectrum (for example, very, somewhat, neutral). Such questions were aimed at measuring perceived importance, (employer) performance, impact, willingness (regarding investing), level of preparedness, adequacy, and likelihood to act. Not every respondent answered every survey question.

To corroborate our survey findings with qualitative data, the interview questionnaires for executives were designed to gain leaders' perspectives and general sentiment on the aforementioned topics. In addition, our interview guides for university officials were designed to shed light on curriculum development plans, enrollment and graduation trends, and anticipated industry needs and preparedness, as well as the institution's efforts for attracting diverse students. Our interviews with start-ups focused on technology use cases and the skill sets required to apply those technologies, to provide insights on the innovation ecosystem.

Analysis and interpretation

We refined the raw survey data to exclude incomplete survey responses and duplicate entries. We then analyzed the refined data by region, tenure, and gender. While the survey provided directional insights, our findings on technology investments, skill sets, and attraction and retention strategies were informed by a combination of survey data and interview insights.

Secondary research

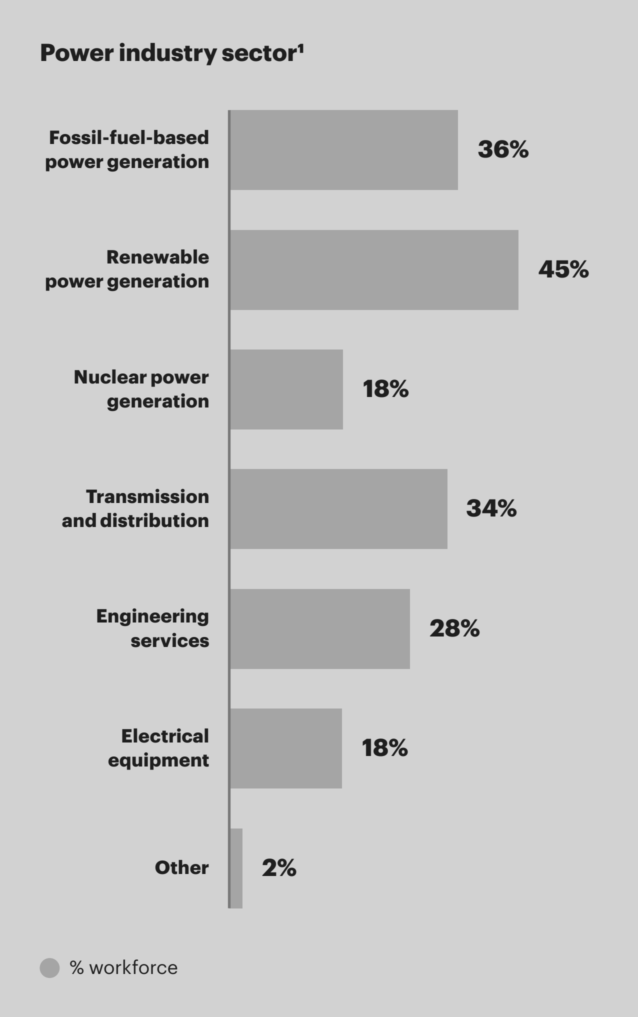
We relied on data from such recognized industry sources as the International Energy Agency (IEA) and the US Bureau of Labor Statistics, in combination with internal benchmarks, to forecast the size of the power engineering workforce that will be needed by 2030.

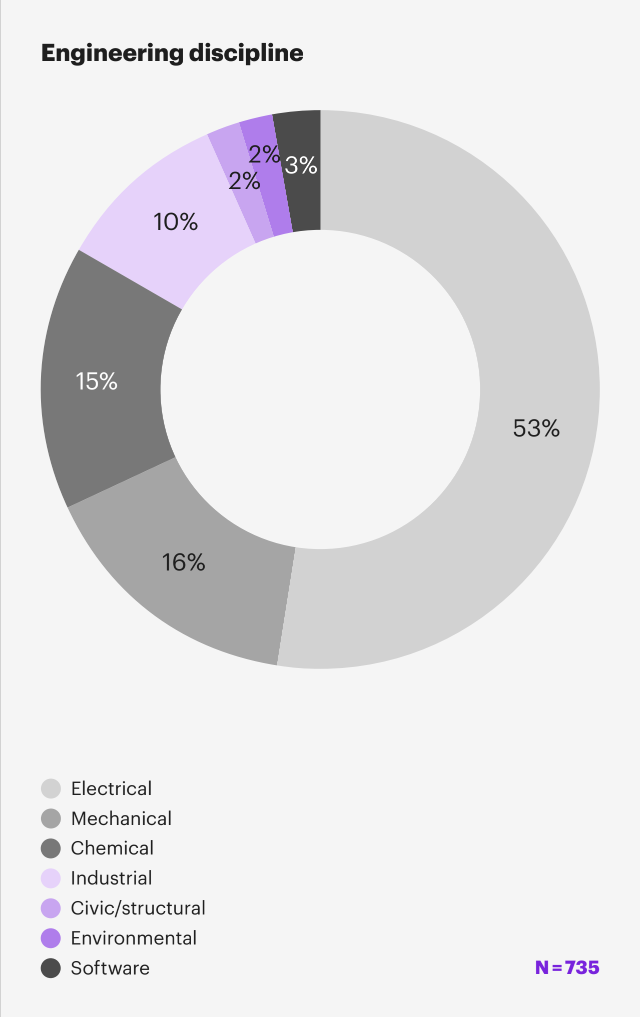
To inform perspectives on technology, skill sets requirements, and attraction and retention strategies, we consulted a variety of sources, including the databases of the IEA, the National Center for Science and Engineering Statistics, and S&P Capital IQ, as well as federal government budgets and the 10K reports of power companies.

Figure B

Electrical engineers represent the majority of the workforce

Overview of workforce demographics





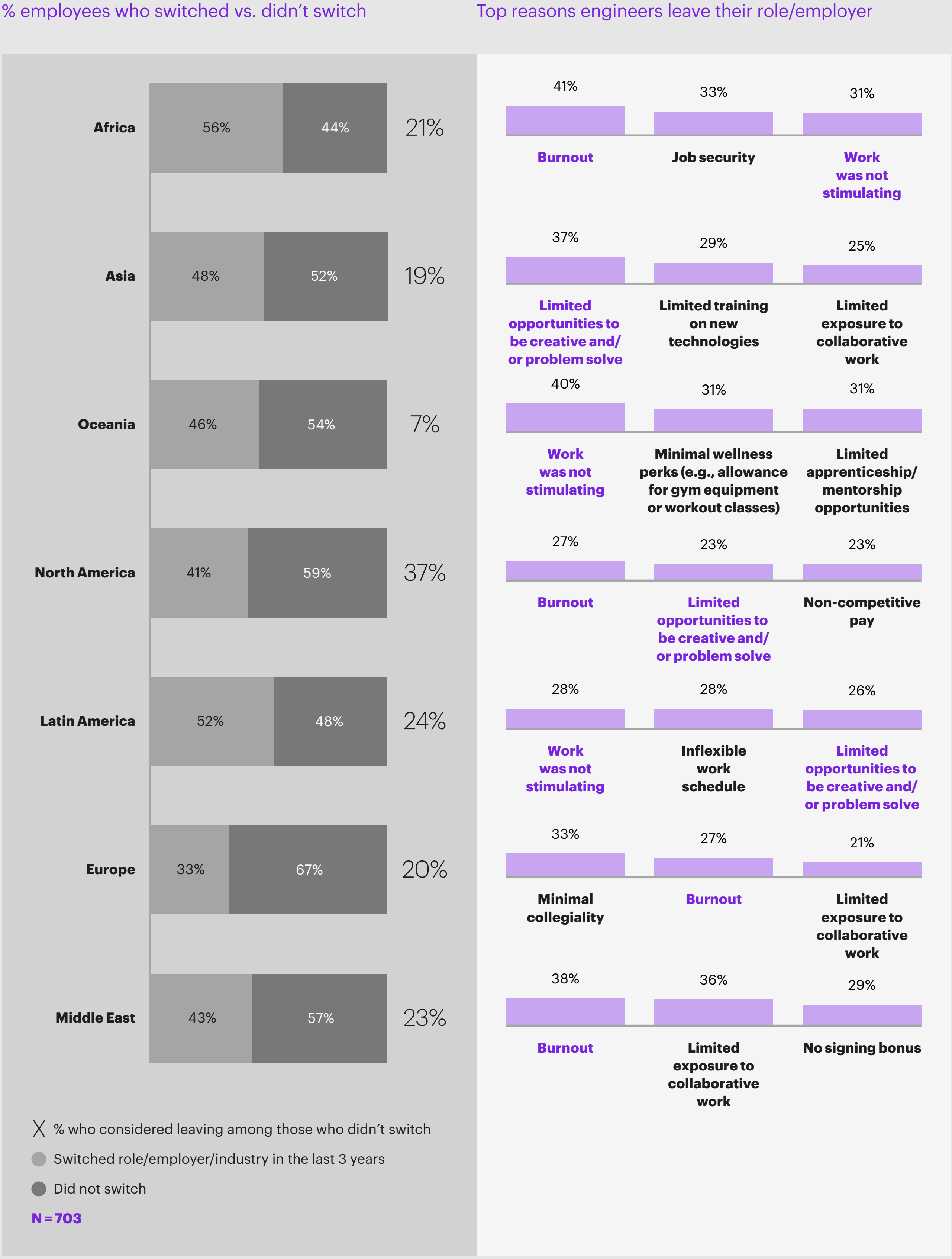
[1] Respondents could select all options that were applicable based on their current or prior industry experience.

Note: percentages may not resolve due to rounding.

Source: 2024 IEEE PES-Kearney Survey

Figure C

Job movement was highest in emerging economies, with key reasons for leaving roles being burnout and non-stimulating work



Source: 2024 IEEE PES-Kearney Survey

Figure D

Job movement is highest among those who have worked in nuclear power generation, with burnout and unstimulating work being the key reason engineers report leaving

[1] Respondents could select multiple sectors as their area of work.

Source: 2024 IEEE PES-Kearney Survey

Figure E

Foundational skill set importance for executives in next 5 vs. 10 years by region[1]

Foundational skill sets

Skill set	North America	Latin America	Asia	Middle East	Africa	Europe	Oceania
Technical proficiency	90% / 93%	79% / 83%	90% / 93%	88% / 85%	88% / 92%	77% / 81%	96% / 84%
Project management	93% / 90%	83% / 79%	69% / 79%	81% / 92%	92% / 100%	65% / 69%	80% / 88%
System or product design	86% / 86%	67% / 79%	79% / 86%	85% / 92%	92% / 84%	73% / 77%	80% / 88%
Data analytics	86% / 83%	83% / 75%	90% / 79%	92% / 85%	72% / 96%	85% / 73%	80% / 88%
Communication	90% / 83%	63% / 83%	83% / 79%	96% / 81%	84% / 92%	81% / 85%	84% / 84%
Interdisciplinary skills	97% / 86%	75% / 75%	69% / 90%	85% / 88%	92% / 88%	81% / 81%	88% / 88%

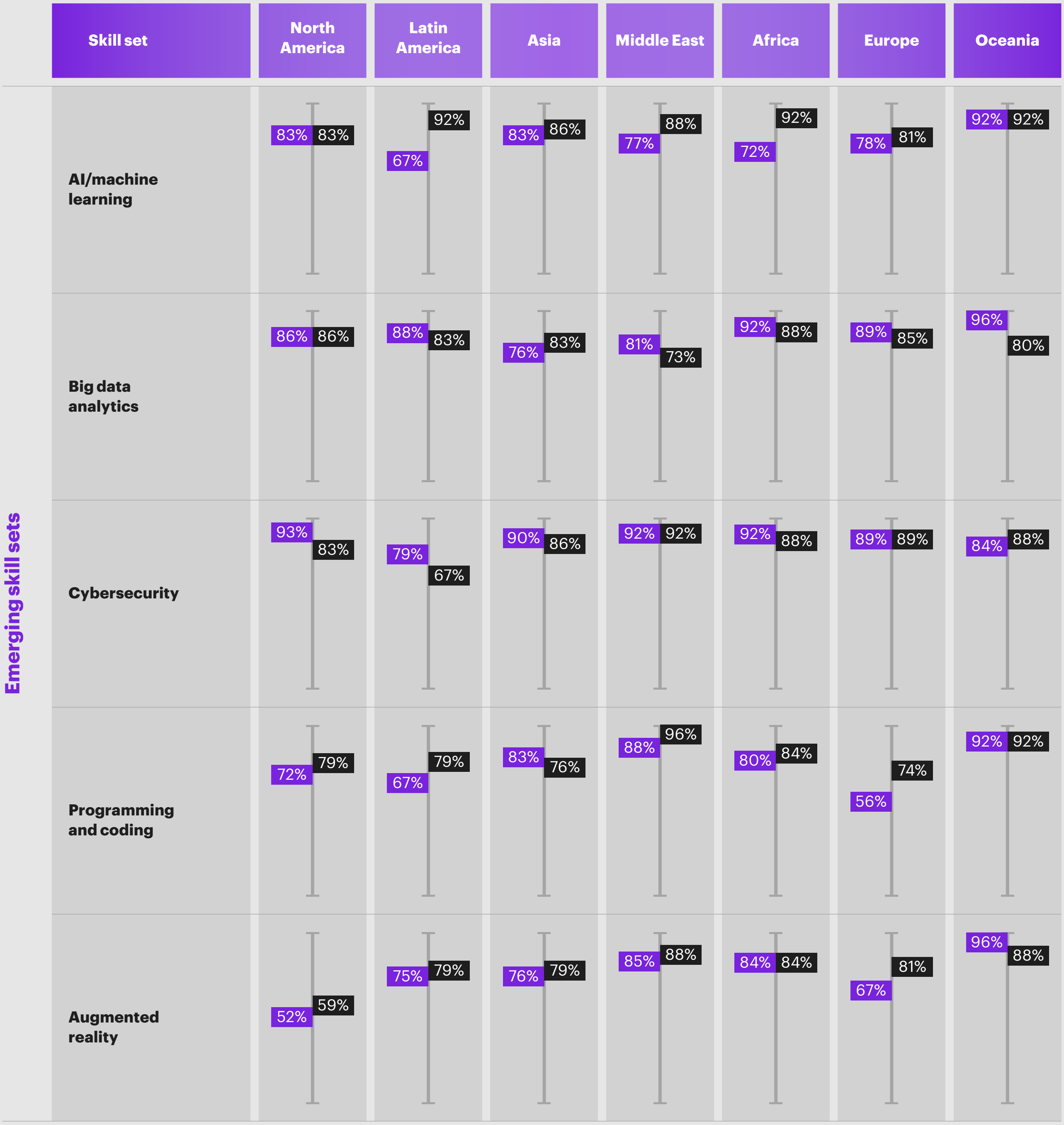
● % executives that believe skill set will be important in 5 years ● % executives that believe skill set will be important in 10 years **N = 184**

[1] % of executives that believe skills will be important. Includes responses "very important" and "somewhat important."

Source: 2024 IEEE PES-Kearney Survey

Figure F

Emerging skill set importance for executives in next 5 vs. 10 years by region[1]



● % executives that believe skill set will be important in 5 years ● % executives that believe skill set will be important in 10 years **N=184**

[1] % of executives that believe skills will be important. Includes responses "very important" and "somewhat important"

Source: 2024 IEEE PES-Kearney Survey

Figure G

Foundational skill set importance for engineers in next 5 vs. 10 years by region[1]

Foundational skill sets

Skill set	North America	Latin America	Asia	Middle East	Africa	Europe	Oceania
Technical proficiency	92% / 85%	96% / 85%	89% / 80%	87% / 86%	88% / 84%	85% / 79%	86% / 90%
Project management	85% / 80%	87% / 84%	80% / 80%	92% / 86%	94% / 89%	76% / 73%	91% / 84%
System or product design	74% / 73%	83% / 83%	78% / 83%	83% / 81%	87% / 84%	76% / 73%	87% / 83%
Data analytics	80% / 83%	86% / 83%	80% / 86%	85% / 86%	88% / 82%	78% / 80%	82% / 88%
Communication	91% / 90%	87% / 82%	75% / 82%	83% / 82%	85% / 93%	80% / 86%	86% / 83%
Interdisciplinary skills	91% / 86%	86% / 83%	75% / 83%	82% / 81%	76% / 85%	75% / 84%	84% / 84%

● % workforce that believe skill set will be important in 5 years ● % workforce that believe skill set will be important in 10 years **N = 706**

[1] % of workforce that believe skills will be important. Includes responses "very important" and "somewhat important."

Source: 2024 IEEE PES-Kearney Survey

Figure H

Emerging skill set importance for engineers in next 5 vs. 10 years by region[1]

Emerging skill sets (5 years / 10 years)

Skill set	North America	Latin America	Asia	Middle East	Africa	Europe	Oceania
AI/machine learning	67% / 71%	79% / 90%	77% / 78%	87% / 89%	88% / 92%	74% / 76%	84% / 87%
Big data analytics	78% / 80%	86% / 88%	79% / 81%	90% / 85%	89% / 94%	73% / 78%	88% / 87%
Cybersecurity	75% / 81%	87% / 84%	74% / 82%	89% / 92%	90% / 90%	81% / 79%	88% / 88%
Programming and coding	68% / 63%	88% / 84%	71% / 79%	82% / 80%	88% / 88%	82% / 81%	73% / 75%
Augmented reality	48% / 52%	79% / 80%	65% / 75%	84% / 84%	80% / 80%	72% / 68%	77% / 74%

● % workforce that believe skill set will be important in 5 years ● % workforce that believe skill set will be important in 10 years **N=706**

[1] % of workforce that believe skills will be important. Includes responses "very important" and "somewhat important."
Source: 2024 IEEE PES-Kearney Survey

Figure I

Employee value proposition framework used in Kearney–PES Survey

The six dimensions of employee value proposition (EVP)
Application: power engineering workforce

Nature of the work

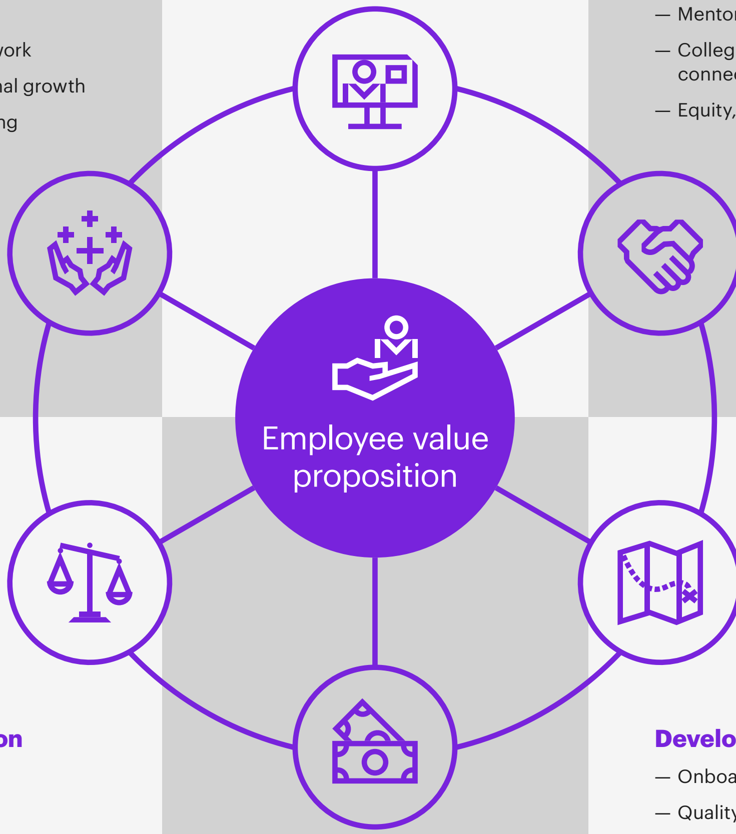
- Extent of creative problem-solving and innovation opportunities
- Exposure working collaboratively with teams
- Work or task variability
- Sense of job security
- AI/ML and automation prevalence
- Level of role outsourcing

Purpose and meaning

- Company's mission and values
- Company culture
- Pride and meaning in work
- Opportunity for personal growth
- Comfort level in bringing authentic self to work

Culture and relationships

- Health and safety culture
- Mentorship support
- Collegiality/community connectedness
- Equity, diversity, and inclusion



Work–life integration

- Rotation scheduling
- Flexible work models
- Schedule predictability
- Number of hours worked per week
- Extent of travel required
- Additional childcare supports (e.g., onsite day care)

Compensation and benefits

- Compensation
- Health/extended health insurance
- Wellness perks
- Sick leave policies
- Parental leave policies
- Above average vacation time
- Relocation or housing supports

Development opportunities

- Onboarding
- Quality of training
- Apprenticeship/mentorship opportunities
- Career growth potential
- Employer sponsorship of higher education

Source: Kearney analysis

Figure J

Employee value proposition top EVP element importance by region

Most important EVP element	Extent of creative problem-solving and innovation opportunities	Number of hours worked per week	Quality of training	Health and safety culture	Competitive pay	Opportunities for personal growth
North America	53% 37%	29% 48%	51% 37%	55% 32%	58% 35%	54% 35%
Latin America	58% 33%	47% 43%	55% 35%	58% 33%	63% 27%	63% 24%
Asia	52% 36%	34% 45%	42% 37%	48% 39%	49% 33%	45% 41%
Middle East	46% 41%	41% 42%	41% 38%	42% 49%	52% 36%	48% 38%
Africa	68% 27%	63% 26%	63% 22%	59% 26%	56% 34%	56% 33%
Europe	38% 44%	32% 41%	32% 36%	46% 36%	33% 49%	33% 45%
Oceania	44% 50%	41% 45%	49% 32%	46% 37%	44% 47%	38% 45%

% workforce that believe element is very important

% workforce that believe element is somewhat important

% workforce that believe element is not important/neutral

N = 735

Source: 2024 IEEE PES-Kearney Survey

Figure K

Workforce rating of employer – EVP element rating by region

Most important EVP element	Extent of creative problem-solving and innovation opportunities	Number of hours worked per week	Quality of training	Health and safety culture	Competitive pay	Opportunities for personal growth
North America	35% 42%	30% 39%	28% 33%	40% 46%	27% 43%	24% 42%
Latin America	38% 47%	35% 46%	41% 38%	46% 35%	34% 48%	37% 39%
Asia	41% 32%	30% 33%	34% 32%	32% 45%	35% 40%	36% 42%
Middle East	46% 49%	40% 43%	36% 43%	43% 40%	42% 47%	55% 28%
Africa	47% 41%	44% 35%	47% 33%	48% 35%	35% 44%	31% 38%
Europe	16% 53%	28% 41%	23% 37%	40% 34%	34% 42%	24% 45%
Oceania	36% 56%	38% 44%	33% 40%	49% 45%	40% 51%	28% 49%

% workforce that rate element as strong

% workforce that rate element as moderately strong

% workforce that rate element as weak/very weak

N = 721

Source: 2024 IEEE PES-Kearney Survey

About IEEE Power & Energy Society (PES)

The IEEE Power & Energy Society (PES) is the leading provider of scientific and engineering information on electric power & energy for the betterment of society and a trusted resource dedicated to the technical, informational, networking, and professional development needs of its members. With over 40,000 members around the globe representing every facet of the electric power and energy industry, IEEE PES is at the forefront of the rapidly changing technological advancements that impact everyone's future. Additional information on IEEE PES can be found at ieee-pes.org.

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Kearney is a leading global management consulting firm. For nearly 100 years, we have been a trusted advisor to C-suites, government bodies, and nonprofit organizations. Our people make us who we are. Driven to be the difference between a big idea and making it happen, we work alongside our clients to regenerate their businesses to create a future that works for everyone.

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