



WHEN TRUST MATTERS

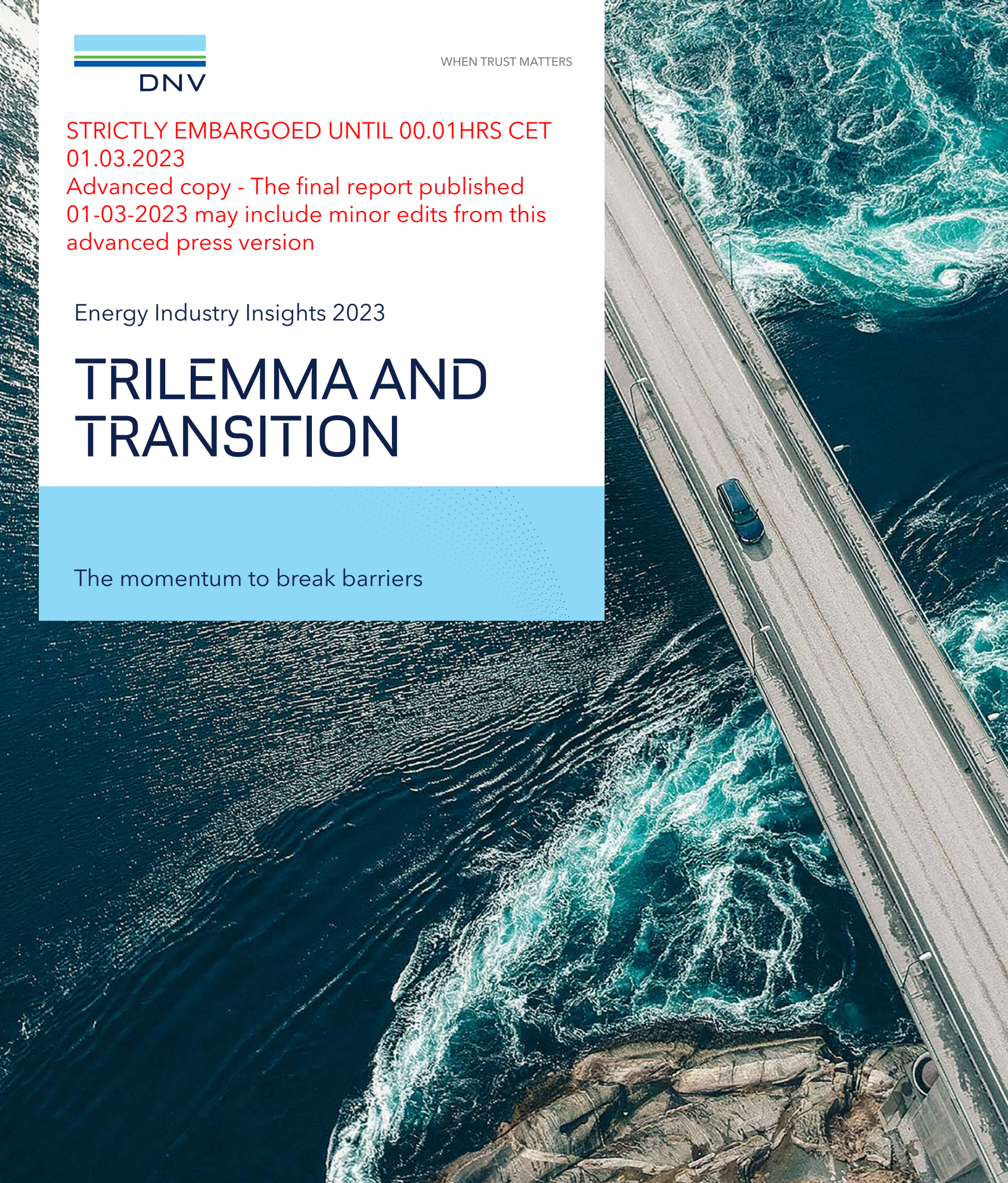
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Energy Industry Insights 2023

TRILEMMA AND TRANSITION

The momentum to break barriers



ABOUT THE RESEARCH

DNV's Energy Industry Insights research – now in its 13th year – explores the confidence, sentiment, and priorities for the energy industry in the year ahead.

Energy Industry Insights draws on DNV's annual survey of more than 1,000 senior professionals and a programme of in-depth interviews with leaders and experts. It is developed and created by teams from DNV and FT Longitude (a Financial Times company).

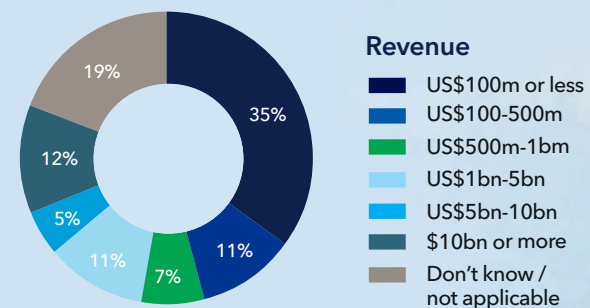
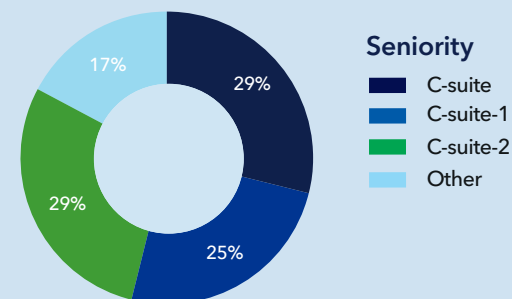
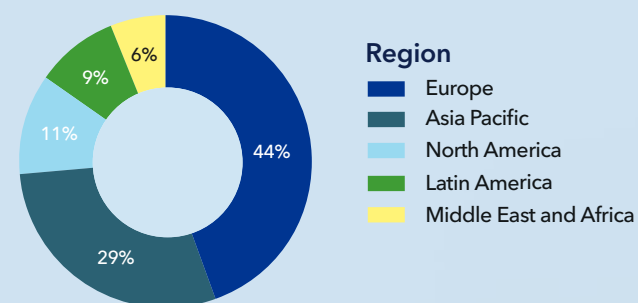
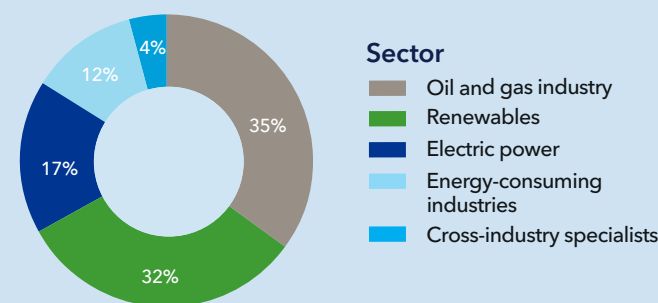
The research was conducted during December 2022 and January 2023. Survey respondents were drawn from across the energy industry, including publicly listed companies and privately held firms, and span-

ning electrical power, renewables, oil and gas, industry specialists (e.g. in technology, finance or policy), and industrial energy consumers. The survey respondents represent a range of functions within the industry, from board-level executives to senior engineers.

Trilemma and Transition is published by DNV, the world's leading resource of independent energy experts and technical advisors.

Survey demographics

We thank our survey respondents from across the energy industry.



1,385

senior energy professionals surveyed



29%

of respondents are C-level



93

countries represented



10

in-depth interviews with industry leaders



28%

of respondents from companies with revenue of more than USD 1 billion

ACKNOWLEDGEMENTS

We extend our thanks to the following interviewees for sharing their time and insights with us:

Liz Burdock,
CEO, Business Network for Offshore Wind (US)

Michael Cohen,
Chief US Economist and Head of Oil Analysis, BP (US)

Ben Hutt,
CEO, Evergen (Australia)

Tom Einar Jensen,
CEO, Freyr (Norway)

Philippe Kavafyan,
Executive Director, Aker Horizons (Norway)

Anabele Natividad,
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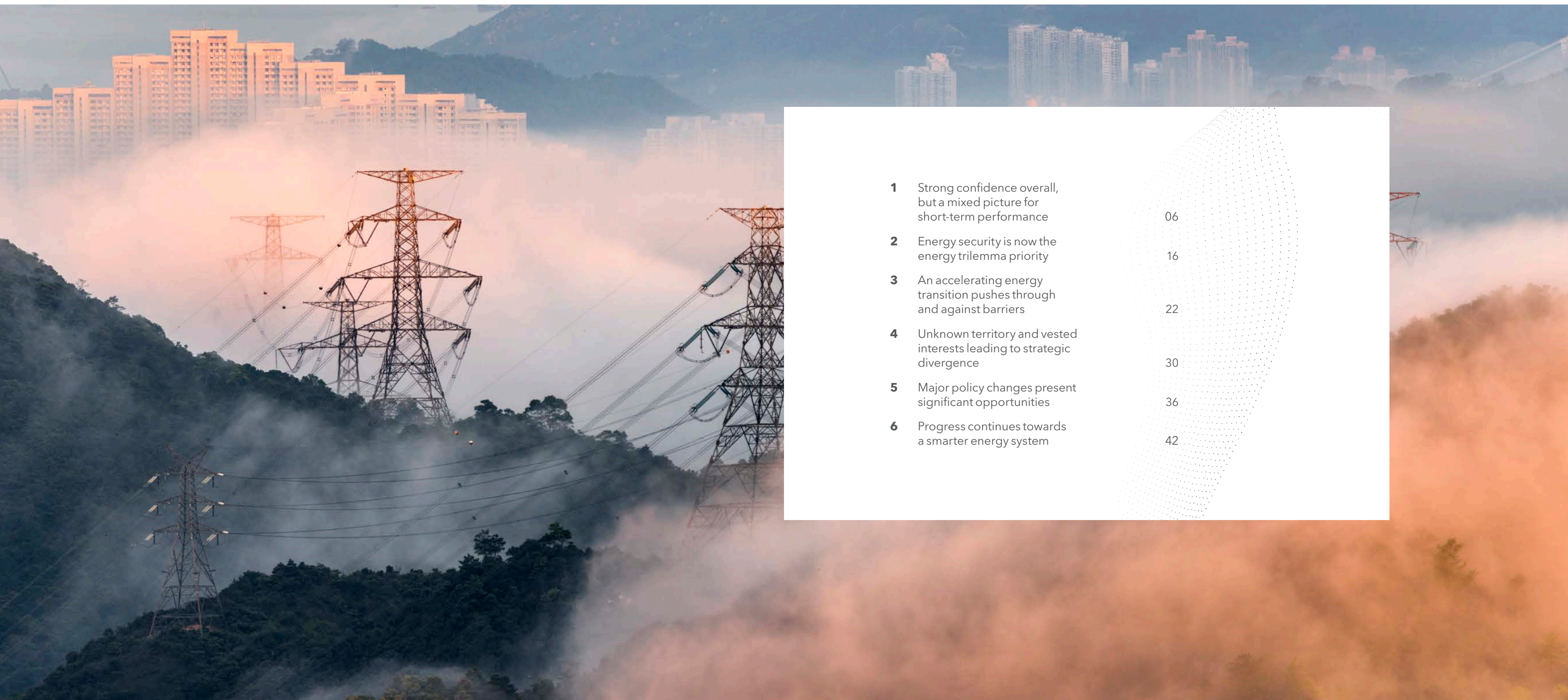
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Chief Data Officer, National Grid (UK)

A senior analyst at a large Chinese oil and gas company

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STRONG CONFIDENCE OVERALL, BUT A MIXED PICTURE FOR SHORT-TERM PERFORMANCE

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1 STRONG CONFIDENCE OVERALL, BUT A MIXED PICTURE FOR SHORT-TERM PERFORMANCE

Early explorers often left with a clear goal - to discover a quicker trade route or to find untapped resources. But often, they set off on their journey without detailed maps and not knowing where they would stop or even sometimes their destination.

Today's energy industry participants need to operate a bit like those pioneers. We have a clear goal - to decarbonize the world - but we are moving forward without a detailed map and only have a high-level idea of the future energy system we are building.

This combination of a fixed, universal goal, but with flexible, diverse pathways, offers historic opportunities to energy sector organizations. In our survey of over 1,300 energy industry executives from around the world, three quarters (74%) are optimistic about the growth prospects (for their part of the energy industry) in the year ahead.

By coincidence, we recorded the same number going into 2022, but there is a much-changed picture underlying this average, particularly across the energy industry sub-sectors - electrical power, renewables, and oil and gas - which we explore below.

Electrical power under pressure

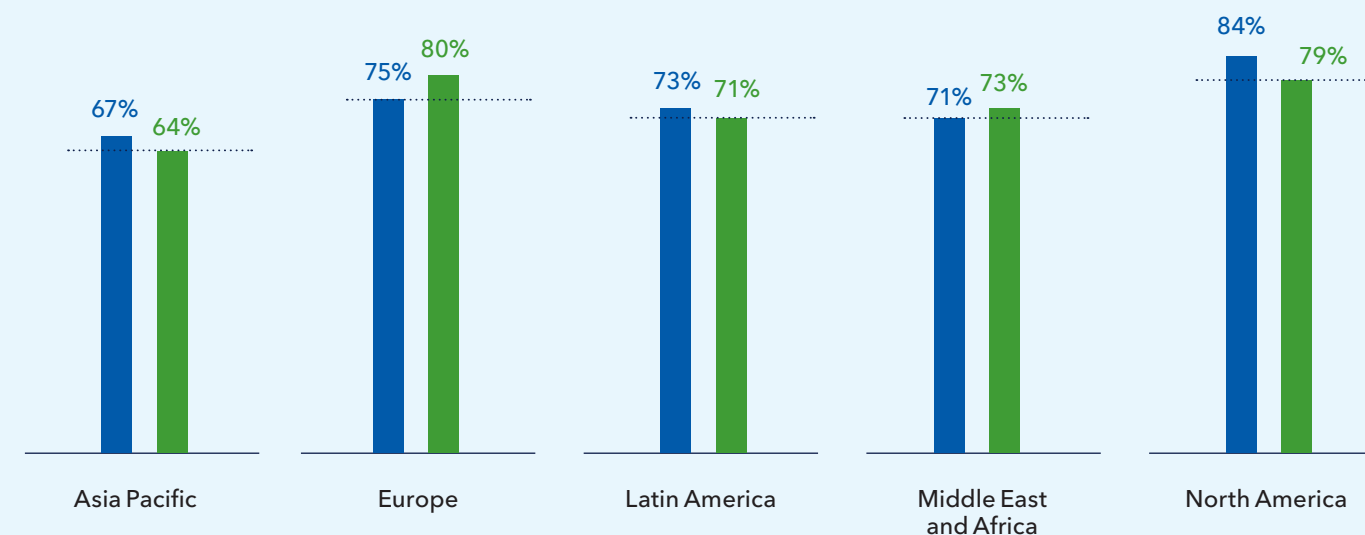
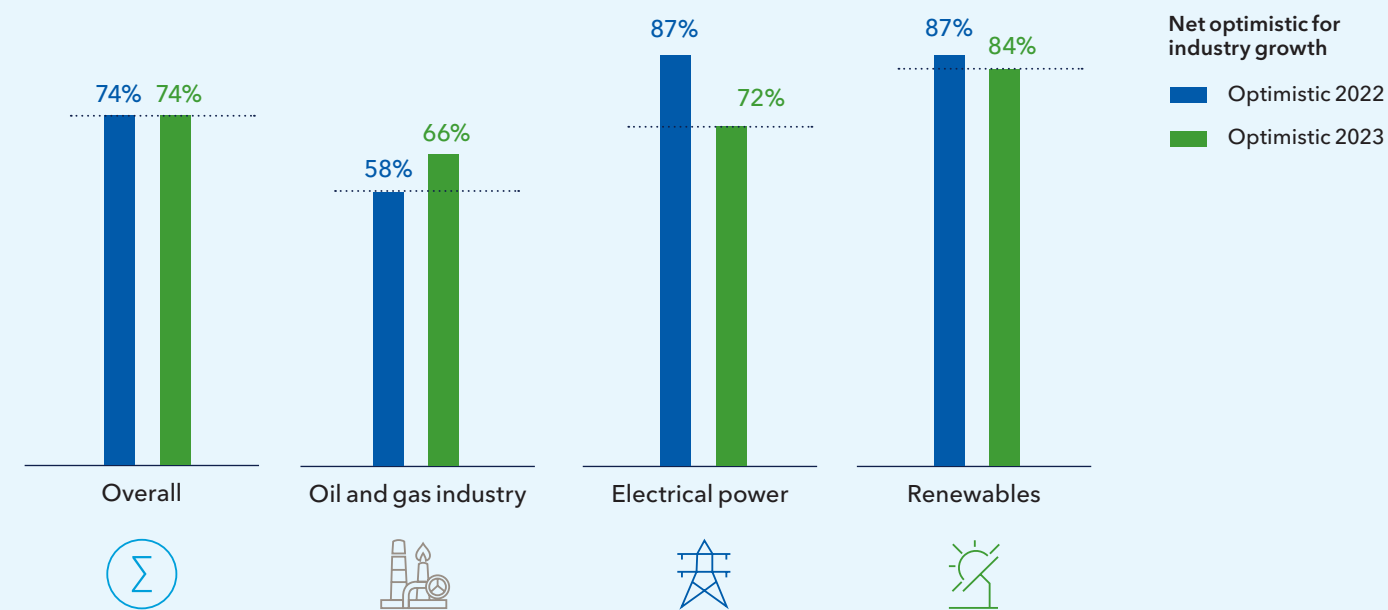
There has been a sharp drop in the proportion of electrical power respondents optimistic about industry growth for the year ahead (72%), down from the heights of 87% going in to 2022. Compared to last year, power sector respondents have lower confidence in their organization's ability to meet revenue and profit targets for the year ahead. Half now say they are more focussed on short-term, than long-term, strategies, up from 34% a year ago. We also recorded a related drop - from 77% to 66% - in the proportion of power respondents that expect to see an increase in the number of large, capital-intensive projects in the year ahead.

The power industry is under pressure to change, to grow, to support the changes around us. This is a massive challenge because the industry comes from a stable background, and we are now operating through a very volatile phase.

Derk Swider, Vice President Group Strategy, Foresight & Analytics at German utility E.ON.



Overall industry optimism remains strong, but only the oil and gas sector shows improved sentiment



Q: How confident are you feeling about the growth prospects for your specific part of the energy industry (i.e. your sub-sector) in the year ahead?

Renewables have a trend to rely on

The renewables sector, like most newer industries, is more accustomed to instability. The industry is expanding at speed, despite the challenges of power grid capacity, energy price volatility, inflation, supply chain failures, regulatory red tape, and delays to supporting infrastructure projects.

Unlike many new industries, however, renewables are swept forward by a megatrend with irresistible momentum - decarbonization - and this appears to provide deep confidence to organizations involved in clean energy.

The market backdrop has never been stronger. The energy and security crisis in Europe is a big challenge, as is inflationary pressure, but we are focussed on the enormous long-term opportunity to contribute to a new energy system.

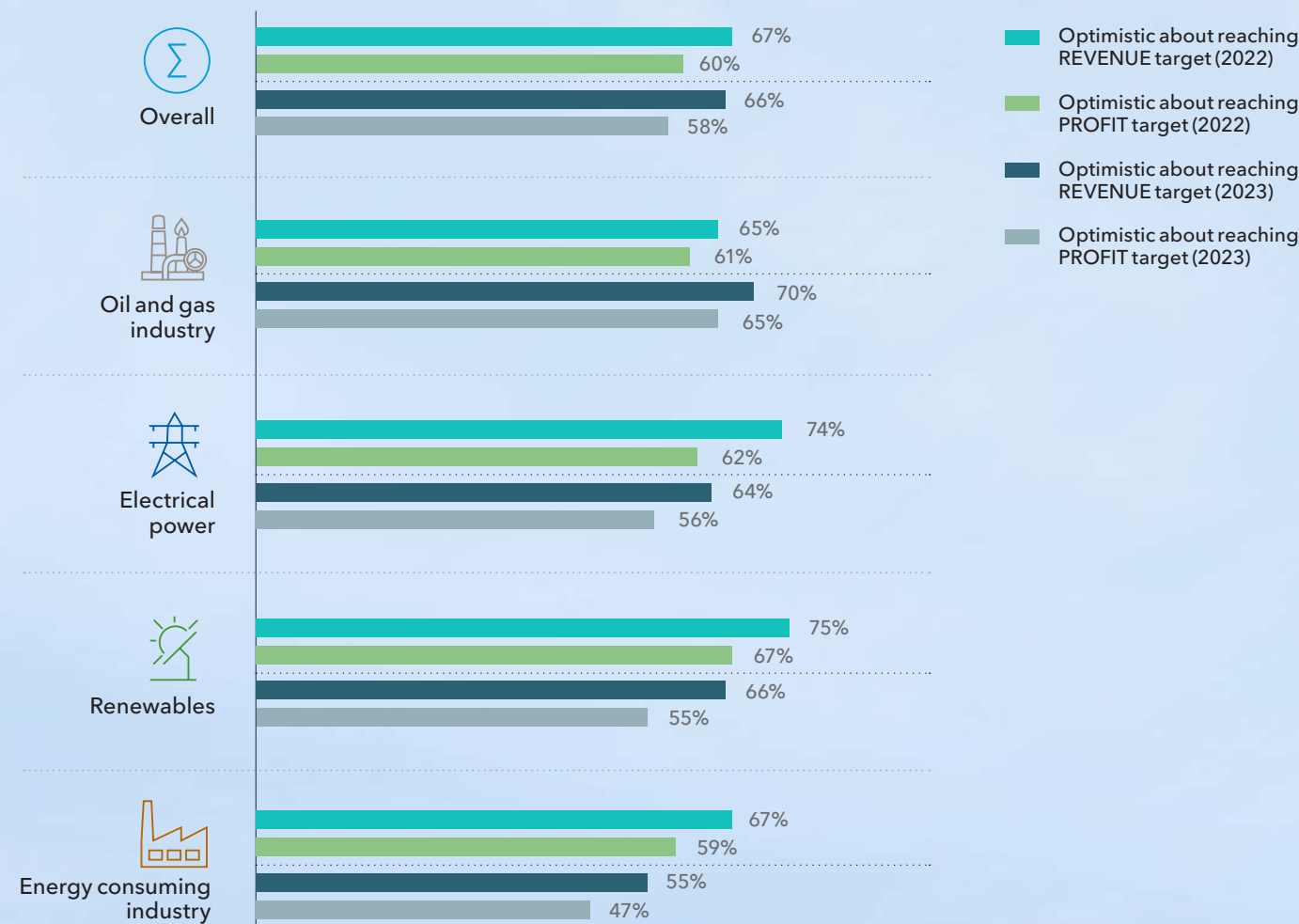
Tom Einar Jensen, Chief Executive Officer of FREYR, a Norwegian battery producer

Most renewables industry respondents (84%) are optimistic for industry growth in 2023, but many expect further challenges in the near-term. This appears to have led to lower confidence in their organization’s ability to reach financial objectives for the year ahead, with optimism for both revenue and profit targets falling circa 10 percentage points year-on-year.

A lack of government support and permitting issues for new projects are the top two barriers for the industry, and renewables respondents also appear particularly hampered by supply chain issues. Nearly eight-in-ten (79%) renewables respondents believe that supply chain issues are slowing down the energy transition, less than half (47%) think there will be significant improvement in the availability of goods in 2023, and 63% believe rising raw material costs will reduce the cost competitiveness of renewables compared with other energy sources.

“Despite the challenges, our overall outlook has not changed,” says Anabele Natividad, Senior Vice President - Development, Solar and Storage at ACEN, the energy platform of the Philippine Ayala Group. “We have seen some significant impacts on specific projects, but our 2030 targets are unchanged.”

Electrical power, renewables and energy consumers all expect worse performance against revenue and profit targets in 2023 (vs. 2022). Oil and gas respondents expect stronger performance



Q: With respect to your organization, how confident are you about the following for the year ahead...

Peak profits (perhaps) for oil and gas

Among oil and gas respondents, growth prospects have improved in the year, rising from 58% to 66%. This is perhaps a modest jump considering the record-shattering profits that many oil and gas companies have posted for 2022. For instance, nearly \$200bn in (adjusted basis) profits were made by the five supermajors: ExxonMobil (\$55.7bn), Chevron (\$35.5bn), TotalEnergies (\$36.2bn), BP (\$27.7bn) and Shell (\$39.9bn) - while several state-owned oil and gas giants did even better.

It was arguably the most profitable year in the whole history of oil and gas, and it will, for a short time at least, redefine what acceptable profits look like. Last year 52% of oil and gas executives said that their organization would make acceptable profits if the oil price averaged USD40 to USD50 per barrel (Brent-WTI average) in 2022. For the year ahead? Just 39% say the same.

Record profits may also have affected the strategies of oil and gas companies, both short- and long-term. A greater proportion of oil and gas respondents say they will increase their investments in hydrocarbons in the year ahead - with gas up eight percentage points to 53%, and oil up nine percentage points to 43% - relative to 2022.

The industry appears to be focussed on investments with returns inside five years, ahead of longer-term commitments.¹ and we are unlikely to see many giant-sized, long-term greenfield projects, or explorations into ultra-deep water, the arctic, or other challenging conditions.

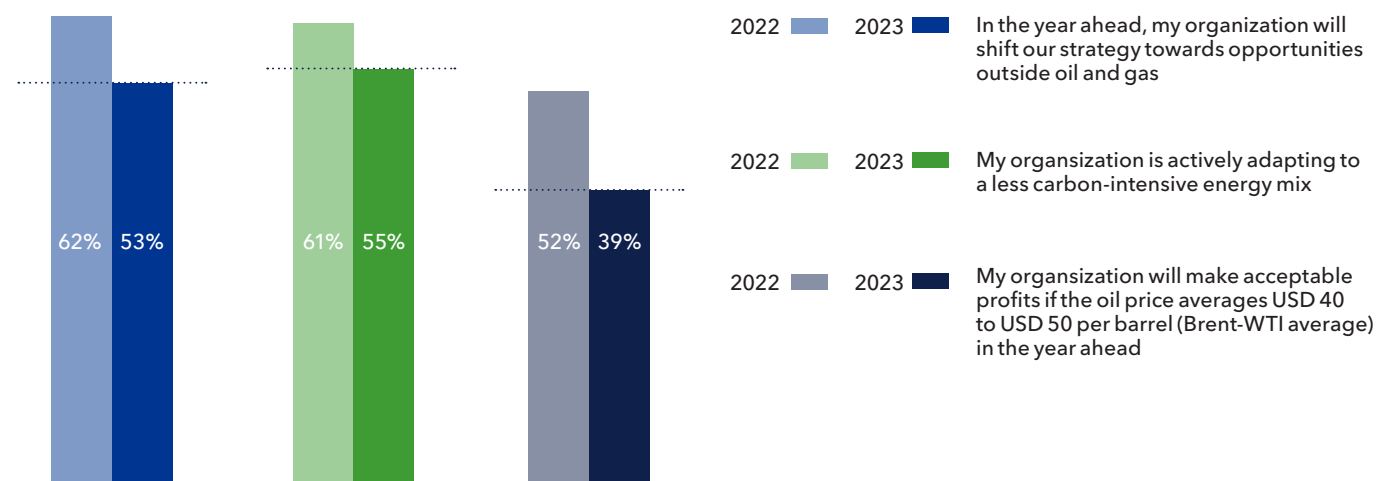
Longer-term, our survey shows oil and gas companies are slowing their shift into areas outside of core hydrocarbons and reducing the pace of decarbonization, compared with their outlook for 2022. Examples of this

have begun to emerge, including BP's announcement to scale-back plans to cut oil and gas production by 2030.²

Many oil and gas companies are still building for the future, but there will be adjustments in the pace of expansion in some areas. For instance, our survey shows

that a smaller proportion are increasing the pace of investment into solar and wind in the year ahead, but green and blue hydrogen and carbon capture and storage (CCS) remain unchanged, with circa half of oil and gas respondents increasing investments there in the year ahead.

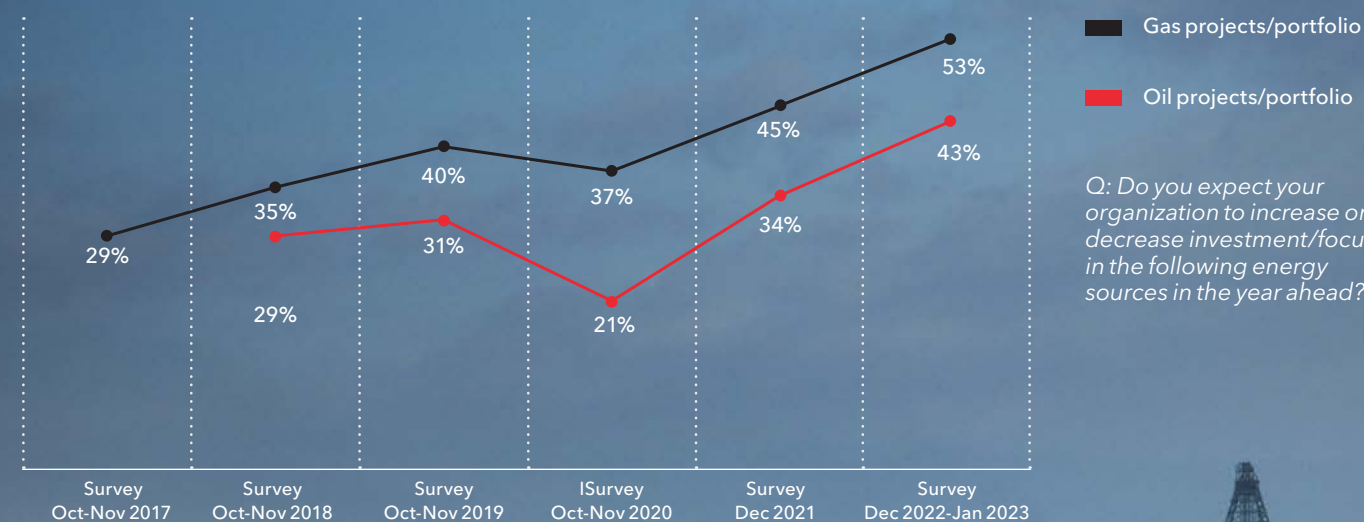
Oil and gas industry in 2023: slowing the pivot into areas outside of core hydrocarbons, reduced pace of decarbonization, and redefining acceptable profits.



Q: To what extent do you agree or disagree with the following? Base: All Oil and gas industry. Percentages reflect net agreement (i.e. moderately + strongly agree).

¹ Where on Earth is big oil spending its \$150bn profit bonanza? The Economist
² BP slows oil and gas retreat after record \$28bn profit. FinancialTimes

Greater number of oil and gas companies expect to increase investment in oil and gas portfolios.



Q: Do you expect your organization to increase or decrease investment/focus in the following energy sources in the year ahead?

Some industrial consumers move to produce their own energy

Our survey also includes respondents from industrial businesses, such as shipping, steel, chemicals, and manufacturing. Like those in energy industry sectors, these industrial energy consumers are less optimistic about hitting revenue targets (down from 67% to 55%) and profit targets (down from 59% to 47%) in the year ahead, compared to 2022.

Heavy energy consumers face daunting barriers and challenging strategic choices as they navigate the energy transition. For a large minority of these organizations (44%) electricity grids in key locations cannot support their organization’s renewable energy ambitions. Grid issues, security and reliability of supply are among the reasons why, for more than a quarter (27%) of industrial energy consumers, it now makes sense to build or buy their own clean energy generation infrastructure or assets.



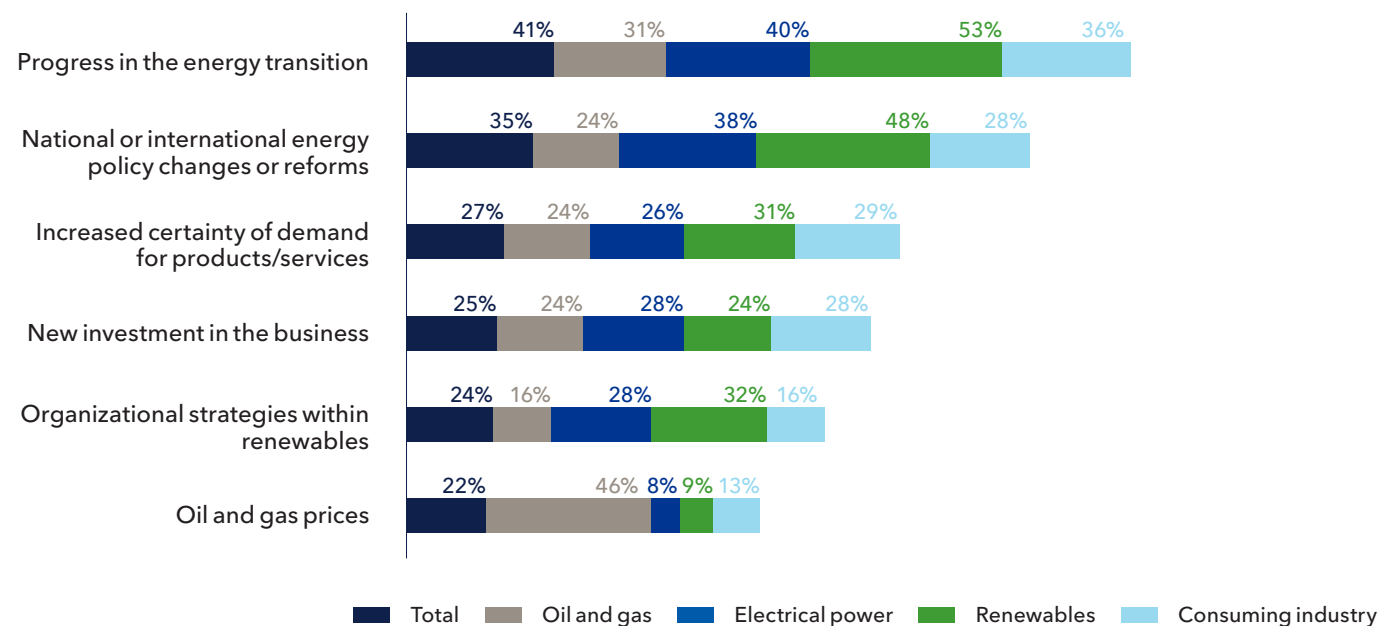
A way to win in the new world

Many factors support respondents’ optimism for their organization in the year ahead, with emphasis differing by sector. For example, sentiment among oil and gas industry respondents remains tied to market cycles, with oil and gas prices and global economic conditions being much more important drivers than for other parts of the energy industry.

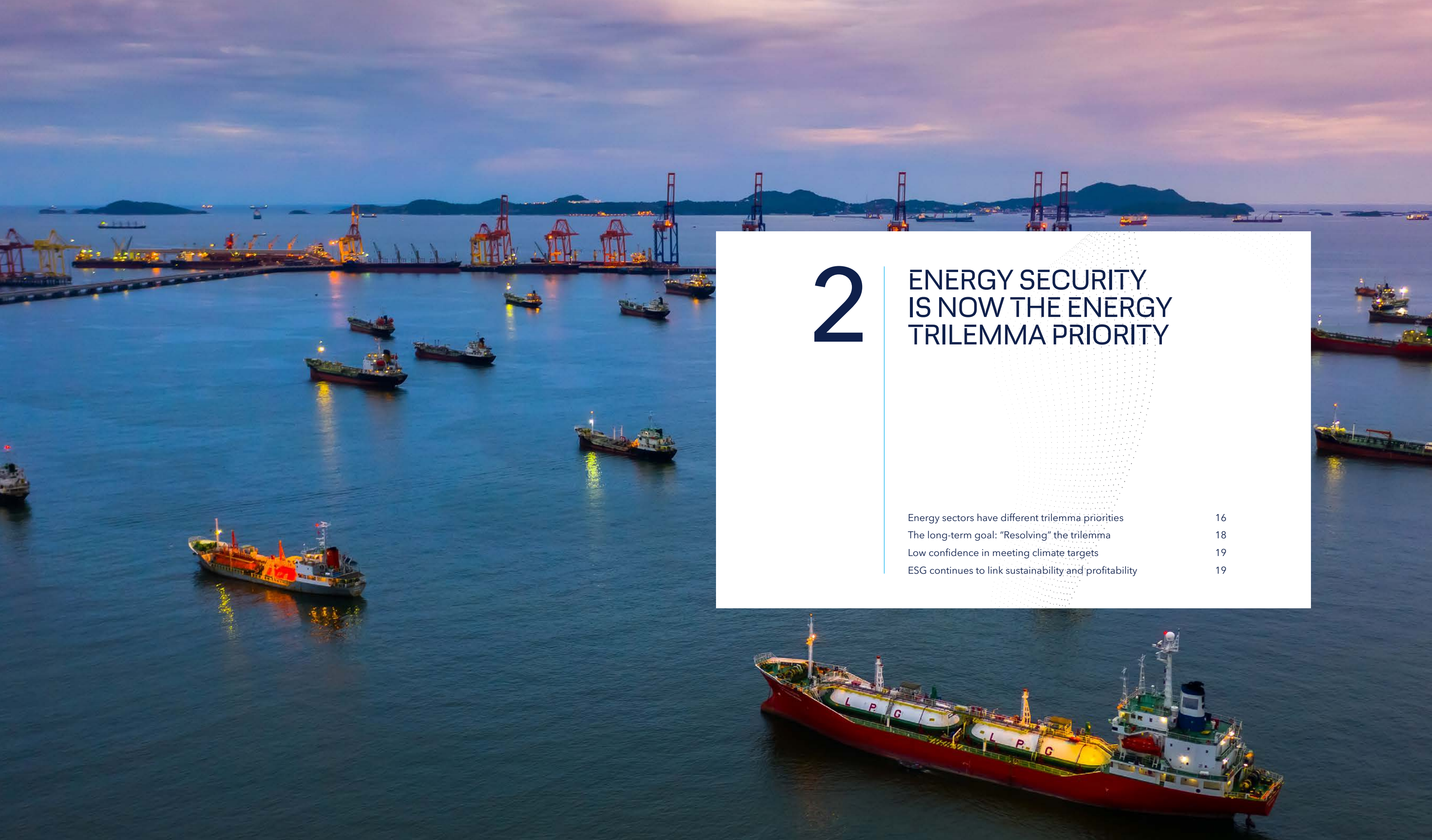
However, “progress in the energy transition” was the stand-out, top driver of optimism - the leading factor for electrical power, renewables and even for industrial energy consumers, and the second highest among oil and gas respondents. This is a remarkable result, given that organizations have typically derived confidence from things like market positioning, new investment, or conventional growth strategies. Instead, efforts to advance the global transformation of our shared energy system appear to positively influence business confidence.

This could be a function of the greater momentum, consensus, coordination, and policy support now behind the energy transition. “Recent responses by countries and businesses reflect the fact that the energy transition is now directly tied to competitiveness,” says Michael Cohen, Chief US Economist and Head of Oil & Refining at energy major BP. “It is a way to win in this new world where clean energy technologies are a solution to ensuring energy security and economic growth.”

Energy transition progress has become a driver of business confidence



Q: In the last question you were asked about your organization’s targets and prospects for the year ahead. When you think about those areas, what factors are the strongest drivers of optimism for your organization?



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ENERGY SECURITY IS NOW THE ENERGY TRILEMMA PRIORITY

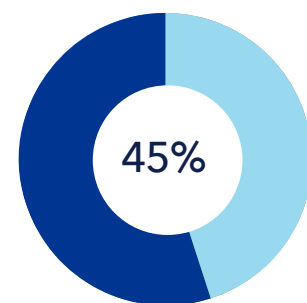
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2 ENERGY SECURITY IS NOW THE ENERGY TRILEMMA PRIORITY

If you have ever shopped for a mountain bike you may have heard the decisions you face summarised with the maxim: light, strong, and cheap – pick two. It reflects the impossibility of getting everything you want, and the need to compromise in at least one area. Beginners typically leave the store with a heavy bike, while enthusiasts leave with a light wallet.

For years, many in the energy industry have viewed the energy trilemma as a similar scenario, implying a need to prioritise between: secure, clean, and affordable. The difference, which events in 2022 demonstrated, is that we cannot – for any extended period – have a strategy that compromises on any aspect of the energy trilemma.

Perspectives on the trilemma change over time. For example, in recent years renewables have become more secure and affordable than in the past. Russia’s invasion of Ukraine, and the pandemic before it, have reminded us of how fragile energy security can be, and how it can impact affordability and clean energy – compromises have been needed across all areas. In 2022, this was especially the case in Europe, as consumers saw their energy bills rocket, coal plants were fired up, and there was a real threat of a gas supply shortfall (relieved only by LNG imports and an unusually mild winter).



My organization is currently focused on short-term rather than long-term strategies

Energy sectors have different trilemma priorities
Across the energy industry, *secure and reliable energy* is the greatest priority in the trilemma for 2023, followed by *clean and sustainable energy*, with *accessible and affordable energy* in third place.

However, the different sectors have varying biases. Energy security takes centre stage for oil and gas and electrical power, renewables respondents make clean energy the top priority, while industrial energy consumers prioritise accessible and affordable energy much more than the energy industry sectors.

“We need an orderly transition,” says Michael Cohen at BP, “so if supply-related pressure results in disruption or price spikes, we lose one foundation of the three-legged stool of the energy trilemma. As a result, we need to see more focus on policies, societal behaviours, and preferences that help to reduce the demand for carbon-intensive fuels, so that we do not get misaligned in terms of supply and demand.”

It is not a simple case that energy strategies and projects have to prioritize one or two aspects over another. In the future, a renewables-based energy system – supplying both green electrons and molecules – has the potential to address all aspects of the transition, such as through greater electrification, energy storage, and grid capacity, or through large-scale low-carbon hydrogen, both combined with low-cost renewable generation.

Indeed, 80% of renewables respondents believe energy security concerns will lead to increased investment in renewables in the year ahead.

But will energy security concerns not also lead to increased investment in natural gas and LNG? “One of the big things for us is ensuring energy security,” says Daniel Toppin, Head of Data at National Gas, the operator of Britain’s gas transmission network. Recent world events have certainly highlighted just how essential gas is across the world. This put gas back in the spotlight, because it shows how gas supply will become a major problem in future if we don’t do something different.”

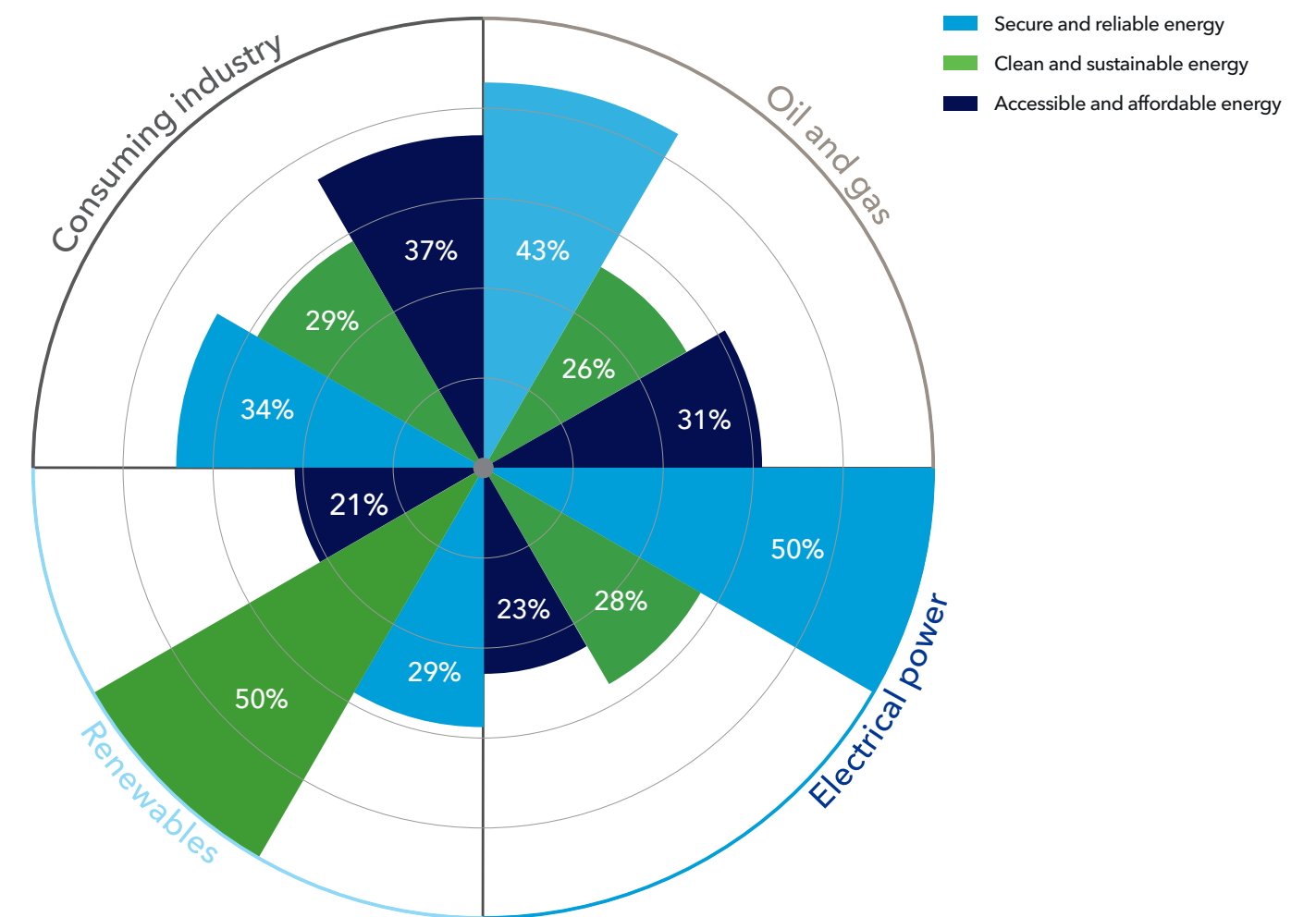
National Gas ultimately sees hydrogen as the answer, but the extent to which this will (or should) scale is another area of debate.

“I do not think we should fantasise that all the gas and all gas grids can be replaced with hydrogen,” says Derk Swider at E.ON. “Hydrogen will play a role. Green gases will play a role. Electricity will play a role. You need to have local solutions. Perhaps houses near to an industrial hydrogen cluster can use hydrogen, other places will be electric, still others will remain on natural gas.”

Swider believes that Europe has not solved its energy

crisis yet, and that in 2023 “We still have to focus on being as efficient as possible with regard to gas, reducing gas demand where possible without distressing the industry in Europe. People have developed the expectation now that gas demand will fade. And natural gas demand will. But green gas demand like synthetic methane, biogas and so on will play an increasing role as a bridge to a clean energy mix. It just might be a shorter bridge than we expected.”

The past year has put the spotlight on energy security, but the transition demands that we push clean and sustainable energy forward as fast as possible without harming security or affordability



Q: Which aspects of the energy trilemma should the energy industry prioritize in the year ahead?

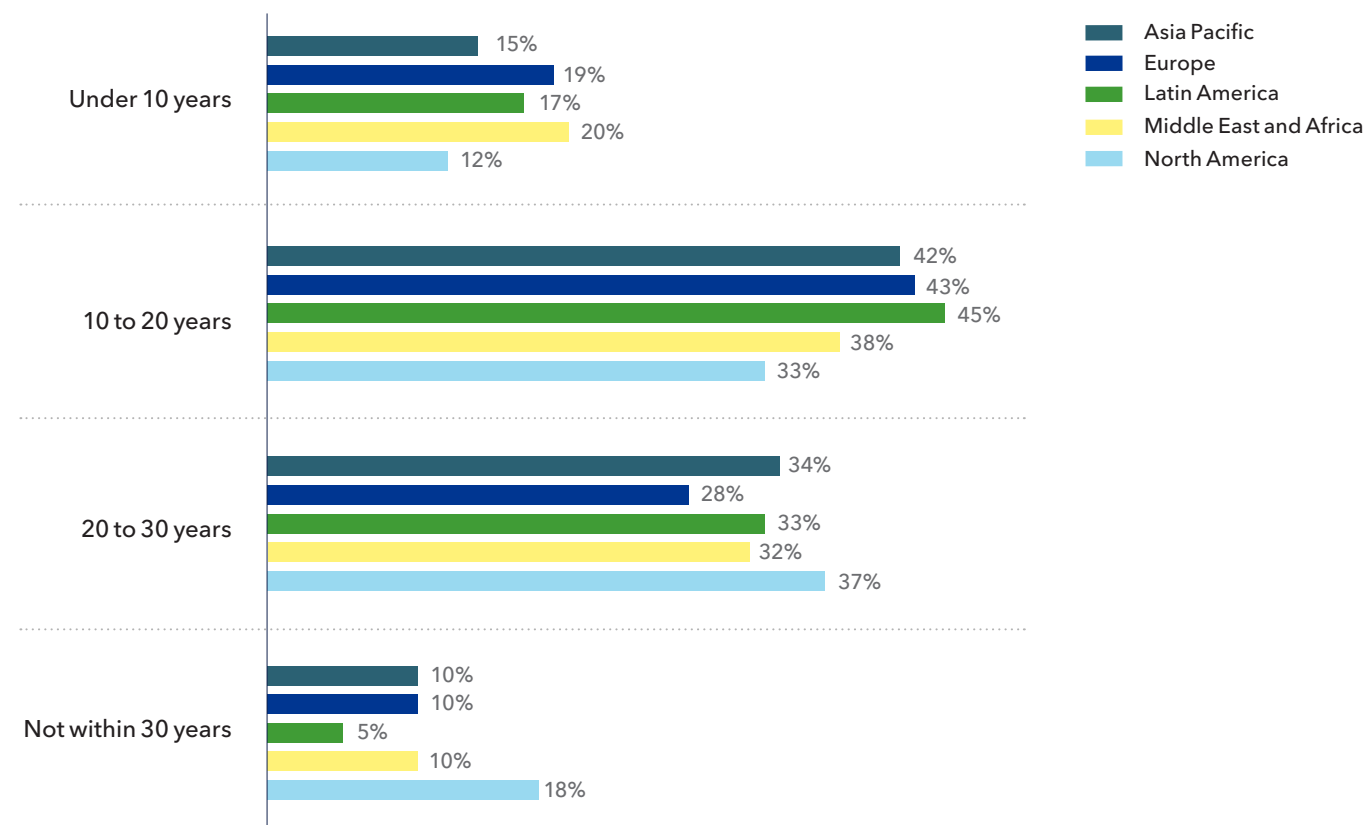
The long-term goal: “Resolving” the trilemma

The energy industry believes it will be a long time before the trilemma is resolved. Just one-in-six believe the energy transition will deliver secure, clean, and affordable energy in their country in the next decade. Four-in-ten see this being achieved in 10-20 years, while a third believe it will be well into the 2040s. This picture is broadly similar across regions, but North American respondents appear to have somewhat slower expectations for the speed in which the transition can deliver on all aspects of the trilemma.

Doing more with the proven technology is an absolute priority for the coming years. We must encourage the development of new technologies, but first and foremost we must accelerate the deployment at scale of what we know is needed in this decade.

Philippe Kavafyan, Executive Director, Aker Horizons

Most in the energy industry believe the trilemma will be resolved, but not this decade



Q: How long do you expect it will be before the energy transition delivers secure, clean, and affordable energy to all parts of the energy system in your country?

Focusing on the benefits of incremental innovation, Kavafyan references the recent announcement of plans to build a hydrogen pipeline between Norway and Germany. “A year ago, the idea of discussing building a pipeline between Norway and Germany that would initially transport blue hydrogen and then moves to green hydrogen over time would have been unthinkable”, says Kavafyan, “but the threat to energy security has driven us to pragmatism.”

Low confidence in meeting climate targets

Perhaps the most concerning finding of this research is that only 39% feel optimistic about reaching their organization’s decarbonization targets, with as much as 29% pessimistic. Similarly, just 38% feel that that net zero targets in their country are realistic and achievable.

Setting and meeting decarbonization targets is not easy. Success in defining objectives, and meeting them, while also implementing a smooth transition is the great

objective of our times for the energy industry. “We have to set targets to focus our business activities, and these need to be as realistic and achievable as possible,” says Michael Cohen at BP. “The challenge for all of us is how to get from the state of the energy system today to a revolutionary new energy system in 25 to 30 years’ time. It is going to take a lot of effort by a lot of different stakeholders, organizations, and companies. None of us are operating in a vacuum. We need investors, customers, suppliers, competitors, society and policy makers to support the targets, get behind the infrastructure, and align objectives to ensure that targets are achievable.”

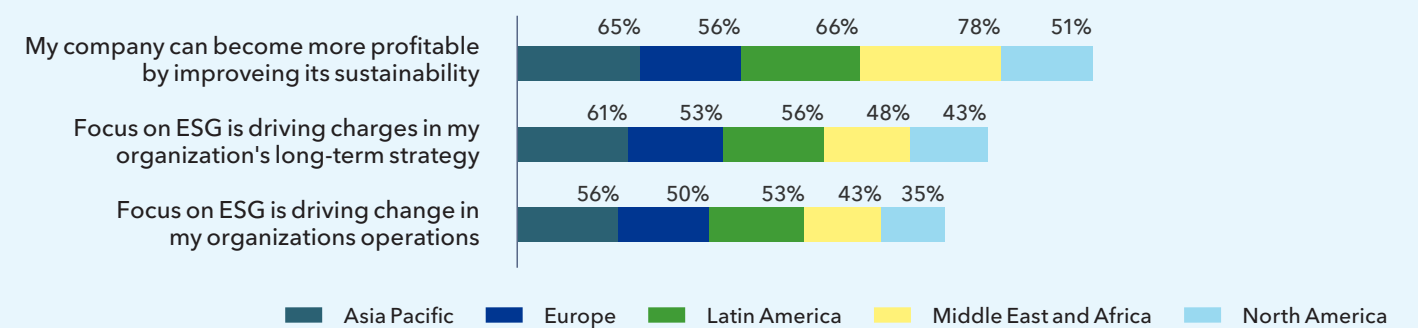
In this regard, while the lack of optimism around decarbonization targets should temper our positivity about profits, growth, and expansion, we can at least report that the level of optimism is similar across all sectors and regions. This represents common ground to build on and can help support agreement about the steps that we need to take to get closer to meeting our targets.

ESG continues to link sustainability and profitability

The financial system has evolved past the era when improved sustainability meant a compromise on returns. Environmental, social, and governance (ESG) criteria are impacting most investment decisions in the energy

industry, half of energy industry professionals say ESG is driving change in their organization’s operations and long-term strategy, while six-in-ten say their company can become more profitable by improving sustainability.

Energy industry sees profitability in sustainability, but this varies significantly by region



Q: To what extent do you agree or disagree with the following? Percentages reflect net agreement (i.e. moderately + strongly agree).

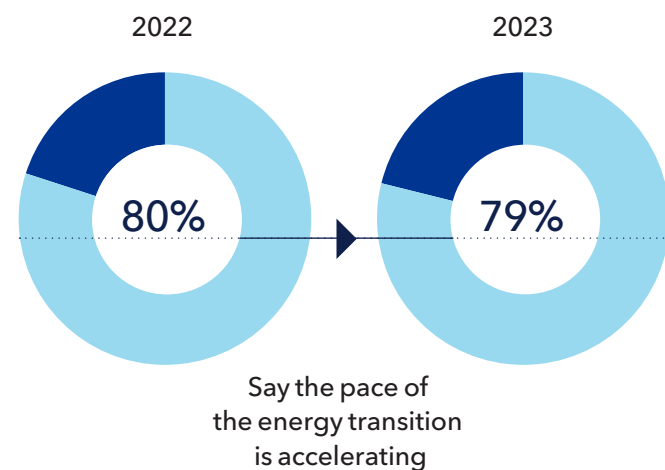
3

AN ACCELERATING ENERGY TRANSITION PUSHES THROUGH AND AGAINST BARRIERS

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Capital is abundant for some, but scarce or expensive for many	26

3 AN ACCELERATING ENERGY TRANSITION PUSHES THROUGH AND AGAINST BARRIERS

There can be little doubt, the pace of the energy transition is accelerating. Eight-in-ten in our survey (79%) across all industries and regions believe this, and there are signs that it will gather even more pace in 2023. It has been suggested that the Russia's invasion of Ukraine may have accelerated the transition by five to ten years.³



"The general trend of the energy transition has been massively accelerated," says Derk Swider at E.ON, "Not only we're talking about new and higher targets, we are seeing consumers buying more solar, batteries, and EVs. We are seeing governments continuing to support renewable deployment. The growth that we see is higher than expected."

Historically, price shocks and energy crises have sparked major corporate or policy decisions. Given that recent turmoil has fallen within an already accelerating energy transition megatrend, it seems likely that we will look back on 2022 as a particularly important turning-point.

"China's energy industry may witness several changes following the energy crisis of 2022," says a senior analyst

³ [War and subsidies have turbocharged the green transition, The Economist](#)

at a large Chinese oil and gas company. "For instance, it may promote the further transformation of China's industrial structure to more technology-intensive. Through several previous energy crises, Japan restructured their industries, and used policies to encourage more R&D and technology development. Especially, the second oil crisis in the 1970s brought about the popularity of small cars in Japan. Similarly, we may see current high oil and gas prices bring about accelerated development of electric vehicles in China."

Barriers heating up

In much the same way as driving faster heats up all the mechanics of a car - from the steel of the engine block to the rubber of the tyres - as the energy transition moves faster, the barriers we face grow more urgent and increase in intensity, throughout the energy system.

Skills is a good example. Across all respondents to our survey, the top barrier to growth is skills shortages (and/or an aging workforce). Close to two-thirds say that not enough people are entering the workforce in their part of the energy industry. As more funds, policies and strategies align to transform and expand the energy industry, it seems likely that greater competition for skilled and talented people will remain a barrier.

"We need to get out there with our positive narrative," says Alix Thom, workforce engagement & skills manager at Offshore Energies UK, "This will enable use to help young people realise the opportunity to help solve one of the biggest challenges facing humankind. But the talent supply is not going to be fixed overnight. This is a long-term transition, so we need a careful and inclusive long-term approach."

Over recent years, our research has highlighted how partnerships and collaborative approaches will be crucial to success in the energy transition. It is important

to understand the impact this has on skills requirements. "The energy industry today is too capital intensive and too complicated for any company to think they can master all of the disciplines," says Tom Einar Jensen at FREYR. "Therefore, we are teaming up with the best and the brightest and bringing them along for the ride."

At the same time, collaboration itself requires skills that have not always been prioritised, given the importance

of technical capabilities for many parts of the industry. "Development requires an understanding of the technical side, of course, but much of the more strategic work and coordination initiatives require us to deal with many different people, including government, regulatory agencies, competitors, and local communities," says Anabele Natividad at ACEN. "This makes people skills more important than before, and so it is an area we are building up."

Top three barriers to growth by sector

Electrical Power	Renewables	Oil and gas	Energy consumers
1. Skills shortage	1. Lack of policy/ government support	1. Skills shortage	1. Lack of investment in technology/innovation
2. Lack of policy/ government support	2. Permitting/licensing barriers for new projects	2. Lack of policy/ government support	2. Skills shortage
3. Lack of investment in technology/innovation	3. Skills shortage	3. Global economics conditions	3. Global economics conditions

Q: Which of the following do you expect to be the biggest barriers to growth for your organization in the year ahead?

Skills challenges across all sectors and regions

		Oil and gas	Electrical power	Renewables	Consuming industry
Not enough people are entering the workforce in my part of the energy industry		66%	66%	61%	55%
	Asia Pacific	Europe	Latin America	Middle East and Africa	North America
My organization is finding it increasingly difficult to attract employees with the skills needed for the energy transition	64%	63%	58%	56%	65%
My organization struggles to find people with the digital/data skills we require	56%	47%	45%	52%	43%

Q: To what extent do you agree or disagree with the following? Percentages reflect net agreement (i.e. moderately + strongly agree).

The urgent need for grid investment

The electricity grid (transmission and distribution), or rather its transformation, is becoming a bigger and bigger issue for the energy industry and for the race to beat climate change. Electrical power industry respondents overwhelmingly (81%) say that there is an urgent need for greater investment in the power grid.

The rate of expansion in renewables generation is significantly quicker than the rate at which the grid can adapt to accommodate this growth. Last year it was estimated that 844GW of new capacity is caught up in transmission capacity queues (with 90% of this being renewables or energy storage).⁴

Only 22% of renewables industry respondents believe current transmission capacity planning is sufficient to enable the expansion of renewables. Most power industry respondents (69%) acknowledge this issue, reporting that power grid infrastructure cannot yet adequately connect sources of renewable energy to areas of high demand.

In many cases, power grids need significant investment just to keep pace with projected growth in demand for electricity, let alone transforming to suit a massively distributed and highly digitalized electricity network. In the electrical power industry, 65% say that aging power

grid infrastructure (and related assets) are a significant barrier to greater use of renewables (in our main regions).

Postponed permissions

The progress of renewables expansion and power grid transformation is often hampered by permitting delays. For example, research across 18 EU states finds that onshore wind permits take anywhere from 2.5 to 10 years to be approved, all slower than the 24 months limit in the EU’s Renewable Energy Directive.⁵ Across Europe, there is a reported 80GW in wind energy projects stuck in permitting, enough to increase total output by over 40%.⁶

Many of the processes involved in permitting – environmental impact assessments, community engagement, due diligence, etc – do need time. We cannot compromise on procedures that are crucial to ensuring we have a just, effective and sustainable transition.

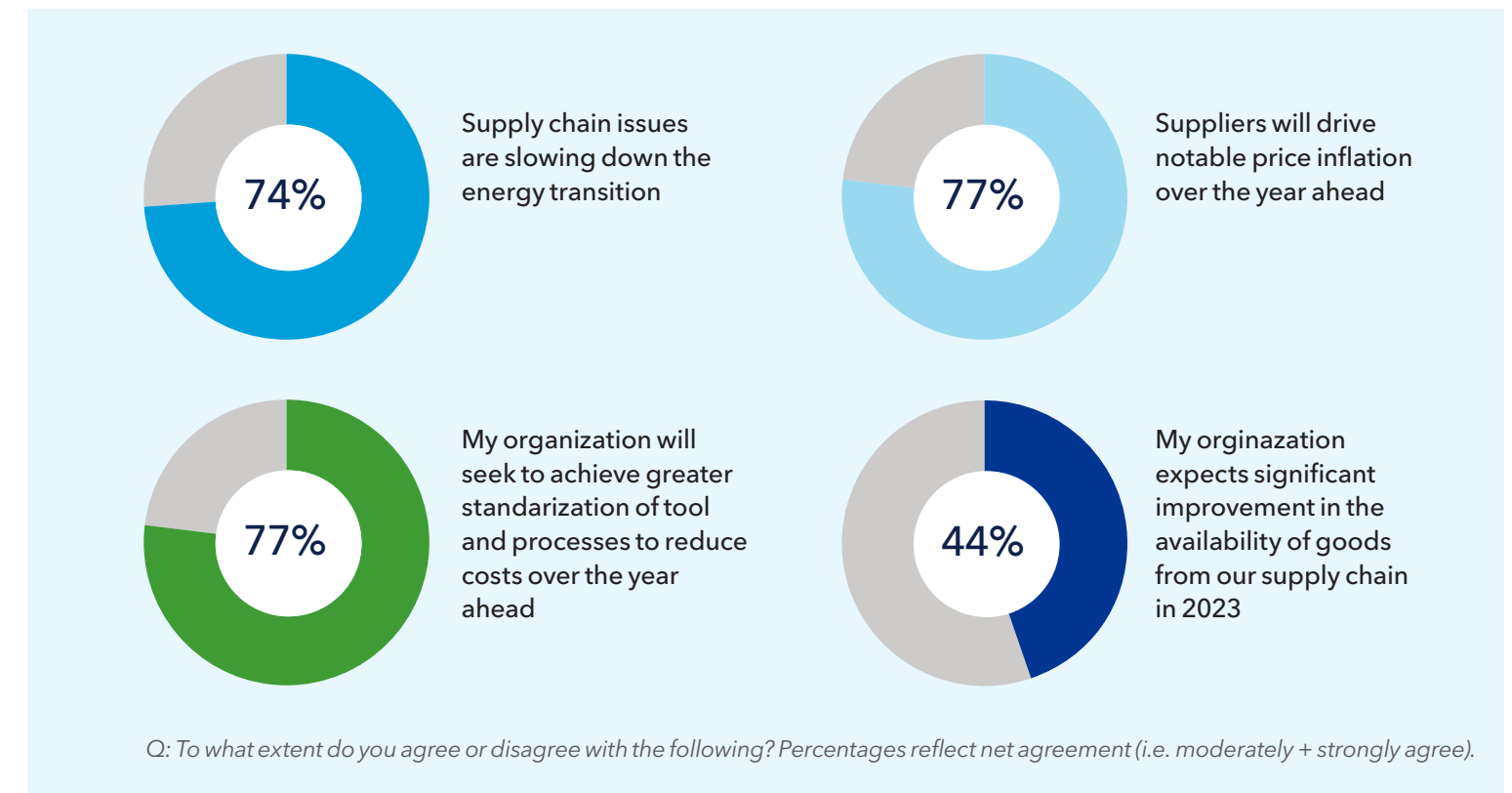
However, the abovementioned research finds that “common issues with permitting include lack of digitalisation in the overall process, lack of resources within local authorities, delays caused by legal appeals and overlap of responsibility amongst different authorities”.⁷

These are all areas we should be able to address or expedite with the right leadership, adoption of new ideas, and targeted funding.

Grid upgrades needed to enable growth in renewables

	Electrical power
There is an urgent need for greater investment in the power grid	81%
Aging power grid infrastructure (and related assets) are a significant barrier to greater use of renewables (in our main regions)	65%
Power grid infrastructure cannot yet adequately connect sources of renewable energy to areas of high demand	69%
	Renewables
Current transmission capacity planning is sufficient to enable the expansion of renewables	22%

Q: To what extent do you agree or disagree with the following? Percentages reflect net agreement (i.e. moderately + strongly agree).



Supply chain slowing the transition

A strong majority of energy industry professionals (77%) expect that suppliers will drive notable price inflation over the year ahead. A minority (44%) expect that there will be significant improvement in the availability of goods from their supply chain in 2023.

There are some areas which are either less unaffected or recovering quickly. For example, the price of photovoltaic modules is expected to fall this year as supply rebounds from several setbacks over the past few years.⁸

There are also new pressures, such as the local content requirements of the Inflation Reduction Act (IRA) in the US. A new supply chain is taking shape for offshore wind

industry there, but it will take time before it has the capabilities already available in other regions.

We're focused on educating and training local companies so that they can enter into the offshore wind supply chain. Our industry cannot continue to be reliant on the European supply chain, so it is imperative that we quickly invest in building up local suppliers.

Liz Burdock, CEO, US-based Business Network for Offshore Wind.

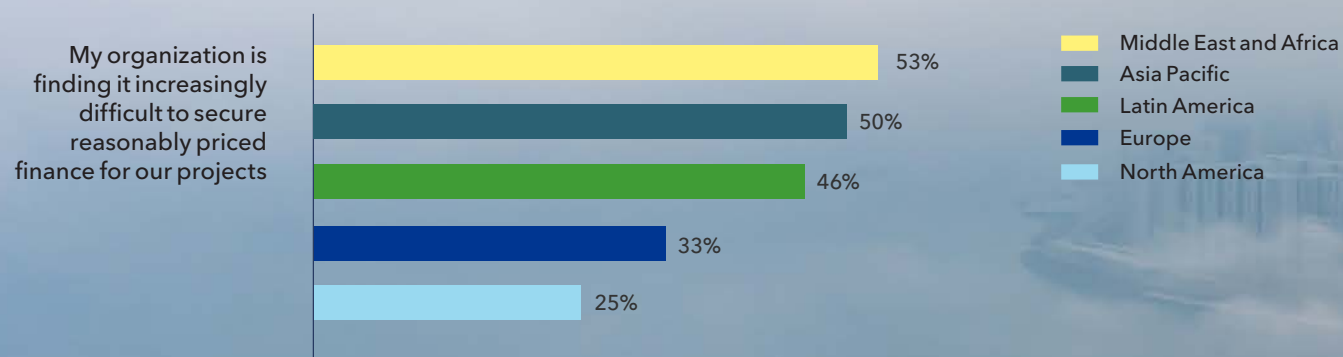
4. 2023 renewable energy industry outlook, Growth unleashed amid headwinds, Deloitte
 5. Ready, Set, Go: Europe's race for wind and solar, Europe's race for wind and solar, Ember
 6. The world needs wind energy – here's how to ramp up production in 2023, World Economic Forum
 7. Ready, Set, Go: Europe's race for wind and solar, Europe's race for wind and solar, Ember
 8. Solar panel prices are tipped to fall after years of increases, so when's the best time to buy? ABC News

Capital is abundant for some, but scarce or expensive for many

Across the energy industry 40% of professionals say their organization is finding it increasingly difficult to secure reasonably priced finance for projects. Regionally,

we see that finance is easier to access for organizations in North America and Europe. Among the sectors, more electrical power respondents (47%) find access to finance challenging, compared to oil and gas (39%) or renewables (36%).

Access to finance varies considerably by region and sector



Σ
40%

⚡
47%

🏭
39%

☀️
36%

Q: To what extent do you agree or disagree with the following? Percentages reflect net agreement (i.e. moderately + strongly agree).



4

UNKNOWN TERRITORY AND VESTED INTERESTS LEADING TO STRATEGIC DIVERGENCE

Where is the energy industry investing?	30
Limited capital and limited certainty	32
Strategies for grid stability	32
New business models and first-mover coalitions	33

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4 UNKNOWN TERRITORY AND VESTED INTERESTS LEADING TO STRATEGIC DIVERGENCE

In the age of discovery, explorers would sometimes take different routes, aiming at the same goal, but each convinced they have chosen the best way to get there. Similarly, as the energy transition scales up and speeds up, companies need to secure (or re-allocate) capital and make increasingly difficult choices about what does and does not get funded. "One of the biggest strategic challenges for us is capital allocation," says Derk Swider at E.ON, "working out how and where to focus and invest is a core issue we are continuously discussing."

Where is the energy industry investing?

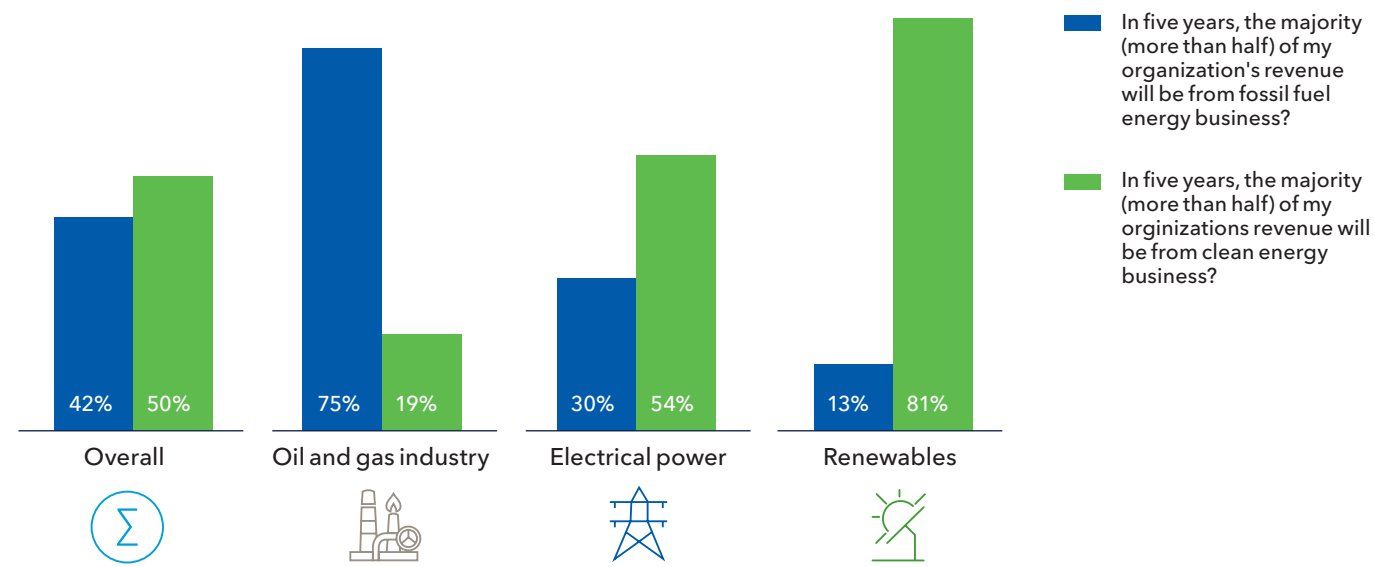
The top business areas in which respondents expect to increase investment/focus in 2023 represent the areas most associated with the energy industry's change

agenda, including decarbonization, energy efficiency, scaling-up new technologies, and digitalization.

In terms of energy vectors, there are five areas that are the most commonly cited for increased investment/focus in the year ahead:

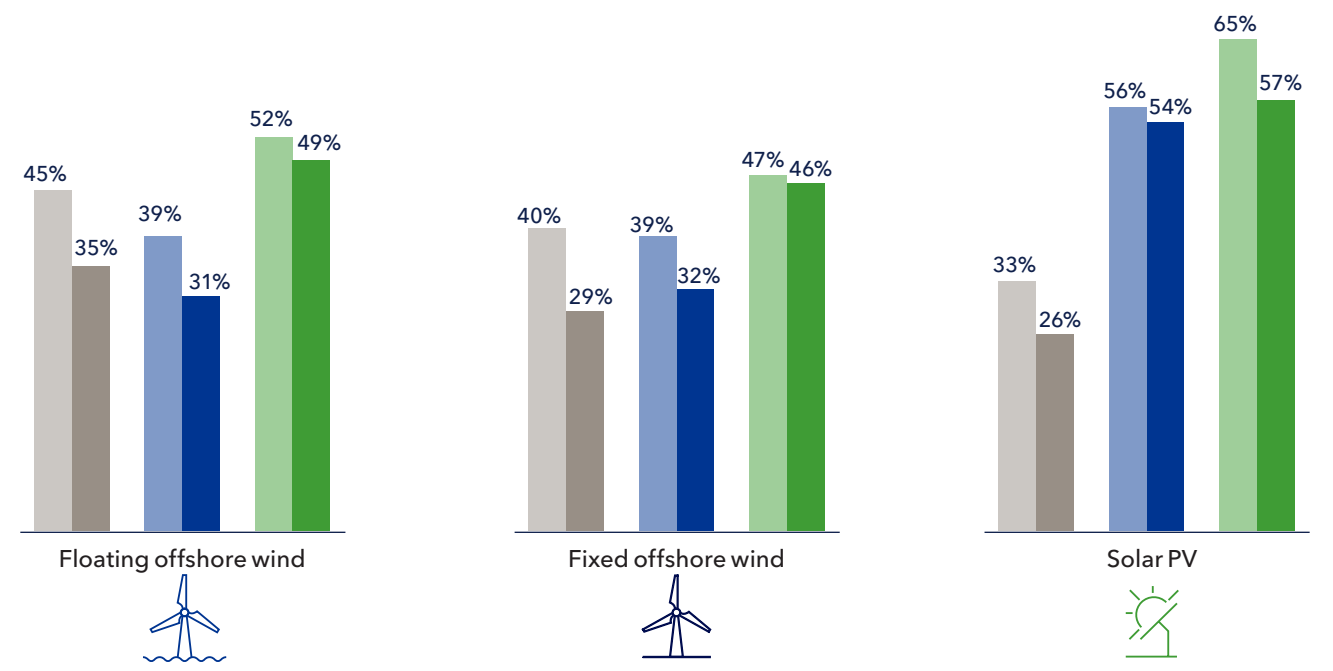
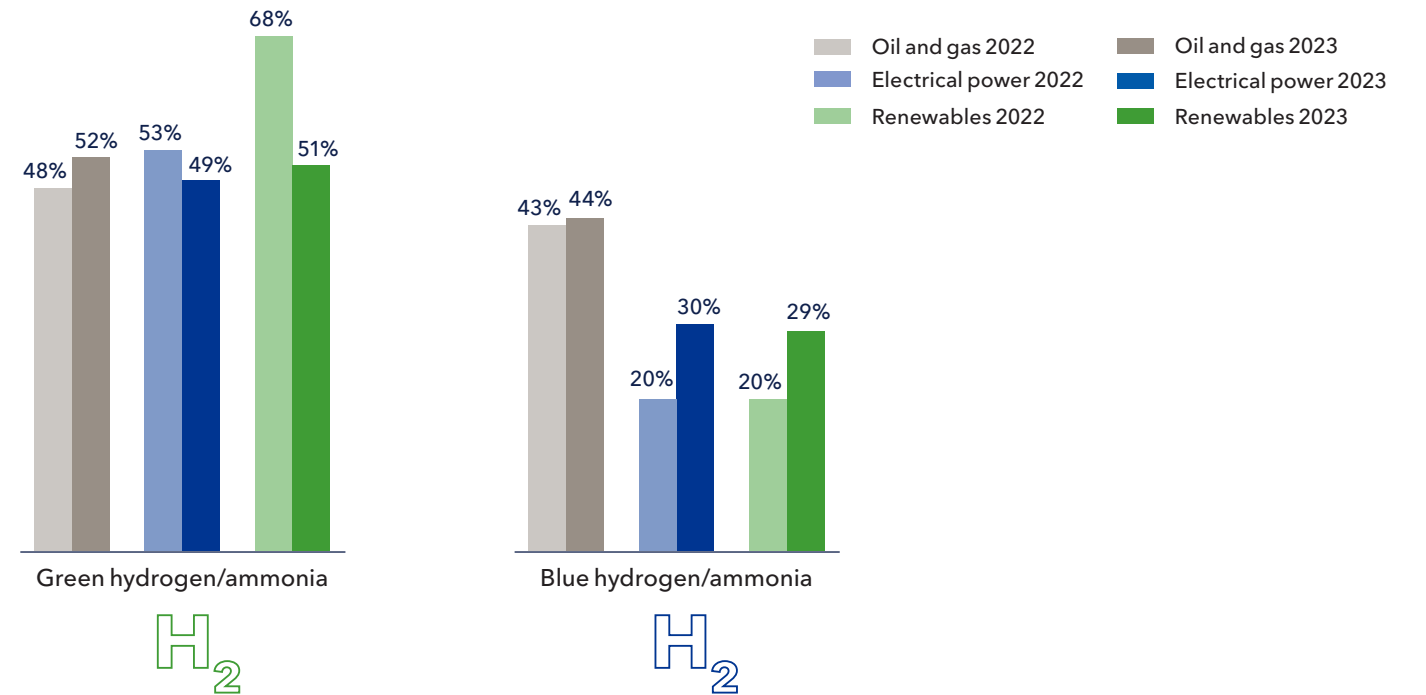
1. Green hydrogen/ammonia
2. Solar PV
3. Floating offshore wind
4. Fixed offshore wind
5. Blue hydrogen/ammonia

In five years, half of all industry respondents expect to have the majority of their revenue coming from clean energy



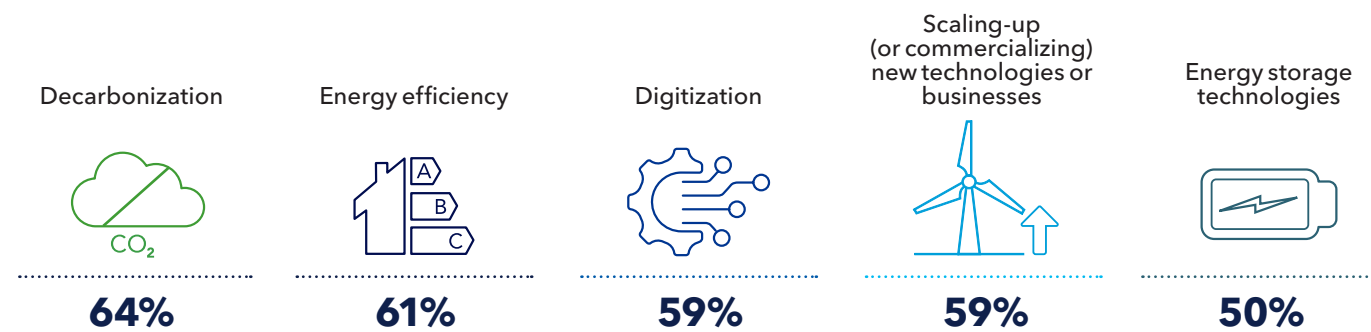
Q: To what extent do you agree or disagree with the following? Percentages reflect net agreement (i.e. moderately + strongly agree).

Energy sources/carriers attracting increased investment (or focus) from the energy industry in 2023



Q: Do you expect your organization to increase or decrease investment/focus in the following energy sources in the year ahead? Percentages shown reflect the proportion that selected "increase".

Much of the energy industry expects to increase investment/focus in 2023 in areas that will transform or enable the transformation of the energy system, continuing a multi-year trend



Q: Do you expect your organization to increase or decrease investment/focus levels in the following areas in the year ahead? Percentages shown reflect the proportion that selected "increase".

Limited capital and limited certainty

There are still many debates and unknowns that surround these areas, making capital allocation decisions more challenging.

For instance, in the electrical power industry, 44% believe hydrogen should be used as an energy carrier to reduce the need for new electricity transmission networks, but 22% disagree. Is there a right answer? If it depends on the region, what are the factors that matter most?

Oil and gas respondents (66%) are far more likely to think that carbon capture and storage (CCS) will scale up rapidly in the next five years than power (48%), renewables (54%), or consuming industries (53%). CCS fits with the other strategies the industry has, for example, to grow blue hydrogen and to make use of their expertise in large-scale, offshore and geological operations. But do we need blue hydrogen? Will the cost of green hydrogen fall fast enough - and capacity increase quickly enough - for us not to need it?

"To achieve carbon neutrality, along with economic development, we think there is a need to speed up the use of decarbonization technologies," says a senior analyst at a large Chinese oil and gas company. "Technologies like hydrogen will help in the traditional energy

industry as well as helping to integrate new energies. However, carbon capture, storage and utilization (CCUS) may end up being even more important. If the scale can be increased, CCUS could decarbonize our entire energy industry. Unfortunately there are bottlenecks in the current CCUS economy. The price is too high, and some remain concerned about leaks from CO2 storage. There is also a need for a much bigger industrial chain that makes use of carbon dioxide. Here, China may be able to develop rapidly, given the scale of the downstream chemical industry in place."

Strategies for grid stability

A key area of strategic divergence is the future of batteries within electricity grids and the energy system as a whole. On the one hand, batteries could offer utility-scale storage that reduces the need to overhaul power grids. "In Oslo, for instance, there is a big discussion on whether we should upgrade the grid coming into the capital because there are bottle-necks limiting how much energy can flow in," Tom Einar Jensen at FREYR. "But if you put GWhs worth of storage facilities in strategic locations, you can basically solve that problem, and that would also cost significantly less than overhauling the grid."

On the other hand, some believe that for larger-scale storage we should look to thermal, hydro, or green

hydrogen, which can store energy for longer periods and are arguably better suited to scaling up energy storage. "I don't think the solution of the future is electric batteries for storage at large scale to stabilize the grid," says Philippe Kavafyan, Executive Director at Aker Horizons, the green investment arm of the Norwegian Aker Group. "There's certainly going to be a need for batteries in local grids and smaller systems. However, regions that have high grid instability and long geographical distances between supply and demand will be better served applying other solutions than batteries."

Kavafyan's objection is that battery systems only offer short duration stabilisation, and that we need much larger scale, more efficient storage to cope with ever-growing reliance on renewables. "Beyond batteries, I think we need

stronger interconnections. Whether it is a hydrogen pipeline between countries or grid connections across borders, or to energy islands, I believe that secure, reliable stability needs greater interconnections," he says.

Jensen's point is that batteries are more flexible, cheaper, faster, and do not require as much regulation. As much as it is tempting to argue that we should use both large-scale batteries and interconnections, depending on circumstances, capital is always limited, and there will be circumstances where industry and government leaders have to favour one strategy over another. "One major problem is that it is not always in the interests of regulators and big utilities to give battery operators a major role," says Jensen. "They lose some degree of control by doing so and this makes it a more difficult conversation to have."

New business models and first-mover coalitions

The energy system needs to evolve fast, incrementally spreading like grass runners over fertile earth, from new sources to industrial clusters, into towns, through transport networks, and across borders, adopting innovations along the way - in technology, business models, the workforce, and more - remaining ready to adapt quickly to changing parameters and resilient to shocks and surprises.

It is not surprising then that most energy industry executives (84%) say that the industry needs to develop new operating models to achieve further cost efficiencies. It is also clear that new business models are needed just to get new markets moving and to allow technologies to flourish.

One example is the way asset-owners and investors drive renewables projects. "There is growing attention being given to systemic approaches in business models, and the emerging importance of securing feedstock or

off-take agreements at the same time as renewable investments are financed," says Philippe Kavafyan at Aker Horizons. "Essentially, you need to ensure that your full value chain is in the equation for there to be a business case financial institutions will get behind."

Such an approach leads to much tighter links between finance and industrial partners, as well as new inter-industry collaborations. Together these groups stand a much better chance of success with innovative renewables projects.

"What we see is that there is much more of a need for early partnerships between players in different industries - these 'first mover coalitions' - which have shown to be effective in helping to trigger new value chains," says Kavafyan.



5

MAJOR POLICY CHANGES PRESENT SIGNIFICANT OPPORTUNITIES

Legislation to enable markets

36

Collaborative, principles-based regulations

38

5 MAJOR POLICY CHANGES PRESENT SIGNIFICANT OPPORTUNITIES

Energy industry executives report that the biggest risks to their organizations' near-term success are public policies (being delayed, inadequate, or unexpected) and political change (or instability).

Policy and politics are also major forces – perhaps the major forces – in determining whether we curb climate change enough to avoid catastrophes.

“While we can all say that all the things we are doing need to happen, and they need to happen faster, quite often things take time because of a very slow-to-evolve regulatory framework,” says Ben Hutt, CEO of Australian energy software provider Evergen. “One of the biggest handbrakes globally is how regulators hamper market development. We're still piloting things that we've proven two or three years ago. We believe that regulations and market bodies need to evolve to allow the future to take hold. It sometimes seems that we are in a similar place to a few years before Uber took hold in major cities, where established forces were scrambling for reasons to stop them.”

But while 71% of respondents say policy failures are holding back greater action on climate change, this proportion may start to fall as new legislation takes effect. Examples such as the Inflation Reduction Act (IRA) in the US,⁹ and the Green Deal Industrial Plan (GDIP) in the EU,¹⁰ indicate that governments are starting to enable, rather than hamper, faster action on climate change. Early estimates suggest that the IRA will add up to 550GW of “new, utility-scale clean power” from 2022-2030.¹¹

The scale of political change is large, as are the challenges ahead. I think that we are entering a new age where industrial policy, climate policy, jobs, and economic growth are all intertwined.

Michael Cohen, Chief US Economist and Head of Oil Analysis, BP

Legislation to enable markets

“A predictable and simplified regulatory environment” is the first pillar of EU’s GDIP, which promises to promote quick deployment, “ensuring simplified and fast-track permitting.”¹² This is an area of critical importance. In our survey, 81% say accelerating permitting and licensing processes is critical to meeting Paris Agreement goals.

Other legislative action has debatable effects. The windfall taxes levied on oil and gas companies in 2022 have stirred controversy. Alix Thom at Offshore Energies UK, representative body for the offshore energy industry, says that “the UK’s Energy Profit Levy is causing real problems.” She says: “The energy industry needs fiscal stability to encourage companies to invest. Without investment supply chain companies can't see a pipeline of work, and so we risk losing them to other areas of the world.”

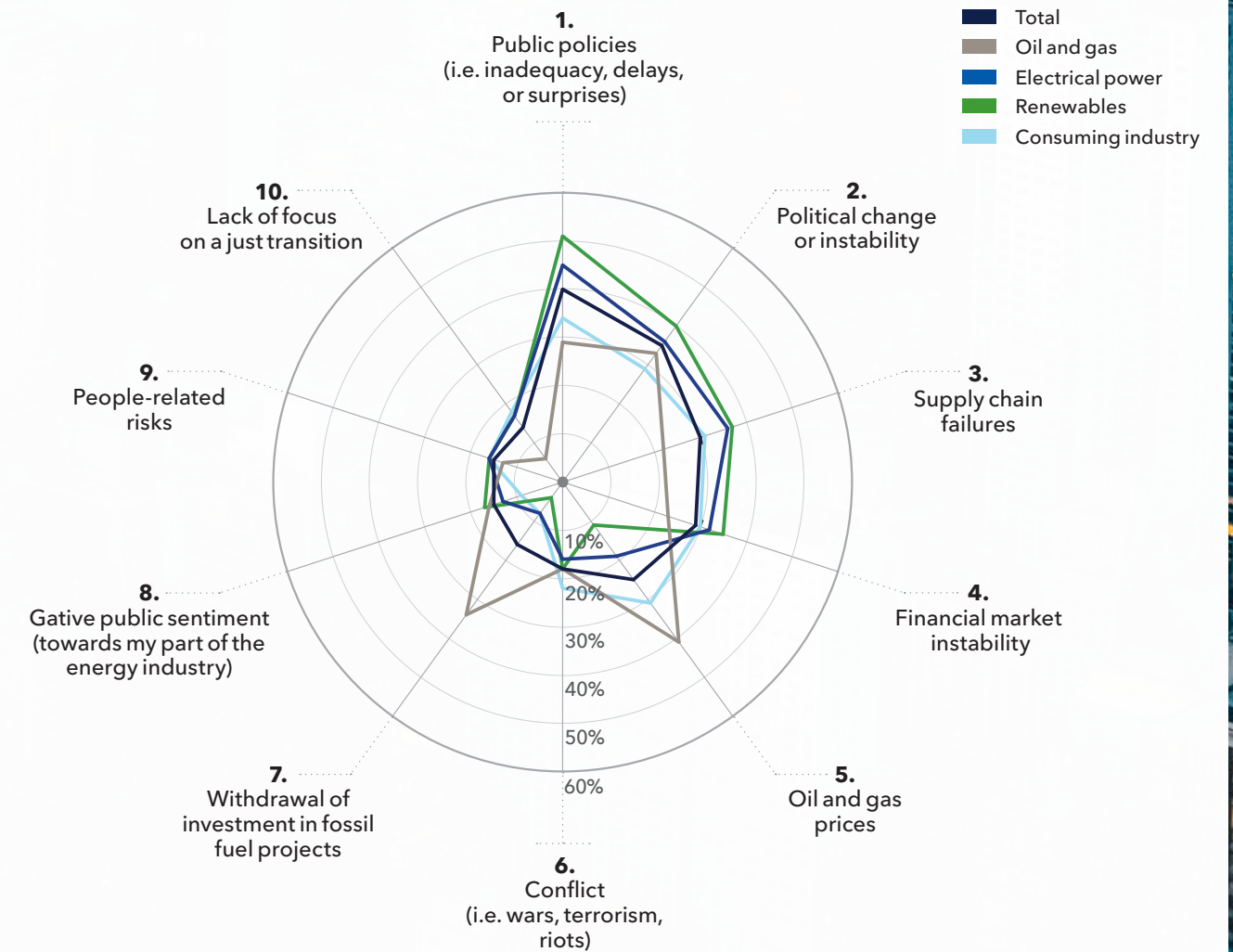
⁹ [Inflation Reduction Act Guidebook, The White House](#)

¹⁰ [The Green Deal Industrial Plan: putting Europe's net-zero industry in the lead, EU Commission](#)

¹¹ [Inflation Reduction Act: It's a Big Deal for Job Growth and for a Clean Energy Future, American Clean Power](#)

¹² [Ibid](#)

Risk radar - the top 10 risks to near-term success in the energy industry



Q: Which of the following represent the biggest risks to your organization's near-term success?

Collaborative, principles-based regulations

As in so many areas of the energy transition, the key for energy industry leaders is to ensure greater cooperation between stakeholders, with regulators and government at the top of the list. “We’re really trying to be more cooperative and more open to the national grid in the Philippines in terms of our plan,” says Anabele Natividad at ACEN. “Even in early stage conceptualizations of our projects, we talk to them, we discuss with them the plans, and at some point we try to convince them to help us advance.”

E.ON’s Derk Swider agrees: “I think we need to come together on common ground and then think about the option spaces from a neutral point of view,” he says. “This is not done often enough. We should find the best solutions for everyone, not just our own companies.”

The challenge with policy and regulation is similar to the capital allocation challenge and the energy transition challenge more broadly: we don’t have it all worked out and agreed in advance. For regulators, this has to lead to a shift towards less prescriptive, and more principles-based governance, so that rulings can be made on future issues that legislators cannot foresee in high definition.

“It should be a framework where you can move, where one can act within, and where there is some room to flex – make it as efficient as possible,” says Swider. “A tightly-regulated, highly-planned approach will not work. We must allow the market to solve the problems.”

The thing about the US is that everything can change overnight, depending on the political will. If you have a governor that decides they will get behind something, it can suddenly happen in a much quicker timeframe.

Liz Burdock, CEO, Business Network for Offshore Wind

Policy and public support key to aligning grid and renewables expansion

	Electrical power
Policy makers do not understand the challenges involved in rapidly expanding and upgrading the power grid	68%
Reforms to permitting and licensing processes (for electrical power infrastructure) are critical to meeting net zero targets	78%
	Renewables
Lack of public support is holding back renewable energy expansion	57%

Q: To what extent do you agree or disagree with the following? Percentages reflect net agreement (i.e. moderately + strongly agree).





6

PROGRESS CONTINUES TOWARDS A SMARTER ENERGY SYSTEM

The era of smart electrical power	42
Digital resistance	43
From collaboration comes standardization	45
Continuous innovation vs. standardized industrialization	46
Ever-evolving cyber threats	46

6 PROGRESS CONTINUES TOWARDS A SMARTER ENERGY SYSTEM

This is the moment for new ideas, technologies and innovations to help to keep the transition in motion. The electrical power industry is turning to technologies to help with many of these issues. Respondents from this sector (69%) are more likely than other sectors to say that digitalization is central to their organization's strategy.

In general, energy industry respondents are becoming more sophisticated with respect to data-driven strategies. Three quarters (75%) say that in the year ahead, their organization will prioritize improving data quality and availability, while 72% also report that advanced use of data is changing the way they work at their organization. But power industry respondents - and power grid operators in particular - are arguably moving through the most urgent, high impact period of digitalization anywhere in the industry.

The era of smart electrical power

"There's all these things happening which the networks don't see," says Ben Hutt at Evergen, "because they aggregate at the substation level. By providing visibility and subsequently control to the networks, we can reduce the cost of network infrastructure by maximising the value of what's there already. For instance, there could be 10 types of EV and 10 types of battery, all different manufacturers, speaking different API languages. Networks or retailers want to be able to measure and influence all of those things easily. They need these disparate systems aggregated so that they can orchestrate the grid more effectively."



75%

In the year ahead, my organization will prioritize improving data quality and availability

72%

Advanced use of data is changing the way we work at my organization

Q: To what extent do you agree or disagree with the following? Percentages reflect net agreement (i.e. moderately + strongly agree).

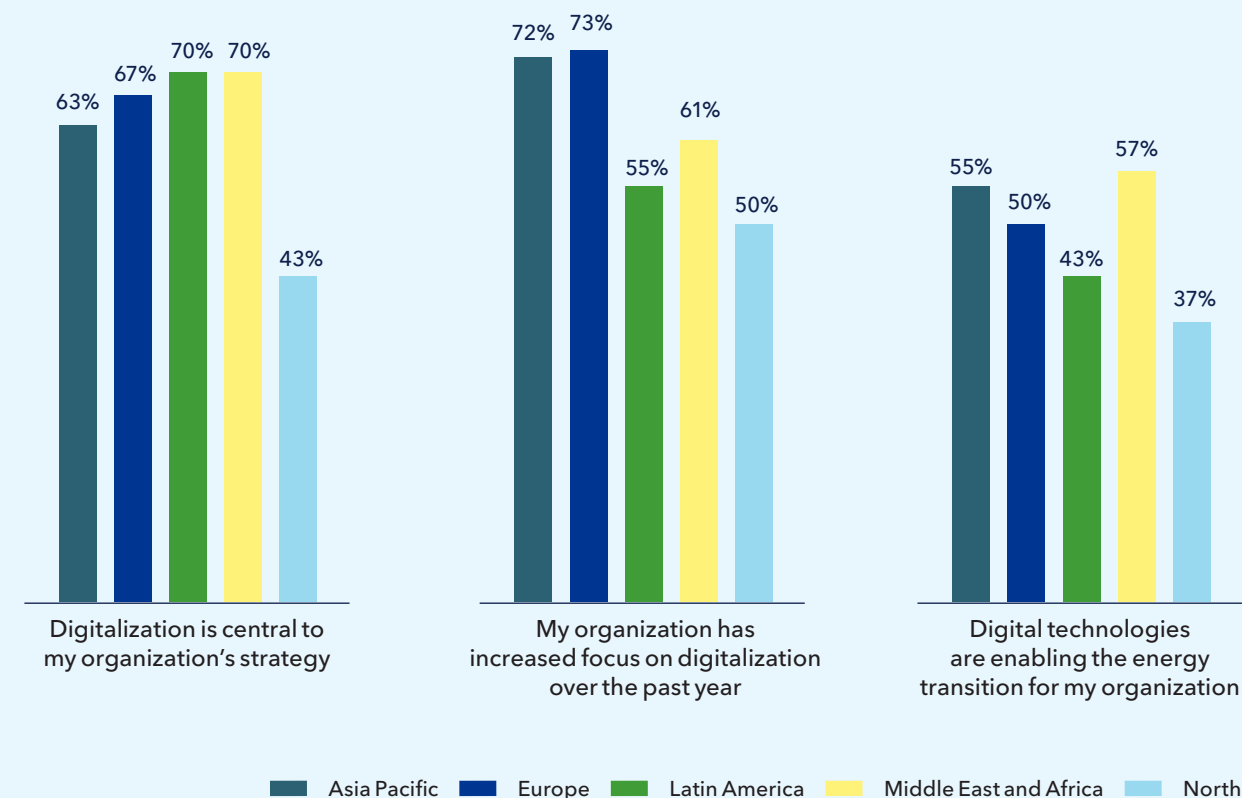
Digital resistance

Just 44% of North America respondents, and 45% of Latin America respondents, expect to increase spending on digitalization in 2023, compared to 69% for the Middle East and Africa, 62% for Asia Pacific, and 61% for Europe.

Those from North American organizations reported that the standout barrier to digitalization is resistance to

change. This could imply that those organization have reached more advanced stages, where deeper, more difficult changes are needed. However, North American respondents are, in general, earlier in the adoption cycle for most technologies in our research, suggesting there is a genuine need for the region to catch-up with global peers on digitalization.

North American respondents lag other regions in the emphasis placed on digitalization



Q: To what extent do you agree or disagree with the following? Percentages reflect net agreement (i.e. moderately + strongly agree).

Cloud-based applications, IoT, and digital automation lead technology adoption

		No existing or planned activity	Early planning	R&D and piloting	Used in live, day-to-day operations	Highly integrated and/or advanced
Establishing	Cloud-based applications and databases	10 %	14 %	10 %	35 %	16 %
	Sensors, internet of things and remote communications	12 %	14 %	15 %	31 %	12 %
	Digital automation and/or control networks	15 %	13 %	13 %	30 %	11 %
	Remote survey/witnessing technologies	15 %	16 %	15 %	24 %	9 %
	Application programming interfaces (APIs)	18 %	12 %	11 %	22 %	9 %
Emerging	Artificial intelligence (including machine learning)	25 %	19 %	19 %	11 %	4 %
	Digital twins	27 %	13 %	16 %	11 %	4 %
	Virtual reality, augmented reality	32 %	15 %	15 %	9 %	3 %
	Blockchain	38 %	13 %	8 %	6 %	2 %

100% 0%

Q: What stage of development is your organization at with respect to the following technologies?

From collaboration comes standardization

Standardization in the energy industry would make tasks like orchestration a bit easier. “We have lots of conversations going on with some of the other networks around how do we start to work together, how we standardise data across the industry, because that’s going to be very important,” says Daniel Toppin at National Gas, “because when we talk about open data and data sharing, we need information to be in the same formats, so that we can efficiently link data points together. It will demand that all in the industry work together and become significantly more open with data – this represents a massive change for the industry.”

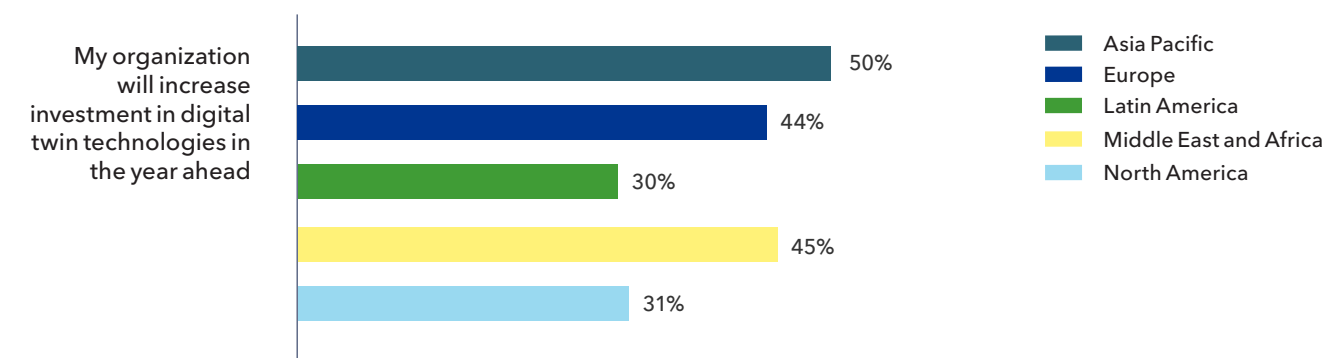
Standardized data will help to improve the speed and accuracy of information operators use to manage their

networks and the interconnections they have with others. It is also important so that we can develop integrated views of electron and molecule networks together. “Interoperability between the energy networks is important,” says Toppin, “because this will give us a view of the entire system – including shipping, interconnections, producers, storage, consumers and everything between. This is going to become more important to both management and strategic planning as we transition further.”

In our survey, 77% say their organization will seek to achieve greater standardization of its tools and processes to reduce costs over the year ahead, while 45% say that a lack of industry standards is holding back my organization’s investment in clean energy technologies.



Digital twins a focus for increased investment



Q: To what extent do you agree or disagree with the following? Percentages reflect net agreement (i.e. moderately + strongly agree).

Continuous innovation vs. standardized industrialization

At some point, a manufacturer must settle on a final design to efficiently start mass production. R&D might soon make improvements, but a business needs something to sell. Similarly, our new energy system needs to scale, and we need to settle on some designs and roll them out, despite continuous technology improvements.

“The challenge with offshore wind is going to be standardisation,” says Philippe Kavafyan at Aker Horizons. “We need to stabilise the size of the turbines and other critical components for a time, to increase the volume, reduce complexity as well as costs, instead of jumping to the next generation. The temptation to keep developing to enhance performance is always there for the developer, but the volume benefit is going to be sufficient for our industry goals.”

More than a third of respondents to our survey (35%) will increase investment in fixed offshore wind in 2023, with a similar proportion (38%) directing capital towards floating offshore wind. The latter has a particularly diverse set of innovations being piloted and promoted, aiming at improved performance, simplification, lower costs, and more.¹³ “In the floating sector there is a big debate going on right now around standardisation and industrialisation,” says Liz Burdock, CEO, Business Network for Offshore Wind.

More generally, Burdock believes that the growth of offshore wind in the Gulf region of the US will lead to further innovations in cost-efficiency and then a major push towards standardization. “I believe our oil and gas sector will innovate in ways that we haven't seen in Europe,” she says, “particularly in making offshore wind development leaner by reducing over-design and over-engineering.”

Ever-evolving cyber threats

More than half (56%) of energy industry respondents will be increasing their spending on cybersecurity in 2023. With the majority of the energy industry becoming more data-driven, and more open about sharing data, organizations need to evolve their governance procedures to ensure sensitive information is not left vulnerable.

“We aim to have a data triage process that is fast but accurate,” says Daniel Toppin at National Gas, “so that projects that involve sharing can be enabled, while those that demand real-time data are not slowed. It is a big challenge but one we can overcome together in the industry.”

Cyber attacks are a major threat to my organization	59%
Cyber security is an urgent priority for my organization's senior management	56%
My part of the energy industry is not investing enough in cyber resilience for operational assets and infrastructure	41%
My part of the energy industry is currently more vulnerable than ever to cyber-attacks	41%

Q: To what extent do you agree or disagree with the following? Percentages reflect net agreement (i.e. moderately + strongly agree).

¹³ T-Omega re-thinks floating offshore wind turbines for huge cost savings. [New Atlas](#)



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