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The shape of power to come

Investment, affordability and security in an energy-hungry world

12th PwC Annual Global Power & Utilities Survey

pwc

worldwide industry viewpoints

72 power and utilities companies

43 countries

Argentina
Australia
Austria
Belgium
Botswana
Brazil
Canada
Chile
Colombia
Czech Republic
Denmark
Finland
Germany
Greece
Hungary
India
Indonesia
Ireland
Israel
Italy
Jordan
Kenya
Korea
Malaysia
Mexico
Namibia
Netherlands
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Norway
Peru
Philippines
Qatar
Russia
South Africa
Spain
Sri Lanka
Sweden
Switzerland
Thailand
UAE
UK
USA
Venezuela

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About the survey

The *12th PwC Annual Global Power & Utilities Survey* is based on research conducted between October 2011 and April 2012 with senior executives from 72 power and utility companies in 43 countries across Europe, the Americas, Asia Pacific, Middle East and Africa. The majority of participants were senior vice-presidents, senior general managers, directors or other department heads from power and gas utilities, with interests covering supply, transmission, generation and trading.

Acknowledgements
PwC thanks all the participants who took time to participate in the survey. This is the 12th power and utilities sector survey. We take this opportunity to thank everyone who has participated over this 12 year period, both within PwC and in the power and utilities sector.

Published April 2012

Introduction

The PwC Annual Global Power & Utilities Survey goes to the heart of boardroom thinking in utility companies across the globe. In this, our 12th edition, we look ahead to how the world of electricity will look in 2030 and assess industry thinking on the changes that will need to take place along the way.

The changes that lie ahead are of great potential significance. New technologies, unforeseen possibilities, different ways of generating, distributing, storing and using electricity will all play their part. The challenges are equally great. The development of effective policy frameworks and the attraction of adequate investment continue to be big uncertainties facing the sector. Until they are resolved, power systems will be on a knife edge in terms of whether they will cope with the huge scale of demand growth ahead.

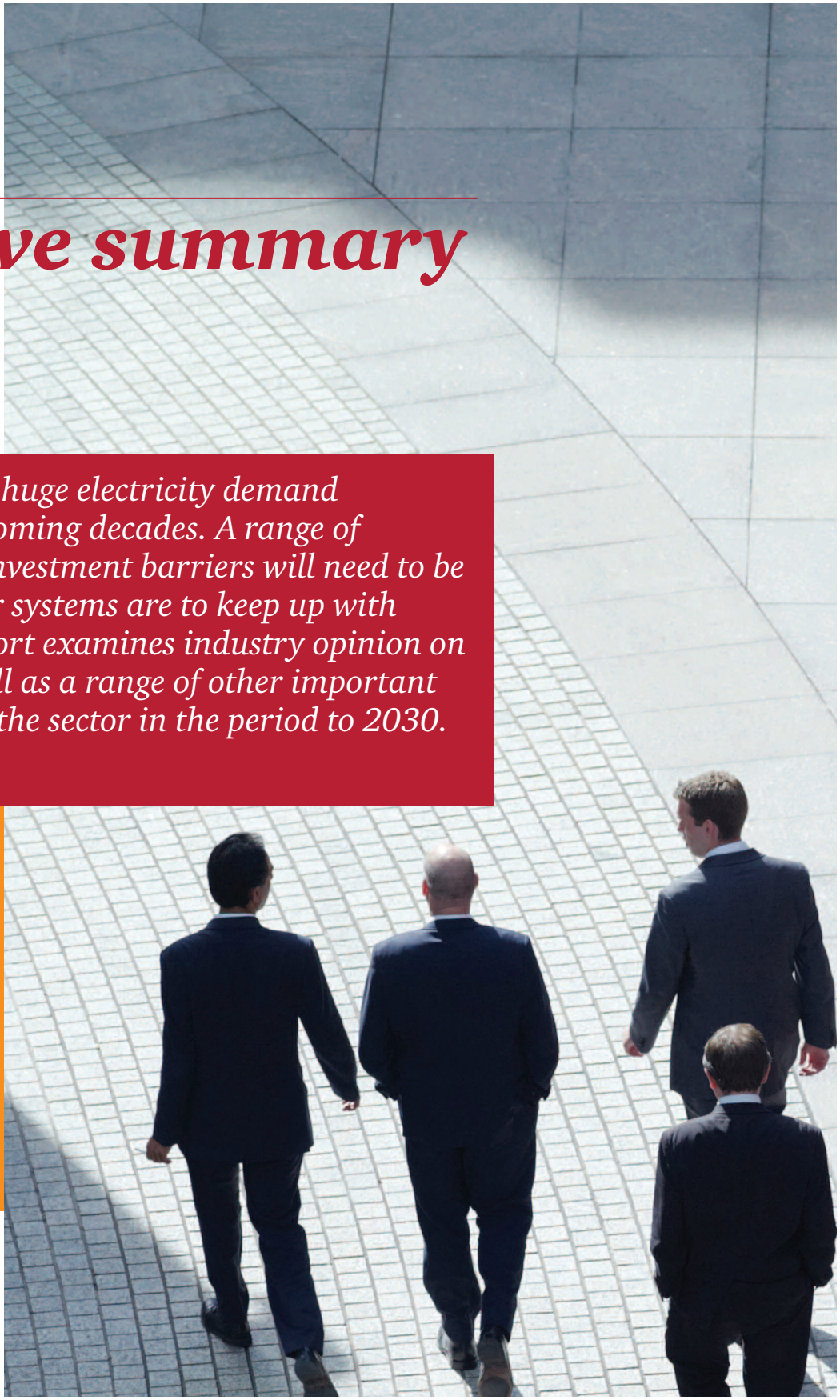
Cleaner energy and the decarbonisation of electricity generation will be central to efforts to reduce global warming. Issues such as energy affordability, security of supply and energy efficiency could have major positive or negative impacts on the sector itself and the wider economic landscape in the coming decades. Our survey highlights a considerable degree of concern about whether there will be good outcomes on these fronts in the next 20 years.

We look at these big issues through the viewpoint of a survey that is extensive in scope as well as intensive in its depth. We have talked to 72 senior power and utility company executives in 43 different countries around the world. The survey is supplemented by the 'on the record' perspectives of a number of CEOs that are also included in the report. We report their findings on a range of questions and also, in a series of 2030 scenarios, their assessment of what key aspects of the world of electricity will look like in 2030.

Manfred Wiegand
Global Power & Utilities Leader

Executive summary

The world faces a huge electricity demand challenge in the coming decades. A range of bottlenecks and investment barriers will need to be overcome if power systems are to keep up with demand. Our report examines industry opinion on these issues as well as a range of other important challenges facing the sector in the period to 2030.



Investment outlook

The capital funding requirement in all markets, both mature and growth territories is considerable. 68% of survey participants are making major or very major investment in upgrades and replacement generation. New gas generation heads the generation priority list. 55% are making major or very major gas generation investments versus only 21% for new coal and nuclear generation, 24% for offshore wind and 37% for onshore wind generation.

But investment has become more difficult. 78% report that the financial crisis and economic downturn has had a medium to very high impact on shortage of capital for infrastructure projects. Overall, more than twice as many survey participants say obtaining finance for generation and transmission is tough compared to those who are finding it relatively easy.

Policy priorities

The policy message from the industry to governments is a clear one – if the demand challenge is to be met, put potentially disruptive market reform on the back burner and focus on the removal of planning bottlenecks and the promotion of an investment-friendly regulatory environment.

Three issues are rated of priority importance:

- a regulatory environment that encourages network investment – highlighted by 80% of the survey participants
- removal of strategic infrastructure planning bottlenecks (76%)
- increased interconnection between different electricity systems (76%).

In contrast, far fewer attach priority to moves such as further liberalisation (38%) or unbundling of distribution networks (31%).

Energy affordability and security of supply

Energy affordability is becoming a concern. Two thirds (66%) see the ability to recover costs fully from customers as a barrier to meeting demand growth. Worries about the outlook for fuel poverty persist. Half see a medium to high probability that the number of customers in fuel poverty will increase significantly over the next 20 years and this is particularly a concern in Europe and South America.

Worries about affordability and the pace of infrastructure investment in western power markets are translating into concerns about security of supply. In Europe, 53% of our survey respondents predict an increased risk of blackouts in the period to 2030 compared with only 16% expecting a decreased risk. In North America, 40% anticipate increased risk versus 20% saying blackout risk will reduce. In developing markets, where power cuts are a current fact of life in many countries, industry sentiment is moving in the opposite direction. Modernisation of power systems is expected to reduce the incidence of failures in these regions.

Cleaner energy

Many in the industry can see a time when renewable energy will compete without the need for subsidy – 80% plus think onshore wind, biomass and all forms of solar will not need subsidies to compete by 2030. There is less confidence in offshore wind but, even so, 69% say it will be competitive by 2030. 66% also think marine energy will be competitive by 2030.

The fossil versus non-fossil fuel generation mix of our survey participants is highly representative of world electricity generation fuel mix. This provides a good base for views on the future fuel mix. Looking ahead to 2030, they expect a major ramping-up of non-hydro renewables. In overall terms, they expect their fuel mix to change from 66% fossil fuels versus 34% non-fossil fuels today to 57% versus 43% in 2030.

These projections suggest that the world's power utility companies are already looking beyond current policies. They anticipate fossil versus non-fossil fuel mix adjustments that are closer to the 'new policies scenario' of the International Energy Agency[1]. But they fall significantly short of the 42% versus 58% split needed by 2035 if the world is to limit global warming to an average 2°C increase, which remains the current climate change global policy goal.

over 80%
think onshore wind, biomass and all forms of solar will not need subsidies to compete by 2030.

1 International Energy Agency, World Energy Outlook 2011, page 178, table 5.2.

43%

*is the forecast **share of non-fossil fuel in generation by 2030** but it won't be enough to limit global warming to an average 2°C increase.*

Energy efficiency

Can we expect energy efficiency to help the supply and demand outlook in the decades ahead? Industry opinion is divided on this issue. Just over half (55%) of the survey participants are optimistic but the remainder assign a medium to high probability that energy efficiency programmes will have largely failed to fulfil their promise by 2030. An important factor in promoting energy efficiency is the phasing-out of fossil fuel subsidies in many parts of the world. But less than a fifth (18%) expect such a move to have taken place by 2020. Instead, the overwhelming industry sentiment in our survey is that a fossil fuel subsidy phase-out is improbable and that such subsidies will persist into the next decade.

Industry sentiment is sceptical about fossil fuel subsidies being phased out in the next ten years.

A new gas era

Gas heads the list of investment priorities for new generation. Our survey highlights the growth in new gas generation, the emergence of shale gas and demand from China and other fast-growth countries as major developments affecting the gas market in the next ten years. More gas generation will certainly play a big role but the industry does not yet see it as a game-changer. Overall, survey participants expect gas's share of their companies' fuel mix to rise from 29% now to 33% in 2030. Despite all the shale gas hype, many questions still remain about its accessibility in some locations and its environmental safety.

In Europe, where gas prices remain indexed against the oil price, gas remains relatively expensive and the market has attracted liquefied natural gas (LNG) cargoes that would previously have served North America. A majority in our survey (54%) believe that a move away from oil indexation to more liquid, traded markets will be an important major development affecting the gas market in the next ten years. In turn, this could reduce differentials in global gas pricing.

Smarter energy

The industry is confident that smart grid technologies will be in place by 2030, giving the technological backbone needed to efficiently balance different generation sources, flexible generation and interconnections between grids or energy storage technologies, such as pumped hydro, compressed-air and large-scale batteries. Some see a potential 'power to gas' breakthrough in electricity storage. Nearly one in five in our survey even go so far as to say it will be the most common form of electric storage by 2030.

The smart grid revolution with the domestic customer, though, may be more of a challenge for utility companies. Our survey participants express concern that customer engagement may be a barrier to the kind of behaviour change needed to fully realise the system efficiency potential of smart energy grids. Interestingly, as they embark on a smart energy world, more than one in four (27%) say the biggest competitive threat to their companies could come from companies with powerful customer brands from outside the sector.

2030 scenarios

We also include a series of glimpses into the future with our industry survey's viewpoint on three important issues that could shape the 2030 electricity world – energy efficiency, transformation of energy systems and electric transportation. On the last of these, three fifths of our survey respondents think there is a medium to high probability that electric cars will form a significant proportion of the world vehicle fleet by 2030.

They anticipate a marketplace where competition for the customer will be intense. Such a marketplace will pose significant challenges for power and utility companies, particularly those used to more captive customer bases. It will demand agility, customer management systems able to cope with a more mobile customer and the ability to forge effective partnerships with a range of other retailers and brands.

Company strategies in a changing world

We conclude with a look at some aspects of current company strategies as they prepare for the decades ahead. We see a world of much greater internationalisation of operational footprints and investment partnerships with companies and investors alike stepping up their 'go abroad' strategies in pursuit of growth and value. We are likely to see more strategic partnerships between power and utility companies and organisations that have got large pools of capital, such as sovereign wealth funds. We also anticipate more joint venture project and investment relationships across the energy chain, such as between upstream gas and downstream utilities.

The changing geographic focus of power and utility industry strategies is reflected in the expansion priorities of our survey participants. Only 12% ranked western Europe and 13% ranked North America as a number one or number two priority for expansion despite the fact that 24% and 28% of the survey sample were from companies based in these regions. Instead, China (getting 40% of number one and number two mentions as a priority target for expansion) and other growth markets around the world rated higher as priority targets for expansion.

More than one in four ***say the biggest competitive threat to their companies could come from companies with powerful customer brands from outside the sector.***

The big issues

Huge demand growth

World electricity demand is projected to increase from 17,200 TWh in 2009 to over 31,700 TWh in 2035[2]. Economic and population growth, as well as technological change and urbanisation, are driving this demand. The result is an increasing electrification of the world. More people will gain access to electricity and more activities and applications will be powered by electricity.

80%

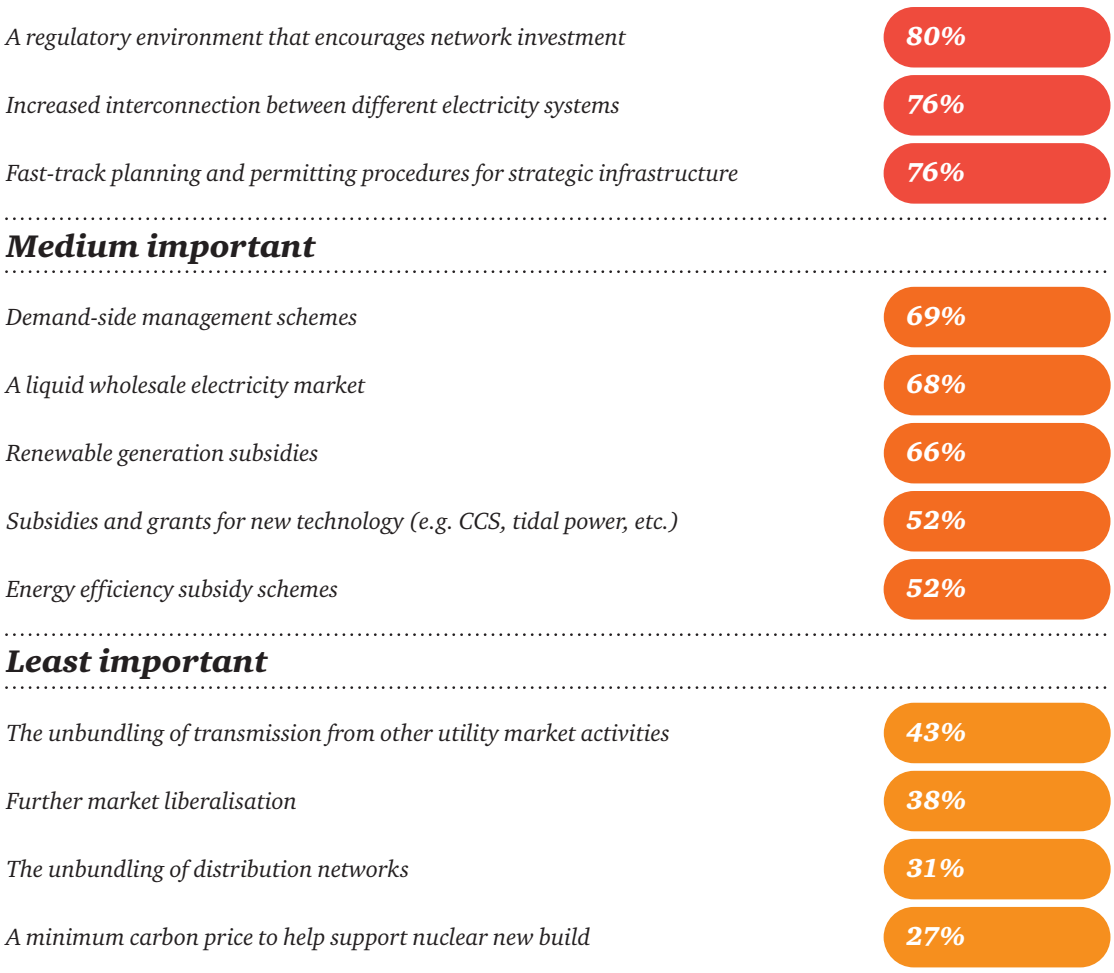
*emphasise the **importance of a regulatory environment** that encourages network investment.*

Meeting this huge demand growth is going to need more investment, effective regulatory policies, better and smarter infrastructure and good energy management. The total investment needed by 2035 in the power sector is estimated at US$16.9 trillion, an average of US$675bn each year[3].

What policies are needed?

The role of government is pivotal. Power markets continue to walk a sometimes ambiguous line between market operation and government direction. Governments have long moved away from directing demand but remain the key influence on supply through a variety of policies. What does the power and utilities industry say are the most important policy priorities?

Figure 1: What policies are needed to help meet world power demand growth in the period to 2030?



Source: 12th PwC Annual Global Power & Utilities Survey

2 Ibid, page 176, table 5.1.
3 Ibid, page 98, table 2.4.

Their focus is clear – they believe greater emphasis needs to be on the promotion of a more certain and investment-friendly regulatory environment rather than potentially disruptive market reform. The importance of 'a regulatory environment that encourages network investment' is highlighted by 80% of survey participants and heads the 'most important list'. In contrast, policies such as unbundling and further market liberalisation are seen as 'least important'. Also, perhaps reflecting the changed outlook towards nuclear power post-Fukushima, carbon prices to support nuclear build are also seen as least important.

The focus on regulatory policy reflects the fact that the stance of governments can be an investment dealmaker or breaker. Changes, delays and uncertainty in regulatory frameworks can inhibit investment and increase the cost of capital. Stable regulation is essential for successful project financing. Factors such as long-term tariff certainty and power purchase arrangements are important for investors. Regulatory changes need to be well-planned and signalled. Retrospective regulation, such as has occurred in some European countries in respect of renewable subsidies, can undermine market confidence.

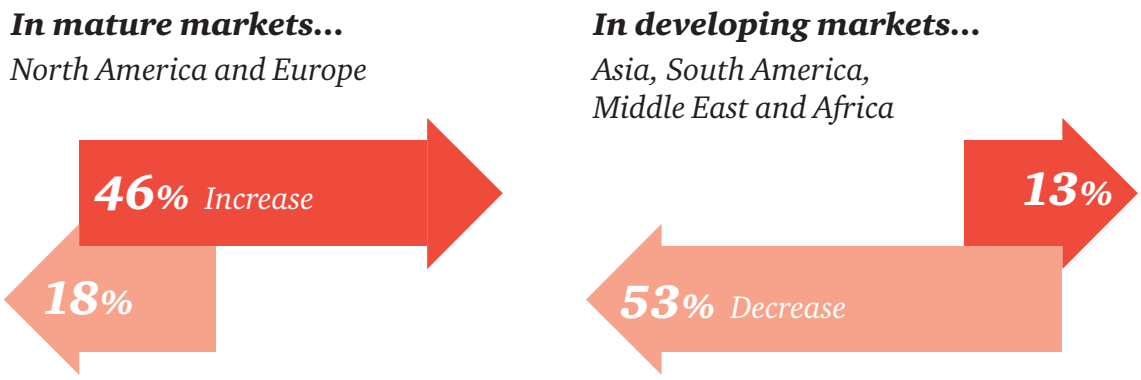
Removing bottlenecks

Governments also have a big role to play in the second and third issues that the industry sees as essential in meeting the growth in future power demand – greater interconnectedness between different electricity systems and the need to streamline planning processes (76% of respondents rate each of these as 'important' or 'very important'). Planning obstacles are proving a major barrier to the development of new generation sources and transmission networks. They are pushing renewable generation offshore and are a cause of significant large project delay.

Interconnections across state or national boundaries will be important to enable a better balancing of supply and demand and prevent power shortages but they will need a high degree of intergovernmental cooperation. The incorporation of more electricity from renewable sources, sometimes in remote locations, will require additional grid connectivity and investment in transmission networks.

Other issues, such as demand-side management schemes, liquidity in wholesale markets and subsidies for renewable generation, are also viewed as important in helping meet demand in the period to 2030. But they are seen as underpinning factors of medium importance compared to the major issues of investment-friendly regulation, power system interconnectivity and faster planning processes.

Figure 2: Security of supply – will the risk of blackouts increase or decrease in the period to 2030?



Source: 12th PwC Annual Global Power & Utilities Survey

Are we heading for a supply crunch?

The scale of the demand growth challenge between now and 2030 begs the obvious question – are we heading for a supply crunch with blackouts becoming more commonplace? Governments and power companies face a tricky balance – reducing dependency on high carbon fossil fuel generation while expanding supply and renewing or replacing ageing generation and transmission assets.

The risk to security of supply is real. European and North American power and utility companies are putting themselves on blackout watch for the period ahead. In Europe, 53% of our survey respondents predict an increased risk of blackouts in the period to 2030 compared with only 16% expecting a decreased risk. In North America, 40% anticipate increased risk versus 20% saying blackout risk will reduce. In developing markets, where power cuts are a current fact of life in many countries, industry sentiment is moving in the opposite direction. Modernisation of power systems is expected to reduce the incidence of failures in these regions (see figure 2).

Figure 3: Probability scenario
"By 2030, energy efficiency programmes will have largely failed to fulfil their promise and will have had limited impact on dampening demand growth"

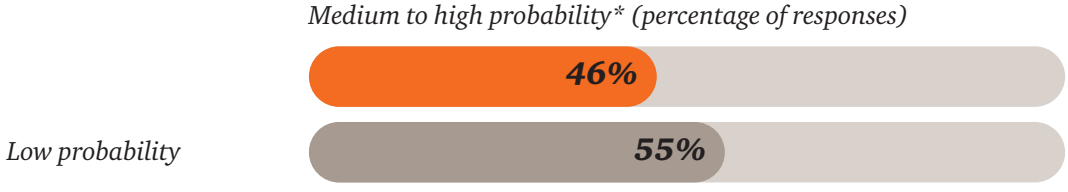
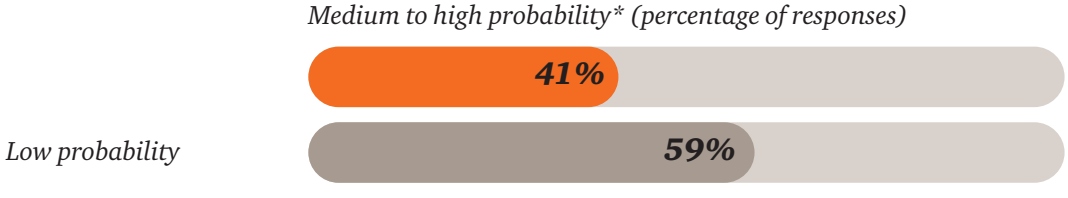


Figure 4: Probability scenario
"Fossil fuel subsidies, which support oil- and coal-fired generation in places such as the Middle East, Russia and parts of Asia, will be phased out across the world by 2020"



*Probability in the range of 40% - 100%
Source: 12th PwC Annual Global Power & Utilities Survey

2030 scenario
Will energy efficiency remain in the land of promise?

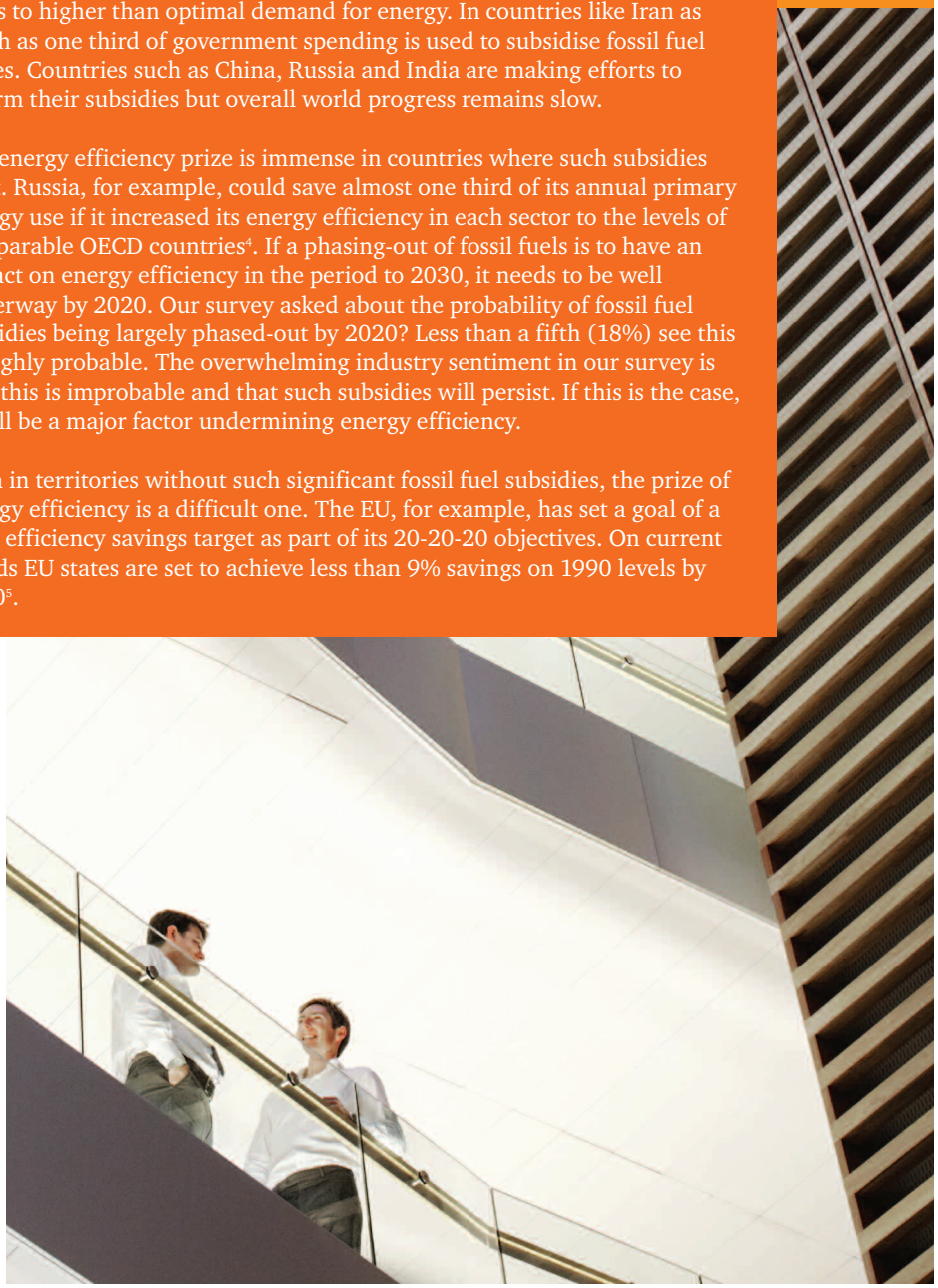
Energy efficiency undoubtedly has an important role to play in easing the demand growth challenge. Back in 2007 the Intergovernmental Panel on Climate Change observed: "It is often more cost-effective to invest in end-use energy efficiency improvement than in increasing energy supply to satisfy demand for energy services." But since that time, despite the priority given to energy efficiency in many policy initiatives, global energy intensity has begun to increase for the first time in more than 20 years.

Can we expect energy efficiency to help the supply and demand outlook in the decades ahead? Industry opinion is divided on this issue. Just over half (55%) are optimistic but the remainder assign a medium to high probability that energy efficiency programmes will have largely failed to fulfil their promise by 2030.

Much will depend on the phasing-out of fossil fuel subsidies. These are a major barrier to energy efficiency as the artificial reduction in energy costs leads to higher than optimal demand for energy. In countries like Iran as much as one third of government spending is used to subsidise fossil fuel prices. Countries such as China, Russia and India are making efforts to reform their subsidies but overall world progress remains slow.

The energy efficiency prize is immense in countries where such subsidies exist. Russia, for example, could save almost one third of its annual primary energy use if it increased its energy efficiency in each sector to the levels of comparable OECD countries[4]. If a phasing-out of fossil fuels is to have an impact on energy efficiency in the period to 2030, it needs to be well underway by 2020. Our survey asked about the probability of fossil fuel subsidies being largely phased-out by 2020? Less than a fifth (18%) see this as highly probable. The overwhelming industry sentiment in our survey is that this is improbable and that such subsidies will persist. If this is the case, it will be a major factor undermining energy efficiency.

Even in territories without such significant fossil fuel subsidies, the prize of energy efficiency is a difficult one. The EU, for example, has set a goal of a 20% efficiency savings target as part of its 20-20-20 objectives. On current trends EU states are set to achieve less than 9% savings on 1990 levels by 2020[5].



4 Ibid, page 262
5 The Political Economy of Renewable Energy in Europe, IHS Global Insight, Dec 2011.

Investment and affordability

Attracting investment will be central to meeting the future electricity demand challenge. But many power and utility companies are facing a reduction in capital raising options. Investment has become more difficult. 78% of our survey participants report that the financial crisis and economic downturn has had a medium to very high impact on shortage of capital for infrastructure projects, with 63% saying it has had a high or very high impact.

78%

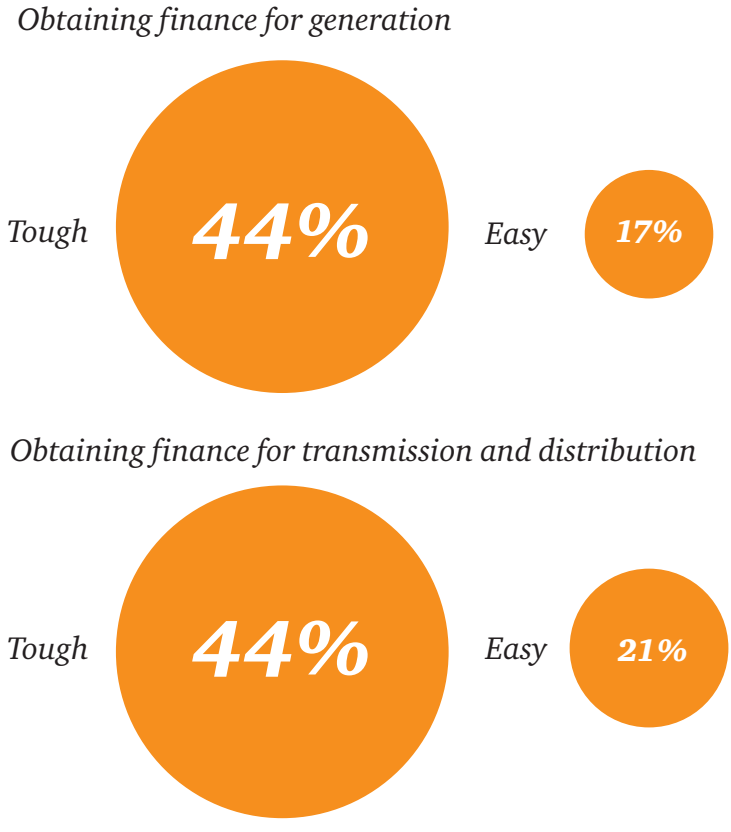
report that the financial crisis and economic downturn has had a ***medium to very high impact*** *on shortage of capital for infrastructure projects.*

Tough funding environment

The large European utility companies have faced particular constraints. Between 2010 and 2011 many European companies have seen larger share price falls than the market average. On the debt side, issuances have declined from 75.6bn euros in 2009 to 14.6bn euros in 2011 as debt markets contracted. In addition, across the whole European utilities sector, 15 groups suffered downgrades in 2011 and 30% are on negative watch or facing downgrade reviews[6].

Overall, more than twice as many survey participants say obtaining finance for generation and transmission is tough compared to those who are finding it relatively easy (figure 5). But despite the pressures on companies in Europe, our survey shows that concerns about shortage of capital for infrastructure projects are felt even more acutely among companies in Asia and the Middle East and Africa. Survey participants in both these regions were more likely to report shortage of capital as a result of the recent world economic and financial uncertainty than their counterparts in Europe and North America (figure 6).

Figure 5: Extent of the financing challenge



% scoring 1 (very small challenge) to 5 (very large challenge)
Source: 12th PwC Annual Global Power & Utilities Survey

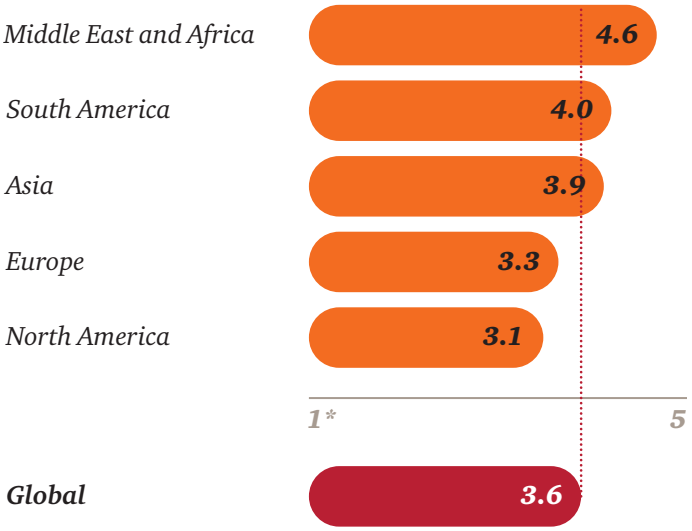
6 PwC, Power Deals: 2012 outlook and 2011 review.

Finance is identified as the biggest risk in the capital project value chain – 85% see it as a medium to very high risk versus only 15% rating it low risk. It outweighs construction risk, which was rated as medium to high risk by 76% of survey participants. Construction risk will reduce in the next five years as companies gain more project experience but the industry is not as optimistic about finance risk. Nearly as many expect finance risk to be as great in five years' time.

Energy prices and affordability

But tough as it is in the capital project context, financing is actually not the biggest challenge for power and utilities businesses as a whole. Investment is running up against regulatory risk, price and affordability worries. The level of regulatory returns and a reasonable degree of forward certainty are critical for long-term capital investment. Regulatory risk, cost recovery from customer tariffs, price uncertainty and workforce skills shortages all outweigh the difficulty of obtaining finance in the minds of survey participants (see figure 7).

Figure 6: Impact of the global financial crisis and economic downturn on shortage of capital for infrastructure projects



*1 = very unimportant, 5 = very important
Source: 12th PwC Annual Global Power & Utilities Survey

Investment is running up against regulatory risk, price and affordability worries.

Figure 7: Finance versus other challenges

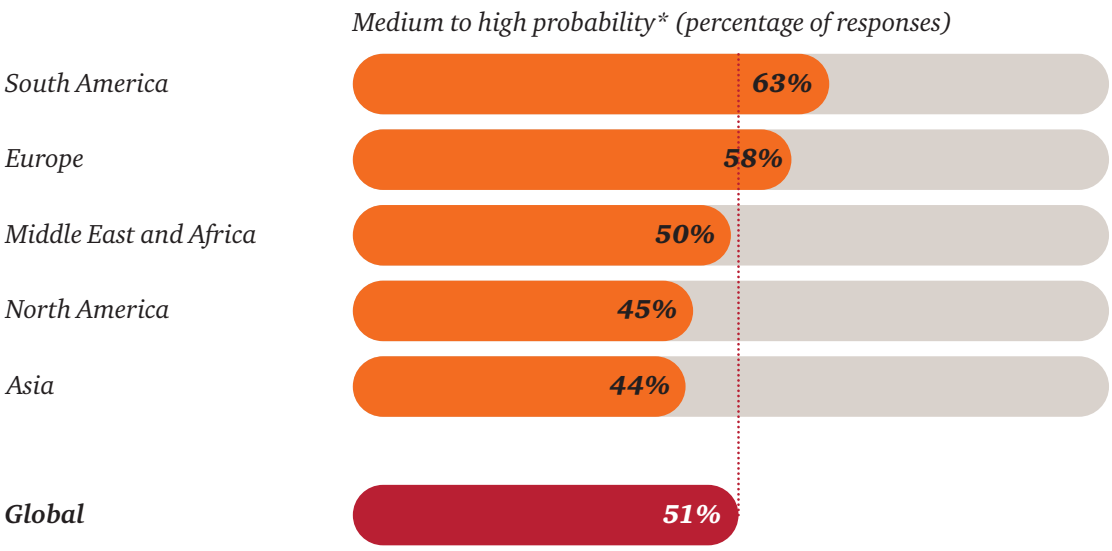
*1 = very small challenge, 5 = very large challenge
Source: 12th PwC Annual Global Power & Utilities Survey

Companies find themselves having to balance government directives with market dynamics. 'Command and control' approaches continue to be blended with market mechanisms and they can sometimes be uneasy bedfellows. Energy prices are a hot issue in many countries as the cost of investment and decarbonisation puts pressure on customer budgets. Concerns about energy prices are creating a 'trilemma' in the triangle that has to be balanced between affordability, sustainability and security of supply and adding to the social pressures on governments.

These concerns are echoed by survey participants. Two thirds (66%) see the ability to recover costs fully from customers as a barrier to meeting demand growth. Worries about the outlook for fuel poverty persist. Half see a medium to high probability that the number of customers in fuel poverty will increase significantly over the next 20 years. Set against this, many more see a very low probability of this scenario (23%) than see it as a high probability (3%). Concern about future fuel poverty was greatest among South American and European survey participants (figure 8).

Worries about the outlook for fuel poverty persist.

Figure 8: Probability scenario
"The number of consumers in fuel poverty will increase significantly over the next 20 years"



*Probability in the range of 40% - 100%
Source: 12th PwC Annual Global Power & Utilities Survey

Cleaner energy

All around the world, companies and governments are committed to a move to cleaner low or no carbon power generation. The United Nations Climate Change Conference meeting in Cancun made a 2°C average warming goal explicit and acknowledged that greater ambition is necessary if it is to be reached. But time is running out and the recent economic downturn and austerity policies in some countries are testing governments' resolve. Also, the Arab Spring and the impact of the Fukushima emergency in Japan have focused attention on security of supply with possible impacts on the pace of travel towards cleaner energy.

66%

fossil versus 34% non-fossil fuel current generation mix of our survey participants ***closely mirrors*** *that of the overall world electricity generation mix.*

Moving away from fossil fuels

The fossil versus non-fossil fuel generation mix of our survey participants closely mirrors that of the overall world electricity generation mix. They report a higher than world share of hydro and non-hydro renewable generation and a lower than world share of nuclear generation. In terms of the overall fossil versus non-fossil fuel mix, they are highly representative. This degree of representativeness provides a good base for views on the future fuel mix anticipated as our survey participants look ahead to 2030. They say non-hydro renewables, which account for an 8% share now, will double to a 16% share in 2030. Windpower's share is also forecast to double and solar power will more than quadruple its current share.

The move to low or no carbon fuels has been given extra uncertainty by the impact of the Japanese tsunami on the outlook for nuclear power. Our survey participants expect nuclear's share of their own companies' generation to remain much the same in 2030 as it is today, implying an expansion of nuclear capacity to match total supply expansion. Different governments have reacted in different ways but a recent World Energy Council report makes the point that the Fukushima accident has not so far led to a significant retraction in nuclear power programmes in countries outside Europe, except Japan itself[7]. In Europe, changes in nuclear policies have taken place in Germany, Switzerland and Italy. Among our survey participants, around half of them (48%) think only a small number of countries will turn their back on this source of energy, 25% expect the impact to be greater and another 27% expect a large number of countries to pull the plug on nuclear power.

Will the move to cleaner fuels happen fast enough?

The following table shows our survey participants' 2030 fuel mix projections and compares them with the 2035 assumptions in three of the IEA's World Energy Outlook projections – the 'current policies scenario (CPS)', the 'new policies scenario (NPS)' and the 450 scenario.

The industry survey projections suggest that the world's power utility companies are already looking beyond current policies. They anticipate fossil versus non-fossil fuel mix adjustments that are consistent with the IEA's World Energy Outlook 2011 'new policies scenario' and, indeed, anticipate moving ahead of these. But we would emphasise that such estimates need to be viewed cautiously. They are based on interview forecasts rather than detailed projections and cannot be weighted to take account of different survey company generation capacities. Indeed, if we restrict predictions to the main regions of Europe, North America and Asia, the path charted by survey participants is markedly less optimistic and indicates that they will fall short of the 'new policies scenario'.

Figure 9: Future fuel mix scenarios versus industry expectations[8]

Industry expectations	IEA 2035 450 scenario	IEA 2035 'new policies scenario'	IEA 2035 'current policies scenario'	PwC survey participants' 2030 projection
Fossil fuel	41%	58%	66%	57%
Non-fossil fuel	59%	42%	34%	43%

8 World Energy Outlook 2011, ps 546 (NPS) and 547 (CPS and 450 scenarios - generation).
Source: 12th PwC Annual Global Power & Utilities Survey

7 World Energy Council, Nuclear Energy One Year After Fukushima, March 2012.
8 World Energy Outlook 2011, ps 546 (NPS) and 547 (CPS and 450 scenarios – generation).

CCS could make all the difference but the pace of development needs to accelerate.

Impact on global warming

These projections certainly fall significantly short of the adjustments required to achieve the 450ppm CO2 reduction needed to limit global warming to an average 2°C increase, which remains the current climate change global policy goal. The 450ppm CO2 reduction scenario is the trajectory needed to achieve the still stated world goal of limiting global warming to an average 2°C increase.

Instead the survey forecasts a fuel mix closer to the 'new policies scenario'. Such a scenario would result in a level of emissions consistent with a long-term average temperature increase of more than 3.5°C. The IEA points out a rise in excess of 3.5°C "would have severe consequences: a sea level rise of up to two metres, causing dislocation of human settlements and changes to rainfall patterns, drought, flood and heat-wave incidence that would severely affect food production, human disease and mortality.[9]" Current policies would leave global warning on an even more dangerous path – with temperature increases of 6°C or more.

Can CCS help make the difference?

The commercial development of carbon capture and sequestration (CCS) technology has got off to a slow start. Governments have sought to give a spur to such technology but, in the UK for example, agreement on demonstration projects has been deferred following difficulties on technology definitions and funding terms. Nonetheless, our survey respondents still see CCS making a significant future contribution in the generation mix. They expect over a third (35%) of their coal-fired generation and around a fifth (21%) of gas-fired generation to be equipped with CCS by 2030. It puts the industry part-way towards but still significantly short of the 60% and 27% 2035 targets that form part of the IEA's 450 scenario.

Figure 10: Industry CCS expectations

Industry expectations	IEA 2035 450 scenario[10]	PwC survey participants' 2030 forecast
Proportion of coal-fired generation with CCS	60%	35%
Proportion of gas-fired generation with CCS	27%	21%

10 International Energy Agency, share of total electricity generation fitted with CCS, data supplied to PwC.
Source: 12th PwC Annual Global Power & Utilities Survey

9 International Energy Agency, World Energy Outlook 2011, p207.
10 International Energy Agency, share of total electricity generation fitted with CCS, data supplied to PwC.

Removing barriers to renewables

Major barriers remain in the way of renewables in the next decade. Three quarters (75%) of our survey participants point to the high cost compared with other generation as an important or very important barrier. Two thirds (66%) highlight the unwillingness of consumers to pay and 62% stress the cost and difficulty of grid connections (figure 11). Cost competitiveness and pricing constraints vary from region to region, affected by a complex interplay of local fossil fuel prices, carbon policies, other subsidy frameworks and capital costs. In North America, for example, low gas prices would, on the face of it, disadvantage renewables but one of their main effects has actually been to disincentivise the construction of new gas generation.

Only 20% of our survey participants think the issue of renewable energy affordability will have fully resolved as a constraint by 2030. Renewable energy subsidies will remain key – two thirds say they will be of high or very high importance in meeting future energy demand. Another 18% rate them of medium importance. But many in the industry can see a time when renewable energy will compete without the need for subsidy – 80% plus think onshore wind, biomass and all forms of solar will not need subsidies to compete by 2030. There is less confidence in offshore wind but, even so, 69% say it will be competitive by 2030. 66% also think marine energy will be competitive by 2030 (figure 12).

75%

*point to the **high cost of renewables** compared with other generation technologies.*

Figure 11: Ranking of major barriers to development of utility-scale renewables

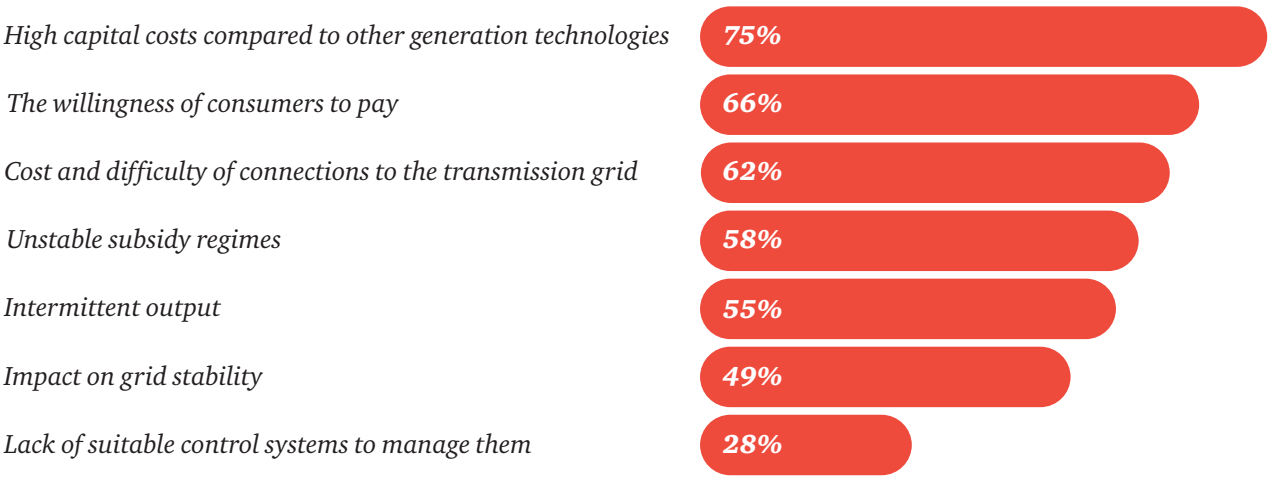
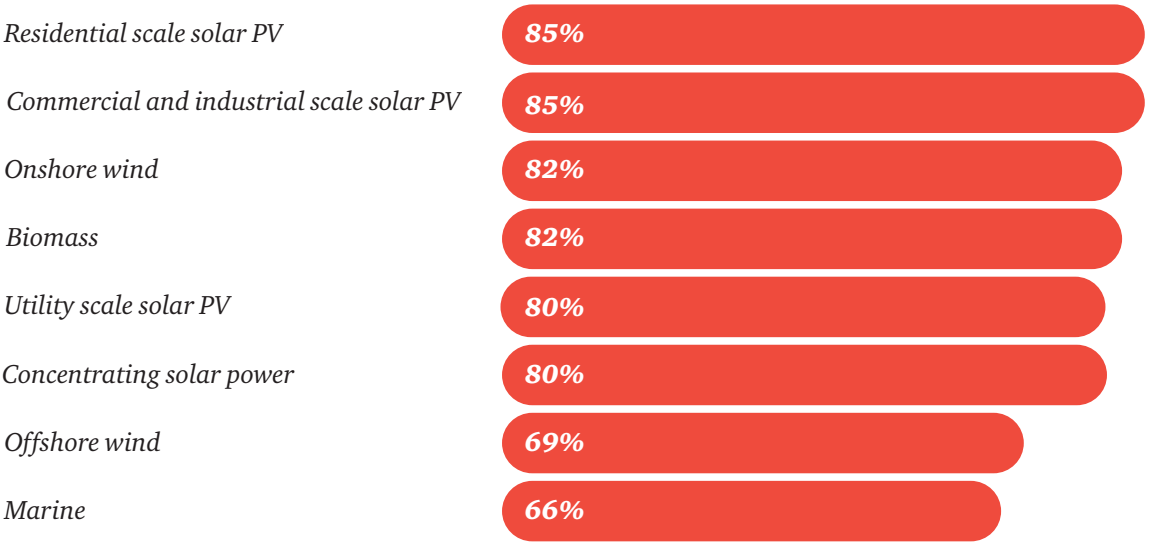


Figure 12: Do you think renewable generation technologies will be able to compete without subsidy by 2030?



Source: 12th PwC Annual Global Power & Utilities Survey

The new gas era

The economics of the new gas era are being played out in different ways in different parts of the world.

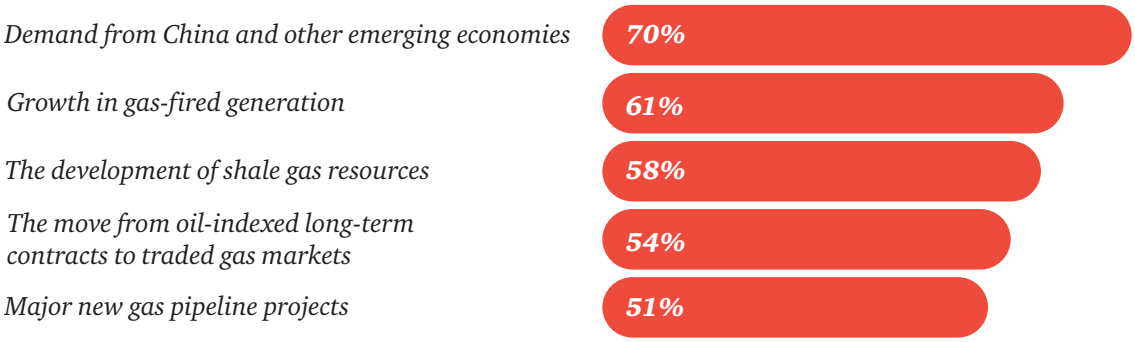
With gas heading the list of generation investment priorities (see page 25) and new sources of gas coming onstream or being exploited in different parts of the world, we are entering a new era of gas. Chinese demand will be an important factor shaping the market with the country's compound average annual growth in primary natural gas demand expected to increase at a rate of 6.7% per annum in the period to 2035[11]. Among our survey participants, 70% attach high or very high importance to gas demand from China and other fast-growth economies (figure 13).

The economics of the new gas era are being played out in different ways in different parts of the world. In North America, the shale gas boom has led to the so-called gas glut and low gas prices which are at a level that is inhibiting new gas generation build. In Europe, where gas prices remain indexed against the oil price, gas remains relatively expensive and the market has attracted LNG cargoes that would previously have served North America.

A majority in our survey (54%) believe that a move away from oil indexation to more liquid, traded markets will be an important major development affecting the gas market in the next ten years which, in turn, could reduce differentials in global gas pricing.

Much of Chinese gas demand will need to be met by LNG imports but China has also released an ambitious five year plan for the development of its own shale gas. It is aiming for 6.5bn cubic meters of shale gas production by 2015, around 2-3% of projected 2015 Chinese gas production, and more than 60bn cubic meters of shale gas production by 2020[12]. In total, China has an estimated 1,275 trillion cubic feet of technically recoverable shale gas reserves, making it the largest repository of shale gas in the world[13].

Figure 13: Major developments affecting the gas market in the next ten years



Source: 12th PwC Annual Global Power & Utilities Survey

11 World Energy Outlook 2011, table 4.2, 'new policies scenario'.
12 China sets target for shale gas development, Financial Times, 16 March 2012.
13 World Shale Gas Resources: an initial assessment of 14 regions outside the United States, US Energy Information Administration, April 2011.

2030 scenario
Electricity transformation

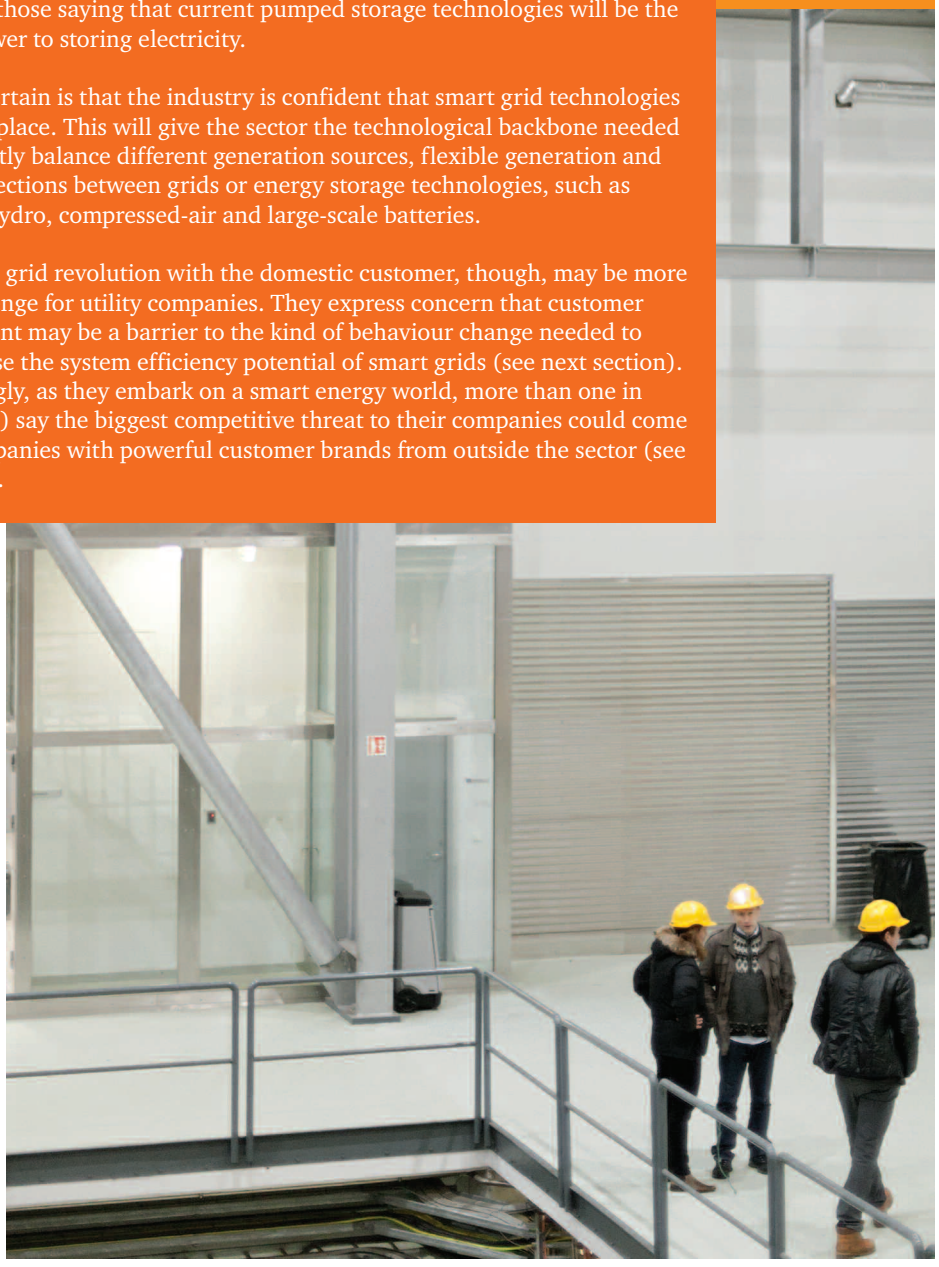
Will new sources and supplies of gas transform the generation mix? Will breakthroughs in electricity storage, such as 'power to gas' technology, dramatically alter the utility of intermittent renewable power and the wider operation of electricity systems? Will smarter grids deliver on their potential and even lead to some convergence of the sector with telecoms, IT and other technology areas?

Our survey respondents are cautious. More gas generation certainly has a role to play but it's not a game-changer. Overall, they see gas's share of their companies' fuel mix rising from 29% now to 33% in 2030. Despite all the shale gas hype, many questions still remain about its accessibility in some locations and its environmental safety. But the survey does lend strong support to a 2030 outlook where onshore wind and a range of solar generation facilities, including utility-scale concentrating solar power, compete and play a major role in the energy mix without the need for subsidy.

There is the potential for a 'power to gas' breakthrough in electricity storage. One in five in our survey even goes so far as to say it will be the most common form of electric storage by 2030. But they are outnumbered three to one by those saying that current pumped storage technologies will be the main answer to storing electricity.

What is certain is that the industry is confident that smart grid technologies will be in place. This will give the sector the technological backbone needed to efficiently balance different generation sources, flexible generation and interconnections between grids or energy storage technologies, such as pumped hydro, compressed-air and large-scale batteries.

The smart grid revolution with the domestic customer, though, may be more of a challenge for utility companies. They express concern that customer engagement may be a barrier to the kind of behaviour change needed to fully realise the system efficiency potential of smart grids (see next section). Interestingly, as they embark on a smart energy world, more than one in four (27%) say the biggest competitive threat to their companies could come from companies with powerful customer brands from outside the sector (see figure 19).



Smarter energy

The future of electricity is set to move a long way from the centralised grids that have dominated modern power systems to date. We are fast moving towards a new energy eco-system with a blurring of distinctions between distribution, transmission and generation. A range of technological innovations are expected to make possible a step change in grid efficiency. They will facilitate automation to reduce cost and improve quality and enable the optimal use of distributed generation. Crucially, they will promote interaction between supply and demand technologies and between the consumer and the utility that will provide benefits for both.

66%

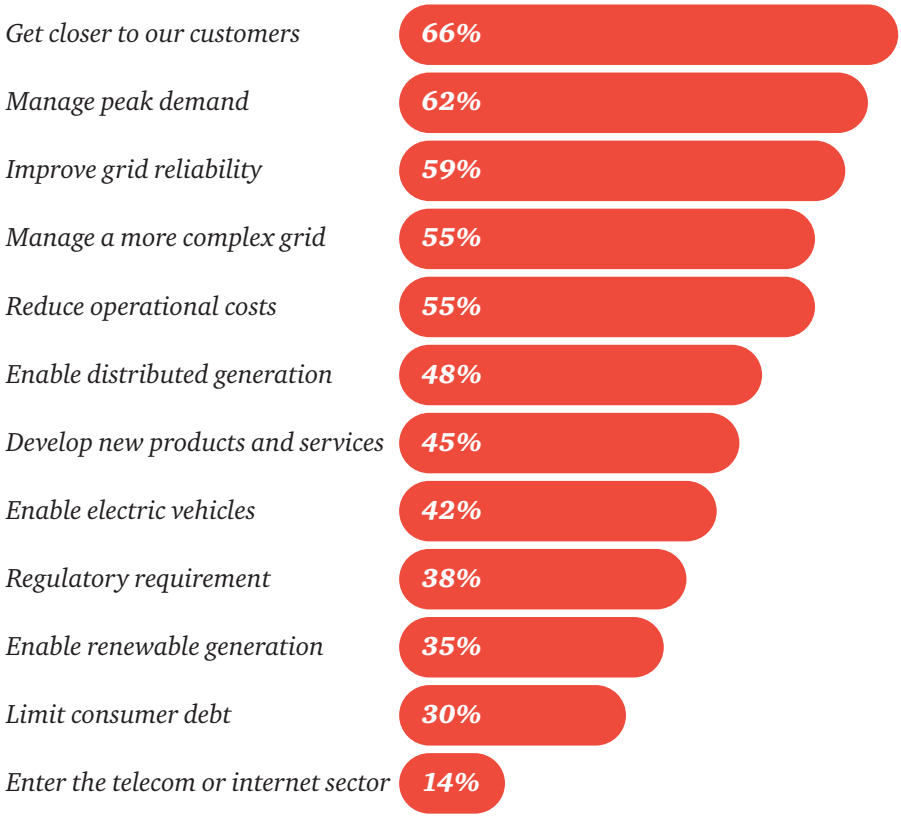
*of survey participants see smart grids and smart metering as an **important or very important** opportunity to get close to their customers.*

Smart energy motivations

Smart grids and smart metering are high on the list of investment priorities – second only to the need to upgrade or replace generation capacity in the view of our survey respondents and on a par with investment in transmission and distribution networks. Interestingly, our survey participants rate the customer relationship potential of smart grids and metering as the most important factor in smart grid investment (figure 14). Two thirds (66%) see it as an important or very important opportunity to get close to their customers with the management of peak demand (62%), which involves changes in customer behaviour, also at the top of the list. These 'customer interaction' goals edge out pure operational gains, such as improved grid reliability (59%) and reduced operational costs (55%).

But companies would be wise to be cautious about the customer opportunity, particularly among residential customers. The nature of the customer-utility relationship varies widely across different regulatory regimes and market frameworks. The experience of smart grid and smart metering deployment so far suggests that gains such as an increased level of 'smart' end-user energy management and peak load shifting are difficult to achieve. Customer inertia is a potential barrier to realising the full potential of smart energy systems.

Figure 14: Smart metering and smart grid rationale



Source: 12th PwC Annual Global Power & Utilities Survey

Customer engagement

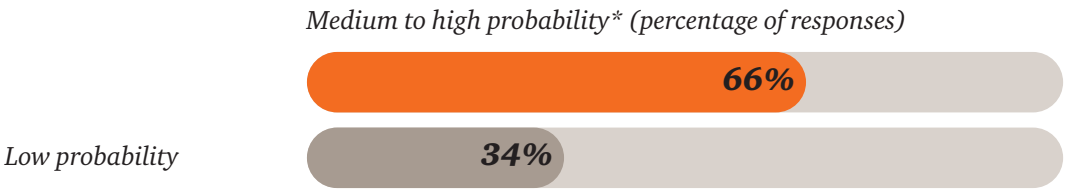
There is increased recognition of the challenge of customer engagement by the industry. Two thirds of survey participants say there is a medium to high probability that the technology will be in place but shortcomings in customer engagement will limit the potential of smart technology, even as far ahead as 2030 (figure 15). This view is particularly strong in the mature markets of North America and Europe (see regional chapter).

In contrast, in Asia and South America respondents were more positive about the prospects for customer engagement and behaviour change with fewer than half anticipating a medium to high prospect that customer engagement would limit the potential of smart grid and smart metering technology. Industry survey participants in developing markets see more positive potential for customer smart grid interaction than their counterparts in mature markets where a greater proportion of smart metering and grid systems have to be 'retrofitted'.

Distributed generation

Nearly half (48%) of the survey population stress the importance of smart grids as an enabler of distributed generation. But they also point to barriers in the way of distributed generation, the biggest of which is cost-effectiveness. Nearly three quarters (73%) say the long return on investment time for customers remains a major barrier and 69% point to the lack of policy support. Fewer than one in six expect distributed generation to supply more than a 10% share of electricity demand by 2025. The consensus estimate is that distributed generation will contribute a 2-5% share by that time. Within this share, solar PV is expected to account for 42% of distributed generation (49% in Europe), compared with a 22% share for fuel cell technology and 22% for geothermal.

Figure 15: Probability scenario
"Smart metering and smart grid technology will be successfully in place by 2030 but its impact will be limited by shortcomings in customer engagement"



*Probability in the range of 40% - 100%
Source: 12th PwC Annual Global Power & Utilities Survey

Two thirds say there is a medium to high probability that shortcomings in customer engagement will limit the potential of smart technology.

Electricity storage breakthroughs

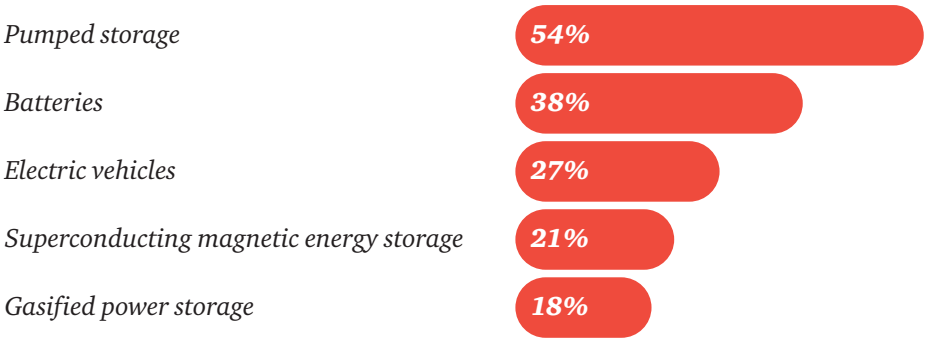
The intermittency and, in some cases, the location of renewable and distributed generation sources will make breakthroughs in electricity storage important for the future energy eco-system (figure 16). Pumped-storage power stations are a good solution for short-term load balancing, but there is only limited capacity available and it is only suitable in certain locations. Long-term storage is therefore a major challenge when it comes to transforming the energy supply system and for power utilities.

Electric cars could play a significant role with smart grids and metering enabling a country's stock of electric cars and their batteries to provide an outlet for intermittent renewable energy that is surplus to other grid requirements. But battery technology, both for vehicles and wider applications, needs to improve in terms of capacity and cost if it is to greatly transform transportation and renewable energy storage. Research continues in improving battery performance and longevity, and breakthroughs are expected with new technology, such as the lithium-air battery. If successful, new batteries will replace gasoline-fuelled engines, improve electricity transmission and impact a host of other potential uses.

Superconducting Magnetic Energy Storage (SMES) systems store energy in the magnetic field created by the flow of direct current in a superconducting coil which has been cryogenically cooled to a temperature below its superconducting critical temperature. SMES systems are highly efficient, power is available almost instantaneously and very high power output can be provided for a brief period of time. They are currently used for some grid stability applications but major cost and scale barriers need to be overcome before they could be used for large-scale storage.

Researchers in Europe are testing 'gasified' or 'power-to-gas' technology that involves the use of excess power to produce hydrogen by electrolysing water and, if required, in a second step converting hydrogen into synthetic methane by reaction with carbon dioxide (CO2). The existing natural gas infrastructure, namely the gas grid and its associated underground storage facilities, could be used to store this methane and also, up to a certain volume, the elemental hydrogen. The idea is not new, but it has become more important in the light of growing share of renewable generation in the energy mix.

Figure 16: Top five forms of large scale electricity storage expected to be most in use by 2030



Source: 12th PwC Annual Global Power & Utilities Survey

2030 scenario
Electric-powered personal transport

Three fifths of our global power survey respondents think there is a medium to high probability that electric cars will form a significant proportion of the world vehicle fleet by 2030. But two thirds (67%) express frustration that regulatory agreement on standards for electric vehicle infrastructure is evolving too slowly.

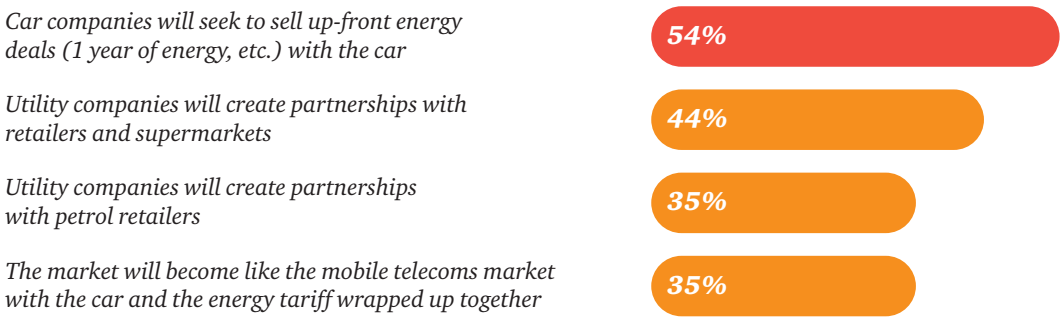
What will an electric car world look like in 2030? Most of our survey participants expect competition for the customer will be intense. Only 7% think this is unlikely. But who will own the customer relationship? A majority think car retailers will sell up-front energy deals with the car. Others see the potential for relationships between power utility companies and other retailers or petrol retailers. Some see the electric car market becoming like the mobile phone market with the car and the electricity wrapped together in contract deals.

Such a marketplace will pose significant challenges for power and utility companies, particularly those used to more captive customer bases. It will demand agility, customer management systems able to cope with a more mobile customer and the ability to forge effective partnerships with a range of other retailers and brands.

Of course, there are many technological barriers to be overcome before electric-powered transport can become more commonplace, principally the evolution of batteries and engine technology. If these can be overcome, there is then the development of electric vehicle charging infrastructure. Nearly three fifths (58%) of our survey participants believe such infrastructure will be a major challenge for power utility companies.

A future electric car marketplace will pose significant challenges for power and utility companies.

Figure 17: What are the most likely electric car customer strategies?



Source: 12th PwC Annual Global Power & Utilities Survey

Company strategies

Continuing growth in regions such as Asia Pacific and South America is contrasting with more limited growth prospects in North America and in Europe. Power and utility companies in these mature markets are turning their sights to growth opportunities elsewhere but are having to balance their acquisitive growth appetite with their considerable renewable energy and infrastructure commitments in home markets.

68%

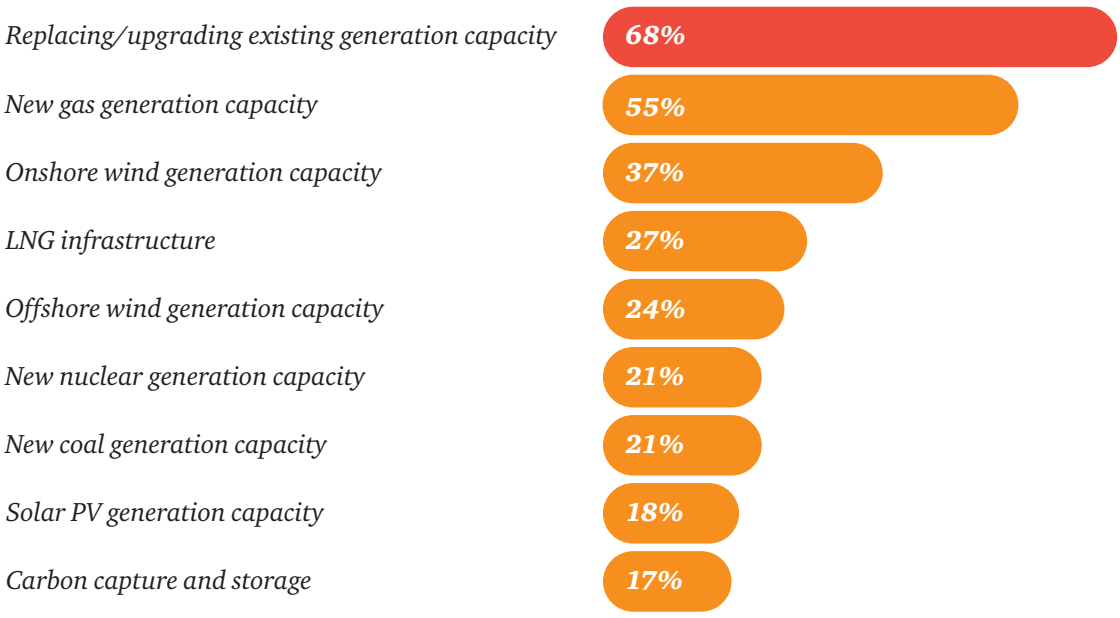
of survey respondents are making ***major or very major investment*** *in upgrades and replacement generation.*

Investment priorities

The capital funding requirement in all markets, both mature and growth territories, is considerable. 68% of survey respondents are making major or very major investment in upgrades and replacement generation (figure 18). New gas generation heads the priority list for generation. 55% of the survey participants are making major or very major gas generation investments versus only 21% for new coal and nuclear generation, 24% for offshore wind and 37% for onshore wind generation. Away from generation, major or very major investments in smart grids (56%) and transmission and distribution infrastructure (52%) also feature strongly.

Utility companies have a relative advantage over companies in some other sectors when it comes to bank financing and the debt markets. But given the scale of capital required and market constraints, some are exploring alternative options, such as the investment in Iberdrola by Qatar Holding, a subsidiary of the Qatar sovereign wealth fund, and GDF Suez's partnership with Chinese sovereign wealth fund China Investment Corporation.

Figure 18: Where are you making major new generation and related investments?



Source: 12th PwC Annual Global Power & Utilities Survey

New partnerships and joint ventures

We are likely to see more strategic partnerships with organisations that have got large pools of capital, such as sovereign wealth funds. Another is joint venture project and investment relationships across the energy chain, such as between upstream gas and downstream utilities. Joint venture project and investment relationships are well established in the independent power generation market involving companies in different parts of the energy chain – for example, between International Power and Mitsui.

These could spread to more parts of the power sector. During 2011, RWE held talks with Gazprom about the possibility of a joint venture covering gas and coal-fired generation plant in Germany, the UK and the Netherlands. They failed to reach a conclusion. Such a move would have given Gazprom access to downstream generation and eased balance sheet risk for RWE. The prospect of such moves across different parts of the energy chain remains a possibility.

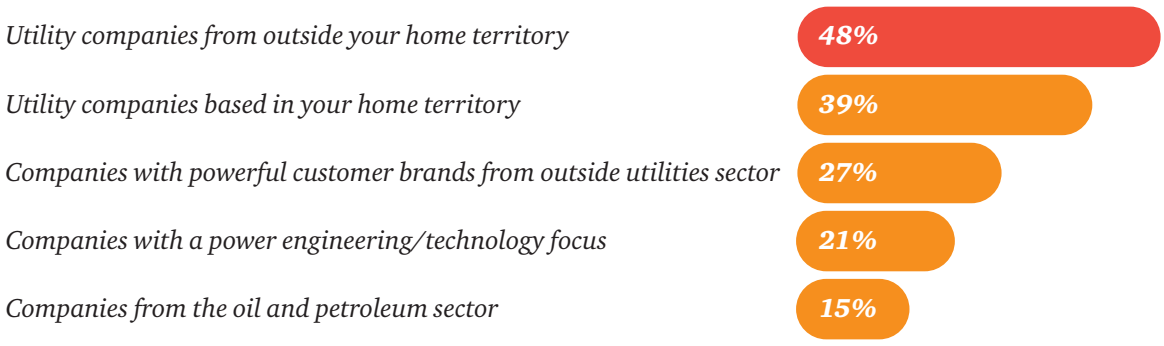
'Go abroad' strategies

We are seeing active east-west investment momentum and 'go abroad' strategies from many companies and investors. Cheung Kong Infrastructure (CKI), the investment vehicle of Hong Kong billionaire Li Ka-shing, has been an active bidder for UK network assets. China Three Gorges Corporation won the auction for a stake in Energias de Portugal, giving it access to the growth market of Brazil. E.ON and Iberdrola have also made significant moves into the Brazilian market with purchases in MPX Energia and Elektro respectively.

The changing geographic focus of power and utility industry strategies is reflected in the expansion priorities of our survey participants. Only 12% ranked western Europe and 13% ranked North America as a number one or number two priority for expansion despite the fact that 24% and 28% of the survey sample were from companies based in these regions. Instead, China (getting 40% of number one and number two mentions as a priority target for expansion), central and eastern Europe (29%), the Indian subcontinent (21%), other Asian countries (19%), the Middle East (17%), Africa and Latin America (14% each) all rated higher as priority targets for expansion.

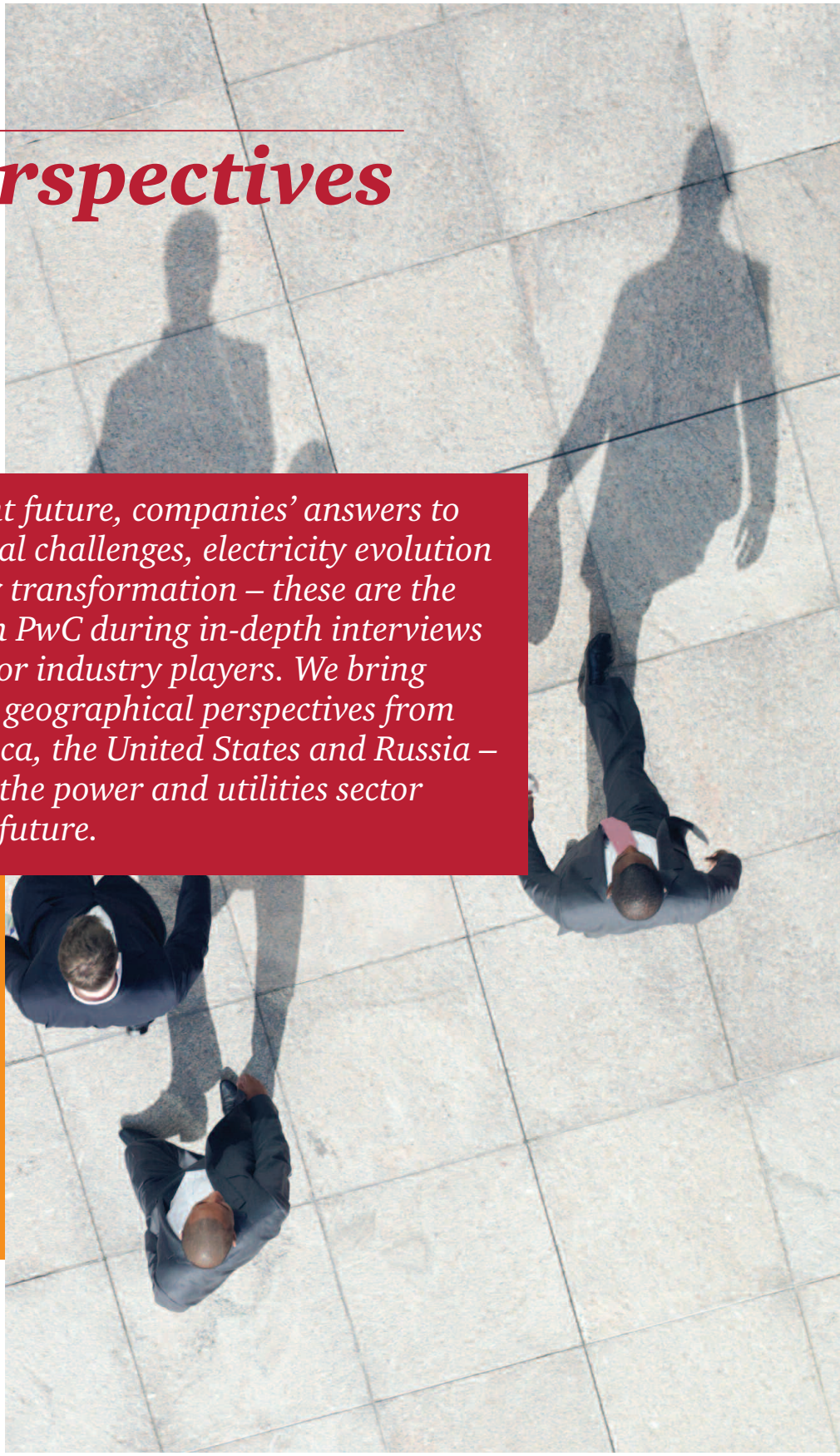
The 'go abroad' nature of power and utilities markets is reflected in the survey participants' view that the biggest competitive threat to their companies comes from utility companies from outside their home market (figure 19). Also striking, in a world where smart energy technologies permit greater interaction with the customer, more than one in four (27%) say that companies with powerful brands from outside the sector also pose a major competitive threat.

Figure 19: Who poses the largest competitive threat?



Source: 12th PwC Annual Global Power & Utilities Survey

CEO perspectives



An energy efficient future, companies' answers to global and regional challenges, electricity evolution and global energy transformation – these are the topics shared with PwC during in-depth interviews with CEOs of major industry players. We bring together different geographical perspectives from Brazil, South Africa, the United States and Russia – a unique view on the power and utilities sector now and into the future.

Perspective: *industry answers to global and regional challenges*

"It is reasonable to expect a continued M&A trend between the market players, with the consolidation of big transnational groups, to provide the scale of business platforms needed for the global energy power sector."

José da Costa Carvalho Neto, chief executive officer, Eletrobras

Eletrobras

Eletrobras is the largest electric power company in Latin America. It is responsible for 36% of Brazil's total generation capacity, with 37 hydroelectric plants, two wind farms and two thermonuclear plants.

Global answers and an increasingly global-scale industry will characterise the future power utilities sector as companies and policy-makers seek answers to the big questions of affordability, security of supply and sustainability.

According to José da Costa Carvalho Neto, the questions facing the world's energy sector will need: "An intensification of the dialogue between the industry's companies and national governments, international agencies and multilateral agencies, in the adjustment of trade-offs between global energy power policies and business plans."

On the question of the search for a balance between affordability, security and sustainability, José da Costa Carvalho Neto believes that they can be complementary and that diversification will be important: "I do not think there is just one source that will change the game. A more diversified mix is likely to be the way. I believe that gas and nuclear will have a wider role to play in this future energy mix."

Scale and cost

Alongside the development of global answers, companies will need greater global scale to compete in a sector where the challenges of cleaner and smarter energy will be dominant considerations: "Companies that cannot face these new challenges will inevitably lose market share or even disappear from the market."

Part of the requirement for scale comes from the need to control costs. Carvalho Neto sees definite dangers of rising energy costs, in part arising from the challenge of cleaner generation sources: "We emphasise the risk of exacerbated elevation of generation costs due to social and environmental requirements, mainly in the developed and emerging countries."

In a world where fossil-fuels will still dominate, Carvalho Neto also highlights the challenge of "geopolitical matters together with the imbalance in the geographic distribution of fossil fuels across power markets and the location of the reserves to be explored."

Regional context

Scale and answers at a regional level reflect the global challenges. Brazil already has a strong focus on renewable energy. It is the largest hydropower producer in the word after China and policies to promote renewable energy have also spurred significant windpower capability. Carvalho Neto points out: "Eletrobras is the largest generator of electric power in Latin America and there is still great remaining hydroelectric potential to be used in the region, as well as the resumption of the expansion of nuclear generation, expanded investment in wind and biomass energy."

In December 2008, the country launched its National Climate Change Plan, focusing largely on reducing deforestation but also containing provisions on energy efficiency and renewable energy. The energy efficiency provisions are significant says Carvalho Neto: "The action plan has the goal of a 10% reduction in electricity consumption by 2030 compared with a reference scenario." Carvalho Neto also emphasizes "the electro-energy integration of South America and universal access to electricity" as very important.

Smarter and cleaner energy

Carvalho Neto foresees significant change in the decades ahead: "In the period to 2030, a lot of changes will occur in the global electric power industry due to global warming, the difficulties of and barriers to nuclear energy and of fossil-fuel sources and, in countries like Brazil, the construction of big reservoirs for hydroelectric plants." He highlights "increasing use of renewable sources, such as the wind, solar, biomass and hydropower, including the development of run-of-river plants that do not need big reservoirs."

Smart grids will be important. Carvalho Neto envisages: "A more informed, demanding consumer that has more options and choices, including the possibility of 'auto generation', with so-called intelligent energy supplies brought about by smart grids, smart buildings and smart homes acting together." He also mentions visionary projects such as Desertec to bring solar and wind power from north Africa to Europe, as examples of the greater international collaboration that will be part of the future power world.

"Companies that cannot face the new challenges will inevitably lose market share or even disappear from the market."

Perspective: *an energy efficient future*

"Energy efficiency is probably one of the foundation stones upon which future energy strategies will be based. The world cannot afford the per capita energy densities that are prevalent in industrialised societies and major strides have to be taken to reduce them."

Brian A. Dames, chief executive, Eskom

Eskom

Eskom generates approximately 95% of the electricity used in South Africa and approximately 45% of the electricity used in Africa. It is one of the top 20 utilities in the world by generation capacity with a net maximum self-generated capacity of 41,194MW.

World demographic trends mean that energy efficiency will be an important part of future energy policies in the view of Brian A. Dames: "Energy efficiency can make a significant contribution but in order to be effective it requires supportive policy frameworks that enable large scale deployment of technologies."

He points out that developing countries have an opportunity to build efficiency into their growth and development models: "Developing nations are not likely to grow their demand along the same trajectories as taken by the developed world. Energy efficiency will probably be built into the roll out plans right from the beginning."

Incentivising efficiency

But this won't happen without design and direction: "In order to be effective they need to either be legislated and enforced or incentivised through demand response tariffs. Subsidies for energy efficient appliances could also to be funded from carbon tax funds. A cost-reflective pricing environment also will incentivise investment in energy efficient technologies as well as in R&D in alternative and more efficient technologies."

Automation will play an important role in making energy efficiency more certain: "Technologies that can be hardwired into the system and do not rely on human behaviour will be required for high levels of sustainability." Ultimately, Dames expects that: "Price parity will be a key factor that makes energy efficiency programmes sustainable. Also, with the increase in the cost of energy it can be expected that energy efficiency initiatives will become self-funded and, as such, sustainable."

Game changers

Dames sees nuclear power as a potential 'make or break' issue: "The world could make an about turn on nuclear technologies when their carbon footprint and inherent risk are better understood by the public." He also points to a number of energy 'game changers' including smart demand management systems, new fuel sources such as shale gas and energy storage: "Energy storage has a high potential to become cheaper as storage density increases and this will enable the use of small amounts of power by loads as and when required, especially in response to pricing signals."

He highlights the potential of high efficiency solar: "As the cost of PV comes down and the efficiencies climb, it is conceivable that almost every residential and small commercial dwelling will have some form of solar augmentation. Solar might impact wind's dominance as the preferred renewable energy source, especially in regions such as Southern Africa."

The transition to such a future could present some intriguing developments: "The wealthy sector of the market may be the first to adopt clean or 'off grid' solutions which will put a financial burden on the utility to pick up those customers that cannot afford to go for self-generation."

Dames says that this could lead to "the possibility that the utility is seen as a back-up to the alternate renewable system and this will raise interesting funding and sustainability issues for the utility. Money from revenues may fall and cost to serve the remaining customer base could rise. In addition to this, distributed generation and higher overall efficiencies could result in differing power flow with the resulting changes in transmission grid investment."

Electric cars

When it comes to electric cars and associated recharging infrastructure, Dames points out that: "The natural link to fill-up is probably more related to the providers of parking space than petrol retailers." He is sceptical that pricing models might mimic those in the mobile telecoms sector: "Wrapping of services like cell-phones make sense if the variable cost of supply like 'air-time' is virtually free, but if the supply is 'electricity' that has a high variable cost, then the wrapping model's economics change significantly."

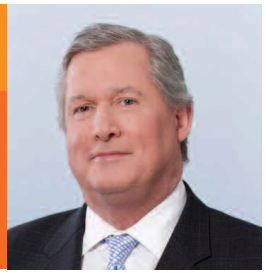
But, despite the potential for a considerable number of technological advances, Dames concludes by stressing the need to be realistic about the nature of timescales in the power sector: "2030 is only 18 years away which is less than the half-life of most of the assets that make up the electricity grid. As such many of the assets we are commissioning today will still be around and thus changes will tend to be evolutionary rather than revolutionary."

"Every home could probably consume 20% less energy and still achieve the same quality of life."

Perspective: *electricity evolution*

"Unforeseen developments can always disrupt an industry – cell phones altered the telecom landscape, digital music drove major change in the music industry – but attempts to force a direction or commit too many resources to an expected outcome tend to lead to results that fall short of what can be achieved."

Christopher M. Crane, president and chief executive officer, Exelon Corporation



Exelon Corporation

Exelon Corporation is one of the US's largest competitive energy products and services suppliers by load (about 164 terawatt-hours per year) and customers (approximately 100,000 business and public sector and approximately 1 million residential), serving more than two-thirds of America's Fortune 100 companies. It has one of the largest and cleanest power generation fleets in the US, with approximately 35,000 megawatts of owned power generation, including more than 19,000 megawatts of nuclear power.

Christopher M. Crane says the path ahead for the power utilities industry needs to be a flexible one: "We need to plan for a natural evolution while allowing for revolution: embracing what we know we can do cheaply while creating an environment where future solutions that best provide clean, affordable, and reliable power can easily access the market when they are ready."

Crane expects such evolution will see "the oldest, dirtiest plants retiring to make way for low-cost energy efficiency, operational enhancements and expansions at existing plants, new assets that leverage newly-cheap natural gas and, finally, some more expensive solutions supported by legislative efforts. While there is some chance that our world will be defined by disruptive paradigm shift, there is also a very real possibility that the world will follow a natural progression from where we are today, particularly in the United States."

The 2030 electricity world

Crane points to "a number of important developments under way that could materially change the dynamic of the electricity world." Among the many changes taking place, he says: "technological developments have unlocked major shale gas resources for development at very low costs and globalisation continues to de-regionalise commodity prices, making competition for resources more global. In certain parts of the world, a fairly depreciated asset base will begin to require retirements, while in other parts of the world, distributed generation may allow emerging markets to skip much of the centralised build-out altogether."

There are "any one of a number of technological developments" that could have "the possibility to upend the demand and/or supply sides of the power sector," according to Crane. Technology is also changing the way consumers interact with the industry: "Younger generations are becoming increasingly technologically savvy, networked and interested in the broader impacts of energy consumption – an important combination that could drive real change in how customers interact with the power sector or how policy makers shape the industry."

Balancing affordability, security and sustainability

Crane stresses that "clean, affordable and reliable electricity is essential for maintaining a developed standard of living and a robust economy." He points to natural gas as a central element in delivering this balance: "We believe that in the near-term, with sustained economically priced natural gas, that combined cycle generation will be the preferred choice for base and intermediate load supplies of affordable electricity at least for the next decade."

"New nuclear is attractive as an efficient, clean, and low-carbon option, but in competitive markets where we operate, the generation produced would not be competitive with projected market prices for some time," observes Crane. "As an alternative to building new nuclear plant, we are increasing the output of our existing fleet through modifications that will enable us to significantly increase the capacity of our fleet."

Energy efficiency

Government-mandated energy efficiency programs, such as those found at Exelon's three regulated delivery companies, ComEd, PECO, and BGE have an important role to play according to Crane. "These programmes at our utilities have been quite successful in achieving their goals, and reasonable energy efficiency programs can be part of a broader approach to cleaning the generation supply stack in a cost-effective and reliable manner."

But he also points out that "energy efficiency is a tough nut to crack. In many areas, it represents a largely untapped resource in the stack to free up additional capacity and generation. One of the biggest obstacles is the difficulty of finding a way to monetize its benefits. Commercial property owners have no incentive to invest in energy efficiency because their tenants pay the energy bill. Homeowners may struggle to finance the upfront cost of efficiency investments, or they may simply be uncomfortable taking the risk that they will not fully recoup the investment, even when payback periods can often reasonably be measured in months."

"Distributed generation may allow emerging markets to skip much of the centralised build-out altogether."

Perspective: *transforming electricity*

"Electricity storage is the most promising current trend in the energy sector. More so than transmission, nuclear fission or alternative sources like the sun, wind or anything like that. It is power storage technology that will change the future of the industry."

Evgeny Dod, the chairman of the management board of RusHydro Group

RusHydro

RusHydro is one of Russia's largest power generating companies in terms of installed capacity. It is also a leader in power production using renewable energy sources, developing power generation using water flows, tidal, wind and geo-thermal energy.

Evgeny Dod is looking ahead to a world where technological breakthroughs could have a profound effect on the operation of electricity systems. "The power industry is a very conservative sector but I do think we seem to be on the brink of real system-wide changes in many areas of electricity and in the energy industry as a whole," he says.

He believes that the changes on the way are "multifaceted" but he singles out electricity storage technology as having the greatest potential significance. "We are on the verge of creating large and relatively cheap, efficient rechargeable batteries," observes Dod. "It will cause a fundamental conceptual shift, changing the way large grid construction is conceived."

Rethinking our approach to power

"I believe, in the next ten years, we will see large scale, industrial production of rechargeable units that will allow us to reconfigure our approach to issues of baseload and peakload power and the construction of additional grids. I think that the whole concept of electricity storage will change our view on how basic fuels such as gas, oil, coal, etc. are used."

He stresses that electricity storage won't be the only big improvement. "Clearly, there are significant and promising projects relating to transmission technologies. They are sure to yield a concrete breakthrough," he says. "But this process is complicated by the fact that huge resources and production capacities are needed to move from scientific research results to actual production. For instance, just replacing all the cables and power lines is, in itself, a huge process. On the other hand, building thousands of storage blocks of 1,000 MW each is a relatively quick and efficient process."

A new power model

The potential of large-scale storage needs to be viewed together with renewable energy and more efficient transmission. "If you take the three together – then that's a fundamentally different setup. This model removes the need to lay expensive transmission lines to remote, isolated areas. In the far east of Russia, for example, you could have communities linked to different standalone systems – with different costs."

Other trends will also be important. "The oil price situation will promote new trends such as shale gas, new sources of energy and coal," says Dod. "These will remain at the fundamental core of the whole energy sector. But, in my view, it is energy storage technologies that will be the transformative breakthrough. It has the potential to be the key issue that will change the world."

Energy efficiency

The survey uncovered considerable doubts about programmes to boost energy efficiency but Dod disagrees. "I think that energy efficiency is a very promising area and I don't share this scepticism. There are very effective and interesting programmes working to cut energy use in production and in the household."

However, he stresses that clear incentives are important if consumers are to adopt energy efficiency technology and habits. "Everything depends on them having serious incentives. From an economic perspective, these should be material incentives, so that they can be measured. All too often, organisations and individuals are not very interested. It won't happen until people are able to really see how much they have saved and be able to use what they save for themselves more directly. This is particularly the case in areas such as the public sector where, typically, the person using the electricity is not the person paying for it."

Electric personal mobility

Finally, Dod also anticipates big potential for electric cars. "I believe that by 2030 the share of electric vehicles, at least in big cities, will be no less than 30%. The key issue is battery life and charging time. In cities, compact ordinary electricity-powered vehicles are our future. I've even ordered a car like that for myself – a Tesla, I think. 95% of all our transport within the First Concrete Ring (Moscow region ring road) that has a mileage of up to 100km per day should be electric-powered. It's environmentally good and clearly profitable for electricity companies."

"The whole concept of electricity storage will change our view on how basic fuels are used."

Around the world

Regional survey highlights

Power markets around the world differ in many ways, not least their design, regulatory frameworks and natural resource context. Carbon is priced in some and not in others. Competition for the end customer is present in some and not others. And the infrastructure development and renewal challenge varies according to maturity of the existing power systems and the scale of new demand. Despite these differences, industry sentiment on many aspects of the big issues is fairly consistent around the world. But there are some notable points of difference. In this chapter, we review the other main regional contrasts in the survey findings.

Energy policy

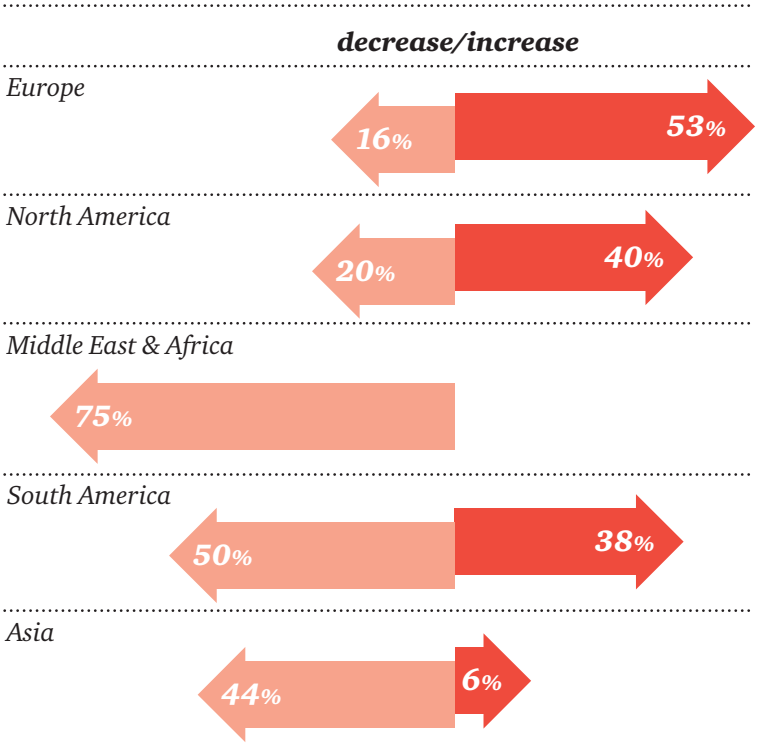
We asked what energy policy levers will be important in helping the utility sector meet demand by 2030. Globally, the emphasis was on a regulatory environment that encourages network investment, the removal of strategic infrastructure planning bottlenecks and increased interconnection between different electricity systems. The regional responses stressed the same things, except:

- survey participants in Asia were less concerned about interconnection between electricity systems, instead emphasising the importance of demand-side management schemes
- responses from the Middle East and Africa also placed a particular emphasis on the importance of renewable energy subsidies.

Security of supply

Companies in mature markets are more pessimistic about the trend for blackouts than those in developing countries (figure 2). Looking in more detail at how this breaks down between different regions, we see that survey participants in Europe are the most pessimistic, envisaging a trend from a period when power interruptions are relatively rare to one where they are possibly more frequent (figure 20). In contrast, of course, blackouts are a more common current occurrence in developing markets and here industry opinion expects the situation to improve, with the outlook most optimistic in the Middle East and Africa.

Figure 20: Will the risk of blackouts change in the period to 2030?

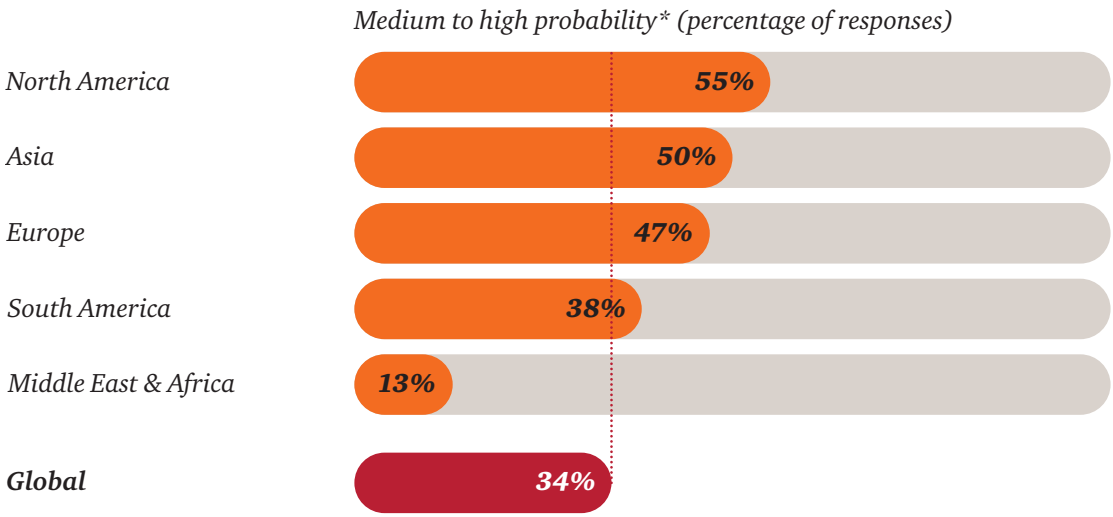


Source: 12th PwC Annual Global Power & Utilities Survey

Energy efficiency

Globally, a third of our survey see a medium to high probability that energy efficiency programmes will fail to achieve their potential by 2030. Industry opinion in North America, Asia and Europe is most sceptical about the potential of energy efficiency programmes. In contrast, in other parts of the world where the scope for improvements is greater, survey participants are more optimistic, including those regions such as the Middle East and Africa where fossil fuel subsidies are a potential barrier to energy efficiency.

Figure 21: Probability scenario
"By 2030, energy efficiency programmes will have largely failed to fulfil their promise and will have had limited impact on dampening demand growth"

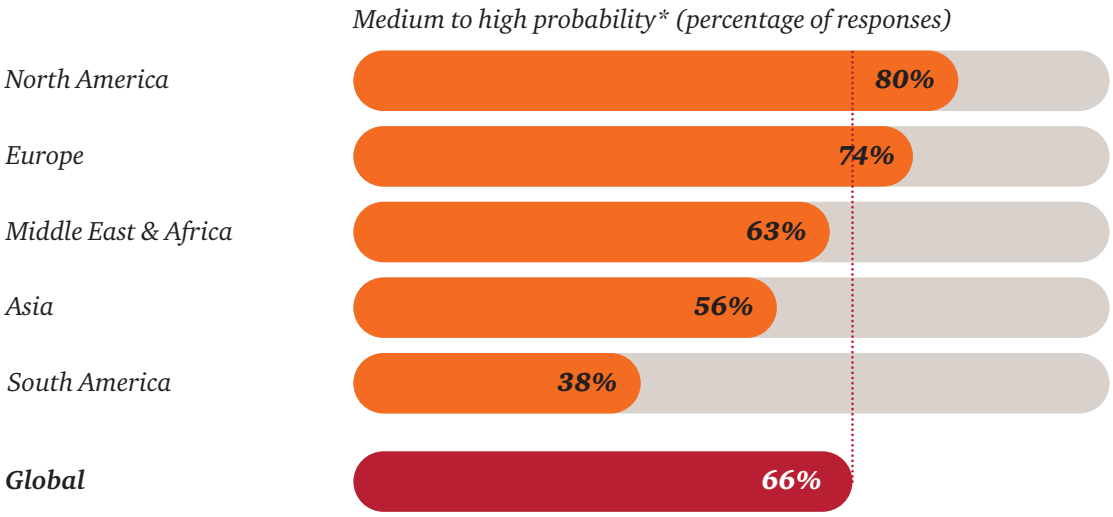


*Probability in the range of 40% - 100%
Source: 12th PwC Annual Global Power & Utilities Survey

Smart grid customer engagement

Worries about customer engagement being a barrier to realising the full potential of smart grid and smart metering technology are greatest in North America and Europe where customer relations and, indeed, physical meters are more firmly entrenched. In North America, 80% are of this view and in Europe 74%. In Asia and South America respondents are more positive about the prospects for customer engagement and behaviour change with fewer than half anticipating a medium to high prospect that customer engagement would limit the potential of smart grid and smart metering technology.

Figure 22: Probability scenario
"By 2030, smart metering and smart grid technology will be successfully in place but its impact will be limited by shortcomings in customer engagement"



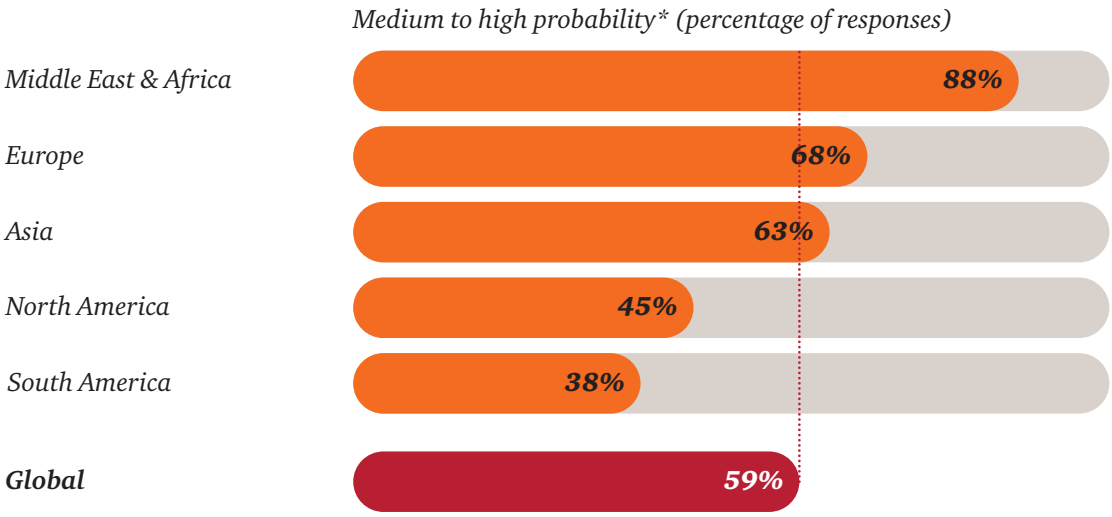
*Probability in the range of 40% - 100%
Source: 12th PwC Annual Global Power & Utilities Survey

Worries about customer engagement limiting the potential of smart technology are less evident in markets outside North America and Europe.

Electric cars

Expectations of the development of electric vehicles are weakest in North and South America. Europe and Asia are in line with the global results but, perhaps surprisingly, optimism about the potential of electric-powered personal transport is greatest in the Middle East and Africa.

Figure 23: Probability scenario
"By 2030, electric vehicles will be a significant proportion of the global vehicle fleet"

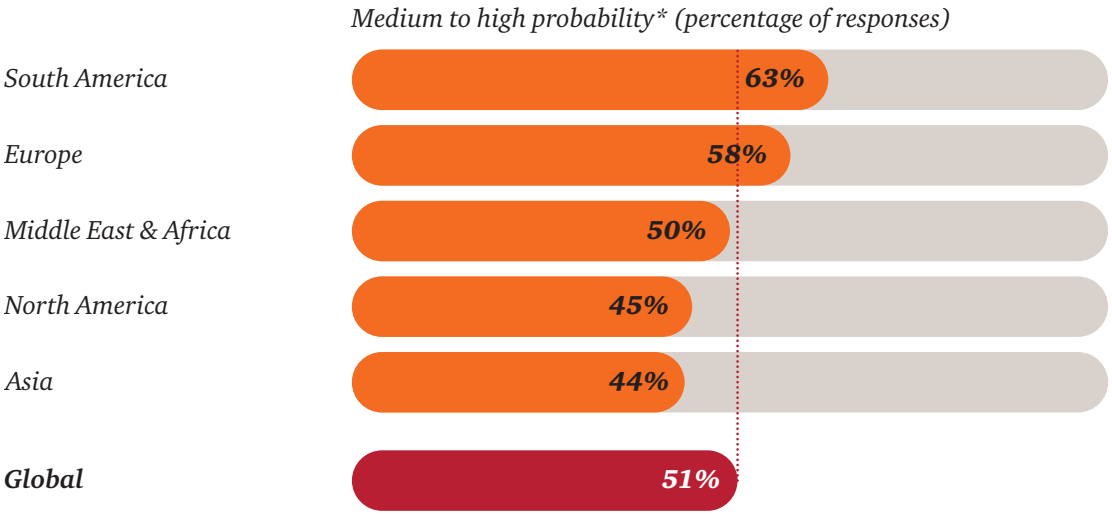


*Probability in the range of 40% - 100%
Source: 12th PwC Annual Global Power & Utilities Survey

Fuel poverty

Finally, when it comes to fuel poverty, survey participants in Asia and North America are more optimistic than their counterparts in other parts of the world on the outlook for fuel poverty. Those in the Middle East and Africa are in line with the global results but European and South American responses are more pessimistic.

Figure 24: Probability scenario
"The number of consumers in fuel poverty will increase significantly over the next 20 years"



*Probability in the range of 40% - 100%
Source: 12th PwC Annual Global Power & Utilities Survey

Contacts

Global contacts

Manfred Wiegand
Global Power & Utilities Leader
Telephone: +49 201 438 1517
Email: manfred.wiegand@de.pwc.com

Norbert Schwieters
Global Consumer and Industrial Products & Services Leader
Energy, Utilities & Mining Leader Germany
Telephone: +49 211 981 2153
Email: norbert.schwieters@de.pwc.com

Jeroen van Hoof
Global Power & Utilities Assurance Leader
Telephone: +31 88 792 1328
Email: jeroen.van.hoof@nl.pwc.com

David Etheridge
Global Power & Utilities Advisory Leader
Telephone: +1 415 498 7168
Email: david.etheridge@us.pwc.com

James Koch
Global Energy Utilities & Mining Tax Leader
Telephone: +1 713 356 4626
Email: james.koch@us.pwc.com

For further information

Olesya Hatop
Global Energy, Utilities & Mining Marketing
Telephone: +49 201 438 1431
Email: olesya.hatop@de.pwc.com

Territory contacts

Australia

Jock O'Callaghan
Telephone: +61 3 8603 6137
Email: jock.ocallaghan@au.pwc.com

Michael Shewan
Telephone: +61 3 8603 6446
Email: michael.shewan@au.pwc.com

Austria

Michael Sponring
Telephone: +43 1 501 88 2935
Email: michael.sponring@at.pwc.com

Belgium

Koen Hens
Telephone: +32 2 710 72 28
Email: koen.hens@be.pwc.com

Brazil

Guilherme Valle
Telephone: +55 21 3232 6011
Email: guilherme.valle@br.pwc.com

Canada

Alistair Bryden
Telephone: +1 403 509 7354
Email: alistair.e.bryden@ca.pwc.com

China

Gavin Chui
Telephone: +86 10 6533 2188
Email: gavin.chui@cn.pwc.com

Denmark

Per Timmermann
Telephone: +45 3945 3945
Email: per.timmermann@dk.pwc.com

Finland

Mauri Hätönen
Telephone: +358 9 2280 1946
Email: mauri.hatonen@fi.pwc.com

France

Philippe Girault
Telephone: +33 1 5657 8897
Email: philippe.girault@fr.pwc.com

Germany

Norbert Schwieters
Telephone: +49 211 981 2153
Email: norbert.schwieters@de.pwc.com

Greece

Socrates Leptos-Bourgi
Telephone: +30 210 687 4693
Email: socrates.leptos.-.bourgi@gr.pwc.com

Contacts

India
Kameswara Rao
Telephone: +9140 6624 6688
Email: kameswara.rao@in.pwc.com

Ireland
Ann O'Connell
Telephone: +353 1 792 8512
Email: ann.oconnell@ir.pwc.com

Israel
Eitan Glazer
Telephone: +972 3 795 4 664
Email: eitan.glazer@il.pwc.com

Italy
Giovanni Poggio
Telephone: +39 06 570252588
Email: giovanni.poggio@it.pwc.com

Japan
Koji Hara
Telephone: +81 90 1618 5601
Email: koji.hara@jp.pwc.com

Latin America
Jorge Bacher
Telephone: +54 11 5811 6952
Email: jorge.c.bacher@ar.pwc.com

Middle East
Paul Navratil
Telephone: +973 1754 0554
Email: paul.navratil@bh.pwc.com

Netherlands
Jeroen van Hoof
Telephone: +31 88 792 1328
Email: jeroen.van.hoof@nl.pwc.com

New Zealand
Craig Rice
Telephone: +64 9 355 8641
Email: craig.rice@nz.pwc.com

Norway
Ståle Johansen
Telephone: +47 9526 0476
Email: staale.johansen@no.pwc.com

Poland
Piotr Luba
Telephone: +48 22 523 4679
Email: piotr.luba@pl.pwc.com

Russia & Central and Eastern Europe
Michael O'Riordan
Telephone: +7 495 232 5774
Email: michael.oriordan@ru.pwc.com

Singapore
Paul Cornelius
Telephone: +65 6236 3718
Email: paul.cornelius@sg.pwc.com

South Africa
Stanley Subramoney
Telephone: +27 11 797 4380
Email: stanley.subramoney@za.pwc.com

Angeli Hoekstra
Telephone: +27 1 1797 4162
Email: angeli.hoekstra@za.pwc.com

Spain
Inaki Goiriena
Telephone: +34 915 684 469
Email: inaki.goiriena@es.pwc.com

Sweden
Martin Gavelius
Telephone: +46 8 5553 3529
Email: martin.gavelius@se.pwc.com

Switzerland
Marc Schmidli
Telephone: +41 58 792 1564
Email: marc.schmidli@ch.pwc.com

Turkey
Faruk Sabuncu
Telephone: +90 212 326 6082
Email: faruk.sabuncu@tr.pwc.com

United Kingdom
Steve Jennings
Telephone: +44 20 7802 1449
Email: steven.m.jennings@uk.pwc.com

United States
David Etheridge
Telephone: +1 415 498 7168
Email: david.etheridge@us.pwc.com

Uruguay
Patricia Marques
Telephone: +598 2916 0463
Email: patricia.marques@uy.pwc.com

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