WORLD ENERGY COUNCIL
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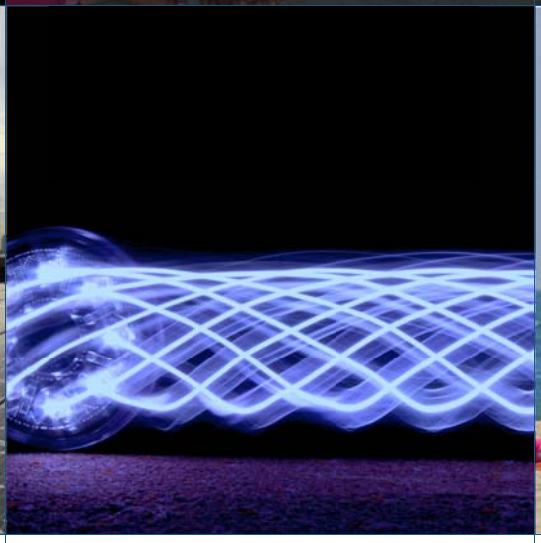
For sustainable energy.

Pursuing sustainability:

2010 Assessment of country energy and climate policies

World Energy Council

Project Partner
OLIVER WYMAN



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Foreword

At a time when all countries are working to develop strategies for putting the crisis behind them, economic growth is an entirely legitimate and worthwhile goal. The problem is that the kind of growth we have pursued in the past forces us to address three fundamental issues:

The first is security of supply. We must invest in new sources and infrastructure to meet demand. The crisis has negatively affected some investment plans, and the recent surge in oil and commodity prices may curb growth.

The second is environmental protection and climate change. Responsible for 60% of global greenhouse gas emissions and much of regional and urban air pollution, the energy sector is clearly on the front line of climate change. And in terms of urban environment, at a time when one out of every two people lives in a city, air quality is a major concern.

And because energy goes hand in hand with development, the question of inequalities within and across countries is another central concern.

Now more than ever, we must work to find a sustainable path that reconciles economic growth, protection of the environment and greater energy equity among peoples.

We can do this and we have the technologies we need at hand.

Energy resources are not a major constraint but their uneven distribution across nations, and the fact that ensuring security of energy supply will lead to an increase in energy prices, are issues. The energy industry will need to go further afield and deploy ever more sophisticated technologies to tap into available resources. And as the recent event in the Gulf of Mexico dramatically reminded us, we will need to respect the highest standards of safety.

But other types of resources are genuinely scarce or under stress.

The environment is one example, and particularly the climate. Water and land use issues have also become real constraints. There is also a need for the skills to conceive, build and operate systems powered by efficient and clean technologies.

The real shortage today, however, relates to governance. We need effective rules and smart policy frameworks to update our energy policies and ensure that the right resources and technologies are available in the right place, at the right time... and at the “right” price.

In sum, innovation in terms of policies, institutions and governance will be just as important as technological innovation.

Copenhagen has clearly evidenced the critical need for new energy governance. By shifting from the top-down approach of Kyoto to a bottom-up approach based on national commitments, the Copenhagen Accord has rightfully put energy policy at the centre of the sustainability debate.

The challenge is now to design sound and effective public policies to deliver the national objectives, which were adopted by more than 80 countries.

This second edition of our yearly Energy and Climate Policy Assessment is WEC's contribution to meeting the challenge of designing new energy governance with sound and effective public policies.

Therefore I want to thank the team that produced this report, including the WEC Project Team in London, the Study Chair Hajime Murata, our partners Oliver Wyman, and of course the WEC Member Committees from almost 100 countries, who provided continuous and precious insight.

Among its numerous findings, two seem of particular importance.

The first is the critical need to factor in thorough assessment of technologies to energy policy making.

Updating energy policies will require planning the rollout of different technologies, starting with those that are mature while preparing others for the market.

- We could in fact already organise a massive rollout of mature technologies over the next 20 years with hydro power, wind, biomass, nuclear and high efficiency coal and gas plants on the supply side, and solutions like efficient lighting, insulation in buildings and heat pumps and more efficient engines on the demand side. These are competitive solutions with prices of up to a few tens of $ per tonne of CO_2 avoided.
- For technologies that are not yet mature, the cost of CO_2 avoided is usually five to ten times higher. So our first step should be to encourage and support R&D and experimentation.

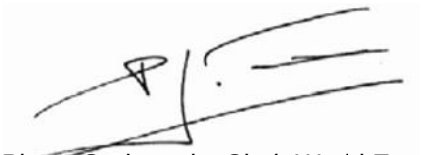
Assessing the maturity of each technology in each local context is a crucial element in controlling the costs of policies and thus ensuring the stability and the long-term viability of rules, which is essential for our sector. An illustration of this can be found in the report: some support mechanisms for renewable energy failed to tailor policies to the maturity of technologies, leading to a dramatic and costly 'stop-start' in policies.

The second element relates to the way policies can encourage our behaviours and habits to change. The report highlights the need to set up bundles of complementary instruments:

- Norms and standards will play a vital role in encouraging business and consumers to incorporate energy efficiency into buildings and transport, for instance.
- At the same time, energy prices must do their part to stimulate investment, guarantee security of supply, and promote energy savings. This will require making sure the poorest members of society continue to enjoy access to energy, for instance by having subsidies specifically for them.
- Some innovations like intelligent energy supply and use (smart grids and smart homes

and buildings) can be real catalysts in changing energy behaviours, making people more aware of the value of resources and therefore more eager to be efficient and responsible.

Sustainable growth is no longer an option – it is a necessity. While the goal is clear, finding the best path to reach it will be a challenge for us all. I believe that to rise to the challenge, we will have to rely more than ever on cooperation and dialogue between all stakeholders – governments, business, research and NGOs. This WEC report is a significant step along that path.



Pierre Gadonneix, Chair World Energy Council

Executive Summary

The pursuit of energy sustainability should be central to energy policymaking

Global population growth and the importance of limiting global warming mean energy policymaking has to accommodate multiple agendas—economic development, national security, social welfare, and environmental protection. As a result, policy approaches to the national primary energy mix, infrastructure development, market operation, and demand management need to be governed by principles relating to long-term energy sustainability.

The World Energy Council's (WEC) definition of energy sustainability has three core dimensions—energy security, social equity, and environmental impact mitigation. For these to be pursued successfully, public acceptance and an economic framework that reflects key externalities are also critical.

Energy Sustainability Dimensions

- *Energy security.* For both net energy importers and exporters this includes the effective management of primary energy supply from domestic and external sources; the reliability of energy infrastructure; and the ability of participating energy companies to meet current and future demand. For countries that are net energy exporters, this also relates to an ability to maintain revenues from external sales markets.
- *Social equity.* This concerns the accessibility and affordability of energy supply across the population.
- *Environmental impact mitigation.* This encompasses the achievement of supply- and demand-side to energy efficiencies and the development of energy supply from renewable and other low-carbon sources.

A wide range of factors contribute to the energy sustainability performance of countries

The sustainability profile of a country's energy system is a function of three factors: the country's resource endowment, its stage of economic development, and policy decisions. An index created for this project offers a historic snapshot of the relative strengths and weaknesses of the country of each WEC member committee, based on the latest comparable data. Incorporating 22 indicators that cover energy sustainability and the political, social, and economic attributes of countries, it ranks each country's likely ability to provide a stable, affordable and environmentally friendly energy system.[1] Table 1 shows the strongest performers.

Despite marked differences in resource endowment and market structure, the leaders in the higher economic groups show low energy-demand growth and robust policy environments. Most exhibit either high levels of energy autonomy, with a strong use of alternative energy, or considerable diversity in their primary energy mix and supply countries. They also tend to have well-established energy efficiency programmes, and a balance between affordable energy and pricing that enables investment.

Table 1
Energy Sustainability Country Index leaders (by economic groupings)
Source: Multiple (IEA, EIA, World Bank, IMF, WEF etc. 2007)

GDP/capita (USD)		> 33,500	14,300 – 33,500	6,000 – 14,300	< 6,000
Positioning	1	Switzerland	Spain	Colombia	Indonesia
	2	Sweden	Portugal	Argentina	Egypt
	3	France	Slovenia	Brazil	Cameroon
	4	Norway	Italy	Mexico	Philippines
	5	Germany	New Zealand	Turkey	Swaziland

Black font = net energy importers. Blue font = net energy exporters

The leading countries in the lower economic groups owe their positions mostly to an effective use of their resource endowment and the impact of long-term efforts towards achieving full access to electricity for their population. Strong environmental scores result partly from their ability to draw on hydroelectric power and partly from the low energy intensity of their economies.

No country ranks high across all three dimensions of energy sustainability (see Appendix C for further details). The scores of most countries implicitly acknowledge that the decarbonisation of the economy comes at significant short- and medium-term costs to energy affordability aspirations. Whether or not this is acceptable to that country depends on that country's stage of economic development. Brazil, by virtue of its hydroelectric power infrastructure, energy efficiency programmes, and pricing regimes, is one country that has had some success in reconciling these different objectives.

Many countries are pursuing energy sustainability through ambitious and versatile programmes

The review of country policy frameworks and their implementation has revealed a wide range of successful approaches. In terms of fossil fuel-based energy security policies, China, Japan, and Russia have effective, yet different, approaches to developing resource-oriented partnerships with other countries, based on strategic alliances, technological expertise, and financial strength. US technology investments have resulted in rapid advances in opening up new domestic natural gas resources through the hydraulic fracturing of deep shale, and the ability to take advantage of that expertise overseas. The Republic of Korea and Germany have mitigated security of supply risks by increasing levels of import diversity and storage capacity, respectively.

In terms of alternative energy supply, several regimes stand out. Using different policy approaches, Germany and Texas (US) have made strong progress in the deployment of renewable energy within their transmission infrastructure. Brazil and Ghana have been particularly successful in using off-grid renewable energy to increase access to electricity for rural populations. France's carefully planned approach to renewing and enhancing its nuclear capacity is a model for an established nuclear nation, whereas the UAE has demonstrated a clear-sighted approach to building new capacity and taking advantage of external expertise.

In terms of energy efficiency and demand-side management, Japan's programmes, directed largely at industry, have achieved significant reductions in consumption, while innovative schemes in Brazil have encouraged domestic manufacturers to develop low energy consumption appliances. Denmark provides a benchmark for building design standards and France has put considerable effort into reducing energy consumption in its building stock. California (US) and Ontario (Canada) are front-runners in the development of smart grids; the Republic of Korea aims to catch up through high levels of R&D investment.

The scale and complexity of the energy sustainability challenge is increasing

The pressure on energy policymaking to support multiple agendas has increased in recent years. The definition of energy sustainability has become broader and the trade-offs between policy priorities sharper.

Developments in four interrelated areas mean the world has reached a critical juncture for energy policymaking. Energy demand is rising from non-OECD countries that are undergoing both rapid population growth and economic development. Domestic fossil fuel reserves are declining in many countries, and the remaining large-scale oil reserves are difficult to access. Strong measures are needed to mitigate the impacts of climate change. Much energy infrastructure in OECD countries needs to be renewed, while many non-OECD countries are still seeking to extend access to energy across their populations.

Both the recent economic downturn and the failure to reach a binding international consensus on reducing greenhouse gas emissions have impeded policy solutions to these issues. Although the global financial crisis caused a dip in global energy consumption and a temporary stabilisation of emissions, it also reduced the availability of investment capital and increased uncertainty about infrastructure project economics. The impasse at Copenhagen has also checked some of the momentum in the efforts to decarbonise economies.

This has placed considerable strain on the pursuit of energy sustainability

- **The issue of energy-supply security has become more of a priority in net importing countries.** Policymakers are placing greater emphasis on energy independence, supply diversity, and energy storage. Political alliances between major importers and countries with significant oil reserves have intensified, involving a wide range of strategic and economic considerations. High levels of demand from China and logistical bottlenecks at key ports are reducing the availability of coal in major supply regions.

  The exploitation of deep shale gas, the development of new pipelines in all continents, and the enhancement of LNG capabilities are raising expectations of new gas-supply opportunities. The contribution to energy independence is proving a key driver for the resurgence of interest in nuclear energy (among existing and aspirant countries), and the growing commitment to renewable energy.

- **Across OECD countries the wholesale adoption of the environmental agenda is only a patchy; beyond this group programmes in many countries remain at an early stage.** There are strong success stories in the deployment of non-hydro renewable energy, and ambitious programmes on the drawing board. Some countries that have undertaken the greatest advances in generation capacity have paid insufficient attention to transmission-grid

improvements. Elsewhere, schemes have proved expensive when incentives have failed to respond to changing market forces. Moreover, programmes that have achieved scale are beginning to cause industry dislocations within countries, as new energy investments are steered away from traditional producers.

Well-established energy efficiency programmes, targeted at energy suppliers and all types of consumers, have generated significant results. However, many schemes need to address low regulatory standards, cumbersome administration, weak enforcement, and inadequate reporting requirements if they are to achieve the required levels of traction.

- **Investment is returning to many parts of the energy sector, despite nervousness about the global economic recovery.** National economic stimulus packages continue to play an important role in some OECD countries, although newly introduced austerity measures mean that governments will be examining the affordability of energy policies more closely. This will inject additional uncertainty into industry planning. Non-OECD countries continue to look to multilateral loans and, increasingly, to joint ventures with technology-rich countries. These arrangements will help them to better exploit their natural resources, reduce energy poverty, and build capacity to meet future demand.

  Nonetheless, problems associated with existing market frameworks (such as supplier diversity and long-standing price distortions), and gaps in regulatory frameworks remain fundamental obstacles to much-needed infrastructure investments. Stronger regulatory requirements and higher insurance costs, following the Gulf of Mexico spill, are likely to influence the accessibility and economics of deep-water offshore drilling in many regions. The absence of a strong and consistent global carbon price remains a critical barrier to the development of immature technologies, and investment in transformational projects such as smart grids.

- **Changing market circumstances and country priorities have contributed to significant levels of volatility in policymaking and affected the quality of policy implementation.** Governments are proving more interventionist about the shape of the energy mix and preferred technologies, and are seeking to adjust market frameworks accordingly. Pricing is under review, given the need to reform subsidy regimes, as is the effectiveness of industrial policies in supporting long-term goals.

  Energy executives are broadly satisfied with the energy policymaking in most parts of the world (although less so in Africa and South America). The most frequently identified policy weaknesses are the absence of a consistent, long-range view, poor policy formulation, and the ineffectual nature of bodies that support policy implementation. Policies designed to encourage renewable energy generation and energy efficiency generate the highest levels of discontent.

The energy sector should undertake a number of measures to address these issues

Each chapter of this report contains "takeaways" for policymakers and the energy industry. Proposals from this *2010 Assessment of Country Energy and Climate Policies*, which cut across all policy areas, are set out below.

Key Implications for Policymakers

- **Rebalance strategic ambitions in light of energy sustainability goals,** through a transparent consideration of policy trade-offs (e.g., consumer affordability versus emissions reduction, incentives for policy preferences versus economic distortions).
- **Develop policy frameworks that are sufficiently flexible** to respond both to strategic market disruptions (e.g., emerging gas supply opportunities) and tactical developments in fast-moving areas (e.g., renewable energy installation).
- **Encourage technology transfer and partnership arrangements** by leveraging foreign expertise and financing to support the long-term success of domestic energy industries.
- **Strengthen regulatory frameworks that support the development of new infrastructure** to reduce construction lead times and ensure the reliable connection of new generation assets to transmission grids.
- **Plan for the completion of economic-crisis stimulus funding and the gradual removal of subsidies** for thermal generation, and, in due course, maturing sources of renewable energy. This will encourage on-going investment.
- **Draw lessons from the growing body of experience around the deployment of renewable energy and energy efficiency** to pre-empt potential issues in the implementation of policies and to reduce the likelihood of hesitancy about, or changes in, policy.
- **Review governance structures and decision-making processes** with a view to enhancing stakeholder engagement and securing greater acceptance for critical energy sector transformations.

Key Implications for the Energy Industry

- **Maintain or pursue diversity in the generation mix** to cope with long-term disruptive changes in resource availability, the likelihood of significant regulatory impacts, changing policy priorities, and more volatile commodity markets.
- **Leverage competitive technologies and strong balance sheets** both to respond to the on-going opening of energy markets across the globe, and to support the growth ambitions of non-OECD countries.

- **Increase energy efficiency efforts and identify areas of potential leadership** (including through participation in cross-industry alliances) to hedge against regulatory scenarios, secure cost-savings and generate revenues through ancillary businesses.

- **Explore with governments how the risks of major investments can be reduced,** resulting in lower costs for consumers.

At this critical juncture in global policymaking, when hard choices have to be made and multiple benefits secured, there is great value in international dialogue around the pursuit of sustainable energy solutions. As its policy assessment work continues, WEC will look to facilitate such interactions among policymakers and the energy industry, hoping to deepen the current extensive exchange of ideas.

A note on the WEC work programme

The 2010 assessment of country energy and climate polices involved three areas of study:

- An examination of the energy profile and broader context of WEC member countries, resulting in an Energy Sustainability Country Index;
- A review of key energy policies deployed in a sample of 30 countries across the world;
- An analysis of stakeholder views on energy policymaking, based on responses to a survey—232 responses from energy executives, and 35 responses from WEC member committees.

Introduction

World Energy Council policy assessment

This report is the second publication of the on-going assessment of energy policymaking across the globe by the World Energy Council (WEC).[2] The long-term goal is to generate insights into practices in different countries. This is intended to stimulate greater dialogue among the policymaking community and encourage more effective interaction between policymakers and the energy industry regarding the pursuit of energy sustainability. In particular, the report aims to provide guidance on innovative and successful policies and consider how they might best be replicated elsewhere.

Although countries make decisions to meet their needs in light of their particular circumstances, a strong degree of commonality exists among the challenges they face and the options for addressing them. Policymakers can learn much from each other's experiences of deploying particular instruments and building partnerships. Indeed, many opportunities exist for cooperation between countries that will support the consideration, development, and implementation of sustainable energy policies.

The first WEC policy assessment report, published in 2009 in the run-up to the climate change conference in Copenhagen, focused on three aspects of policymaking: poverty and social equity; security and economy; and climate and environment. By drawing on examples from across the globe, that report highlighted the rich diversity of practices in different countries. It also established that successful energy policymaking can be attributed to several common factors: clarity of policy vision, institutional leadership, appropriate policy design, public acceptance, and effective industry partnerships.

2010 approach

Inevitably, such a wide-ranging survey left questions unanswered, details unexamined and implications unexplored. The 2010 work programme, therefore, sought to build on last year's analysis and bring to it new perspectives. In 2010, the WEC's assessment focused on identifying the challenges that national policymakers face in the pursuit of energy sustainability, the policy options available to them, and their preferred approaches. At the heart of this investigation, as with the 2009 assessment, is the pursuit of 'energy sustainability': balancing energy security, equity in terms of access to and affordability of energy, and the mitigation of environmental impacts associated with energy supply and consumption.

Energy Sustainability Dimensions

- *Energy security.* For both net energy importers and exporters this includes the effective management of primary energy supply from domestic and external sources; the reliability of energy infrastructure; and the ability of participating energy companies to meet current and future demand. For countries that are net energy exporters, this also relates to an ability to maintain revenues from external sales markets.

- *Social equity.* This concerns the accessibility and affordability of energy supply across the population.
- *Environmental impact mitigation.* This encompasses the achievement of supply- and demand-side efficiencies and the development of energy supply from renewable and other low-carbon sources.

Economic feasibility and public acceptance are critical to the achievement of these policy goals. In other words, the pursuit of sustainability must not only make long-term commercial sense for the energy industry, but also achieve the support of consumers and other stakeholders in the energy system.

This project investigates the challenges, questions, and requirements surrounding the achievement of these goals, including:

- The effectiveness of chosen policy solutions;
- The location of high-performing policy regimes;
- The potential for achieving critical synergies between areas of policymaking;
- The requirement for trade-offs between areas of policymaking;
- The potential for replicating policy approaches between countries.

The assessment work programme comprised three elements: an examination of the energy profile and broader context of WEC member countries; a review of key energy policies deployed in a sample of 30 countries; and the collection of stakeholder views on key energy policy issues and the quality of policymaking.

The incorporation of country data into an index gave a snapshot of the relative energy performances and contextual attributes of member countries. The energy policies provided detailed information on key policy challenges, the range of responses, and the outcomes achieved. Surveys targeted at energy industry executives and WEC member committees generated perspectives on the priorities and effectiveness of policymaking in different countries around the globe.

Both the research and the formulation of the key messages in this report have benefited from the extensive involvement of energy experts around the world. The World Energy Council conducted the overall project in partnership with the global management-consulting firm Oliver Wyman; the University of Sussex, UK, provided support for the country policy reviews. Representatives from WEC member committees served on a Study Group that guided the analysis and shaped the report contents, and an Expert Advisory Group, consisting of leading academics, provided invaluable quality assurance.

Further details on the project's participants and the analyses undertaken can be found in Appendix A and Appendix B, respectively.

2010 report

Against the backdrop of historical country performance, this report concentrates on key policy developments and outcomes from the past 18 months. It illustrates progress being made through examples of programmes and strategies that have achieved significant success, some of which have been in place for a longer period of time. By choosing to look primarily at broad topical issues and case studies, the report is intended to stand alongside more purely data-driven exercises, single-issue studies, and single country analyses of similar questions.

The report has five central chapters. Chapter 1 examines the context for policymaking in 2010, highlighting critical drivers and concerns. This sets the scene for Chapters 2 and 3, which explore recent efforts to adjust the resource mix and achieve energy efficiencies. Chapters 4 and 5 examine investment issues and other cross-cutting themes fundamental for successful policy implementation. Each chapter concludes with some "takeaways"—insights for consideration by policymakers and the energy industry.

1. The context for policymaking in 2010

This chapter introduces three different starting points for our review of energy policymaking:

- The performance of WEC member countries against selected energy sector and contextual indicators;
- Drivers and other factors that underpin policymaking decisions;
- Stakeholder concerns regarding key energy sector issues and the quality of policymaking.

Comparing country situations

The Energy Sustainability Country Index is derived from country scores against 22 key indicators focused on two axes:

- The "energy performance" axis, which covers the three dimensions of energy sustainability;
- The "country context" axis, which includes three dimensions for relevance on political, societal, and economic aspects that aid the development and implementation of effective policies.

The index, therefore, ranks countries in terms of their likely ability to provide a stable, affordable, and environmentally sensitive energy system. More details on the methodology can be found in Appendix B.

Figure 1 and Figure 2 show the results of the index. It divides WEC member countries into four almost equal economic groups by GDP per capita, and identifies in bold the top five countries in each group.[3]

So as to give a clearer view of how overall country scores were reached, the charts present the results across the two main axes in the index, with error bars reflecting a sensitivity analysis conducted on the six dimensions. The different scale on the two axes reflects the selected 3:1 weighting of the index in favour of the energy performance scores, since these are most central to the overall focus of the index. Appendix C contains the full index results and each country's group.

In Group A (countries with GDP above USD33,000 per capita), most of the leading countries are based in Western or Northern Europe, with Canada and Japan also in the top ten. While the countries vary significantly in terms of resource endowment and market structure, they all exhibit effective energy security, based either on a high level of autonomy or considerable diversification by commodity or supply country. They also have well-established programmes for reducing greenhouse gas emissions. The lowest scoring countries in this group (circled on the far left) tend to be smaller countries, which either have an abundance of a single resource type (Qatar, Kuwait, and UAE) or are high-energy consumers (Hong Kong, China, and Luxembourg).

Countries in Group B (with GDP between USD14,300 and USD33,000 per capita) show greater diversity in both energy and contextual scores. Mediterranean countries take the lead, followed by a cluster from Central and Eastern Europe (circled).

Group C (countries with GDP between USD6,000 and USD14,300 per capita) shows a significant

Figure 1

Energy Sustainability Index (higher economic groups)

Source: Multiple (IEA, EIA, World Bank, WEF etc. 2007),

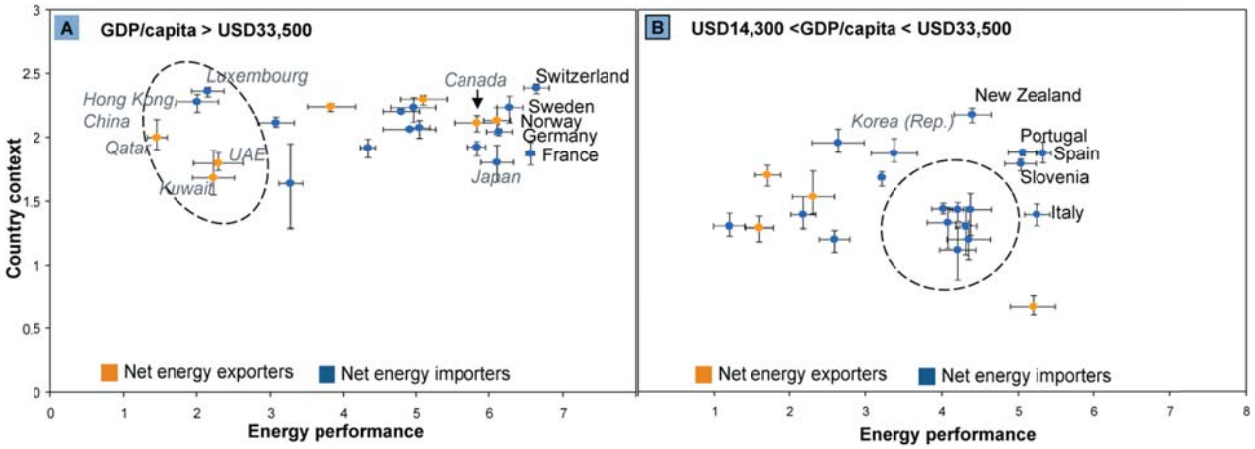
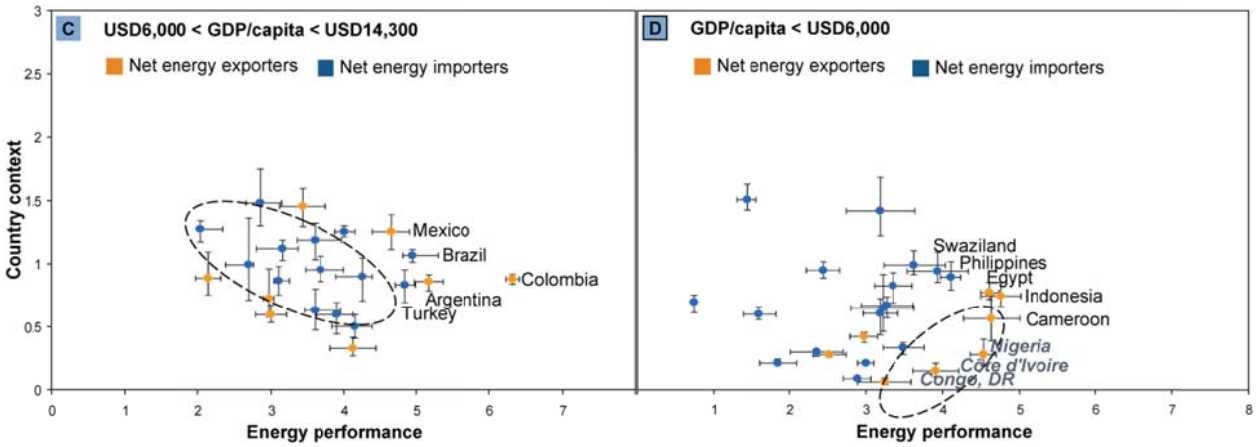


Figure 2

Energy Sustainability Index (lower economic groups)

Source: Multiple (IEA, EIA, World Bank, WEF etc. 2007)



divergence in the performance of energy-exporting countries. Some of the larger Latin American economies are in leading positions, while the net importers tend to be grouped in the middle (as circled).

In Group D, containing those countries with GDP below USD6,000 per capita, the top-ranked countries (from Africa and South East Asia) have very diverse characteristics. The group also shows a cluster of resource-rich West African countries (Nigeria, Côte d'Ivoire, and Congo—circled) with relatively strong energy performance but weak contextual scores. The leading countries in these lower economic groups owe their positions mostly to an effective utilisation of their resource endowment and long-term efforts towards achieving full access to electricity. Some of these countries also have strong environmental scores, owing partly to their ability to draw on hydroelectric power and partly to the low energy intensity of their economies.

Two examples, Switzerland and Colombia (the top-scoring countries in Groups A and C respectively), serve to illustrate different country situations. Switzerland's per capita energy consumption has decreased over the last five years, and it has a record of clean electricity generation fuelled largely by domestic resources, especially nuclear and hydroelectric power. Colombia shows some growth in energy consumption, but most of its electricity is generated by hydroelectric resources. Its production of coal and oil has primarily provided strong export revenues, while the energy and emissions intensity of its own economy compare favourably to others.

Comparing the index scores with the review of individual country policies suggests that recent developments in certain regimes will most likely yield stronger index scores in the future. For example, the Republic of Korea's recent green policy growth initiatives should in due course bolster its environmental scores, while investments by, respectively, Indonesia and UAE in new power generation infrastructure should strengthen the energy security performances of these countries, albeit in the longer term.

Acknowledging the drivers of policymaking and other influencing factors

In identifying and implementing successful programmes for enhancing their energy sectors, national governments across the globe must contend with a multitude of strategic and practical considerations. Energy is not a standalone area of policymaking: policy frameworks must not only meet the needs of domestic (and foreign) consumers, they must also align with economic, social, environmental, and national security agendas.

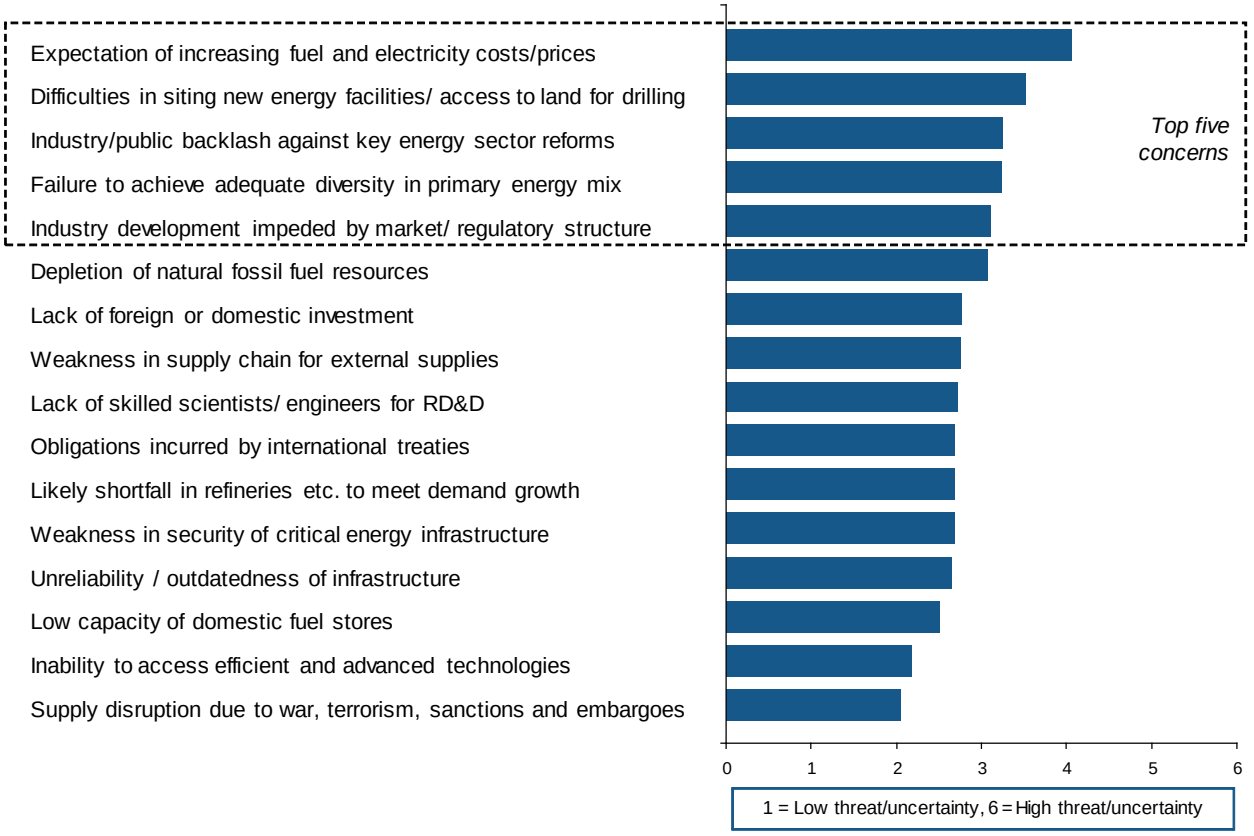
It is arguable that global energy policymaking is currently underpinned by two fundamental, yet often conflicting, drivers and their consequences. The first is the need to meet potential global growth in demand, which is particularly striking in countries undergoing rapid economic development. The second is the global need to make deep cuts in greenhouse gas emissions in order to mitigate the effects of climate change.

If economies develop along current lines, a 1.5% annual growth in consumption between now and 2030 is expected.[4] The greater part of this growth will come from non-OECD countries. This level of growth will put inordinate pressure on energy resources and infrastructure, driving both commodity and energy prices upward. In turn, this will threaten the energy security of many countries, the affordability of energy for consumers, and attempts to contain the impacts of global warming.

Global energy systems, in their entirety, account for more than 60% of greenhouse gas emissions (or 25% when considering direct energy and heat-related consumption only).[5] This places significant responsibility on countries to develop future energy pathways that minimise emissions while still meeting needs. Efforts to increase energy efficiency and exploit domestic sources of renewable energy should in many cases enhance energy security. However, the cost and complexity of transforming both energy industry and consumer behaviour present a multitude of policy challenges.

Against a backdrop of rising demand, increased price volatility, the gradual depletion of fossil fuel resources, and growing international climate change concerns, policymakers face major challenges. New energy sources must be opened up, ageing infrastructure upgraded, and new plants and networks developed. Policymakers must make significant trade-offs between energy policy objectives, contend with competing stakeholder interests, and commit large sums of money to long-range plans on which a final verdict will remain uncertain for many years to come. Meanwhile, they

Figure 3
Perceived threats to energy sustainability (World Energy Council Member Committees)



must try to ensure that energy remains affordable for consumers.

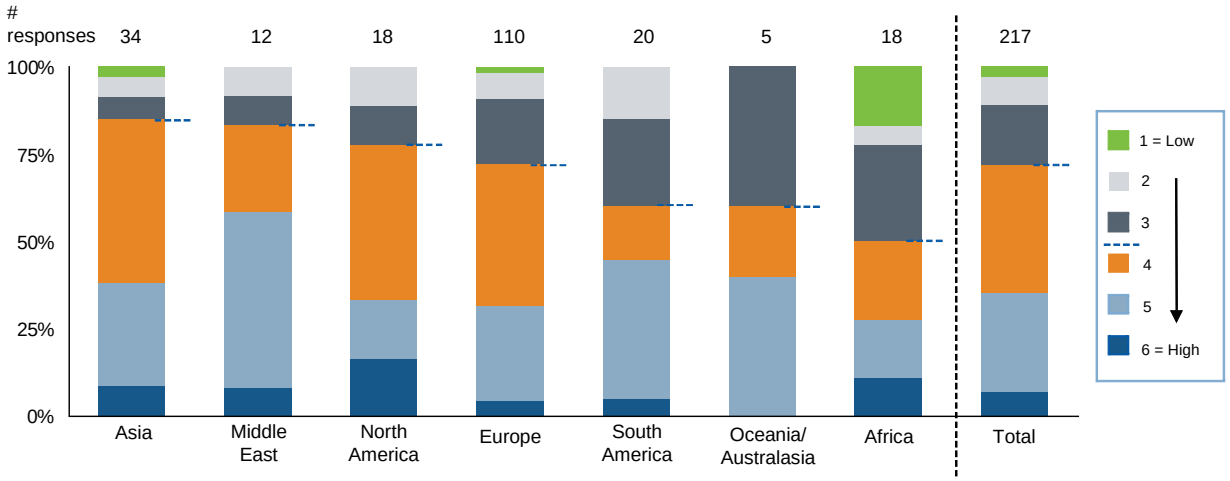
The last twelve months have presented particular adversities that will influence policymaking over the next few years. The economic downturn resulted in a 2% dip in global energy consumption, compared to 2008—although this did not fully pass through into global greenhouse gas emissions results due to industrial growth in China and India. This has temporarily depressed prices, and thus industry revenues, particularly for oil and gas companies. Moreover, the failure of international climate change talks to reach an agreement has dented some national commitments to reduce greenhouse gas emissions. Notwithstanding the stimulus funds that have been established by a number of countries, heightened uncertainty around project investment economics, and austerity measures being adopted by many countries, are making it more difficult to finance infrastructure development. As a result, the scope and nature of projects have to be re-examined, and/or start dates delayed. This will lead to sharp price rises for energy consumers in the medium term.

Recognising stakeholder concerns

The dynamics and challenges described above are well known to WEC member committees, which comprise policymakers, industry executives, and academics. The particular issues faced by each country vary: for example, high-income countries view technological developments, such as nuclear generation and carbon capture and storage (CCS), as critical issues, while the priorities of low-income countries continue to be reducing energy poverty, balancing the water requirements of the energy system and agriculture, and combating corruption.

Anticipating a more intense competition for resources and costs associated with transitioning towards a low-carbon economy, the member committees view rising energy prices as the dominant threat to energy sustainability in their countries (see Figure 3). Not only does this affect the affordability of energy for domestic consumers and the profitability of major industrial consumers, it can also influence primary energy mix choices and decisions on the structure of energy markets.

Figure 4
Satisfaction with policymaking (energy industry executives)



The next four threats in the top five concern strategic development decisions and their implementation—the construction of new facilities and adjustments to the primary energy mix. These represent common problems for the transformation of energy systems, and may be just as important as rising energy prices over the long term. An unfavourable regulatory environment, low public acceptance of policy measures, the mismatch between policy vision and industry preference, and the slow execution of planning processes are regarded as key inhibitors of successful policy implementation.

In planning for the future, many countries are competing not only for resources, but also for the participation of energy companies that can help them achieve their policy goals. To play their part, companies and financial institutions seek clear signals about energy and technology choices, appropriate policy details around which to base planning, and confidence that governments will remain committed to declared policies.

In most regions, energy executives are broadly satisfied with the quality of policymaking, with 72% overall providing above average scores, although there are significant regional variations (see Figure 4). Executives operating in non-OECD countries are in general less satisfied than those operating in OECD countries.

However, there remains significant concern about weak political leadership and poor policy formulation—either too complex or lacking detail. Other factors causing problems include short-term or changeable policy agendas and a lack of support from organisations or other entities responsible for policy implementation, especially those involved in sanctioning the siting of new infrastructure.

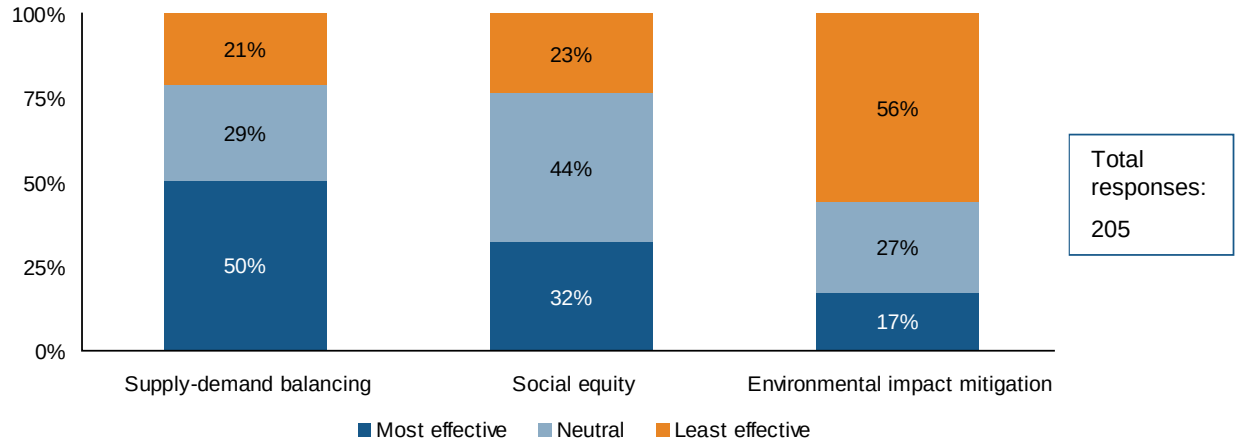
The consensus in all regions, regardless of the economic status of countries, is that these issues are most sharply felt in policies focused on renewable energy and energy efficiency (see Figure 5). The novelty of the policy area and associated market mechanisms, as well as the international nature of the agenda, are key reasons.

Conclusion

Energy policymaking in 2010 is at a critical juncture. Sustainable solutions need to be developed for multiple, interlinked problems at a time of considerable economic uncertainty. Delays in the development of major projects could result in significant price rises in due course.

In assessing what is most appropriate in terms of policy design, countries need to be mindful not only of their national resources and policy priorities, but also other factors, such as the extent to which proposed policies fit with existing market structures, and the strength of support for policy implementation from relevant organisations.

Figure 5
Perceived effectiveness of policymaking by sustainability dimension (energy industry executives)



Takeaways for Policymakers

- **International cooperation on an unprecedented scale is required to address the scale and complexity of global energy challenges** relating to security of supply, energy poverty, and climate change mitigation, if solutions are to be achieved within acceptable timescales.
- **Significant adjustments to energy supply policies and demand management are critical** to anticipate rising energy costs. These are a result of growing demand in non-OECD countries, the greater integration of international markets, and currency exchange volatility.
- **International alignment on policies tackling climate change and a more consistent approach across regions are critical** if the energy industry is to make sustainable investment decisions. This includes international agreement on a price for carbon emissions that will guide technology choices effectively.
- **Stronger decision-making processes are needed to resolve trade-offs** resulting from the increasing demands of national economic, social, environmental, and security agendas.
- **Greater efforts to address the barriers to policy implementation at national and local level will help to overcome concerns** around issues such as the siting of new infrastructure, market regulation, and the provision of (dis)incentives.

2. Ensuring supply

Countries' decisions on energy sourcing and the future energy mix are guided by many factors. These include the rising cost of imported energy commodities, their own resource endowment, security of supplies from abroad, commitments to reduce greenhouse gas emissions, and the availability of new technologies. The weighting between these factors varies from country to country, and decision-making inevitably takes into account the quality of the existing infrastructure and the interests and capabilities of existing energy sector stakeholders.

Although oil and coal continue to be important in the global energy mix, this chapter focuses other energy sources, taking up three key resource stories of recent years: the efforts to increase the uptake of renewable energy; a resurgence of interest in nuclear power; and the new dash for gas.

As Figure 6 shows, the last two decades have witnessed little change in the overall global energy mix. However, over a shorter period, we have seen (non-hydro) renewable energy has begun to take

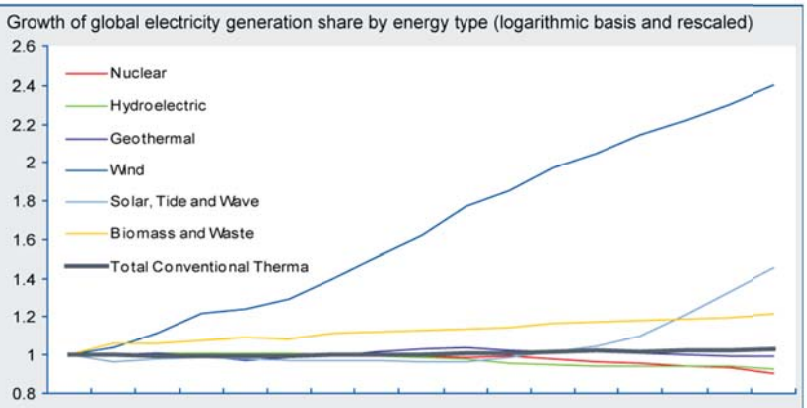
Figure 6

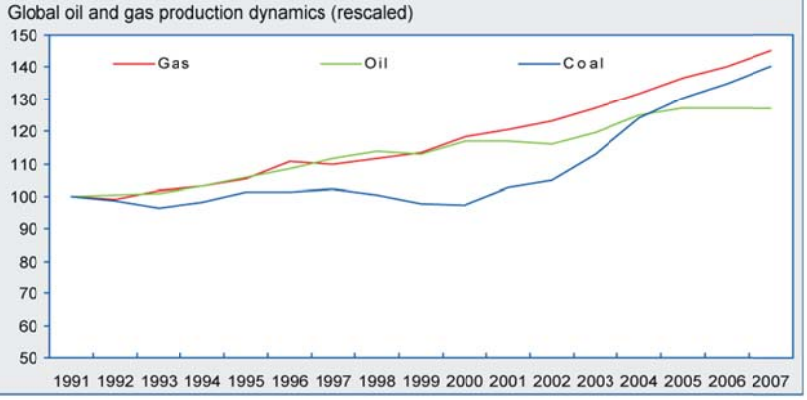
Perceived effectiveness of policymaking by sustainability dimension (energy industry executives)

Source: U.S. Energy Information Administration

Electricity Generation	1991	2007
Total Conventional Thermal	62.76%	67.84%
Hydroelectric	18.93%	15.97%
Nuclear	17.31%	13.81%
Biomass and Waste	0.81%	1.32%
Wind	0.03%	0.88%
Geothermal	0.31%	0.31%
Solar, Tide and Wave	0.01%	0.03%

Energy Production	1991	2007
Gross natural gas production (billion cubic feet)	91,628	132,934
Total oil supply (thousand barrels per day)	66,399	84,394
Total primary coal production* (short tonnes)	5,019,694	7,046,862





* Data adjusted in 1992/1993 due to incompleteness in source

Table 2
Schemes to support the deployment of renewable energy

Policy category	Description / benefit	Schemes and mechanisms	Example countries
Quota-based	Guaranteed amount / share of generation to be renewable	Renewable portfolio standards / Renewable Energy certificates	US, Sweden, Japan, UK, Australia France, Brazil, China
Price-setting	Mandated prices for renewable energy	Feed-in tariffs	Germany, Ontario (Canada), Algeria, Brazil, South Africa, Philippines
Financial incentive	Cost reduction	Tax credits Subsidies / grants Clean development mechanism	UK, US, France Finland, Poland Ghana, Mexico, China
Public investment / market facilitation	Equity or debt support	Direct investments Loans Guarantees	UAE, Norway Poland, Saudi Arabia Germany, Mexico

off in a number of countries; gas has become proportionately more attractive than oil; and there has been strong growth in coal production, largely attributable to demand from China. Although the deployment of nuclear energy shows a decline over the past decade, the level of current policy interest indicates that by 2020 the graph may be heading in a different direction, on the basis of an expected 30% increase in capacity.

The following sections look at how these energy resources are being encouraged, through strong or innovative programmes, some well-established and widely known, others more recent developments.

Increasing the uptake of renewable energy

Countries such as Norway, Brazil, and Iceland have for a long time used their hydro, biomass, and geothermal assets to help meet their energy needs. However, over the past few years, many other countries have tried hard to increase the percentage of renewable energy in the primary energy mix, largely for the generation of electricity.

Decisions by regional groups (such as the European Union) and individual countries have been based on performance in this area to date, the nature of their renewable asset base, and the maturity of associated renewable technologies. In the wake of the 2009 UN conference in Copenhagen, at least 40 countries pledged specific emission reduction targets, reconfirming the importance of developing renewable sources of energy.[6]

Four basic options are available to policymakers for stimulating the deployment of renewable energy (see Table 2). Separate measures, such as tax-based incentives or direct investment, are important for encouraging technologies that are further from widespread deployment, to support early-stage research and development (R&D) and to deliver investor-ready propositions.

For relatively mature technologies, policymakers must decide whether their primary approach is quota-based or price-based. For example, renewable portfolio standards (RPS) and auction-based schemes seek to create price competition among energy generators so as to meet defined renewable targets at least cost. In contrast, the feed-in tariff (FIT) model offers a long-term and fixed payment to renewable energy generators to offset the cost disadvantages, with utilities usually passing additional costs to customers.

RPS schemes have achieved strong growth in renewable energy volumes in certain regimes, often supported by additional financial incentives

such as tax credits. The system favours the least-cost option (usually wind in large electricity grids) and major utilities, over smaller renewable energy developers. There are, however, several drawbacks. The short-term nature of the renewable energy certificates market creates some instability and obliges investors to seek higher returns and a shorter payback period for the additional risks assumed. Moreover, where sufficient penalties have not been imposed for failure to meet targets, the momentum for increasing the generation capacity of renewable energy has sometimes not been maintained.

By fixing payments, well-designed and stable FIT schemes lower the perceived risks and cost of capital to investors, and enable cash flows to be forecast. Since profitability depends on being able to control costs, the system creates market competition between technology manufacturers rather than renewable-energy generators. Through the application of different premiums for different renewable energy sources, FIT schemes are able either to achieve diversity in the renewable mix or to privilege certain technologies or sizes of generation asset. However, assigning an efficient price is not easy and guaranteed payments can impose a significant burden on governments and consumers, and encourage over-investment and unsustainable development.

Texas (US) and Germany represent good examples of the effective introduction of renewable energy through RPS and FIT schemes, respectively.

Texas – Renewable Energy Mandate

Renewable energy was already on Texas' energy agenda during the electricity market restructuring in 1999. The Public Utility Commission of Texas established regulations for Texas' Renewable Energy Mandate, creating a renewable portfolio standard (RPS) and a renewable energy credit-trading programme. The initial 1999 target was to increase the collective electricity output from competitive retailers, municipal electric utilities, and electric cooperatives from 880 MW to 2,000 MW by 2009.[7] In 2005, however, the targets were adjusted to 5,800 MW by 2015, and 10,000 MW by 2025, of which 500 MW was to be derived from non-wind sources. The renewable energy target for each electricity provider was determined by the percentage of its market share in proportion to the overall RPS target.

The cumulative impact of both measures helped Texas to exceed its 2015 target in less than seven years. This rapid growth can be ascribed to a favourable policy environment, competitive pricing, abundant wind resources, and a USD1 billion investment from Texas wind firms and utilities.[8] Electricity consumers have also benefited from the increased percentage of renewable energy in the overall electricity mix, because it has reduced the need for natural gas- and coal-fuelled electricity-generating plants during peak hours. Since the cost of wind power is decreasing, economies of scale and abundant wind resources are

creating a more financially and environmentally sustainable means of electricity generation. There are some problems: the state will need to work out how to make use of the currently undispatchable supply-spikes that develop in times of high wind. There is also some unreliability in the system, stemming from intermittency and the now significant percentage of wind in the primary energy mix.

Germany – Renewable Energy Source Act

Germany's Renewable Energy Source Act (2000) provided producers of green electricity with a guaranteed rate for 15-30 years, depending on the technology. Importantly, the Act also gave electricity generated from renewable energy priority access to the grid for transmission and distribution. It obliges grid operators to purchase the electricity, with the cost difference being passed on to customers in the form of a surcharge.[9] The initial goal of the Act was to increase the percentage of renewable supply to 12.5% by 2010 and 20% by 2020.[10] Since 2000, the share of renewable energy in gross electricity generation has more than doubled, from 6.4% in 2000 to 16.1% in 2009. The government's new long-term ambition is to achieve a 30% share by 2020.[11] Key to the success has been the stimulation of a mass market that includes diverse, small-scale installations (including private homes), rather than simply relying on large wind and solar farms. The effort has delivered significant economic benefits. Domestic turnover from these installations amounted to EUR33 billion (USD46 billion) in 2009 and the renewable energy industry now employs over 300,000 people.[12] These benefits, however, come at a price: in 2009 German electricity consumers paid €10 billion (USD14 billion) through the surcharge created by the Act, of which €5.9 billion (USD8.2 billion) is considered to be an additional cost for consumers.[13]

Not all programmes have worked as well as those in Texas and Germany. Some quota-based schemes (in the United Kingdom, the Netherlands, and New Zealand) have resulted in under-performance due to under-investment and an over-concentration on certain resources. A cautionary tale of a FIT scheme comes from Spain, where generous subsidies (which were not passed on to the consumer), the absence of a cap on capacity, and weak control of infrastructure quality resulted in an unsustainable boom. This was followed by a rapid decline in the price of solar modules, due to overcapacity in the market, when the FIT was reduced. In 2008, the country installed 2.6 GW of solar power, more than the entire global installation of solar in 2007.[14] The government has since scaled back on subsidies and capped the amount of subsidised solar power that can be installed. However, due to its initial generosity, Spain faces significant costs into the future and its solar industry has already lost 15,000 jobs.[15]

FIT schemes are currently proving to be more popular than RPS, with nearly 40 countries worldwide already having chosen this approach and others in the process of doing so.[16] Indonesia, for example, is currently in the process of establishing an appropriate price in order to attract

the investment that will enable it to meet its aspiration of generating 6,000 MW of power from geothermal sources over the next ten years.

However, whether countries choose RPS or FIT schemes, they must closely monitor overall renewable capacity expectations and the declining cost of installation. Earlier this year, Germany lowered its FITs for new installations, particularly solar, in line with broader market economics, and introduced a discount rate that increases with the quantity of PV installed. California (US) has set a 750 MW ceiling for its RPS obligations for utilities. While this cap presents risks to renewable energy developers, it indicates the state's desire to address the conflict between economics and the development of clean energy. The state's goals can be revised upward if they are easily met, but the cap can to some extent limit the financial burden on society. This is an important factor in the context of California's current financial difficulties.

Recent policy developments in the support for renewable energy reveal two key features: the deployment of hybrid quota and price-based approaches, and the need for constant policy reinforcement to maintain momentum.

An increasing number of RPS regions are starting to implement FIT schemes for small-sized projects. California initiated a FIT programme to support its RPS in 2009. The UK has recently followed other US states and Australia by launching a FIT programme for projects that generate less than 5 MW of energy.[17] The Netherlands is also considering feed-in premiums for particular technologies to support an RPS approach on the grounds that this will align better with national industrial policies. Concerns can arise when the FIT rate is benchmarked to the market price of electricity (as in Algeria and California), which means that on occasion the market price plus the FIT may still be below the cost of renewable energy generation.

In terms of reinforcement, many countries are strengthening the integration of renewable generation assets with the transmission grid, especially with respect to setting standards for the interconnection of distributed facilities, ensuring priority access to the grid, and handling intermittency in the electricity supply. China, for example, is continually updating its policies to address emerging vulnerabilities in the sector.

China – Renewable Energy Law

While renewable energy may form a small percentage of China's energy mix, progress over the past few years has been impressive. The Renewable Energy Law of 2006 was China's first macro-level renewable energy framework and superseded all existing renewable energy-related policies. The framework covered medium- and long-term targets, and established renewable energy as a preferred means for developing the energy, industrial, and high-tech sectors. This framework and a linked national strategy became the basis for more specific policies covering different energy sources (e.g., hydro, solar), financial measures, and regulatory issues (e.g., tariffs, grid usage, and planning).

In response to identified weaknesses, the law was revised in December 2009 to re-emphasize mandatory grid-connection obligations and to establish enforcement measures to ensure utilities purchased a mandatory market share of electricity from renewable energy. Utilities can apply to a new Renewable Energy Fund to cover the extra cost of integrating renewable energy. Earlier competitive bidding approaches that resulted in low tariffs and low profitability in the wind sector have been replaced by FITs, with similar measures for solar under consideration. To ensure the additional costs of electricity from renewable energy are met and that the development of renewable energy is adequately financed, a premium is added to the cost of each kWh sold. This has risen fourfold since 2006 to keep up with growth in the sector.[18]

Renewable energy and rural electrification

Rural electrification programmes across non-OECD countries illustrate how renewable energy can play an important role in supplying communities whose distance from the grid means that they are often marginalised by conventional electrification programmes. Small-scale, distributed generating systems based on low-cost technology, relying on local and renewable sources (small hydro, solar, wind, or biomass), can often provide sustainable solutions, depending on the characteristics of local conditions.

Brazil – "Lights for All" Programme

Brazil's "Lights for All" programme was launched in 2003. It grew out of earlier "Lights for the Countryside" and PRODEEM programmes, in which communal facilities were provided with electricity-generating systems using renewable energy. Coordinated by the Ministry of Mining and Energy, and executed by the national utility through its subsidiaries with the participation of regional committees, the programme had provided power to 11 million people by early 2010.[19]

The estimated total investment has been USD12 billion, with 70% covered by the federal government, and the remaining share divided between local governments, licensed industry players, and electricity cooperatives. However, where initial electrification rates were very low, up to 90% of the supply company's total investment could be subsidised through national funds. The government funding came from two sources: the concession fees and fines paid by energy supply companies, and a tariff paid by all electricity consumers. Challenges experienced in the early stages of the programme included the financing of energy distributors, difficulties in employing local contractors, as well as delays in the delivery of necessary material. These increased the costs of the programme, and may increase the energy costs to end-consumers. It is expected that the programme will create 300,000 jobs overall.[20]

China's Township Electrification Programme, initiated in 2001 and now succeeded by the Village Electrification Programme, also shows how renewable energy can be used in rural areas to achieve both social equity and environmental impact mitigation objectives, as well as to support economic development. The programme is an extension of the Brightness Programme, which, between 1998 and 2004, provided electricity for 1.78 million households, 2,000 village systems and 200 station systems. It did this by creating local grids, since this was a cheaper and more practical solution than using individual diesel generators or connecting rural users to the grid.[21] The Township Electrification Programme provided over 1,000 towns with electricity in 20 months through the installation of 20 MW of solar photovoltaics (PVs) and 263 MW of small-scale hydro power. The cost amounted to CNY4.7 billion (USD0.56 billion), over half of which was funded by government bonds.[22] The implementation of this programme kick-started China's solar PV industry, with the production of PV modules increasing tenfold over the duration of the programme.

Interesting models exist in Africa too. Financed largely by multilateral donors and a domestic National Electrification Fund, Ghana makes investments in solar PV off-grid infrastructure for remote communities, in addition to grid extensions. The programme has helped raise electrification rates in Ghana to 54%, significantly above the Sub-Saharan African average of 28%.[23] South Africa has also created an innovative poverty tariff that provides 50 W solar home systems for those not within reach of the grid. The tariff also provides an allowance of ZAR48 (USD6.4) per month for operation and maintenance, enabling the poorest households to have basic lighting and media access.[24] Such approaches need to be supported by capacity-building measures to ensure the reliability and longevity of off-grid infrastructure.

Finally, the right regulatory context can open up opportunities for the commercial sector. Mobile telephone operators have begun to use renewable energy to power off-grid base stations (equipment that provides cellular network coverage) in remote areas of Africa and Asia. It is estimated that between 2008 and 2012 the number of renewable-powered base stations in developing countries will have risen from 1,500 to over 118,000.[25] Operators are looking to see how these facilities can help to anchor larger investments by third parties in village energy systems—investments that will power both the base station and local homes and businesses.

A resurgence of interest in nuclear

Notwithstanding concerns about the proliferation of nuclear technology and the safe disposition of nuclear waste, nuclear power is under consideration by an increasing number of countries. Three key reasons are driving the increasing acceptability of this policy agenda:

- In many countries, nuclear power is the only readily available large-scale, base-load alternative to fossil fuels that can meet base-load demand.
- Nuclear power is relatively insensitive to commodity price movements and potential supply-chain disruptions.

- Nuclear power plants are near-zero emitters of greenhouse gases.

Over 30 countries are currently planning or delivering nuclear energy programmes. Across the world, 52 reactors are under construction, with a further 140 on order or planned, and an additional 344 at the proposal stage.[26] Assuming some shortfall in delivery (due to long development time, high costs, and safe waste disposition requirements), the current world capacity of 367 GW is expected to rise to between 600 and 1,340 GW by 2030.[27]

Much of this development will take place in countries with an existing nuclear infrastructure approaching the end of its lifespan, who are also often looking to reduce coal in the energy mix. While Germany is of two minds about its nuclear future, other countries (such as the US, Italy, Finland, and Sweden) whose nuclear-power programmes have been dormant for some time due to cost and safety fears, have decided to delay the phase-out of their plants and expand their nuclear capacity. Countries with the strongest growth plans include the BRIC countries, South Africa, Japan, Ukraine, the Czech Republic, and the US. New entrants are closely examining the potential of nuclear to help satisfy growing energy demand. These countries include Indonesia, Iran, Kazakhstan, Vietnam, the Gulf States, Nigeria, Poland, and Italy.

In 2009, China's completed investment in nuclear power infrastructure was 75% higher than in 2008—nuclear-power construction on the largest scale in the world.[28] At the beginning of this year, China adjusted its medium- and long-term development plans for nuclear power, targeting the achievement of 70 GW installed capacity by 2020 with a further 30 GW under construction at that time.[29] The proportion of the installed capacity of nuclear power will therefore rise from the current 2% to approximately 5% in the total installed capacity of electric power across the country, largely funded by the two state-run nuclear power companies.

Country strategies depend on particular circumstances. Those with existing nuclear capacity are looking at three options (or combinations thereof): i) extending the life of existing infrastructure; ii) increasing the capacity of existing infrastructure; and iii) building new facilities. In doing so, they are balancing numerous issues such as safety, supply continuity, development cost, timescales, and technology efficiency. Some new entrants are using their experience with research reactors as preparation for the development of power plants.

France – Nuclear Energy Programme

Over 75% of France's electricity needs are supplied from nuclear energy as a result of energy-security decisions made in 1969, which were enhanced following the oil shocks of 1974. The country is able to export ~12% of production to neighbouring countries, making electricity the country's fourth largest export. This policy has given France a substantial level of energy independence, among the lowest-cost electricity in Europe, and a very low level of CO_2 emissions per capita from electricity generation. Another 12% comes from hydro.[30]

Plans for the next stage of development began in 2003, with a national debate on energy policy. This was followed through in 2005 with a law establishing guidelines for energy policy and security-- ensuring a standardised approach to technology as a conscious industrial policy decision. The policy recognised the importance of nuclear power and included the decision to build an initial unit of the European Pressurised Water Reactor as a first step towards deciding by 2015 whether to construct a series of approximately 40. The policy also set out a research policy for developing innovative energy technologies consistent with reducing CO_2 emissions. In 2008, a top-level Council on Nuclear Energy was established, chaired by the President. Development priorities are underpinned by planning and long-term investment programmes.[31]

The extension of nuclear power to new countries is underpinned by international cooperation. This helps to drive down costs, albeit with the loss of operating profits, along with possibly other strategic concessions. Companies from nations with substantial nuclear expertise (such as France, the US, Russia, Japan, the Republic of Korea, and Canada) are currently working with nuclear aspirants. Canada is supporting China, India, and Jordan, while France has signed agreements with North African countries (Algeria, Egypt, Libya, and Tunisia) to provide practical assistance as they take their nuclear programmes forward. These countries are also being helped by the International Atomic Energy Agency, along with countries such as Ghana, Morocco, and Nigeria.

UAE – Nuclear Energy Programme

The UAE's estimate of energy-demand growth signified a need to expand its power generation and transmission capacity by 150% to 40 GW by 2020. An analysis of resources revealed that nuclear was the most commercially competitive option given the value of oil as an export and the desire to contain the growth of carbon emissions from domestic consumption. Known volumes of natural gas were found to be insufficient to meet future demand, while solar and wind would only be able to supply 6-7%. In late 2009, the Emirates Nuclear Energy Corporation, which runs the nuclear programme (led by Abu Dhabi), awarded a consortium from the Republic of Korea a USD20.4 billion contract for designing and constructing four 1,400 MW units, as well as assisting their operation. Under the agreement, Korean investors will have an equity interest in the project. The UAE hopes the first of its nuclear units will begin producing electricity for its grid in 2017, with the other three being completed in 2020.[32]

Some countries' ambitions go beyond meeting their own demand. Jordan, which currently imports over 90% of its energy needs, intends to shift from being a net energy importer to being a net energy exporter, by exploiting its natural uranium resources and developing nuclear facilities. The

country's Committee for Nuclear Strategy, set up in 2007, is tasked with setting out the programme needed for Jordan to bring its first nuclear plant on line by 2015 and obtain ~30% of its energy needs from nuclear sources by 2030. The country also intends to use nuclear energy for desalination and, in due course, to sell electricity to neighbouring countries.[33]

The new dash for gas

Natural gas has been the third major resource story over the past few years. This has been driven by improved project economics due to: the rise in gas prices over the past decade (yet showing good value compared with oil); its thermal efficiency in combined cycle gas turbine power plants; and its lower CO_2 emissions compared with coal and oil. Many countries now view gas as an important bridge between their current fossil fuel-dominated energy mix and an increased use of renewable energy. This section surveys policymaking that focuses on the exploitation of national reserves, the diversification of gas imports, and enhancements to storage.

A key goal of countries with limited gas reserves is to maximise available resources through careful policy design, as evidenced in the UK and the Netherlands. Slow progress on the renewable energy agenda and the need to decommission all but one of its 19 nuclear reactors in the next decade has increased the importance of offshore oil and gas reserves to the UK. Reforms to the North Sea Fiscal Regime (2009) have therefore focused on encouraging the development of the potential of the UK's continental shelf, and investment in small or technically challenging oil and gas fields.[34]

Netherlands – Small Fields Policy

The Netherlands, where gas represents 40% of primary energy demand and contributes 60% of the electricity output, has a long-standing policy for developing gas reserves. The "small fields" policy (in place since 1973) targets the premature depletion of its biggest gas field in Groningen by making smaller fields economically viable. It involves limiting the Groningen output, limiting national gas sales through gas pricing, and imposing reductions in gas use in the power sector. The policy has supported large increases in the output of small fields and encouraged the development of offshore gas, while maintaining the life of the Groningen field. In 2009, 36% of all produced gas originated from fields other than Groningen. However, given the rapid decline in small field production, the government will eventually have to either start drawing more on the Groningen field or adjust its policy to make the development of new small fields more economic. This would inevitably affect prices for consumers.[35]

While Northern European countries strive to maintain the lifespan of their declining fields, and countries such as Saudi Arabia and Mexico struggle to find and develop reserves that will enable them to keep up with rapid growth in domestic demand, the sudden availability of shale gas in regions with high import requirements

presents new options. Indeed, it can be argued that the policy interest in shale gas is not about encouraging its exploration and production (notwithstanding the need to contain methane release and ensure the proper disposal of drilling fluids). Rather, it lies in the implications of the potentially huge reserves for global gas supply systems and the positioning of gas as a fuel of choice.

Investments in technology innovation by US companies when gas prices were at historically high levels has led to the reserves of economically recoverable gas in the US rising by 14 trillion cubic metres (or a third) in the past two years, with some estimates being double that.[36] Supported by US companies, exploration is now under way in Europe (especially Germany, Hungary, and Poland) and China. Technological advances, along with the benefits of experience, are already driving down costs, providing a cushion for profitability in the event of a gas price dip.

The potentially "game-changing" nature of shale gas (there are still significant uncertainties regarding the extent of recoverable resources) raises two key issues for policymakers. One relates to the economics of renewable energy development. This would appear more expensive to subsidise if gas can present itself as an immediate large-scale substitute for coal in electricity generation, particularly given the ability of many coal-fired plants to switch to gas. The other relates to import expectations. The presence of viable shale gas in North America, Europe, and China would significantly reduce dependencies on the Middle East, Russia, and Africa for supplies, either in piped or liquefied forms. It would provide greater competition for the recently developed Gas Exporting Countries Forum instigated by Russia, Iran, and Qatar, which involves eleven countries in total.

Irrespective of the shale gas opportunity, many countries have taken measures over the past few years to strengthen their gas supply chains from abroad, through new pipelines, the construction of liquefied natural gas (LNG) terminals for ships, and enhanced storage facilities.

To reduce the risk of repeated disruptions to supply due to Russia's disputes with Ukraine and Belarus, Europe has made significant efforts to develop alternative supply routes. Germany's active sponsorship of the Nord Stream pipeline between Russia and Europe, both politically and through the provision of project finance from its banks, has ensured that the country (which imports 86% of its natural gas needs), will be a new hub for Russian supplies.[37] The EUR8.8 billion (USD12.3 billion) pipeline, on which construction work has recently begun, will carry 55 bcm of gas to Europe under the Baltic Sea starting in 2012. This will allow Russia to increase its share in European gas markets from 25% to ~33% under current estimates.[38]

Other European countries, including the European Commission, remain cautious about the future dependency of Europe on Russia. This is at least partly due to concerns about Russia's long-term investment in ageing gas fields and associated infrastructure. The planned Nabucco pipeline, which competes with Russia's South Stream

proposals, would allow imports from the Caspian region into European gas markets through Turkey and Central and Eastern Europe. A final investment decision is expected on this project by the end of 2010. Similarly, the Central Asia-China gas pipeline (inaugurated December 2009) will help reduce China's dependency on Russian gas by providing direct access to Turkmenistan.

South Africa's effort to diversify its energy supply away from an almost complete reliance on coal includes using more gas in its energy mix. The Natural Gas Project is an agreement between South Africa and Mozambique, stemming from a 2001 decision to build a gas pipeline from two gas fields in Mozambique to deliver gas to South Africa. In 2006, South Africa imported 33% of its total consumption, up from 8% in 2004. Gas as a percentage of total primary energy supply increased from 1.6% to 3% from 2004 to 2005, but fell back to 1.6% in 2006, despite higher consumption in absolute terms (with the overall increase being fed by coal).[39] In January 2008, an agreement was reached to upgrade the Mozambique pipeline to deliver twice the capacity of gas, with financing secured in March 2010. Another agreement has been made with Namibia, and further deals may be sought with other countries.

Countries, such as Japan and the Republic of Korea, which do not have easy access to pipelines, are also seeking a diversity in supplying countries as part of their approach to maintaining energy security.

Japan – Financial Support and Resource Diplomacy

Japan is the largest importer of LNG in the world, consuming approximately 40% of global exports. The highest levels of imports come from Indonesia, Australia, and Malaysia, but LNG is also sourced from the Middle East, Africa, and the US.[40] Japan's approach to improving its energy security combines two approaches. The first is government support (in the form of equity financing and liability guarantees) to private companies engaged in overseas exploration and production activities. These are often in partnership with other countries. Regarding gas, this support is centred on Indonesia, Russia, and Australia. The second approach is the political negotiation of bilateral and multilateral ties with the Middle East and various Asian and Australasian countries centred on economic assistance, technology transfer, and geological surveys. While this has led to fruitful partnerships (e.g., with Russia), in times of high commodity prices exporting countries depend less on Japanese funding.

Similarly, the Republic of Korea has entered into cooperative agreements with Russia: for example, the Action Plan on Economic and Trade Cooperation with Russia, 2005, and the Intergovernmental Agreement for the Gas Industry, 2007. Through these, it has pursued joint projects, such as the Sakhalin gas project and the East Siberia Pacific Ocean oil pipeline. This focus on Russia is balanced by more recent attempts to

establish energy-related cooperative relations with other Northeast Asian countries. Although this diversity will reduce the Republic of Korea's reliance on very few countries, it does mean that the national gas supplier now faces greater price volatility because it has fewer incentives to seek long-term contracts and depends more on the spot market.

In terms of gas storage, Germany and the Netherlands have different approaches. Germany has a gas storage capacity of 80 days of average demand, with 46 underground storage facilities able to hold 20 bcm forming the fourth-largest storage capacity in the world. These storage facilities are operated by major gas companies and smaller regional utilities. There are plans for an additional 15 projects for new facilities with a storage capacity of 3 bcm of working gas. The energy industry in Germany is an important investor in storage capacity, providing EUR130 million (USD178 million) in 2007.[41]

Despite the availability of domestic gas supplies and existing pipeline imports, the Netherlands has chosen to diversify into LNG. The country aspires to become the North-West European gas hub, and is promoting the construction of LNG re-gasification terminals. Currently, four projects are planned, with Gas Access to Europe being the most advanced. Construction on this project started in 2008 and is expected to be completed in 2011. Investors have been granted a 20-year exemption from the Gas Act for 16 bcm per year.[42] Investment in LNG terminals has also strengthened Spain's diversity of supply and provided another entry point for supplies to Europe.

Indonesia's increased usage of LNG is less a matter of choice. The country's strategy to achieve a significant increase in its use of natural gas has faced a range of challenges, such as inadequate gas pipeline infrastructures and declining supplies from existing gas fields. Indecisiveness regarding the allocation of newly developed gas fields for export or domestic markets has led to an increased reliance on (more costly) LNG and the need to develop floating LNG-receiving terminals for its major gas power plants.

Not all countries regard storage as a critical need. New Zealand has no import or export capability for natural gas, or storage facilities. Although it relies on domestic sources that are expected to be depleted within the next ten years, its policy is to incentivise the search for new offshore discoveries that will forestall any crisis. Finland, by contrast, depends on one Russian company for its entire wholesale gas supply. Despite having no storage facilities, it is comfortable with this situation, given the reliability of supplies since the 1970s.[43]

Conclusion

Coal and oil are critical resources for many countries and will clearly remain so for many years to come (particularly if CCS proves commercially viable). However, recent drives towards renewable energy, nuclear, and gas have the potential to alter the shape of energy mix and associated dependencies in many countries. Problems of scalability on the one hand, and development time on the other, mean that, for most countries, neither renewable energy nor nuclear power offer solutions in the short term. Renewed commitments to gas

may also mean that both these sources appear uneconomic, depending on how gas prices develop. Nonetheless, the value of a diverse energy mix, in addition to achieving security and environmental objectives, suggests that all three can be taken forward together.

Takeaways for Policymakers

- **Frameworks for deploying renewable energy should be reviewed regularly** in light of experience across the globe to ensure investment momentum is maintained, implementation fully achieved, and programmes are responsive to changing market conditions:
  - Support for R&D should ensure that strong projects can develop to a level so that they can attract sufficient levels of private sector investment.
  - RPS schemes should be prepared to raise the cap on renewable energy take- up in order to encourage continued investment.
  - FIT schemes should set an economic limit on installed capacity and expect to revise the tariff downwards at periodic intervals to avoid windfall profits for developers and additional costs to consumers.
  - Strong regulations, standards, and enforcement measures must be in place to support grid connectivity of renewable energy, including priority access, and promote the development of energy storage.
- **The development of businesses based on locally relevant technologies should be encouraged** since those countries that have prioritised the development of a domestic renewable energy industry have tended to show the strongest results in terms of installed capacity.
- **More effective regulatory frameworks are needed to facilitate investment by third parties in decentralised rural electrification systems** in non-OECD countries, especially sub-Saharan Africa and the Middle East.
- **Stable policies based on the floor price of carbon, clear siting procedures, and the availability of financial support will make it easier to deliver nuclear power programmes,** where uncertainties result from high up-front costs, stiff technical requirements, and lengthy development times.
- **Long-term resource strategies should take account of major developments in global gas supply systems.** These include shale gas exploitation, the development of new pipelines, and the depletion of key gas fields.
- **Diversifying the sources of gas supply (countries and supply routes) and the**

development of new storage facilities will help mitigate growing threats to security based on supply-chain disruption and peaking demand.

Takeaways for the Energy Industry

- **Diversity in the generation mix will help mitigate the impacts of changing market conditions** resulting from disruptions to resource availability, volatile commodity prices, changing policy priorities, and stronger regulatory impacts.
- **Increasing competition for renewable energy development is prompting new markets and cost-savings for infrastructure**, as technological advances and industrial production moves from Europe to the US and North East Asia.
- **The new nuclear agenda is creating significant business opportunities** in a widening range of markets for companies that possess expertise in nuclear technology and plant operation.
- **Investors in energy import infrastructure will see increasing opportunities** from continuing country adjustments to their primary energy mix, such as the increased interest in gas.

3. Managing demand – securing efficiencies

Countries are not only adjusting their generation mix and sources of energy supply, they are also strengthening their ability to meet future needs through the pursuit of energy efficiency. While this is technically the least-expensive method for doing so, the costs are still significant and there are significant barriers to widespread implementation. More and more countries now have strategies and policies in this area, the most fully developed of which have the following components:

- An assessment of current consumption patterns (possibly in comparison with other countries). This acts as a baseline for considering future performance and a means of prioritising sectors of the economy.
- Appropriate programmes and targets for each sector, including households, public sector, high-energy consuming industries, low-energy consuming enterprises. This is based on a cost-benefit analysis.
- Ambitious targets (including by sector) for energy efficiencies, which are supported by mechanisms for monitoring and reporting on progress.

Most initiatives are targeted at industry, even if the actual efficiencies are to be achieved by domestic consumers. Fewer initiatives are directly aimed at households since it is more cumbersome to persuade fragmented consumers to change their behaviour than it is to mandate business and industry through regulations and incentives.

This chapter focuses on some of the main policy approaches across the globe. Initiatives targeting households tend to be educational, tax-based, or incentive-based, whereas industry schemes focus on regulatory or voluntary standards for building design and manufacturing, and tax- or market-based measures aimed at energy consumption. A particular spotlight on obligations is placed on the energy sector.

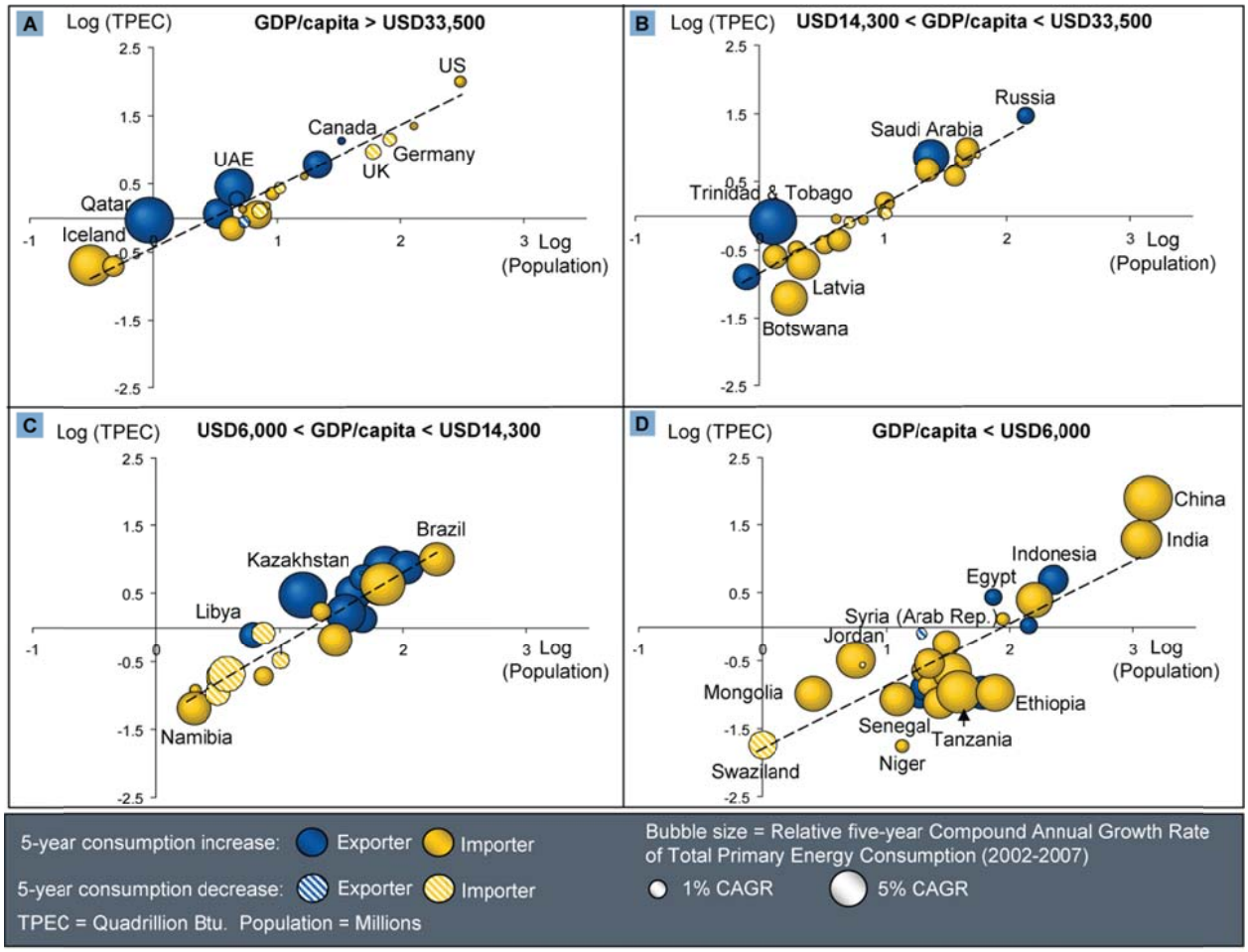
Comparing energy consumption

Figure 7 presents the Total Primary Energy Consumption (TPEC – quadrillion Btu) against the population (millions) for four economic groups of countries. The results are shown in logarithmic form for ease of representation. The area of the circle represents the compound annual growth rate over a five-year window for both net energy exporters and importers.

The graphs show, broadly speaking, that the relationship between the TPEC of a country is proportional to its population, although the spread of energy consumption relative to population widens through the economic groups. While resource endowment, economic mix, and environmental factors inevitably play a role, Figure 7 highlights those countries consuming more or less energy than expected, based on their current population. Perhaps more importantly, the plots show the likely future trends in short-term energy use.

In general, countries that exhibit strong growth and sit above the trend lines (e.g., Qatar, China, and India) are heavy consumers of energy for their population, relative to the selected peer group. As their economies grow, their energy consumption is expected to increase, although some of this will

Figure 7
Country total primary energy consumption and growth versus population (GDP/capita groupings)
Source: EIA, IMF (2010)



result from industrial expansion in sectors (such as mining and manufacturing) where the end products are for export purposes, not internal usage. Countries below the trend lines (e.g., Ethiopia and Botswana) are perhaps using less energy than expected, but their consumption growth suggests a strong uptake in energy use, which is representative of a developing nation. In contrast, Niger appears to consume much less energy than might be expected for its population, but also has low consumption growth. This suggests that Niger's situation is unlikely to change in the short term, and may well increase the stress on existing energy assets.

Directly targeting consumers – buildings, appliances, and transportation

Raising consumer awareness is a common starting point. Popular initial measures include educational initiatives based on schools, equipment labelling, and advice on basic home adjustments. The harder policy challenge is determining additional measures, which may incur costs to the householder, industry, or the state.

Subsidies are offered in Australia, Ontario (Canada), and France, among other locations. Australia's Energy Efficient Homes Package came into effect in February 2009 as part of the Nation Building Economic Stimulus Plan. The programme is capped at AUD3.2 billion (USD2.53 billion), and has two components: the home insulation scheme, capped at AUD2.45 billion (USD2.01 billion) and a solar home rebate, capped at AUD727 million (USD576 million).[44] The home insulation scheme seems to have received some negative responses.[45] The goal is to install roof insulation in many Australian homes and help up to 420,000 households install solar hot-water systems.[46]

Householders (including owner-occupiers, landlord, and tenants) can access insulation assistance of up to AUD1,200 (USD950) or a rebate of up to AUD1,600 (USD1,270) for the installation of a solar hot-water heater, or AUD1,000 (USD790) for the installation of a heat-pump hot-water system to replace an electric hot-water storage system.[47]

To meet plans to phase out coal-fired electricity generation and reduce peak demand by 20% by 2025, Ontario's Home Energy Savings programme is designed to help homeowners conserve energy and save on energy bills.[48] The programme subsidises home energy audits that identify possible improvements and assess potential savings. By 2009, 250,000 consumers had taken part. The audit is combined with retrofit rebates of up to CAD10,000 (USD8,800) for implementing changes suggested in the audit. These are funded by the province and the federal government. The scheme's coverage includes upgrades to the heating systems and insulation.[49]

France – Finance Law and Ecological Solidarity Assistance

France uses preferential loans, tax credits, and targeted grants. To achieve a 38% reduction in energy consumption in the existing housing stock by 2020, approximately 400,000 building improvement projects need to be undertaken each year by 2013. To encourage homeowners, the 2009 Finance Law introduced a 0% interest "eco-loan" on the understanding that any energy savings achieved would go towards repaying of the loan's capital. Eligible measures include the provision of thermal insulation, upgrades to heating and hot-water systems, and the installation of heating or hot-water systems using renewable energy. The maximum loan amount is EUR30,000 (USD42,000). Another measure is to modify the system of tax credits for interest paid on loans used to buy or build a new home: the time period was extended and the level of the rate increased for homes that meet thermal efficiency standards.[50]

France has also established a national fund for assistance with thermal renovation in private housing for the fuel-poor. The National Housing Agency and the Environment and Energy Management Agency will provide EUR600 million (USD840 million) to support home improvements that will achieve at least a 25% reduction in energy consumption. Authorities will assist homeowners throughout the entire cycle of the improvement works. The fund will cover the costs of the preparatory works (identification of needs, household visits, and consumption analysis) in their entirety, with physical renovations being supported on a matched funding basis. There are some concerns about the scope of the scheme and the pressure it will put on the budgets of these two agencies.

Basic measures in the transportation sector include ensuring greater transparency around vehicle fuel consumption and CO_2 emissions. In addition, a number of countries have now adjusted vehicle registration or annual licensing fees to privilege vehicles with low emissions (including hybrids and those that run on a petrol-ethanol blend), over high

emission vehicles. The thresholds for penalties are adjusted periodically to encourage carmakers to introduce more efficient vehicles into the market.

Some countries are now extending these measures to the car showroom. France's bonus-malus system applies to new vehicles purchased after December 2007. Buyers receive a refund (up to EUR5,000 or USD6,850) for low-emission vehicles, or pay a penalty (up to EUR2,600 or USD 3,560) for high-emission vehicles. An additional bonus is available for scrapping vehicles older than 15 years when a new car is purchased. The initiative is expected to be self-financing, with the revenues from penalties funding the costs of refunds and bonuses. While the government has credited the programme with a swing in car sales towards low-emission vehicles, critics have noted that the scheme only covers approximately 50% of overall vehicle sales.[51]

Governments have also introduced initiatives to encourage consumers to buy energy-efficient household appliances. The Republic of Korea has been piloting a "Carbon Cashbag" system since May 2009, under which carbon points are awarded to customers when they purchase low-carbon products, such as televisions, refrigerator, and washing machines.[52] Collected points can be put towards the purchase of other low-carbon products. Other Northeast Asian countries, such as China and Japan run similar schemes, which are intended to stimulate the economy. The state of Texas (US) offers tax reductions for efficient appliances and also runs green appliance sales at key times during the year.

Raising industry standards – buildings, appliances, and transportation

In recent years many developed countries have sought to strengthen building standards to improve energy efficiency. Denmark, with one of the lowest levels of energy intensity in the European Union, is a world leader in this area. Energy certification for the sale and rental of all types of buildings has been mandatory for more than ten years. Public buildings must be re-certified every five years with respect to meeting energy efficiency improvements. From 2015, all new buildings must use less energy than a passive house.[53] The longer-term goal is that all buildings should eventually produce more energy than they use. In addition, the Agreement on Danish Energy Policy has allocated DKK20 million (USD3.9 million) a year between 2008 and 2011 for campaigns to promote energy savings in buildings.[54]

US – Leadership in Energy and Environmental Design Rating System

Another widely respected scheme is the US Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) rating system. This voluntary scheme has become a national benchmark for green building design and construction.[55] Applicable to both commercial and residential buildings, existing or new, it has been adopted by state and local governments for public sector buildings, and is also used by architects and construction managers in the private sector. California's Green Building Order commits

existing and new public buildings to meet the standards. The state's long-term objective is that new residential construction should be at zero net energy by 2020 and all new commercial construction should be at zero net energy by 2030. In addition, the Energy Efficiency Standards for Residential and Non-residential Buildings have saved more than USD56 billion in electricity and natural gas costs. The standards are updated periodically to allow the consideration and possible incorporation of new energy efficiency technologies and methods. The latest 2008 standards came into effect in January 2010. It is estimated the standards will save an additional USD23 billion by 2013.[56]

The LEED rating system has been imitated in other countries. For example, the new building code in Dubai (UAE), effective January 2009, is based on the LEED system, with modifications made to account for local environmental conditions. The LEED system places particular emphasis on commercial and residential/mixed use facilities.

While countries are increasingly committed to the efficiency of new construction, the problems faced by major house-building companies during the global economic downturn have led to some plans for building standards regulation being softened or implementation delayed.

In terms of manufacturing, Brazil has a long-standing programme focused primarily on electrical equipment to generate electricity savings. Created in 1985, Brazil's National Electrical Energy Conservation Programme (PROCEL) was reinforced by an energy efficiency law following the power shortages of 2001. Over the following two years the programme sought to limit annual consumption by some 8,400 GWh, equivalent to 2.5% of the country's power consumption.[57] Energy efficiency standards were established for a list of products, including electrical appliances, gas and LPG stoves, and vehicles. Minimum energy efficiency standards are now in force for equipment that accounts for roughly half the power consumption in the industrial sector. The PROCEL Label and Award has been especially powerful and, along with marketing activities, has accounted for almost 70% of the results. In 2008, the programme produced savings of 4,300 GWh, and reduced CO_2 emissions by 212,000 tonnes.[58]

The PROCEL programme has spurred the development of a domestic manufacturing industry for products such as demand limiters, lighting controls, electronic ballasts for fluorescent lamps, and solar water heaters. It has also fostered the development of an energy services industry and trained a large number of energy managers and other professionals. It has reduced the risk of power shortages, and increased public awareness of energy efficiency.

Japan – "Top Runner" Programme

Also mentioned in last year's policy assessment report, Japan's "Top Runner" programme, a voluntary scheme to enhance competition among appliance and equipment manufacturers, is often hailed as an innovative instrument to increase energy efficiency. Different types of equipment and appliances

(e.g., air conditioning, cars, computers, ovens, and televisions) are grouped into 21 categories and an energy efficiency target is established for each. In each category, the "top runner" in terms of energy efficiency becomes the basis of the mandatory product standard for national producers and importers for the target year.[59] The programme covers approximately 70% of energy consumption in the residential sector, with new categories introduced as appropriate. The system of moving targets provides dynamic incentives for further efficiency gains and thereby increases the international competitiveness of the producers.[60] In terms of compliance and enforcement, where targets are not reached, the Ministry of Economy, Trade and Industry can publish the names of unsuccessful companies and impose penalties.

Raising standards in the transportation sector takes three main forms: increasing fuel economy, reducing emissions in vehicles, and/or encouraging the development of electric vehicles.

Several countries have programmes and policies targeting fuel-consumption standards. The US has long targeted passenger cars and light trucks with fuel economy standards under the Corporate Average Fuel Economy (CAFE) Act. However, last year it proposed a new national fuel-economy programme mandating automakers to increase the average fuel economy of cars and light trucks sold in US from the 2009 average of 27.5 mpg to 35.5 miles per gallon (mpg) by 2016.[61] Japan, on the other hand, has been using the Top Runner programme to enhance fuel economy, including that of heavy-duty vehicles. However, the European Union focuses more on fuel-emission standards, and is due to introduce a new set of standards in 2014 for passenger cars and light commercial vehicles.

As a further means of reducing dependence on oil and mitigating the environmental impact of automobiles, biofuels are increasingly being used as motor fuels. In 2009, the European Union established a target for member states to obtain at least 10% of final energy consumption in the transport sector from renewable sources by 2020 (the short-term target is 5.75% by 2010).[62] Renewable Fuel Standards in the US currently permit a 10% usage of ethanol in gasoline, although proposals are under consideration to increase this to 15%.[63]

The importance of fuel economy and oil independence means that auto-manufacturing countries are investing heavily in battery technologies and plug-in hybrid electric vehicles. The US government in 2009 provided USD2 billion in grants to fund 48 new advanced battery and electric-drive component manufacturing projects. The grants focus on battery building and recycling capacity, with up to USD400 million being invested in projects focused on the deployment of electric vehicles.[64] The government of the Republic of Korea has called for domestic automakers to mass-produce electric vehicles in the country starting from 2011, and has extended full support to auto manufacturers for electric vehicle developments. The vehicle manufacturers already benefit from an R&D fund worth KRW400 billion (USD340 million) set aside by the government until 2014.[65] Japan also pledged JPY25 billion (USD215 million) in

2008 over the following five years to help its companies develop these next-generation batteries.[66]

Reducing industry energy consumption – high energy-intensive and low energy-intensive sectors

The continued push for innovation in energy-saving technologies has become increasingly important for manufacturing industries. For example, scrap-material recycling in the iron and steel industry can reduce energy needs by four times as much. The cement sector in China, which produces close to half the world's cement needs, has been moving away from inefficient vertical shaft kilns to rotary kilns. Furthermore, the substitution of biomass feedstocks for petroleum feedstocks reduces energy needs in the petrochemical industry, since naturally occurring fibres can be used in polymer production.

A wide range of policy measures encourages industry to reduce energy consumption. The voluntary Keidanren agreements are a key instrument of Japan's industrial energy efficiency policy to reduce energy consumption in key sectors. Nippon Keidanren (the Japanese Business Federation) entered into this agreement with the government in 1997, with the overall goal of keeping industrial CO_2 emissions in 2010 below the 1990 level and thereby contributing savings of 42.4 Mt CO_2 to the government's Kyoto Protocol Target Achievement Plan. Thirty-five industries in the industrial and energy-conversion sectors are included in the agreements. The overall target is broken down for each industry in terms of targets for CO_2 emission limits and energy intensity. Each sector suggests voluntary action plans including numerical targets and specific measures. These are then verified by the Keidanren Committees before being implemented. Industry and sectoral performance is reviewed annually to ensure continuous and active effort to reduce emissions, and the results are published to ensure credibility and transparency.[67] Although, in aggregate, the 2008 CO_2 emissions of the 35 industries were 10.5% below 1990 emissions, 20 industries failed to reach their targets. The programme faces some criticism for setting easy targets that keep tougher regulations at bay.[68]

China's Top 1,000 Industrial Energy Conservation Programme, formed in 2006, focuses on the 1,000 largest energy-consuming enterprises in China, which consume 33% of national energy and 47% of total industry usage. Depending on China's GDP growth, the programme is expected to contribute around 10-25% of the country's targeted 20% reduction in energy intensity by 2010. The programme is led by a collaboration of five national government bodies (including the National Development Reform Commission and the National Bureau of Statistics), along with provincial governments and industry associations. Targeted enterprises are responsible for decreasing energy use by establishing an energy conservation organisation with efficiency goals, a system for reporting and auditing energy use, energy-savings incentives and training plans, and investment plans for energy efficiency improvements.[69]

Companies report how much energy they use every year. Energy savings reached ~20% of the

target in the first year alone (2006)—partly as a result of increasing management attention and the appointment of energy managers. Other savings have resulted from shutting down inefficient production processes. Reducing energy use may, however, become more difficult during the later years of the programme when greater investments will be needed for repairs and upgrading inefficient equipment.

China's energy intensity had reduced by over 15% from 2005 levels by 2009, but the USD586 billion economic stimulus package launched in 2008 drove up demand for energy-intensive products, such as steel. To meet its targets, the government is cracking down on 2,000 companies in 18 energy-intensive industries, identifying the amount of production that must cease by the end of September, 2010. Penalties for non-compliance include having business licences revoked, power cut off, and bank loans and government approval for new projects refused.[70]

Australia – Energy Efficiency Opportunities Programme

Australia's approach to business sector energy consumption contains both regulated and voluntary elements. The Energy Efficiency Opportunities programme (initiated 2006) recognises that information failures and organisational barriers work against companies identifying and implementing cost-effective improvements in energy efficiency. The scheme requires companies consuming 139 GWh or more annually to undertake detailed energy assessments every five years, which will identify opportunities for improving energy use, and publicly report the outcomes. The measure covers almost half of Australia's total energy end-use. Activities under the programme are supported by a range of capacity-building tools, guidance materials, case studies, and workshops that enable companies to understand and improve their energy productivity.[71]

By the end of 2008, the combined reports of all 199 designated companies showed an assessment of 65% of their total energy use, and identified over 7,000 opportunities to improve energy productivity that had a payback of four years or less. While the implementation of the energy efficiency opportunities is voluntary—corporations are free to make decisions on energy efficiency investments through their normal business processes—61% of energy savings identified have either been implemented or planned. The expected savings amount to almost 10 TWh of energy a year.[72]

The Republic of Korea underpins voluntary agreements with subsidies. Under the Voluntary Agreements for Energy Saving and Emissions Reductions Scheme, the government offers preferential loans for efficiency investments at energy-intensive industrial facilities. It has also instigated information-sharing initiatives for energy-saving technology, and labelling for high-efficiency appliances.

Committed to reducing energy consumption to 20% below its projected levels, the EU's Emissions Trading Scheme (now in Phase 2) offers market

signals for curtailing consumption of energy or investing in energy efficiency. Adjustments have been made to the scheme to avoid a repeat of the price collapse witnessed in Phase 1 due to the over-allocation of allowances and the inability to bank them, and the system will progressively move towards full auctioning instead of allocating them freely to nations. However, the reduction in European energy consumption along with an 11% reduction in emissions (due to the economic downturn) has resulted in an average 2010 price of EU allowances 50% below the peak in June 2008.[73] This has weakened the pressure on energy-intensive companies to press ahead with major efficiency programmes. Proposals for Phase 3 of the trading scheme, starting in 2012, include more countries, more greenhouse gases, and more industries.

Although Canada, the Republic of Korea, and New Zealand have announced plans to implement cap and trade schemes, efforts to pass climate legislation in the US and Australia have stalled. The US federal government, faced with a weakened economy, a financial system meltdown, and determined industry opposition, has postponed plans to merge the existing regional emissions trading schemes. The Australian bill on a Carbon Pollution Reduction Scheme was unable to reach a majority in the Senate, and the government has decided to delay its introduction until the end of 2012.

In the UK, an innovative regulation is being introduced this year, focused on low energy-intensive sectors that fall outside the EU Emissions Trading Scheme. The Carbon Reduction Commitment Energy Efficiency Scheme targets large companies that use more than 6 GWh/year of electricity. The scheme obliges participants to buy allowances to cover their carbon emissions. Revenue generated through auctions of these allowances will be redistributed among the scheme's participants, with each company receiving a larger or smaller amount than it originally paid for its allowances, depending on its energy consumption performance relative to its peers. The spread of bonuses and penalties will gradually increase over time. A league table, ranking companies according to performance, will be developed: it is hoped that companies will be spurred to act through reputational issues, in addition to the financial incentives.[74]

India – National Mission for Enhanced Energy Efficiency

India's new National Mission for Enhanced Energy Efficiency, launched in June 2010 and funded with INR2.4 billion (USD51 million) for the balance period of the XI plan, is expected to avoid the addition of almost 20 GW of generation capacity and reduce greenhouse gas emissions by nearly 100 million tonnes. Stimulating a market that is estimated at INR740 billion (USD16 billion), the Mission focuses on four new initiatives: the trading of energy-saving certificates by companies in energy-intensive industries, measures to increase the affordability of energy-efficient appliances, the financing of demand-side management programmes in all sectors, and the deployment of fiscal instruments to promote energy efficiency.[75]

Energy or carbon taxes are widely used in Scandinavia, Denmark, and the Netherlands. These taxes have helped reduce CO_2 emissions by stimulating efficiency measures and fuel-switching by industry. Finland's Energy Tax focuses on high-carbon energy sources, particularly fossil fuels used in transport, heavy and light fuel oils, coal, and natural gas. The approach is largely unchanged since 1997. A basic tax is charged for mineral oils, while an additional tax is charged for refined oil products, fossil fuels, and electricity. Transport fuels have additional taxes based on their CO_2 emissions. There is an exception for natural gas, which has a 50% reduction on the additional tax rate. Fuels used in electricity production are not taxed, but electricity consumption is. Revenue from the Energy Tax, amounting to EUR300 million (USD400 million), is used to support electricity generation from renewable sources.[76]

As well as imposing taxes, the Dutch government also offers tax deductions for companies investing in energy-saving equipment and renewable energy. Established in 1997, with an annual budget of EUR139 million (USD185 million), the energy investment allowance allows companies investing in energy-efficient equipment and renewable energy to deduct 44% of such investments from their taxable profit.[77] The scheme covers five application areas, each of which has its own energy-performance requirements: corporate buildings, processes, transport resources, sustainable energy, and energy advice. To be eligible for the tax deduction, the purchased equipment usually has to be on the "energy list", which is updated yearly to ensure that only the most efficient equipment receives this support.[78] The model is broadly respected and has been copied by other countries, such as the UK. One drawback is that it only applies to commercial companies able to deduct investments from their taxable profits. In response to this problem the Netherlands has introduced a separate scheme for energy investment in the non-profit sector.

Supporting energy efficiency – the energy sector

Over time, governments have strengthened their expectations of the energy sector, especially utilities, which have been charged with achieving energy efficiencies from their residential customers. California and the UK have programmes that target low-income households in particular. The Low-Income Energy Efficiency programme in California has offered support on energy efficiency and savings, minor home repairs, energy education, and weatherisation for more than 20 years.[79] In 2007, it was redirected to implement a state-wide energy efficiency strategy up to 2020 and the major utilities were asked to set up a two-year programme focused on low-income and disabled customers with high energy usage. The initiative is funded by nearly USD1 billion subsidised by regular rate-payers.[80]

UK – Carbon Emissions Reduction Target

The Carbon Emissions Reduction Target is a supplier obligation in the UK that came into force in 2008. It requires energy suppliers to install energy-saving measures for households to meet government-set carbon saving targets.

Doubling the targets of an earlier Energy Efficiency Commitment, it seeks annual net savings of 4.2 million tonnes of CO_2 by the end of the programme. At least 40% of carbon savings due to the programme have to come from priority groups, mainly from low-income households that live in fuel poverty.[81]

France uses a market-based approach to encourage utilities to achieve energy savings across their customer base. Under the White Certificates Trading programme, energy suppliers have considerable freedom in how they meet efficiency objectives. Those exceeding their targets can trade energy-savings certificates, while those failing to meet their obligation must pay a penalty of EUR0.02/kWh. The first phase of the scheme ran from 2006 to 2009 and, according to the government, achieved 65 TWh of cumulative savings (20% above target), 80% of which came from residential buildings. The latest target is 100 TWh of cumulative savings per year, with transport fuel included in the new system. Concerns about the programme relate to the low liquidity of the certificates market, and the administrative complexity of the scheme.[82]

Energy efficiency standards for electric utilities in Texas have been in place since 1999. These were amended in 2007, with utilities mandated to meet a target that rises each year until 2015. The initiative focuses on air-conditioning equipment, water and space heating, weatherisation, fluorescent lamps, and efficiency in school districts, as well as load management by city authorities. Approximately 65% of expenditures target the residential sector, with over half of this aimed at low-income groups. The total expenditure of Texas utilities on energy efficiency in 2008 amounted to USD96 million. Although this amounts to a cost of USD506/kW, the savings are considerable when compared with the costs of conventional electricity generation, which ranges from USD600/kW for peaking gas turbines to USD5,000/kW for nuclear energy. The additional energy efficiency costs incurred by the utilities are mostly reimbursed through the utility tariff or base rate. However, the system also contains other financial incentives, including a performance bonus for utilities that meet targets.[83]

A certain level of supply-side efficiency improvements can be demanded of utilities through tightening regulations. However, a sustainable financial model that compensates companies for participating in demand-side management programmes is often viewed as critical, especially in competitive markets. This additional investment needs to come either as a form of state-sponsored investment or as a result of revenues from higher prices paid by consumers. Thailand's demand-side management programme was widely considered a success, especially for a non-OECD country, but the reduction in support from the World Bank led to a significant decline in its activities.

Supply-side efficiencies are also sought in the oil and gas sector. In 2006, the Danish government agreed an Action Plan with oil and gas operators to reduce offshore energy consumption by 3% during 2006-2011, a 4.5% improvement on business-as-usual projections. The Danish Environmental Protection Agency is responsible for supervising the operators' compliance with the Offshore Action Plan and submits an annual status report to its Parliament.[84]

Revamping infrastructure – smart grid innovations

Finally, some policymakers are also investing in the development of smart grids that will enable utilities to balance supply and demand by better managing consumer needs through the use of pricing mechanisms. Through the Energy Policy Act (2005) and Title XIII of the Energy Independence and Security Act (2007), the US is providing funding to encourage the application of robust technologies for controlling energy, which will enable cost-effective energy conservation. By optimising the introduction of energy from multiple sources, the transmission and distribution network, and the use of appliances in the home, savings may be in the order of USD46-117 billion over the next 20 years.[85] The smart grid market has been estimated to be worth USD90 billion in 2010, and is projected to reach USD171 billion by 2014.[86]

California took the first state-wide action on smart grids in 2009, aiming to achieve a 10% reduction in consumption and a 25% reduction in carbon emissions. California's Public Utility Commission was appointed, along with other major energy stakeholders, to establish the requirements for a smart grid implementation plan, and electricity companies have to submit an implementation plan by 2011.[87] Ontario, Canada, is already in the midst of a large-scale Smart Grid Initiative, installing smart meters in homes and small businesses across the province. By the end of 2010, the system will serve 1.3 million customers.[88]

Republic of Korea – Jeju Smart Grid Test Bed

As part of its Smart Grid Road Map, guiding nationwide smart grid implementation by 2030, the Republic of Korea initiated the establishment of the Jeju Smart Grid Test Bed to examine advanced smart grid technologies and determine the most viable smart grid business model. The Test Bed presents a wide array of prototypes and their integration within a single environment, including smart meters, in-home displays, smart appliances, wind turbines and photovoltaics. The potential role of electric vehicle-charging infrastructure is of particular significance, since this could become the most reliable electricity storage device in such an environment.[89]

Given the very large costs associated with the realisation of ambitions for smart grids, successful and widespread implementation will depend on four factors:

- Evidence from pilot projects that justifies the scale of investment required for more fully developed programmes
- Approaches to pricing that incentivise utilities to develop new transmission infrastructure in the face of demand destruction
- Regulations that establish internationally scalable standards for appliances
- Active consumer engagement to ensure the optimisation of new opportunities

Table 3
Energy efficiency measures – comparison

Approach	Advantages	Disadvantages
Education campaigns	▪ Inexpensive ▪ Engagement with the next generation	▪ Unlikely to have much impact by themselves / in the short term
Subsidies / investments / tax credits	▪ Ability to focus on areas with greatest potential	▪ Can be expensive if too high and inadequate if too small ▪ Risk of free riders ▪ Quality control issues
Incentive / market mechanisms	▪ Flexibility for industry responses ▪ Incentives and penalties can be adjusted at regular intervals	▪ Complex administration ▪ Some uncertainty around results
Taxation	▪ Simple application ▪ Revenue generation can subsidise green economy	▪ Often ultimately regressive in impact ▪ Negative impacts on industry competitiveness
Voluntary industry agreements	▪ Flexibility for industry responses	▪ Weak ability for enforcement or strengthening
Compulsory standards	▪ Clarity regarding targets ▪ Stimulation of innovation	▪ Potential negative economic impact on industry

Conclusion

Against a backdrop of energy security and climate change concerns, energy efficiency is an important goal for both OECD and non-OECD countries, and is compatible with economic growth. Although in many countries it has proven slow and sometimes costly to change behaviours, with effective stimulation, the goal of energy efficiency can spur investment in technological innovation and achieve cost-savings for residential and industry consumers alike. Countries with well-developed approaches have tended to combine incentives and regulatory provisions in areas where the greatest impact can be achieved, with some deployment of market-based mechanisms. Table 3 sets out the advantages and disadvantages of different approaches.

However, some countries' targets, based on a reduction in energy intensity, appear to be over-optimistic. Even in many developed countries, nominal energy efficiency achievements are being nullified by an overall rise in energy consumption and a reluctance to move towards energy pricing that will support the required transitions. Moreover, results obtained through quick, easy wins during the early years of a programme will be hard to sustain when more costly and demanding measures need to be adopted, especially where these affect the international competitiveness of a country's industries. In support of these developments, five key issues that undermine policy implementation need to be addressed:

- An absence of clear standards
- Burdensome administrative procedures
- Weak processes for results measurement and reporting
- A reluctance to enforce compliance and issue penalties
- A lack of co-ordinated institutional leadership

Takeaways for Policymakers

Addressing energy use should be regarded as a cost-effective, flexible and low-carbon way of meeting future demand if the significant barriers to participation can be overcome.

- Energy efficiency programmes have additional benefits where they can be leveraged for the alleviation of fuel poverty.
- Programmes should have standardised processes for measuring efficiencies

achieved, and also adequate enforcement provisions and penalties to discourage non-compliance.

- **A broad, but standard, range of mechanisms should be focused on areas of major energy consumption,** although some issues (such as housing stock) are hard to address in the near term.
  - Incentive-based schemes, market instruments, and taxation each have different impacts on the speed of innovation and different economic costs.
  - Raising standards in design and manufacturing can have enduring results, particularly when aligned with informational or educational programmes.
  - Subsidies, in the form of tax credits or other means, may be necessary to stimulate investment in the early stages of a programme. However, control needs to be exercised over the quality and purposes of the goods/services for which rebates are sought.
- **Considerable thought needs to go into how pricing can best be used to stimulate consumer action and enable the energy industry to invest** in major infrastructure projects that will achieve efficiencies.
- **Countries with established programmes now need to graduate from quick wins to addressing less tractable issues.**
  - True energy sustainability can only be achieved if policy conflicts around transportation (e.g., support for public versus private transport infrastructure) are resolved.
  - Smart grids provide a good opportunity for optimising supply and demand over the long term, although the up-front investment costs may make this a lower priority for many countries in the near future, especially where serviceable infrastructure already exists.

Takeaways for the Energy Industry

- **The importance of energy efficiency should be raised in company strategies and operations** and, where this is not done already, steps should be undertaken to enhance efficiency, with the results recorded and communicated.
- **Technological leadership in aspects of energy efficiency can bring commercial advantages** in terms of cost savings and competitive positioning (e.g., in the development of new infrastructure and/or ancillary service businesses).

- **Utilities should expect to play a leading role in the development and delivery of national energy efficiency programmes,** not least because they have deep knowledge of consumption patterns and access to customers.
- **Cross-industry alliances can help to identify and promote leading practices,** set standards and assess how systemic changes to the energy system might best be developed and funded.

4. The investment environment

One of the greatest challenges in the next few decades is securing very high levels of investment in new energy infrastructures to maintain and replace existing systems, as well as to meet growing demand and environmental objectives. In 2008, the International Energy Agency (IEA) estimated that the world would need to invest more than USD26 trillion in energy infrastructure by 2030. About half of the total, USD13.6 trillion, needs to go towards the power sector, split fairly evenly between generation, and transmission and distribution. The oil and gas sectors require USD6.3 trillion and USD5.5 trillion respectively, mainly for exploration and development.[90]

This is equal to an average of USD1.1 trillion (or 1.4% of global GDP) per year. The burden is greatest in non-OECD countries, where 2.1% of GDP will need to be invested on average, almost double the 1.1% for OECD nations (see Figure 8). Although in absolute terms the greatest investment is required in North America and Asia, the highest levels of annual investment as a percentage of GDP are required in the Middle East—USD100 billion, approximately 5% of GDP.

If the climate stabilisation goal proposed in Copenhagen (preventing global temperatures from increasing by more than 2 degrees Celsius above pre-industrial levels) is to be achieved, a further USD10.5 trillion is required.[91] This would target the development of low-carbon power generation and energy-efficient equipment and buildings.

Securing investment of this magnitude will require innovative policies, appropriate regulatory frameworks, high levels of co-operation, and increased investment in energy research, development, and innovation.

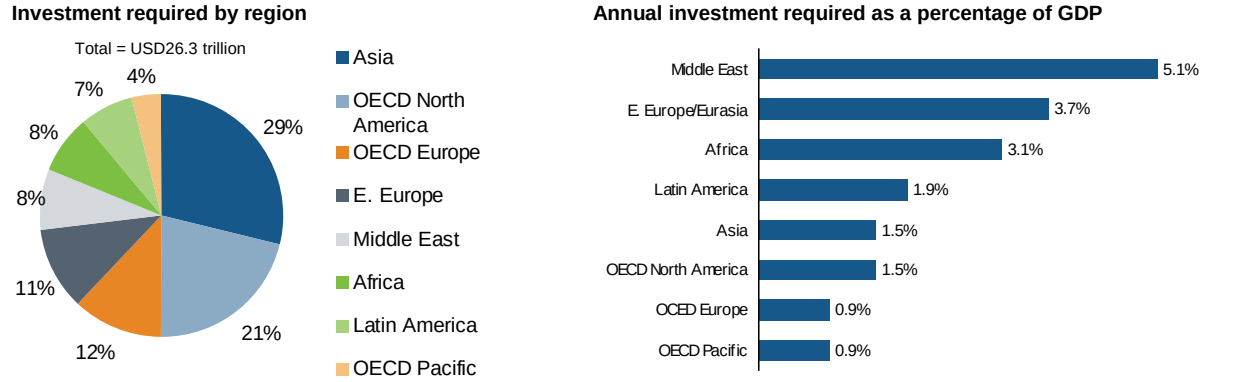
Understanding the barriers

The required investment is expected to come from multiple sources: existing energy industry players, renewable energy and low-carbon equipment manufacturers, financial investors, governments. Policymakers need to address two interrelated issues: the global economic downturn and systemic market framework dislocations, both of which have affected investment capacity and project economics. These are discussed in this chapter; a third important issue, policy uncertainty, is discussed more fully in Chapter 5.

The global financial crisis had a significant effect on the availability of investment capital. Not only were capital expenditure budgets reduced due to slumping cash flows and the need to preserve liquidity, but also credit and asset finance dried up due to the precarious state of financial markets and bank balance sheets.

In 2009, global upstream oil and gas investment budgets were cut by USD90 billion, down by approximately 19% compared with 2008.[92] Moreover, total global investment in clean energy fell nearly 7%, to USD162 billion, due partly to the reduced availability of investment and partly to unsustainably low fossil-fuel prices undermining project economics. While asset financings fell by only 6%, venture capital and private equity financings fell by as much as 43%, compared to 2008.[93] Two examples highlight the implications for planned energy infrastructure developments. Loan

Figure 8
Energy investment required by region and as a percentage of GDP
Source: International Energy Agency (2008)



negotiations resulted in the completion of Indonesia's Crash Programme, which aims to build 32 coal-fired plants, being delayed by two years. Following a dramatic fall-off in energy consumption and a need to reduce the public deficit from 11.4% of GDP in 2009 to 3% by 2013, the Spanish government decided in April 2010 to postpone EUR3.2 billion of investments into natural gas and electricity infrastructure.[94]

Regarding energy market frameworks, investment challenges have arisen due to issues in two key areas: liberalisation and subsidies.

Since the 1990s, market liberalisation has aimed to deliver market efficiencies through increased competition, bringing about new generators, improved transmission infrastructure, and low consumer prices. However, while some countries have seen significant performance improvements (most notably the UK), others have experienced problems with implementation that have affected the achievement of key policy goals, including those relating to energy security. For example, over the past decade, markets in Brazil, Chile, and California have, for a variety of reasons, all experienced periods of severe supply shortage and extreme price peaks.

Given high capital costs and tighter profit margins, some countries are concerned that liberalised markets do not sufficiently incentivise the construction of new power plants, particularly those using technologies preferred by the government. In the UK, the regulator has opened a debate about alternative market structures, so as to provide participants with better signals for investing in electricity and gas infrastructure, and supporting the renewable energy agenda. Similar debates are being held in other countries, such as Norway, where there has been minimal investment in new generating capacity, other than for mandated renewable sources, since the reforms to liberalise markets were implemented.

The second area with significance for energy market frameworks is subsidies and price caps: issues in this area can result in continual under-investment. For the sake of social welfare and economic growth, many countries have capped the price of energy, in some cases below the full cost of production. Artificially low prices can be key factors in impeding investments necessary to meet future demand and boost energy accessibility for the poorest households.

Recent estimates suggest that 37 countries (most notably Iran, Russia, Saudi Arabia, India, and China) spent over USD550 billion on energy subsidies for oil, natural gas, and coal consumption in 2008. Such subsidies not only encourage inefficient consumption (and associated carbon emissions), they also obstruct investment in clean energy sources and act as a drain on national budgets—amounting to on average 2.1% of GDP.[95]

Heavy subsidies for fossil fuels are also working against newer renewable energy policies. Argentina's long-running regime of subsidised energy tariffs, stemming from earlier financial and energy crises in the country, is a key reason for the low contribution (less than 0.1%) to the energy mix

from wind energy, despite a FIT and an abundance of wind resources in regions such as Patagonia.

In terms of price caps, the ceiling rate of BRL83 (USD42)/MWh set by the Brazilian government for the electricity produced from the Belo Monte hydro-power project proved unattractive this year to private sector investors. They considered the scheme economically unviable, given anticipated construction costs and the known seasonality of the water flows. As a result, the government will finance 80% of the USD12-16 billion costs from public funds, as well as providing income tax breaks.[96]

Nigeria will need to triple the regulated tariff charged to electricity customers to make the proposed privatisation of its state electricity system commercially attractive to external investors. This is largely due to the poor quality of existing infrastructure, and the need to extend access to the 50% of the population who are unconnected and often rely on costly diesel generators. This might help the country make domestic use of its considerable natural gas reserves: currently, some gas-fired power stations stand idle, since natural gas companies are able to obtain much higher prices on the export market.[97]

After two decades of declining energy prices (now 30% lower than the European average), and due to the strength of its nuclear parks and government price regulation, France is now facing the prospect of energy price hikes. The revenue would fund the large-scale renovation of its nuclear power assets and transmission network. The aim is to ensure long-term supply and to avoid dependency on increased imports at times of peak demand in the medium term. The shortfall in investment capital has been exacerbated by a dip in demand and the state of the national economy.[98]

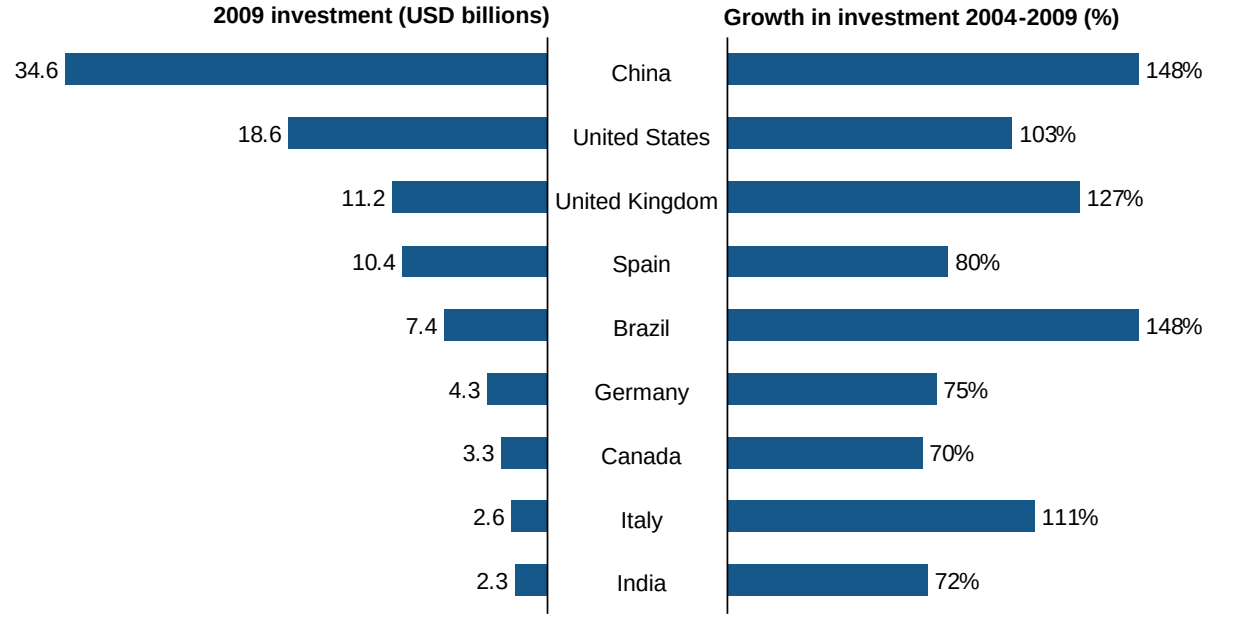
The household consumer is not the only subsidised market. In Saudi Arabia the price of natural gas for industrial and petrochemical use was set by the ministry at USD0.75 per million Btu. This was at a time when most of Saudi Arabia's gas production came from inexpensive associated gas. Now the price is a challenge to foreign operators and investors looking to discover and exploit resources in offshore areas, where extraction is likely to cost between USD3.50 and USD5.50 per million Btu. As a result, the country now risks domestic supply shortages.[99]

Although much of Iran's oil and gas sector's investment problems stem from its inability to attract western oil technology while US, European Union, and UN sanctions remain in place, the high level of subsidies for domestic consumption acts as a further hindrance on its investment capacity. In 2009, Iran faced a USD16 billion funding shortfall to finance its outstanding gas projects. It needs up to USD40 billion more just to complete the next phases of the development of the South Pars gas field.[100]

Providing solutions

Previous chapters noted the scale and source of funding for key policies. This section highlights recent public financing of market failures, including (co-)investments, loans, and government guarantees.

Figure 9
Leading countries in clean energy investment 2009 and five-year growth
Source: Bloomberg New Energy Finance/Pew (2010)



In response to the financial crisis, many governments have sought to stimulate their economies through public spending, with some attempts to co-ordinate action through international organisations such as the G20. Approximately USD184 billion of global stimulus funding is "green", and investment is pouring into areas such as rail, electrical grids, water and waste, building efficiency, renewable power, and low-carbon vehicles.[101] Figure 9 shows where the largest investments in clean energy took place in 2009.

The stimulus packages in the Republic of Korea and China have proved the greenest, with close to 80% and 34% targeted for green initiatives, respectively. China's target of doubling its domestic wind capacity in 2010 to 30 GW is underpinned by an investment of CNY100 billion (USD14.6 billion). The overall investment in alternative energy could amount to CNY2 trillion (USD0.29 trillion) by 2020.

Republic of Korea – Framework Law on Green Growth and Economic Stimulus

The green aspects of the Republic of Korea's economic stimulus package amount to USD10.8 billion, and a new law, enacted in April 2010, directs 2% of GDP towards promoting environmental technologies with a view to creating nearly one million green jobs in due course. Finance is being supported by a raft of new regulations, including a new Renewable Energy Portfolio Standard, the roll-out of a Million Green Homes by 2020 programme, a smart grid initiative, and a hydrogen vehicle programme. The country's environmental companies between them are expected to invest USD3.4 billion in 2010. The government has signalled that it is ready to invest USD2.4 billion in a smart grid over the long term, with USD21.8 billion to come from the private sector.[102] This will help the country to address its high energy intensity and increase the proportion of renewable energy in the energy mix from current low levels.

Overall, although globally perhaps only 9% of the green stimulus funding was drawn down in 2009, the effect on market confidence was positive, with a lift in investment during the second half of the year. The resurgence is continuing, with the bulk of the remaining stimulus expected to be spent this year. In the first half of 2010, new investments in renewable energy (especially wind farms) totalled USD65 billion, up 22% on the same six months of 2009.[103] Total global investments in clean energy this year are forecast to be between USD175 billion and USD200 billion.[104]

Recognising that between GBP800 billion and GBP1 trillion (USD1.2 billion to USD1.5 trillion) is required to decarbonise the UK economy by 2030 (with GBP230 billion or USD350 billion to come from low-carbon energy investments), the UK is planning to set up a Green Investment Bank to facilitate private investment. Capitalised by a combination of public and private sector funds, it is hoped that such an institution will help to deepen the pools of long-term debt finance; aggregate capital to enhance the availability of equity for early-stage commercialisation; and support the accumulation of small projects into propositions that are ready for investment. Supported by enhanced subsidy regimes and regulatory frameworks, the government aims to accelerate investment by the private sector in the green economy, by reducing risks and giving greater clarity around returns.[105]

Technology R&D support is often seen as a way to foster internationally competitive domestic industries. One example of this approach comes from Japan, which for years has had a very high ratio of public R&D spending to GDP, with a focus on nuclear and renewable energy. For some time, one of the priority areas in its renewable energy R&D policy has been solar technology. The Japanese stimulation of solar investments is based on a combination of supply-side technology-push policies and demand-side policies, such as subsidies for roof-top installations. These have been consistently pursued over a long timeframe, leading to significant cost-reductions and a strong PV industry. The country has the third-largest overall PV capacity in the world after Germany and Spain. Since 1999 it has been amongst the top three producers of solar panels globally.[106] In another example, the German government, which currently plans to dedicate nearly EUR400 million (USD530 million) for energy research in 2010, now spends nearly 40% of federal energy research funding on projects dealing with energy efficiency and renewable energy.[107]

Brazil – National Programme for the Mobilisation of the Oil and Gas Industry

Some countries have made significant investments in other ways to support the development of their energy industry. National Programme for the Mobilisation of the Oil and Gas Industry (PROMINP) was instigated in 2003 to counter the loss of competitiveness in the oil and gas supply industry that followed the opening up of the country's economy in the 1990s. By focusing on the maximisation of local content, technology transfer and the development of skilled Brazilian employees, the policy has sought to broaden the participation of national industries in the provision of goods and services.

Key features of the programme are the implementation of industrial policy, raising performance standards in the energy industry, and improving professional qualifications. Since its inception, over USD100 million has been spent on professional development programmes (with much of the funding contributed by the industry), and more than USD23 million on projects to help develop the capacity of national suppliers to produce

equipment and materials not produced in Brazil.[108]

Since the programme began, the local content percentage in oil and gas investments increased from 57% in 2003 to 75% by the end of the third quarter of 2009. This represents an additional value of nearly USD18 billion of domestically sourced goods and services and the creation of 755,000 jobs.[109]

Not only do many non-OECD countries require higher levels of investment, they face additional challenges in attracting the necessary capital. Private investors tend to demand higher returns in developing countries, due to greater perceived risks. Local capital market systems are either non-existent or lack the depth to fund large investments. As a result, some countries have had to find new routes for securing energy investments.

The government of Thailand looked at the availability of credit finance: it established funds to provide loans to prospective financial institutions at an interest rate of 0.5%. In turn, these financial institutions are allowed to lend these funds for energy efficiency projects at an interest rate of no more than 4%. Combined with technical assistance, the fund has helped stimulate the banking community's interest in energy conservation and efficiency, resulting in loans worth a total of THB10.1 billion (USD 300 million), almost half of which was provided by the banks themselves.[110]

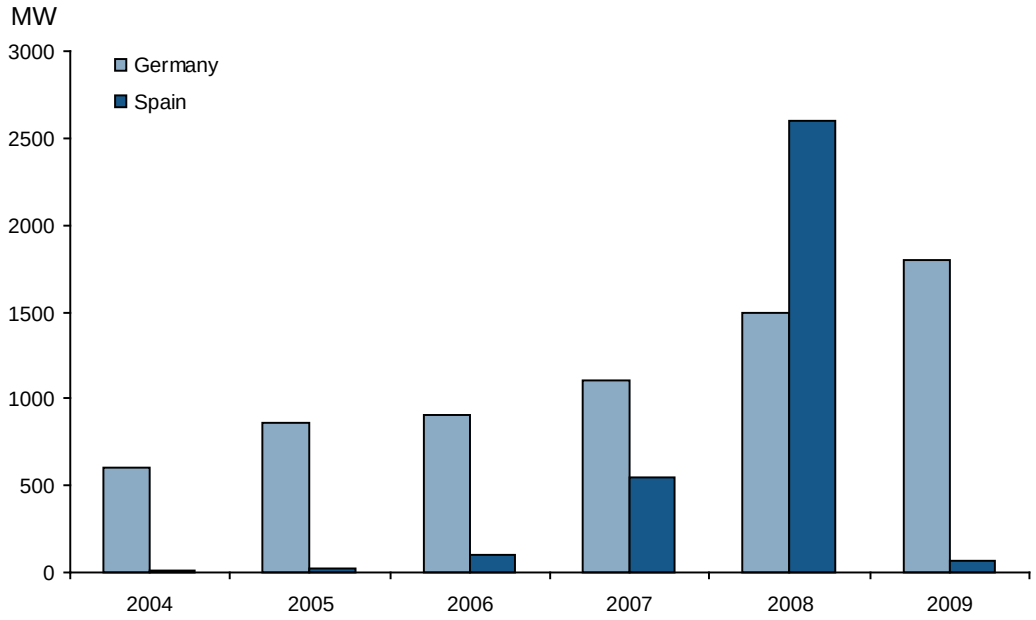
India set up a pioneering business structure to support a number of 4 GW coal-fired plant construction projects. Each project was placed in a Special Purpose Vehicle—a separate company to handle land acquisitions, regulatory issues, and environmental clearances in advance of the winning bidder. This innovative structure helped lower risk perception for investors, and has attracted strong interest from them.[111]

Ghana – Multilateral Financing Assistance

Ghana has turned to not-for-profit and international organisations for help with its renewable energy projects. A number of projects have been identified under the UN Clean Development Mechanism. These include the capture of methane from industrial and biomass wastewater, the reduction of oil consumption through waste-heat recovery, and improvements in boiler efficiencies. In addition, Ghana has secured funding from the World Bank for the deployment and scale-up of renewable energy technologies, supported by a USD500,000 petroleum levy.[112] A National Electrification Fund collects nearly USD600,000 a year through a levy on electricity bills, which is spent on extending the transmission network.[113]

South Africa's state-owned utility has obtained a major loan from the World Bank to invest in energy projects and address its energy supply difficulties. USD3.05 billion is supporting the construction of a 4.8 GW coal plant expected to be completed by 2013, while USD0.7 billion will be spent on enhancing solar and wind capacities and energy efficiency measures such as rail lines.[114]

Figure 10
Germany and Spain solar PV capacity additions (2004-2009)
Source: European Photovoltaic Industry Association (2010)



Ensuring sustainable growth

Despite pressure to secure investment quickly, fast growth does not always equal sustainable development. As described in Chapter 2, the generous incentives for renewable energy, especially solar, offered by the Spanish government were regarded as a triumph of clean-energy development until the market collapsed. Germany's less explosive progress might be regarded as more durable (see Figure 10).

Warning signs from rapid development driven by government incentives are present for the wind market in China, where installed capacity rose from 764 MW in 2004 to 12,020 MW in 2008 and 25,805 MW in 2009, with the growth in 2009 representing one-third of new global capacity during that year.[115] In 2008, the recently formed National Energy Administration's Wind Base programme established targets for 100 GW of wind capacity in six provinces. This was intended to help achieve the Chinese government's goal of 3% production of non-hydro renewable electricity by 2020.[116]

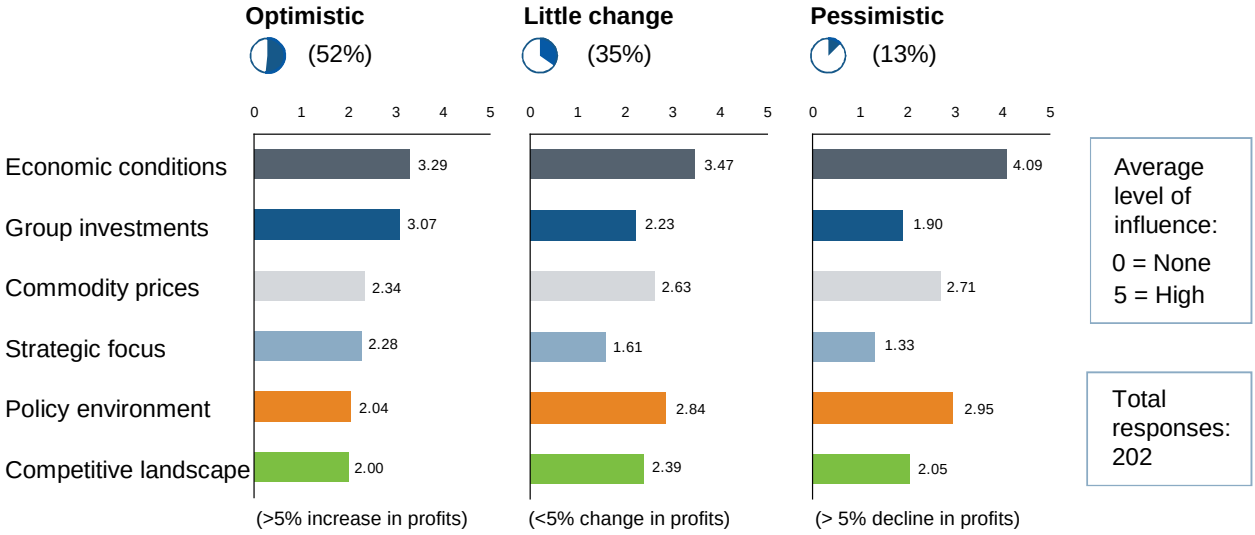
Chinese government wind-power development targets have resulted in a surge in the number of manufacturers and output, and profits have declined as a consequence. There has also recently been a relaxation of the rule requiring 70% of turbines to be manufactured domestically—with the goal of increasing competition and product quality. Together, these factors have given rise to the expectation of a shakeout in the near future.[117]

Wind farms remain loss-making ventures for several reasons. Under-investment in the transmission network means it can take up to six months for wind farms to be hooked up to the grid. Even then, capacity constraints often result in only 50% of the wind power being deployed. Moreover, in several areas the bidding process led to some state-owned companies tendering tariffs that were too low to cover their costs. These issues are being addressed through new policies, but questions remain about what policy adjustments will be required after the stimulus comes to an end.

Conclusion

In the past few years, countries have taken bold steps to stimulate investment in their energy sector, across all fuel types and stages of the value chain. Nonetheless, much more is needed, and, with energy and private equity companies being ever more selective about their investments, countries must compete with each other to offer attractive regimes. As the policy emphasis moves from stimulus to austerity in some parts of the world, the

Figure 11
Energy company business confidence for 2010



differences between regimes are likely to become more acute.

Following a tumultuous period in 2009, global business confidence is, in general, returning. Energy companies across the Gulf region have started to increase spending again, as oil prices recover and engineering, procurement, and construction costs fall (by as much as 45% from their peak in July 2008). In UAE alone, state-run energy companies were expected to award contracts worth USD18 billion in the first half of 2010. Kuwait, Qatar, and Saudi Arabia together will award a further USD38.9 billion-worth between 2010 and the end of 2012.[118]

According to our survey of energy industry executives, most companies are expecting higher profitability in 2010 (see Figure 11). This is despite the fact that business confidence this year is likely to be fairly volatile, owing to significant fluctuations in macro-economic performance data and the recent fiscal tightening in many countries. A more detailed examination of the responses suggests that oil, gas, and coal companies are more optimistic than firms in other sectors. Executives with a positive outlook for 2010 tend to have a more bullish view of economic conditions and are confident in the strength of their company investments. Those with a more negative outlook anticipate on-going market weakness and are concerned about changes in the policy or regulatory environment.

Takeaways for Policymakers

- **Steps need to be taken to give greater certainty for large-scale energy-sector investments** in the aftershocks of the recent financial crisis, including through loan guarantees, insurance schemes, co-investments, and policy stability.
- **The removal or more precise targeting of distortionary instruments such as price controls and subsidies will increase the availability of investment capital** and stimulate consumption efficiency.
- **Incentive packages for the energy industry should be underpinned by clear, transparent analyses** focused on the likely costs of the package relative to the benefits to be obtained; the potential returns that participating energy companies might achieve; and the relative attractiveness of the offerings of other countries seeking the involvement of the same energy companies.
- **Incentives for the development and deployment of renewable energy must respond to continuing reductions in installation costs** to avoid unsustainable growth.
- **Policy design (including incentives) should factor in key co-dependencies in**

country energy systems to ensure that supply and distribution infrastructure keeps pace with the development of new assets for electricity generation.

Takeaways for the Energy Industry

- **Funding within country economic stimulus packages remains available** for drawdown by energy companies to support appropriate opportunities.
- **Comparing the new austerity programmes of different countries will identify threats** to current or potential investments and is important for reappraising the attractiveness of different regimes.
- **The clear articulation (possibly through industry associations) of conditions that would help to lower the risk of investments would assist government thinking** around financial support frameworks.

5. Cross-cutting issues

This chapter examines the kinds of challenges governments may face as they set out to design and implement sustainable policy frameworks. It focuses on the difficulties presented by concerns that cut across different policy areas—the need to balance competing priorities, the tensions between policy stability and flexibility, and the increasing role played by international partnerships. It concludes with some considerations about the possibility of replicating successful policies across countries.

Choosing between or reconciling competing objectives

Fundamental tensions exist between the diverse policies required to achieve "energy sustainability". The regimes analysed illustrate unavoidable policy trade-offs between the objectives of energy security, social equity, and environmental impact mitigation, which are being aggravated by a tighter climate for investment. Additionally, many non-OECD countries face the challenge of reconciling climate change concerns with economic growth requirements and extending the accessibility of energy resources across the population.

Many, if not most, large-scale, energy-supply policy choices bring negative environmental impacts. For example, consider the continued construction of coal-fired power stations by Indonesia, South Africa, and China, as a low-cost means of meeting rapidly growing demand, or the exploitation of oil sand assets in Alberta (Canada). Both have significant environmental implications. So, too, does the production of shale gas (due to methane release and groundwater contamination from drilling fluids), or the operation of nuclear power plants (waste disposition). Even the deployment of renewable energy can have negative environmental impacts—large hydroelectric power infrastructure, for example, or the intense production of some biofuels in sensitive locations, can damage ecosystems.

Gulf of Mexico Oil Spill and Safety Regulations

The oil spill in the Gulf of Mexico has had considerable human, economic, and environmental impacts, but it is still early in terms of understanding the full policy consequences. In their responses to date, countries are seeking to balance very significant environmental, health and safety concerns with broader economic and energy sector issues. In other words, in considering stiffer regulations and even bans on offshore drilling in deep waters, policymakers recognise that offshore drilling represents the most significant remaining opportunity for many countries with declining reserves. A reduction in activity would negatively affect their long-term energy security, oil affordability, and the oil industry's contribution to GDP and employment (including the government's take).

Policy responses to the Gulf incident across the world have varied. Political uncertainty has put a temporary stop to most deep-water drilling in US waters in the Gulf of Mexico (despite the failure of a federal moratorium to pass legal hurdles), and the federal government is considering legislation to eliminate the cap on

oil spill damages; tighten regulatory standards for offshore drilling, enhance rig inspection regimes, and give the government greater powers over oil spill responses. The UK has doubled its annual drilling rig inspections and set up a group that can take charge quickly in the event of any oil spill. Ghana has stepped up safety measures for offshore production; China is drafting more stringent regulations; Nigeria and Canada are reviewing the adequacy of their existing requirements. On the other hand, there is little appetite currently for bans on deep-water drilling, with recent progress on permits, leases, and bid openings in waters off Australia, Brazil, Libya, Norway, and Russia.

The spill has, however, highlighted the absence of international conventions on oil platform safety, and raised questions about the ability of countries to mount effective recovery operations in the event of a disaster. An international harmonisation of safety standards, which could be enforced by peer review, would help to reduce the potential for safety to be a differentiator between firms. In this context much can be learned from the principles and procedures adopted by the nuclear power industry over the last 20 years.

The need to meet growing demand does not always mean social equity. Subsidised energy is designed to assist those in fuel poverty and stimulate economic growth, as in India. However, it can also act as a disincentive to efficiencies and systematically inhibit the development of new sources of energy supply, by reducing both the current and future profitability of investments.

Some countries, such as Indonesia, are finding it hard to achieve full electrification. Providing power for the final few percent of the population in areas of low-population density often comes at a significant marginal cost, with little prospect of returns.

Indonesia – Long-Term Development Plan

Indonesia, which consists of 6,000 inhabited islands, started its rural electrification programme in the 1970s.[119] Development has been slow and over 81 million people in more than 10,000 rural villages still live without electricity. Logistical reasons, such as a lack of roads, make projects expensive with low levels of return. To raise electrification rates from 65% to 80% of the population, the government intends to increase the budget from IDR400 billion (USD47 million) in 2000 to IDR2-5 trillion (USD 215-537million) a year from 2010 to 2014. To achieve these goals the government will need to have a clear operational framework, including a stronger audit and oversight of funds provided for these projects.

Finally, there are also tensions between environmental impact mitigation and social equity. On the one hand, as in Saudi Arabia, subsidised fuel prices provide little incentive for energy efficiency and reduced consumption. On the other, policies promoting renewable energy and energy efficiency compromise affordability objectives. The UK's Low Carbon Transition Plan might push 600,000 more households into fuel poverty (i.e., make energy unaffordable) since costs will be

Table 4
Index leaders by energy performance dimension and economic group

Group A. GDP/capita > USD33,500		
Energy security	**Social equity**	**Environmental impact mitigation**
Canada	United States	Switzerland
Switzerland	Japan	Sweden
Denmark	Germany	Norway
Finland	Canada	France
Japan	United Kingdom	Denmark
Group B. USD14,300 < GDP/capita < USD33,500		
Energy security	**Social equity**	**Environmental impact mitigation**
Russia	Italy	Latvia
Slovenia	Spain	Portugal
Czech (Republic)	Korea (Republic.)	Italy
Portugal	Russia	New Zealand
Slovakia	Poland	Lithuania
Group C. USD6,000 < GDP/capita< USD14,300		
Energy security	**Social equity**	**Environmental impact mitigation**
Colombia	Mexico	Colombia
Iran (Islamic Republic)	Argentina	Brazil
Argentina	Brazil	Peru
Ukraine	Turkey	Uruguay
Tunisia	South Africa	Serbia
Group D. GDP/capita < USD6,000		
Energy security	**Social equity**	**Environmental impact mitigation**
Cameroon	China	Nepal
Nigeria	India	Tanzania
Egypt	Indonesia	Swaziland
Indonesia	Egypt	Congo (Democratic Republic)
Swaziland	Philippines	Cameroon

Black font = net energy importers. Blue font = net energy exporters

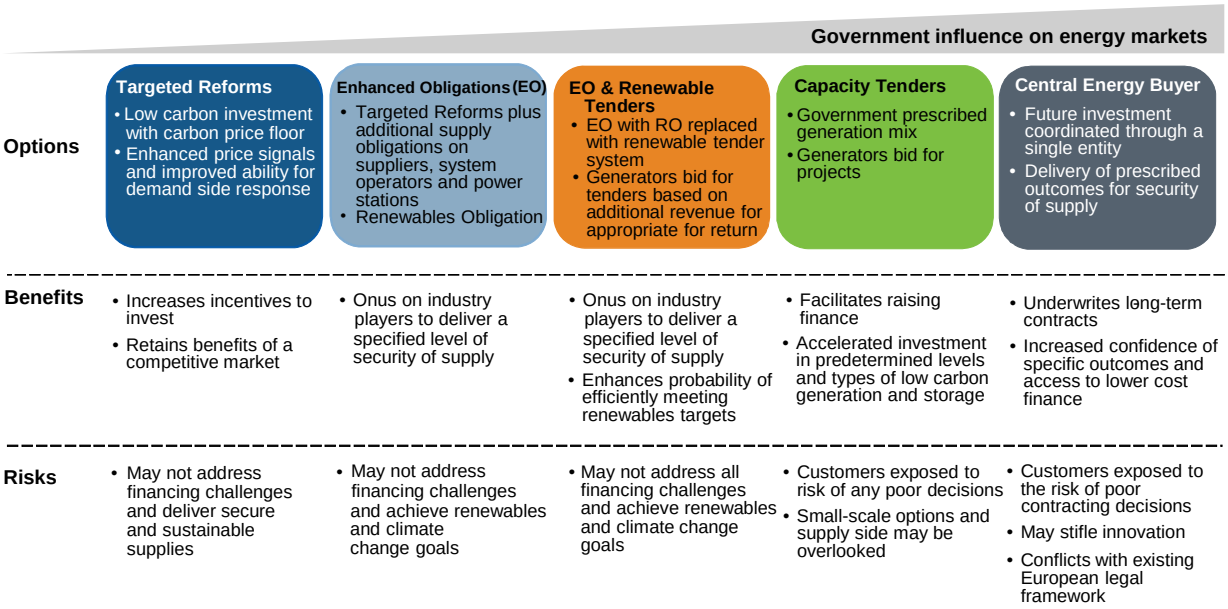
passed on to consumers. Recent government estimates indicate that the price of electricity will need to rise by 33% and gas by 18% to fund the changes.[120] Moreover, carbon-related regulations and increased energy prices can affect the profitability and international competitiveness of important national industries.

These conflicts are borne out in the performance of WEC member countries in the Energy Sustainability Country Index presented in Chapter 1. As indicated in Table 4, no country appears as a leader in all three energy performance dimensions in any of the four economic groups.

Across all the groups, the most common trade-off between objectives appears to be between social equity and environmental impact mitigation. The fact that across the four groups only Italy (Group B) and Brazil (Group C) come out as leaders in social equity and environmental impact mitigation suggests the trade-off between these two dimensions is hard to manage.

Despite these tensions and trade-offs, there is scope to achieve synergies or “double dividends” in some policy areas. For example, many European countries are pursuing the renewable energy agenda not simply to mitigate climate change, but also to enhance energy security by diversifying their energy mix and reducing dependency on supplies from abroad. The role played by renewable energy in the electrification of rural areas (as seen in China, Brazil, and Ghana) highlights a notable way of achieving both environmental and social equity objectives. This is further emphasised by Brazil’s index scores in these areas. Energy efficiency measures can, arguably, help to achieve all three energy goals—most clearly, energy security and environmental impact mitigation, but also social equity. France, the US, and the UK (among others) show how efforts to improve building insulation and energy

Figure 12
Consultation options for UK electricity and gas market development
Source: Ofgem, adapted (2010)



management are mostly targeted at poorer households. Mexico's new National Energy Strategy shows a clear attempt to bring together different goals. It has three main pillars—energy security, economic efficiency, and environmental sustainability—with specific medium-term objectives for each.

Managing the conflicting demands of energy sustainability requires an all-embracing energy policy aligned to meet the different dimensions of energy sustainability and the many different goals within them. This has implications in two areas: first, political leadership and, second, the influence of government on decision-making by the energy sector.

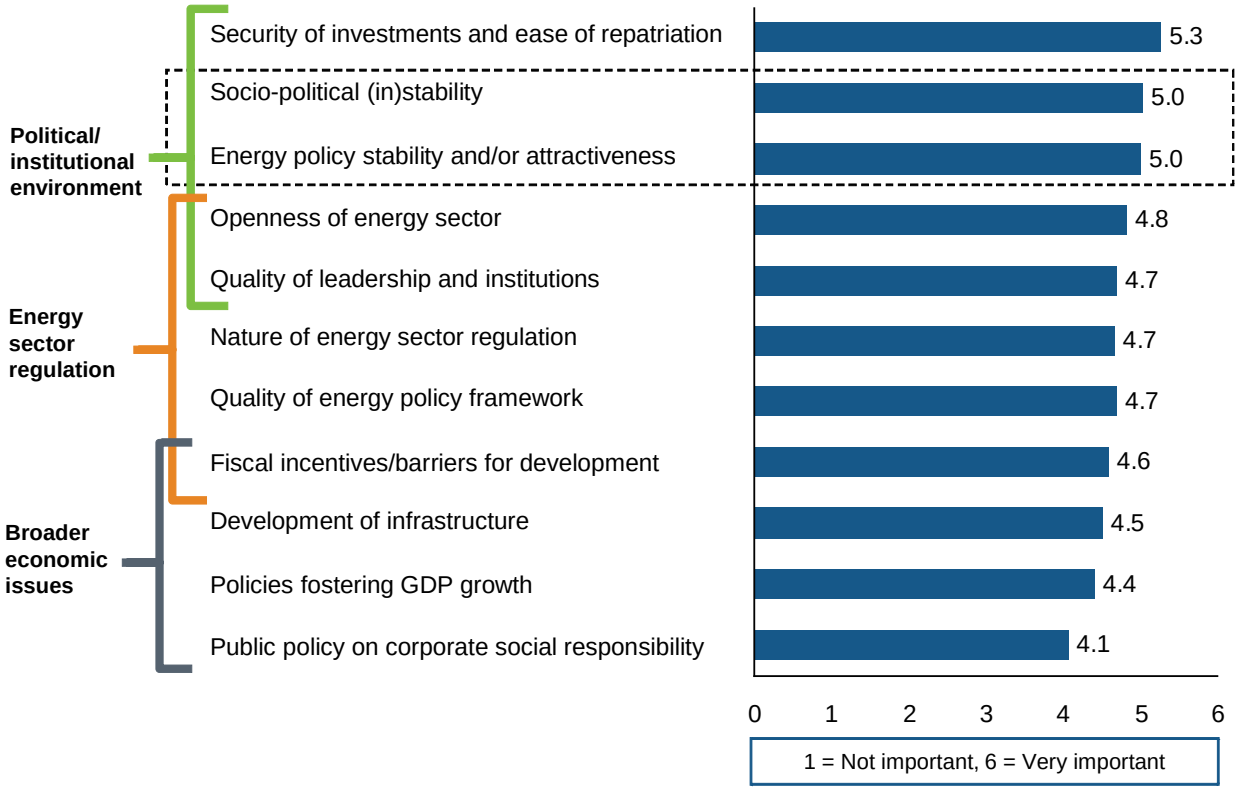
First, the stature and scope of the ministerial energy brief differs from country to country. In some, it is embedded within the Economics or Finance Ministry; in others, it is a separate ministry. There may be different ministries for fossil fuel and renewable energy usage, or a division between energy and environmental responsibilities. The energy and environmental agendas are combined in one cabinet-level position in only relatively few countries (such as Australia, France, the UK and Brazil). Although there are often good reasons for a country to have chosen a particular structure, it is possible that, in some cases, policymakers have more to do to overcome institutional barriers, align competing agendas, and achieve critical national goals.

Second, achieving these goals simultaneously inevitably puts pressure on the relationship between governments and the energy industry. In particular, it diverges from the trend towards liberalised markets that has been active since the early 1990s. While the pursuit of market efficiencies through the introduction of competition has had some success in driving down costs, more directive frameworks make it easier for governments to intervene in the case of market failures. Under these circumstances, policymakers may be better able to specify preferred technologies to support adjustments to the energy mix, ensure adequate levels of investment in vital infrastructure projects, and drive through required efficiency standards.

UK – Electricity and Gas Market Consultation

In February 2010, the UK regulator opened a consultation on market-reform options. The aim was to better enable the UK respond in a timely manner to key challenges that will appear before 2020. These challenges include the need for additional gas-storage facilities as import dependence passes key milestones; new power plants (CCGT, nuclear or plants

Figure 13
Key policy concerns prior to investment (energy industry)



fitted with CCS) to offset plant closures associated with European Union directives; and significant increases in the deployment of wind assets to meet EU 2020 renewable energy targets.

The market reform alternatives (see Figure 12) ranged from minor adjustments to the existing liberalised framework (which may not be sufficient to achieve critical goals) to larger-scale reforms, which centralise key decisions, but at the potential expense of stifling energy company innovation and conflicting with European regulation.

The recent change in government in the UK means that a further consultation document on electricity market reform will be issued in the autumn of 2010, with a white paper published in spring of 2011.

Balancing stability and evolution

One of the key concerns of energy industry executives relates to the strength and consistency of the policymaking environment. In the survey undertaken for this project, this was cited as an important consideration when considering an investment in a country (see Figure 13).

Stability was frequently listed when executives commented on the reasons underpinning strong or weak policymaking. There was a widespread plea for national energy systems to be shaped by long-range and consistently held views, for well-formulated policies with clear objectives to enable industry planning, and for appropriate market mechanisms to stimulate investment. Against these criteria, environmentally focused policies were regarded as the least effective. Just as important as the details of energy sector regulation is the more radical shift in direction that comes with a change of government. This is as much of an issue (if not more so) in advanced democracies as it is in more authoritarian regimes: political parties can have strongly differing views on the need for renewable energy and nuclear power.

The energy industry may want clarity and certainty, but the evidence from the policy reviews shows there is a considerable difference between the

unhelpfulness of erratic, indecisive policymaking and well-managed policy evolution, which is essential for keeping abreast of market developments. This is particularly important with respect to renewable energy and energy efficiency, where much uncertainty surrounds the future success of different measures. Policymaking needs to be dynamic, taking into account market economics (in terms of the decreasing cost of certain technologies), and frictions in the implementation process (such as the need to reinforce grid connection regulations). The example of Denmark shows how a leader in renewable energy is continually strengthening its regulatory framework.

Denmark – Policy Framework

In 1991, renewable energy contributed just 3.1% of Denmark's domestic electricity generation; by 2008, this proportion had grown to around 30%, with 19% from wind sources alone.[121] The country has built up a commanding position in renewable energy and, in September 2009, it launched the world's largest wind farm to date, the offshore Horn Rev 2.

Denmark's policy is based on FITs, whose end-costs are recovered from consumers. A key feature of Denmark's approach lies in the extensive opportunities for popular participation in decision-making about wind-power development. This has led to high levels of acceptance among the population. The policy framework for renewable energy has recently been updated and is collected under the Promotion of Renewable Energy Act (2009). This requires all municipalities to reserve areas for wind-turbine capacity of 75 MW in 2010 and 2011. The Act also sets out FITs for wind, biomass, biogas, and other sources. In addition, there are four new schemes: a guarantee fund for initial feasibility and siting studies; a compensation scheme for lost property value; an option for local people to purchase wind turbine shares; and a "green" scheme to encourage municipalities to promote greater acceptance of onshore wind. The transmission system operator is mandated to provide loan guarantees of up to DKK500,000 (USD94,000) out of a total of DKK25 million (USD4.6 million) per year for four years.[122]

Embracing a new internationalism

The desirability of supply diversification and the quest for resources have expanded the interconnectedness of the global energy system. This is most visible in three key areas: i) strategic exploration and production partnerships; ii) technology transfer; and iii) supply network growth.

i) *Strategic exploration and production partnerships.* National oil companies and other institutions of both net importer and net exporter countries have been more aggressive in securing cross-border agreements. China's three, large state-owned oil companies are probing for resource endowments in Kazakhstan, Sudan, Iraq, Nigeria, Argentina, and Venezuela, sometimes partnering with international oil companies to do so, and, at other times, making large-scale acquisitions. Earlier this year Japan's Bank for International

Cooperation offered a major loan for the development of Mexico's oil and gas fields. This illustrates the country's strategy of strengthening relations with oil-producing nations in Central and South America in order to ease its oil dependency on the Middle East.

Russia's recent moves have been more multilateral, focused on resources and technology to strengthen its ties in key geographies. Over the last 18 months, it has signed agreements with Venezuela (for the extraction of oil), and Nigeria and Algeria (for the exploitation of natural gas resources). The Nigerian and Venezuelan deals have also laid groundwork for the construction of nuclear power plants, while the additional interest in Nigeria and Algeria includes the possible construction of a trans-African pipeline to transport gas to Europe. Earlier this year, Russia also signed agreements with Ukraine to cut gas prices to its neighbour by 30%. In exchange, Russia received a long-term extension of its lease of the naval base at Sevastopol, and contracts for Russian companies to build two nuclear reactors in the country.[123]

ii) *Transfer of technologies.* Russia, France, Japan, the Republic of Korea, Canada, and the US have long-standing expertise and experience in nuclear power stations and the development of associated technologies. This puts companies in those countries in a strong position to take advantage of the new nuclear agenda in emerging markets. Often, as in the case of Russia and Ukraine, these deals are constructed as part of a broader package of economic opportunities and preferential considerations.

Similarly, there are relatively few companies that possess technology for shale gas exploitation. This provides them with a strong, near-term, competitive advantage in the investigation of new reserves beyond the US. This is already taking place in Europe. Through the US-China Shale Gas Resource Initiative (announced in November 2009), they are also helping to assess China's shale gas potential, conduct joint technical studies, and promote investment prospects.

Countries investing in renewable energy technology have been mindful not only of their growing domestic renewable energy industry, but also of the impact of technological advances and declining production costs across the world. In terms of wind power, the early leadership shown within Europe by Germany, Denmark, and Spain has been whittled away by recent high levels of investment in the US and China, and the ambitions of both in terms of export markets. Technological advances and a reduction in installation costs will inevitably be reflected in FIT adjustments and tender prices for quota-based schemes.

iii) *Supply network growth.* The increase in pipelines and transmission infrastructure is strengthening the links between countries. To meet the growing interest in natural gas, as noted in Chapter 2, in Europe the Nord Stream pipeline is under construction and the Nabucco pipeline is awaiting the go-ahead. Looking eastward, a gas pipeline is planned that would run parallel to the 4,900 kilometres of the Eastern Siberia-Pacific Ocean oil pipeline, the first phase of which opened at the end of 2009. This would enable Russia to enter new markets in the Asia-Pacific region,

including China. A pipeline from Nigeria and Algeria to Europe is being considered. Additionally, two major pipelines are planned to link Alaska and Alberta in Canada, and Brazil is gradually linking its major supply regions in the north of the country with high demand regions in the south.

Ambitious international networks are also being assessed in the power sector. These would both ease the trading of high volumes of electricity across long distances, and optimise the generation potential in different countries. In January 2010, nine European countries (Germany, France, Belgium, the Netherlands, Luxemburg, Denmark, Sweden, Ireland, and the UK) formally drew up plans to create and connect to an international electricity grid dedicated to renewable power. The linkage of Norway's hydro-electric power stations with the more volatile output of wind and solar assets will create a more reliable supply, as the percentage of renewable energy in the energy mix increases. When demand is low, excess electricity can be used to pump Norway's water uphill, to be available in times of high demand. The cost is likely to be in excess of EUR30 billion (USD40 billion), given the intention to use new high-voltage DC cables, which lose significantly less energy during transmission than earlier versions.[124]

Even larger plans are being proposed to develop a super-grid to connect planned concentrated solar power (CSP) generators in North Africa and the Middle East with European consumers. This large-scale project will need to attract investments in the region of EUR400 billion (USD540 billion) over the next 40 years.[125] However, should it achieve the scale anticipated by its proponents, it may be able to meet as much as 15% of Europe's electricity demand by 2050, as well as powering desalination plants in North Africa. In 2009, Morocco declared its intention to become a pioneer of CSP as a way of reducing its dependency on oil and gas imports. The country plans to build five plants, with a total capacity of 2 GW, by 2020; this is part of an anticipated overall investment of USD9 billion in solar power.[126] To support these developments across the region, the World Bank has agreed to invest USD750 million in CSP, with a view to this helping to bring in a further USD4.25 billion from other sources.[127]

Canada and the United States – Shared Infrastructure

The tightly integrated infrastructure possessed by Canada and the US along their shared border—including oil and gas pipeline networks and electricity grids—has been decades in the making. Traffic is two-way, although much of the flow travels from Canada to the US. Canada supplies the US with 9% of its total energy demand, including 13% of total oil consumption, 15% of natural-gas consumption, and one-third of the uranium for US nuclear plants. An integrated electricity grid means Canada is a major supplier of power to the US states of New England, New York, and California, as well as those in the Upper Midwest and the Pacific Northwest. Much of this comes from sources that do not emit greenhouse gases (hydro and nuclear), thus helping to contain the carbon footprint of the US. In addition, there is considerable two-way investment and technology flows between the two countries in the oil sector.[128]

Transferring successful policies

Internationalism is also evident in the interest that energy policymakers take in developments and innovations in countries they consider to be peers, competitors, or sales and supply markets.

This study has shown a commonality of issues between countries in which, often, similar policies are being implemented: for example, incentives for investing in new generation assets, provisions to help low-income consumers, and programmes to extend access to electricity. Generic similarities between country policies are often accompanied by differences in detail. This has implications for policymakers wishing to learn from the experience of others, who seek to transfer policies from other countries or regions.

With regard to national energy priorities, different countries will make different trade-offs between particular policy objectives. For example, market liberalisation policies designed to help deliver low energy prices to consumers have gone furthest in pioneering countries such as the UK and Chile. However, although there has been much discussion and many attempts to transfer models of liberalisation to other countries (not least within the European Union), the form varies widely, with considerable differences in the role of independent regulators and the extent of consumer choice.

Policymakers must take into account existing policies. New policies need to fit existing frameworks and may need to be changed significantly for this to be successfully achieved. It is often unproductive to analyse single policy instruments in isolation. Their effectiveness often depends on how they fit into an overall portfolio and whether complementary policies have been implemented.

Cultural norms will also affect the suitability and potential of particular policy instruments. For example, in Japan voluntary agreements with industry appear to have been effective without any formal sanction for firms that do not comply. Normative pressure has been sufficient. However, this is not true in other countries, where greater emphasis is placed on regulatory policy instruments with formal sanctions.

Policy instruments are often revised to fit the structure of local energy markets and the availability of resources. The German FIT model of incentives for renewable energy has spread around the world, but it is implemented quite differently in different countries. In some cases, the incentive rates for different renewable technologies are fixed, while in others they depend on electricity prices.

The partition between FITs and RPS partially reflects a philosophical divide between the *laissez-faire* orientation and the command-and-control traditions of social democracy. Countries that have embraced a liberalisation agenda have tended to choose RPS, while countries with more active government engagement in energy policy tend to use FITs. Schemes based on competitive bidding for long-term supply contracts tend to be more suitable for countries where the state plays a strong role in resource decision-making.

On the other hand, FIT systems may be most suitable for non-OECD countries. FIT systems are characterised by simple, transparent, and cost-effective procedures that combat the reputation for political instability that developing nations often have. In these countries, steady prices are often more important than precisely achieving a certain predetermined quota. Furthermore, because non-OECD countries rely more heavily on national and international investors, developers and entrepreneurs, FITs are seen as less risky to investors than the RPS system.

Conclusion

To develop strong energy systems, policymakers need a complex range of capacities: effective processes for engaging with the energy industry and other stakeholders; openness to policy innovation; and the ability to assess the costs and benefits of different options rigorously and transparently. These will enable them to make long-range commitments, while retaining the capability to respond to market changes in the short-term, and without sacrificing coherence and clarity of approach.

Takeaways for Policymakers

- **Raising the stature of the ministerial energy brief and aligning it with the environment brief** may help to reduce policy conflicts and institutional barriers to policy implementation.
- **Well-designed policies can contribute to multiple policy goals simultaneously,** even if significant trade-offs between the different dimensions of energy sustainability are inevitable.
- **Greater efforts should be made to harmonise energy infrastructure safety standards internationally** in order that this should not be a competitive differentiator between jurisdictions or companies.
- **Frameworks that balance industrial policies supporting the growth of domestic industries with the need to acquire technological and operational expertise from abroad should be reviewed** to address urgent infrastructure development needs and leverage the increasingly international nature of country energy sectors.
- **The growing body of experience around the operation of renewable energy and energy efficiency programmes should be used to accelerate the learning curve for new schemes** and reduce the likelihood of policy vacillation and change.

Takeaways for the Energy Industry

- **Greater intervention from governments in matters currently determined by the market should be anticipated,** given the necessary pursuit of multiple policy objectives.

- **Commitments to all three dimensions of energy sustainability should be factored into strategy development and communicated strongly to policymakers** so companies can position themselves most effectively.
- **Energy sector growth ambitions in non-OECD countries and the critical need for new global supply infrastructure are creating new markets** for well-capitalised companies.

Final thoughts

Energy policymakers across the globe face numerous, complex challenges, some of which they need to react to and some of which they need to anticipate. Global economic and environmental concerns in 2010 have placed energy policymaking in a state of flux. This study suggests that while many countries have developed ambitious and versatile programmes to address core priorities, others are finding it more difficult to achieve their targets and nurture new opportunities.

Policymakers need to establish priorities and respond to changing events in a way that provides clear signals to energy companies, wherever they are positioned in the value chain. This is particularly important when uncertainties regarding investment are so high.

Consolidating the findings

The examination of energy policymaking in 2010 gives rise to eight overarching messages. These derive from the more detailed takeaways for policymakers and the energy industry that close each chapter of this report.

Key Messages

1. Energy policymaking is increasingly interwoven with other agendas—economic, social, environmental, and national security. Requirements of the energy sector to contribute to GDP and industrial development, assist social development, support the climate change agenda, and strengthen geopolitical positioning have given rise to tough trade-offs. **New governance and decision-making processes will be needed to ensure appropriate stakeholder engagement and facilitate solutions that are sustainable over the long term.**

2. Despite the nervousness of the global economic recovery, investment is returning to many parts of the energy sector. However, countries will need to strengthen market and regulatory frameworks if they are to achieve the high levels of investment required to meet critical long-term goals. **Greater focus should be placed on investment in currently immature technologies that may have a transformative impact in due course, and approaches to pricing that take fuller account of externalities in the pursuit of energy efficiency and other sustainability goals.**

3. Energy-supply security concerns are higher than they have been for a number of years, driven by higher price volatility and a perceived increase in the competition for resources. **More directive policy frameworks will be required in some countries to enhance energy autonomy and achieve greater diversity in supply countries and energy types by shaping markets and guiding company actions.**

4. Growing international ties within the energy sector provide new opportunities for countries of all types to achieve their energy goals. **In seeking to strengthen their energy sector, policymakers should seek to balance policies that protect domestic industries**

with approaches that encourage technology transfer and partnership arrangements that leverage foreign expertise and financing.

5. The reduction of energy poverty remains a priority for large parts of the world. **Many non-OECD countries should consider how they might alter subsidy regimes to better balance the requirement for affordable energy in the near term with investment that will meet needs over the long term.** Moreover, the development of decentralised or off-grid solutions for remote communities needs to be facilitated by appropriate frameworks that accommodate the role of independent power providers.

6. Long-term energy supply will be influenced by major projects under development or consideration, namely the exploitation of shale gas; new gas pipelines in Europe, Africa, Asia, and the Americas; the extension of nuclear power to new countries; and a new grid to strengthen the supply of renewable electricity across Northwest Europe. **Countries need to factor the implications of major expected supply-side developments into their strategic energy-mix choices.**

7. The deployment of non-hydro renewable energy shows clear country leaders in the deployment of non-hydro renewable energy, although in some fast-moving countries, incentives have failed to respond to changing market forces and there has been an insufficient focus on transmission grid improvements. **Countries should ensure that incentives for renewable energy development are responsive to market changes and are backed up by continual policy reinforcement and additional infrastructure investment.**

8. The best energy efficiency programmes are multi-faceted (focusing on both supply and demand) and have over time become part of the cultural fabric of industry and household management. **Countries that do not have established efficiency programmes should learn from the experience of others with regards to identifying appropriate programmes, setting standards, ensuring compliance, and encouraging behavioural changes.**

Taking the agenda forward

More detailed comparisons of policy approaches within and across country peer groups would be helpful in evaluating choices available to policymakers. In addition, there would be significant benefit in a more extensive, informal interaction among policymakers and between policymakers and the energy industry. As its policy assessment programme continues, WEC is willing to facilitate such discussions to deepen the dialogue that already exists.

It would be particularly valuable to consider at an early opportunity the following topics:

- *Public-private partnerships.* Market reform and the transfer of technological expertise are creating new structures and modes of

interaction between governments and energy companies, both domestic and international. Examining the different ways in which innovations can be disseminated to achieve policy goals would assist the transfer between countries of leading practice technology solutions, regulatory procedures, and investment approaches.

- *The longer-term impacts of the economic downturn.* Notwithstanding the stimulus funds set up in some countries, planned infrastructure developments remain at risk due to capital constraints. With governments focusing on austerity in the short term, it is timely to consider the potential impact on energy security and energy markets in the next decade.
- *The social risks of environmental policymaking.* Now that an increasing body of evidence on the impacts of renewable energy and energy efficiency programmes exists, it would be useful to consider how governments and industry can build a meaningful consensus around environmental policies, while also addressing energy poverty. This would help to capture unforeseen costs and trade-offs, and inform future programme design.

Input on these and other issues are welcomed. Those interested in participating in the on-going agenda of this work programme should contact the World Energy Council at assessmentstudy@worldenergy.org.

Notes

1. See Appendix B for further details on the methodology

2. “Policymaking” includes strategic and regulatory planning, trade negotiations, programme development, policy implementation and compliance enforcement.

3. GDP is compared on a purchasing power parity basis.

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Appendix A. Project participation

The Project Team would like to thank the individuals who informed the project's approach, supplied information, provided ideas, and reviewed drafts. Their support and insights have made a major contribution to the development of the report.

World Energy Council Study Group

Hajime Murata (Japan) – Chair
Maria Belen Carusoni – alternate (Argentina)
Horacio Fernandez (Argentina)
José Henrique Danemberg (Brazil)
Pietro Erber – alternate (Brazil)
Steve Dorey (Canada)
Daniel Romero (Colombia)
Claudia Granados – alternate (Colombia)
Miroslav Vrba (Czech Republic)
Jean-Eudes Moncomble (France)
Gudrun Lammers – alternate (France)
François Dassa – alternate (France)
Djoko Prasetijo (Indonesia)
Takashi Tanaka (Japan)
Ken Koyama (Japan)
Yongduk Pak (Republic of Korea)
Raul Livas (Mexico)
Abubakar Malah Umar (Nigeria)
Maya Czarzasty (Poland)
Iulian Iancu (Romania)
Tatiana Mitrova (Russia)
Fareed Al-Asaly (Saudi Arabia)
Maria Sunér Fleming (Sweden)
Gerald Davis (Switzerland)
David S. Hong (Taiwan)
Feng-Shuo Yang – alternate (Taiwan)
Bundit Fungtammasan (Thailand)
Sarat Prakobchat – alternate (Thailand)
Paul Loeffelman (US)

Expert Advisory Group

Zhou Dadi (China)
Jean Tirole (France)
Fatih Birol (Turkey)
Rajendra Pachauri (India)
Yoichi Kaya (Japan)
Ongulade Davidson (Sierra Leone)

Research support (for review of country policies)

University of Sussex (UK), Sussex Energy Group

Oliver Wyman Advisory Group

Alex Wittenberg (Partner)
Roland Rechtsteiner (Partner)
David Hoffman (Partner)
Michael Denton (Partner)
Mike King (Senior Vice President, NERA)

Project Team

Christoph Frei (WEC, Secretary General)
Robert Schock (WEC, Director of Studies)
Hajime Murata (WEC, Study Group Chair)
Sandra Biesel (WEC, Project Manager)
Boris Galonske (Oliver Wyman, Partner)
Richard Smith-Bingham (Oliver Wyman)
Daniel Summons (Oliver Wyman)

Appendix B. Analyses undertaken

The 2010 work programme had three key components: i) an index of historic country energy performance data; ii) a review of current energy policies in selected countries; and iii) opinion surveys of energy industry executives and WEC member committees.

Development of an index

Country data was brought together in an Energy Sustainability Country Index. This provided a snapshot profile of WEC member countries in terms of both the three dimensions of energy sustainability and the broader political, social and economic context. Indicators were selected that had a high degree of relevance to the research goals, exhibited low correlation, and could be derived from reputable sources to cover a high proportion of member countries (all but one). These sources included the International Energy Agency, the US Energy Information Administration, the World Bank, the International Monetary Fund, and the World Economic Forum.

The structure of the index and the coverage of its 22 indicators are set out in Figure 14. The index is weighted in favour of the energy performance axis by a factor of 3:1, with the scores for each dimension carrying equal weight within their axis. The results are found in Appendix C.

Figure 14
Index structure and weighting

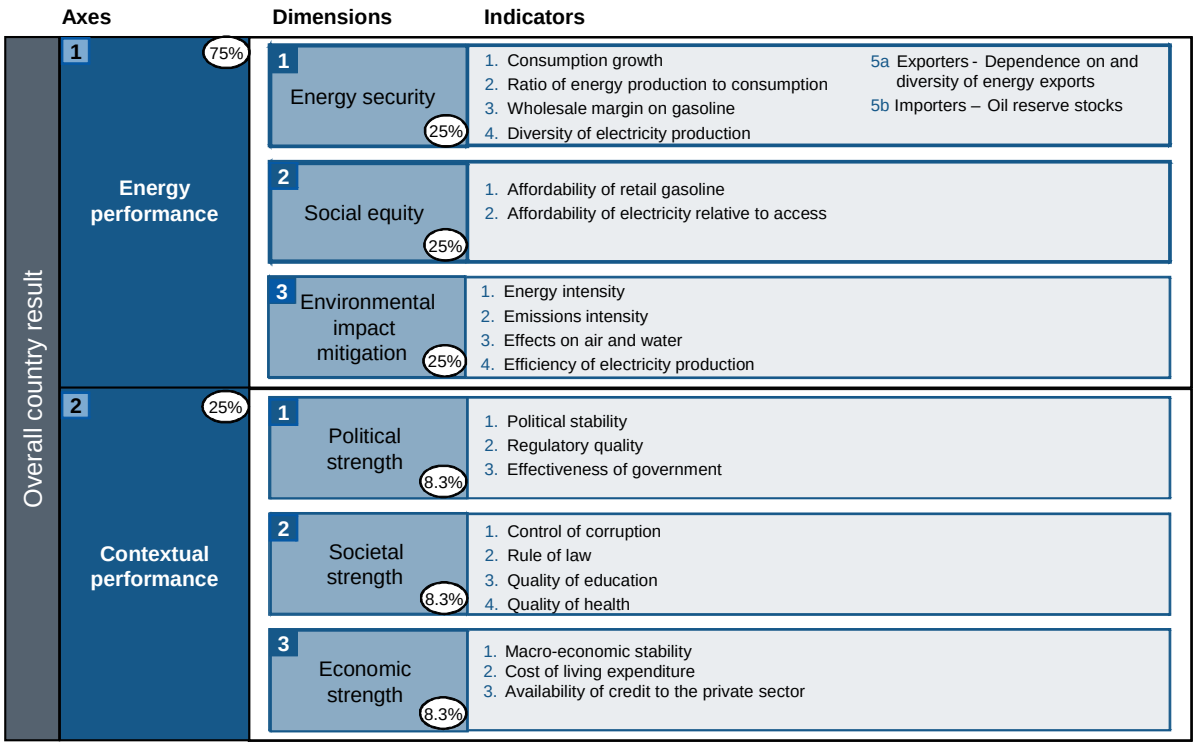


Table 5
Country policy reviewed

Algeria	Ghana	Poland
Argentina	India	Russian Federation
Australia	Indonesia	Saudi Arabia
Brazil	Iran	South Africa
Canada	Japan	Spain
▪ Alberta	Korea (Rep.)	United Arab Emirates
▪ Ontario	Latvia	United Kingdom
China	Mexico	United States of America
Denmark	Netherlands	▪ California
Finland	New Zealand	▪ New York
France	Norway	▪ Texas
Germany	Philippines	▪ Wisconsin

The 2010 index is a refinement of the 2009 index, deploying fewer primary indicators and more centred on the goals of our research programme. The concept of the index is dynamic, and further work will sharpen its focus, although this depends to some extent on data availability and integrity. Full details of the indicators and sources are on the WEC website at www.worldenergy.org/documents/index_2010.xls.

Review of country policies

In order to understand the quality of, and recent trends in, energy policymaking, key energy policies in thirty countries, four US states, and two Canadian provinces were subjected to a brief review. The selected countries varied in size, geography, resource endowment and economic wealth (see Table 5).

The 239 policies selected for review included international agreements, regulatory measures, and financial incentives. They spanned the dimensions of sustainability and over 50% were enacted in the past five years (see Figure 15). In addition to a brief critical review that captured policy goals, mechanisms, and outcomes (where this was available), each policy was also quantitatively scored against eight criteria that related to planning, institutional, regulatory, and financial issues. The reviews made use of information provided by government ministries, leading international energy bodies, industry associations, academic researchers, academic publications, reputable journals, and newspapers.

Survey of industry executives

A survey was distributed to approximately 1,800 senior energy-company executives around the globe to obtain industry perspectives on government policymaking. A largely multiple-choice questionnaire asked the executives not only for opinions on the quality of policymaking in their

Figure 15
Breakdown of reviewed policies

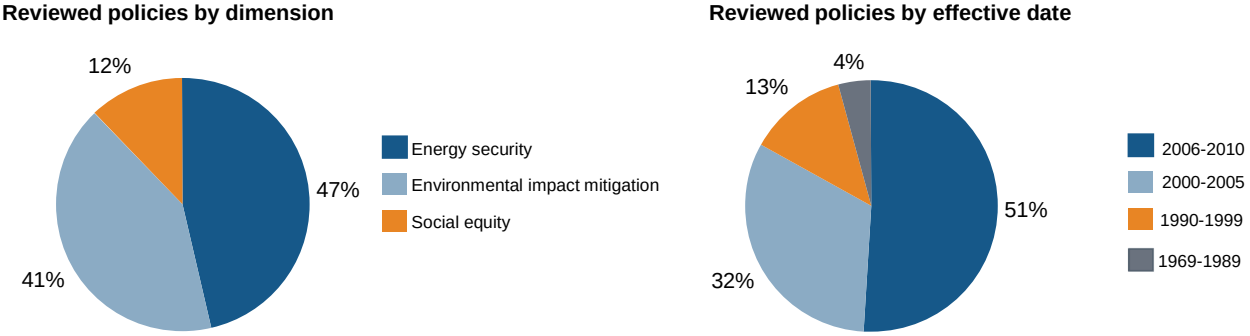
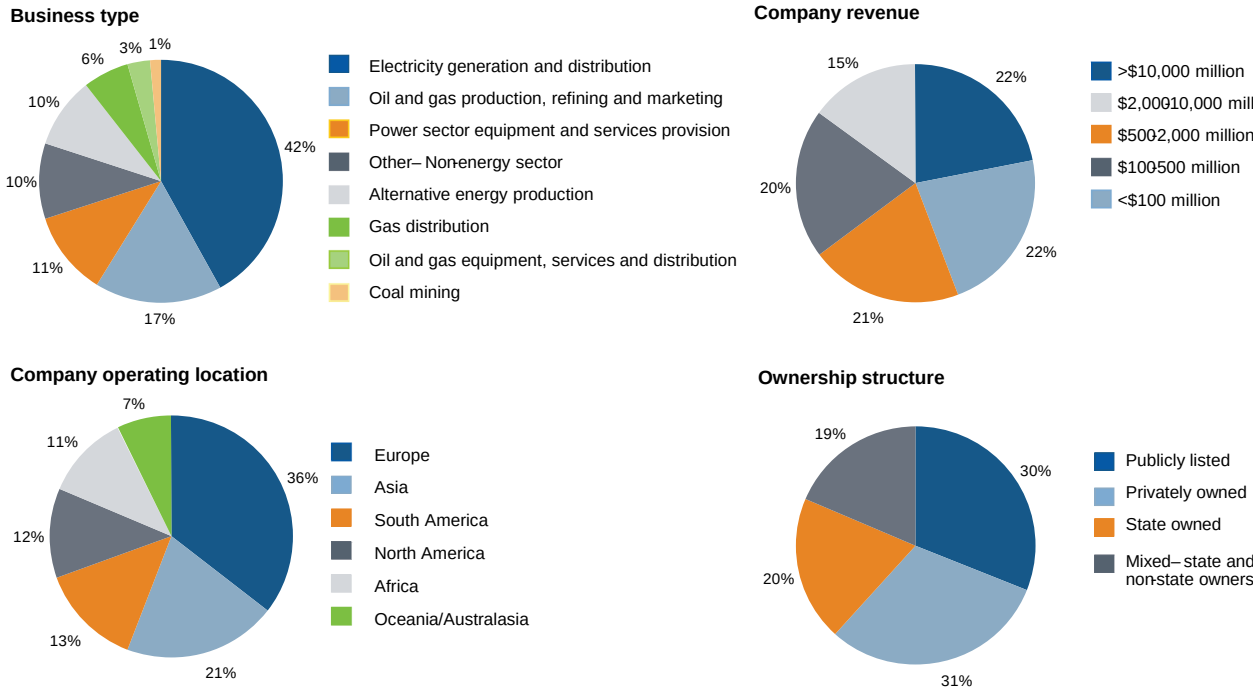


Figure 16
Breakdown of industry survey responses



main country of operation and the appropriateness of government priorities, but also sought to understand key policy-related factors underpinning major investment decisions.

The questionnaire received a response rate of 13%, with 232 executives replying either on-line or by hard copy. Among respondents there was a wide range of countries, energy sectors, company size, and ownership (see Figure 16). Partially completed submissions were also accepted, with all answers used except where the respondent's views could not be determined.

Survey of WEC member committees

Member committees comprise a broad range of energy system stakeholders in their respective countries. Each member committee was sent a similar, although more detailed, largely multiple-choice survey to obtain its views on the priorities, concerns, and effectiveness of energy policymaking in its particular country.

Thirty-five (35) member committees responded (see Table 6), giving an overall response rate of ~38%. The countries represented ranged widely in terms of geography, resources, and economic status.

Table 6
Member Committees responding to the survey

Argentina	Germany	Romania
Austria	Hong Kong, China	Slovenia
Ontario	India	South Africa
Alberta	Indonesia	Spain
Canada	Ireland	Sweden
China	Italy	Switzerland
Colombia	Japan	Thailand
Croatia	Kazakhstan	Tunisia
Czech Republic	Korea (Rep.)	Turkey
Denmark	Lithuania	United Kingdom
Estonia	Mexico	United States of America
Finland	Peru	
France	Poland	

Appendix C. Energy Sustainability Country Index results

Based on the approach described in Appendix B, the results of the 2010 Energy Sustainability Country Index are set out in Figure 17. The presentation shows the output of a sensitivity analysis, indicating positional changes that result from allowing dimension weights to change randomly by up to +/- 5%, with the horizontal bars denoting the observed position volatility from repeated measurement.

The four economic groups (A, B, C, and D) are based on dividing countries into four (nearly) equal-sized groups:

- Group A: GDP per capita greater than USD33,500
- Group B: GDP per capita between USD14,300 and USD33,500
- Group C: GDP per capita between USD6,000 and USD14,300
- Group D: GDP per capita lower than USD6,000

The export/import column signifies whether a country is a net energy exporter or importer based on 2007 data using production and consumption statistics.

Figure 18 shows the rank ordering of countries against the energy performance dimensions of the index.

Fuller details of country scores by indicator and dimension can be found on the WEC website at www.worldenergy.org/documents/index_2010.xls.

Figure 17
2010 Energy Sustainability Country Index ranking

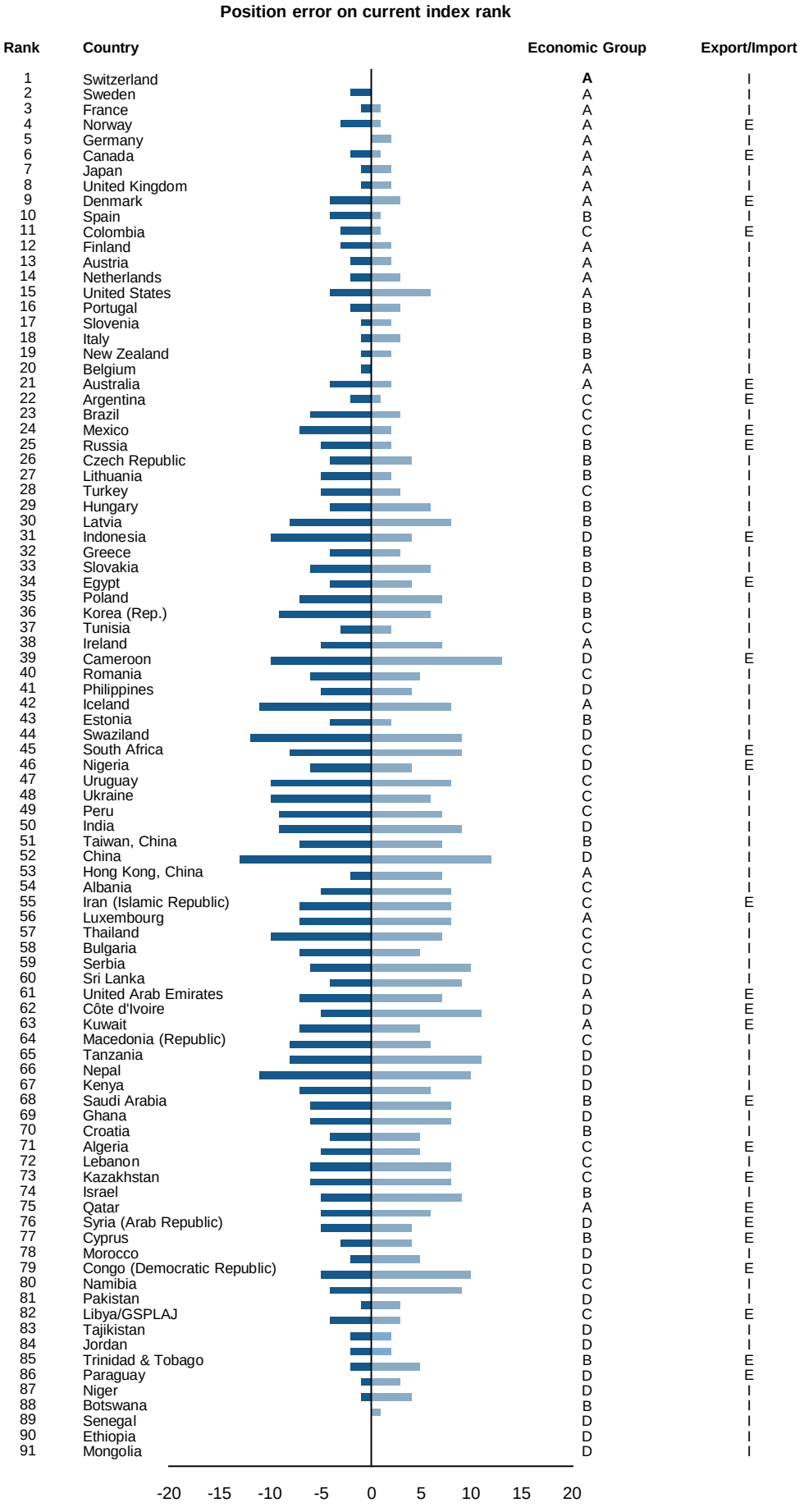


Figure 18
Country rankings against the index energy performance dimensions

Rank	Supplydemand balancing	Social equity	Environmental impact mitigation
1	Canada	United States	Switzerland
2	Switzerland	China	Sweden
3	Denmark	Japan	Nepal
4	Finland	India	Colombia
5	Russia	Germany	Norway
6	Japan	Canada	Latvia
7	Slovenia	Mexico	Brazil
8	Germany	United Kingdom	France
9	Norway	France	Tanzania
10	Sweden	Indonesia	Peru
11	Cameroon	Argentina	Uruguay
12	Czech Republic	Italy	Swaziland
13	Portugal	Brazil	Serbia
14	Netherlands	Australia	Congo (Democratic Republic)
15	Slovakia	Spain	Cameroon
16	New Zealand	Korea (Rep.)	Denmark
17	Nigeria	Turkey	Austria
18	Colombia	Russia	Albania
19	United States	South Africa	Niger
20	France	Poland	Sri Lanka
21	Iran (Islamic Republic)	Thailand	Côte d'Ivoire
22	United Kingdom	Taiwan, China	Portugal
23	Egypt	Colombia	Ireland
24	Argentina	Greece	Finland
25	Hungary	Iran (Islamic Republic)	Italy
26	Ukraine	Netherlands	Kenya
27	Tunisia	United Arab Emirates	Ghana
28	Indonesia	Ukraine	Namibia
29	Austria	Belgium	Philippines
30	Poland	Romania	New Zealand
31	Spain	Switzerland	Luxembourg
32	Swaziland	Kuwait	Lithuania
33	Romania	Kazakhstan	United Kingdom
34	Côte d'Ivoire	Saudi Arabia	Spain
35	Syria (Arab Republic)	Sweden	Iceland
36	Belgium	Czech Republic	Croatia
37	Macedonia (Republic)	Egypt	Slovenia
38	Australia	Hong Kong, China	Hungary
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40	Paraguay	Bulgaria	Slovakia
41	Tajikistan	Philippines	Morocco
42	Bulgaria	Pakistan	Ethiopia
43	Kenya	Serbia	Turkey
44	Mexico	Lithuania	Japan
45	Lithuania	Austria	Nigeria
46	Italy	Israel	Senegal
47	South Africa	Slovenia	Egypt
48	Uruguay	Nigeria	Estonia
49	Libya/GSPLAJ	Algeria	Tajikistan
50	Greece	Latvia	Tunisia
51	Albania	Tunisia	Belgium
52	Iceland	Trinidad & Tobago	Argentina
53	Algeria	Lebanon	Botswana
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57	Ghana	Cyprus	Romania
58	India	Morocco	Lebanon
59	Kazakhstan	Syria (Arab Republic)	Paraguay
60	Latvia	Qatar	Netherlands
61	Korea (Rep.)	Jordan	Pakistan
62	Pakistan	Macedonia (Republic)	Russia
63	Sri Lanka	Peru	Macedonia (Republic)
64	Tanzania	Albania	Indonesia
65	Ireland	Libya/GSPLAJ	Algeria
66	Lebanon	Finland	Cyprus
67	Taiwan, China	Iceland	Czech Republic
68	Peru	New Zealand	Thailand
69	Saudi Arabia	Sri Lanka	Israel
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76	Trinidad & Tobago	Nepal	United States
77	Luxembourg	Côte d'Ivoire	Hong Kong, China
78	Nepal	Kenya	Bulgaria
79	Hong Kong, China	Tajikistan	Iran (Islamic Republic)
80	Niger	Cameroon	India
81	Israel	Mongolia	Mongolia
82	Thailand	Tanzania	Australia
83	Namibia	Paraguay	Libya/GSPLAJ
84	Mongolia	Senegal	South Africa
85	Senegal	Uruguay	Kuwait
86	Morocco	Congo (Democratic Republic)	China
87	Jordan	Swaziland	Qatar
88	Serbia	Botswana	Saudi Arabia
89	Ethiopia	Niger	Trinidad & Tobago
90	Cyprus	Namibia	Taiwan, China
91	Botswana	Luxembourg	United Arab Emirates

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World Energy Council
Regency House 1-4 Warwick Street
London W1B 5LT United Kingdom
T (+44) 20 7734 5996
F (+44) 20 7734 5926
E info@worldenergy.org
www.worldenergy.org

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