

Global Electricity Initiative

2014 Report



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This report has been drafted by the GEI project team consisting of the World Energy Council, World Business Council for Sustainable Development, Global Sustainable Electricity Partnership and the Project Partner Deloitte Africa, Southern Africa Office.

This report is a summary of questionnaire responses and statements by utility leaders. It does not necessarily reflect the individual views of all participating utilities.



Foreword by the Chair

Modern society could not exist without a reliable, clean and affordable supply of electricity. Electricity is a basic prerequisite for economic and social development, health, education and other aspects of human life. During the last two decades, substantial changes have taken place in the electric power sector. While in the past utilities based their strategies on predictable and stable conditions, today the industry – which is still highly regulated – is facing frequently changing regulatory and environmental frameworks. In addition, utilities are exposed to contradictory priorities and signals from different stakeholders, such as regulators or customers.

These developments have prompted three of the world's largest energy and sustainability networks to join forces and establish the Global Electricity Initiative (GEI) to support and showcase electrical utilities' efforts to ensure reliable electricity supply, improve energy access and mitigate or adapt the impacts of climate change. The World Energy Council (WEC), the World Business Council for Sustainable Development (WBCSD) and the Global Sustainable Electricity Partnership (GSEP) launched the initiative at the COP18 meeting in Doha in 2012. The GEI builds on the work spearheaded by the South African utility Eskom, presented at the COP17 meeting in Durban at the end of 2011.

The GEI aims to build an international community of electricity industry leaders. The regular surveys the GEI is conducting will record and share information, main trends and issues as well as best practices. Moreover, the GEI expresses the voice of the industry and conveys the messages of sector leaders to policymakers and provides input into other WEC activities, including the Energy Trilemma.

The main findings of this survey, coming from countries that together account for more than 80% of global installed generation capacity, are as follows:

- ▶ Universal access to electricity will not be achieved by the target date 2030 set by the United Nations Sustainable Energy for All (UNSE4ALL) under the current 'business as usual' scenarios. But it can happen if, and only if, governments, industry and the international community undertake immediate concerted action.
- ▶ Utilities are investing significant financial resources in the development of new, renewable, and other carbon-free technologies. However, the world will have to continue to rely on fossil fuels for power generation for many decades.
- ▶ Long-term thinking, stable and clear regulation, strong collective commitment and a meaningful carbon price are important factors to be taken into account when deciding to redirect investment. Climate change is already a reality today and the focus will now be placed on adaptation as much as mitigation.
- ▶ Utilities are often exposed to contradictory expectations and signals from governments, industry, consumers and other stakeholders. As the electricity sector is still a regulated industry, clear and consistent messages and directions from the regulator are required.
- ▶ Ensuring security of electricity supply remains the number one priority for utilities.
- ▶ The energy-water nexus and competition for land are becoming major issues.

Finally, I would like to extend grateful thanks to all utilities for their participation in the survey and their contributions to this report. The support from the Project Partner Deloitte Africa, Southern Africa Office has been indispensable in compiling and processing survey questionnaires and developing the contents of this report. I also extend my gratitude to the core team of executives from the three partner organisations who have produced the final report. My very special thanks go to the WEC for hosting the GEI secretariat and demonstrating powerful leadership in bringing forward the GEI.

The next GEI survey will focus on a few selected topics emerging from the present survey, for example, regional integration, energy-water nexus, future fuel mix in the context of the increasing shares of renewables or the integration of intermittent renewables into the grid.

The effects of a growing population, such as the development of infrastructure and services and their associated impacts on the environment, will lead in a change how we produce and consume electricity. The findings of this report provide fact-based information as a basis for leaders in politics, industry and civil society to take meaningful decisions. They also highlight the areas in which further action and commitment are needed to achieve the appropriate goals. In addition, the findings showcase the way forward to increase electricity access in a sustainable and affordable manner. The GEI will be spearheading and facilitating the electricity sector's change to a new business model that is already on its way.

Philippe Joubert
Executive Chair



Message by the United Nations

Two major challenges that the global community must come together to confront now is ending energy poverty and mitigating the effects of climate change. In other words, we must ensure that the developing world have access to clean, affordable, reliable and modern energy services and the industrialized world, reduce energy-related carbon dioxide emissions that threaten global prosperity and security.

Transforming the current inequitable and unsustainable global energy system will require sustained political efforts as well as the participation of many stakeholders including governments, the industry, the private sector, civil society and multilateral development partners among others to ensure everyone is able to manage their lives and thrive economically.

Sustainable Energy for All is about partnerships. Achieving our three global targets in order to create an energy revolution requires that we work closely with the Global Electricity Initiative. That the world's largest energy and sustainability networks have joined forces means they understand that energy is a pre-requisite for sustainable development and is needed for powering our economies. We could not ask for a better partner.

As energy sector stakeholders, they account for over 80 percent of the world's electricity supply. Access to modern energy services, lighting, refrigeration, and clean water is essential in nearly every sector; in health care, it is more than that – it can mean the difference between life and death. Every time you switch on your light, television, mobile phone, refrigerator or any device that relies on electricity in your home or office, give thanks to this group.

The power sector has a critical role to play in providing universal access to energy for almost 1.3 billion people living mostly in developing Asia or Sub-Saharan Africa and in rural areas without access to electricity and another 2.6 billion people rely on traditional use of biomass for cooking and heating purposes. This can be done by expanding links to the existing grid and by deploying mini-grid and off-grid systems and through the use of renewables which will also help to mitigate climate change and make improvements in energy efficiency.

In my capacity as the Secretary-General's Special Representative for Sustainable Energy for All and chief executive of the initiative, I welcome the Global Electricity Initiative as we work together to ensure shared prosperity for all citizens, protect the environment and ensure sustainable socio-economic development and provide sustainable energy for all. As United Nations Secretary-General Ban Ki-moon says, "energy is the golden thread that connects economic growth, increases social equity, and an environment that allows the world to thrive." Together, we can do it!

Kandeh K. Yumkella
United Nations Under-Secretary-General
Special Representative of the Secretary-General and
Chief Executive Officer for Sustainable Energy for All

Global Electricity Initiative Partners

Bringing secure, affordable and clean energy to all people in the world requires an effort on a global scale. The utilities have the necessary know-how, the best practices and an access to financial resources to make this happen, provided adequate support from policymakers, businesses and consumers.

The Global Electricity Initiative (GEI) is a unique partnership between the World Business Council for Sustainable Development (WBCSD), the World Energy Council (WEC) and the Global Sustainable Electricity Partnership (GSEP). It was established to demonstrate the action undertaken by the utilities to improve energy access and help mitigate climate change consistent with the objectives of the UN Sustainable Energy for All initiative.

Long-term thinking, stable and clear regulation, strong collective commitment and a meaningful carbon price are important factors to be taken into account when redirecting investment. Utilities are making large investments in new, renewable and other carbon-free technologies. The electricity sector is engaging in a major revision of its traditional business models and generation mix in an effort to meet these objectives. The GEI helps to showcase the best practices currently in use.

The GEI is an initiative which based on the worldwide industry surveys and the visions of the industry leaders helps to scale up and accelerate the ongoing sustainability projects around the world. The GEI represents an important milestone for the sector to move forward on sustainability and this is why our three organisations have joined forces to support this exceptional initiative.

Martine Provost
Executive Director
GSEP

Peter Bakker
President
WBCSD

Christoph Frei
Secretary General
WEC

Contents

1. Executive summary	6
Why GEI?	7
Main findings... ..	10
2. Report 2014.....	11
Survey 2014	12
<i>Electricity access and security of supply.....</i>	<i>13</i>
<i>Resources and technologies</i>	<i>18</i>
<i>Economics and policies</i>	<i>27</i>
<i>Affordability</i>	<i>30</i>
<i>Efficiency</i>	<i>32</i>
<i>Adaptation and mitigation.....</i>	<i>36</i>
<i>Land and water use</i>	<i>43</i>
<i>Stakeholders</i>	<i>45</i>
3. Conclusions	47
Acting now.....	48
<i>GEI utilities – working together to transform the electricity sector.....</i>	<i>48</i>
4. List of figures, tables and best practice examples	49
List of figures	49
List of tables	49
5. References.....	51

1. Executive summary

A comprehensive survey of electricity utilities around the world, was conducted as a part of the GEI activities in 2014, covered countries that together account for over 80% of global installed generation capacity (see Figure 1). The survey confirms that:

- ▶ The goal of providing access to energy for all people in the world by 2030 set by the UNSE4ALL shows insufficient progress, particular in Asia and Africa. This goal will not be achieved, unless governments, industry and the international community undertake immediate concerted action.
- ▶ Renewables and other carbon-free technologies will continue their strong growth and their share in the fuel mix will increase, as they are expected to help reduce carbon emissions and complement utilities' supply of electricity from conventional energy sources. Nevertheless, the fuel mix of the GEI utilities between 2015 and 2035 will still be dominated by fossil fuels, primarily coal and natural gas.
- ▶ For the large-scale deployment of renewables and other carbon-free solutions, the introduction of advanced new technologies such as energy storage, smart grids or carbon capture and storage (CCS), needs to be accelerated and some regulatory barriers should be removed.
- ▶ The CO₂ price will need to increase considerably to bring about a significant shift in investment decisions. Long-term thinking, commitment and a meaningful carbon price are important factors to be taken into account when deciding to redirect investment.
- ▶ To manage climate change effectively, investment in adaptation is as important as in mitigation, hence investment in adaptation research and development will need to increase.
- ▶ Frequently changing and sometimes contradictory regulations and expectations from different stakeholders, including governments, industry and consumers are inhibiting efficient management of utilities. Clear, long-term, consistent and transparent ground rules are required.
- ▶ Providing reliable supply of electricity to customers is the main business for utilities. To remain efficient and competitive, utilities are closely monitoring developments in their operating environment and adjusting their business models to reflect new emerging challenges. Currently, many utilities are focusing on regional integration to enhance energy security and increase integration of renewables.
- ▶ The growing land and water requirements are becoming major issues, not only in the markets where utilities operate, but also globally. This will affect the development of new power generation projects and other infrastructure.

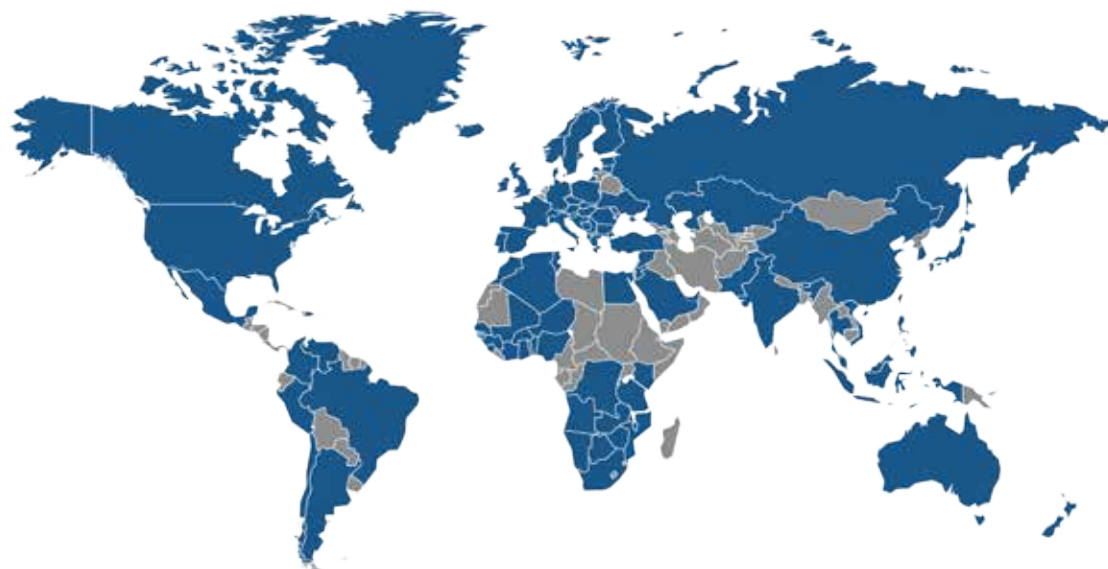
The report also showcases best practice examples from around the world

Why GEI?

These challenges have to be addressed globally and by all stakeholders. The GEI provides the unique global forum where utilities from all over the world can exchange best practices and learn from each other. Electricity utility leaders can use the GEI to share their visions and ideas with their peers and policymakers. By bringing together utilities from all around the world, the GEI facilitates contacts between utilities from countries representing all levels of economic development and this helps identify performance-improving solutions and new business opportunities.

The GEI encourages governments and global electricity industry leaders to join forces and help spread a sense of urgency and the need for immediate action. The GEI utilities and their leaders call for a deeper and stronger dialogue and information exchange with government bodies and other stakeholders. By providing the unique opportunity for knowledge sharing, the GEI is inviting all stakeholders to join the global electricity community.

Figure 1: Countries of the GEI participating utilities (in blue)



The GEI project is strongly supported by the electricity industry leaders from all regions of the world and the work is guided and supervised by the board of top level industry executives.

Table 1: GEI Industry Leaders Advisory Board

Name	Company	Country
José da Costa Carvalho Neto	Eletrobras	Brazil
Thierry Vandal	Hydro Quebec	Canada
Liu Zhenya	State Grid Corporation	China
José Antonio Vargas Lleras	Codensa	Colombia
Hervé Machenaud	EDF Group	France
Peter Terium	RWE	Germany
Richard Lancaster	CLP Holding Group	Hong Kong
Arup Roy Choudhury	NTPC	India
Sam Amadi	Nigerian Electricity Regulatory Commission (NERC)	Nigeria
Evgeny Dod	RusHydro	Russia
Saleh H. Alawaji	Saudi Electricity Co.	Saudi Arabia
Steve Lennon	Eskom	South Africa
Nicholas K. Akins	American Electric Power	US
James E. Rogers	Duke Energy	US

In recent years, energy has become a daily feature in the media around the world. Be it energy poverty, climate change, air quality, mobility, access to water, heating or cooling, practically all aspects of modern society are connected to or directly depend on energy. Energy provides many useful services, but it also brings along a number of challenges. This is the first time in history when electricity utilities from six continents come together to face the challenges and exchange ideas on common issues.

Electricity demand is growing strongly all over the world, and it is expected that in the coming decades over 90% of this demand growth will come from the developing countries. In these countries, rapidly rising incomes, the shift from rural to urban areas and significant increases in industrialisation and mobility will result in many years of high growth in electricity consumption.

The WEC in its work on World Energy Scenarios projects the annual electricity demand to increase up to 53.6TWh (Jazz Scenario) and 47.9 TWh (Symphony Scenario) by 2050 compared to 22TWh in 2011. This increase is equivalent to the total annual electricity demand of a country like Belgium or Finland.

This would also mean investment requirements for electricity generation of between US\$19 trillion (Jazz Scenario) and US\$25 trillion (Symphony Scenario). If the history is anything to go by, the demand will grow even faster than expected in the high growth scenarios, as for example the total global electricity production increased from 6,100TWh in 1973 to 13,200TWh in 1995 (~46% over 22 years) and from 13,200TWh to 22,200TWh in 2011 (~60% over 16 years).

Today, the need for new generation capacity is particularly acute in developing countries with low electrification rates. Furthermore, in many countries, electricity generation facilities are ageing and need to be replaced. Some estimate indicates that, by 2020, the world would need to add at least 2,000GW of new generating capacity and further 1,000GW to replace the facilities due to be retired within the next decade. Energy projects have long lead times and require high amounts of long-term financial commitments. This does not align with the current volatility and the short-termism of the markets. Moreover, volatile signals from the financial markets do not leave much room for making long-term strategic decisions.

In the last two years, electricity utilities from all regions of the world were invited to participate in the GEI survey of the power-generating sector across all regions. Utilities with more than 1,000GW installed generation capacity, representing roughly a quarter of the total global installed generation capacity, responded positively and submitted questionnaires. The data and information in this report are based on the GEI survey of utilities, interviews with CEOs of major electricity companies and WEC's own research. The case studies and statements of the electricity industry leaders have been provided by the utilities.

The sections of this report that are specific to the utilities which participated in the survey are called 'GEI utilities'. This is to distinguish from the general information about electricity utilities where 'non-GEI utilities' are referred to as 'utilities'.

Main findings ...

All

GEI utilities point out that ...

adaptation to current and future climate change is as important as mitigation measures to avoid further climate change.

However, investment in adaptation research and development needs to increase.

96%

of GEI utilities indicate that ...

energy storage technologies are a crucial success factor, especially for growing share of renewable energy sources.



78%

of GEI utilities state that ...

land requirement is becoming a major issue. This could affect the development of new power generation projects and infrastructure.

73%

of GEI utilities believe that ...

smart grids/smart meters are key for smoothing the integration of renewables.



61%

of GEI utilities indicate that ...

water requirements will increasingly be a challenge. GEI utilities are working with key stakeholders and conducting water conservation initiatives to address this challenge.

%

100

90

80

70

60

50

97%

of GEI utilities agree that ...

consumers are not willing to pay higher prices for non-carbon electricity than for fossil fuel based electricity.



94%

of GEI utilities report that...

security of supply is the priority implementation focus area

81%

of GEI utilities indicate that ...

there is a regulatory requirement for energy efficiency in most countries of operation.

In many countries, due to the economic climate and upward cost pressures from government policies to lower carbon emissions, utilities could have **difficulties to cope with further reduction in sales and loss of revenues resulting from energy efficiency policies.**

62%

of GEI utilities are ...

facing a challenge of integrating intermittent renewables into their electricity systems.

However, there have also been a few success stories in Europe, North America and Asia.

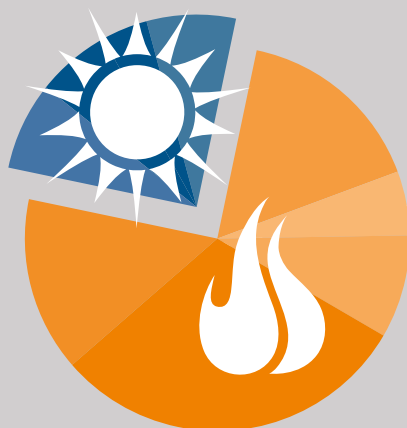
44%

of GEI utilities are ...

evaluating the feasibility of Carbon Capture and Storage but do not consider it commercially viable at present.



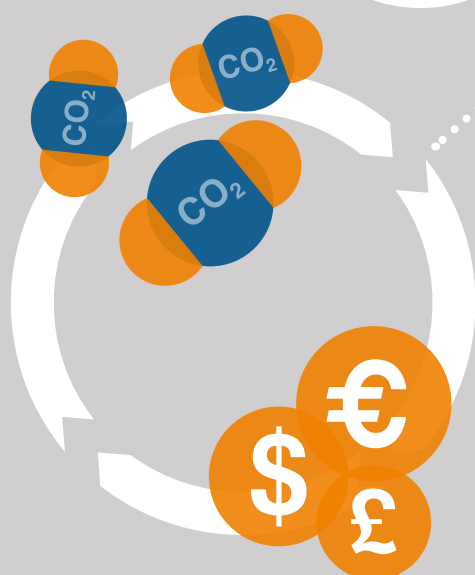
... and key messages



Renewables and other carbon-free technologies are expected to have a **growing** share in the fuel mix as a means of reducing carbon emissions and complementing the provision of electricity from traditional energy sources. However, the **fuel mix** of the GEI utilities between 2015 and 2035 will still be **dominated by fossil fuels**, primarily coal and natural gas.



Despite their ongoing efforts to increase electrification rates, GEI utilities think that **universal access** to electricity in Africa and Asia is **unlikely** to be achieved **by** the target date of **2030 under the business as usual scenario**.



GEI utilities indicate that the **carbon market** based mechanisms still carry a **lot of uncertainties**. These uncertainties could slow the pace of the future development of renewable and other carbon-free technologies and energy transition in those countries that mostly use market based mechanisms. The GEI utilities operating in the countries which have introduced some sort of a carbon price, report that CO₂ prices that would lead them to change their technology portfolio mix and investment vary project by project. Some utilities indicate that the projected **CO₂ price** would need to **increase considerably** to bring about a significant shift in utility **investment and portfolio decisions**. Other factors than CO₂ relating to energy security and affordability also need to be taken into account.



It appears that all GEI utilities are exposed to numerous **contradictory priorities** and signals from various stakeholder groups who expect the utilities to address their expectations simultaneously. Today, GEI utilities' activities are largely regulated, including their mitigation activities. This has a negative impact on the investment decisions as the regulations often limit availability of technology choices the utilities can invest in.

Survey 2014

Energy is not an isolated economic activity; it is an essential component of the overall economic development. Utilities have to support economic and social goals in the countries where they operate, taking into account the growing scientific evidence of changes to the global climate and the focus on protecting the environment.

Moreover, sustainability for utilities is becoming broader than environmental sustainability, as it also includes energy supply sustainability (security of supply), financial sustainability and increasing access to electricity. Growing energy demand and declining public spending are further changing the roles of the government and private sector. In many countries, this reallocation of responsibilities creates an uncertain business and political environment with frequently changing and sometimes contradictory regulations and, in many cases, excessive demands on utilities.

The following issues have been identified as priority concerns in the countries where GEI utilities operate:

- ▶ Electricity access and security of supply
- ▶ Resources and technologies
- ▶ Economics and policies
- ▶ Affordability
- ▶ Efficiency
- ▶ Adaptation and mitigation
- ▶ Land and water use
- ▶ Stakeholders.



Thierry Vandal
President and Chief
Executive Officer
Hydro-Québec,
Canada

“Guaranteeing access to sustainable electricity for the greatest possible number of people is one of the biggest challenges of our time.

Demographic expansion makes this challenge even greater – the WEC predicts a population of more than 9 billion in 2050. The WEC estimates that, between now and 2050, the world will need to invest in the region of US\$19 trillion and US\$26 trillion in electricity generation alone.

Consequently, the timing of the initiative announced this year by the United Nations to make 2014–2024 the decade of Sustainable Energy for All is significant. The initiative recognises that access to energy has become a basic human right: energy is both the source and a consequence of development. Among its objectives, the UN initiative aims at doubling the share of renewable energy in the global energy mix.

It is reassuring to see that a continuous dialogue is engaged among policymakers and industry leaders to explore strategies that help to ensure the provision of sustainable and affordable electricity and energy for the greater benefit of all.

The GEI coordinated by the WEC has a unique role to play in this broad-based effort to transform the world’s electricity systems.

In documenting and sharing best practices of utilities in various regions of the world, it provides a roadmap to electricity leaders in their endeavours to increase electricity access in a reliable, affordable and sustainable manner. Hydro-Québec, a world leader in hydropower and sustainable development, is proud to support this initiative.”

Electricity access and security of supply

Highlights from the survey

- ▶ 54% of GEI utilities view electricity access as a priority.
- ▶ 84% view universal access as being compatible with environmental sustainability.
- ▶ 66% indicate that increasing access is in line with ensuring financial sustainability.
- ▶ Grid extension is the main solution electricity utilities are using to increase access, while off-grid presents a growing opportunity mainly for remote rural areas for use with renewable energy sources.

The WEC’s World Energy Scenarios study indicates that, by 2050, approximately 319 million people in the world will not have electricity in the best case (Jazz Scenario) and 530 million (Symphony Scenario) in the worst case. This means that today, under the ‘business as usual’ scenario, the energy gap is not closing rapidly enough. This is particularly true in sub-Saharan Africa and South Asia, where the electrification rates are 31.8% and 70.4%, respectively. In other regions of the world, nearly all people have access to electricity.



Nicholas K. Akins
Chairman, President &
Chief Executive Officer
American Electric
Power, USA

“American Electric Power (AEP) is fundamentally changing the way it operates and manages its business. This business has become one of optimising resources and focused capital allocation in the midst of substantial structural and technological shifts within the United States (US) energy landscape.

The utility of the future has seven key characteristics: a balanced, more diverse and less carbon-intensive resource portfolio; an entrepreneurial and engaged workforce committed to continuous improvement; a more modern, efficient electrical transmission grid that can handle new technologies; the ability to constructively influence regulatory and public policies; customers whose needs are met or exceeded; investors who seek consistent dividends and earnings growth; and strong, trusting relationships with the communities it serves and other stakeholders with whom it works.

I believe that a combination of issues in the US – the emerging Environmental Protection Agency carbon dioxide emission regulations, the questions around capacity markets, and the physical and cyber threats that our facilities face – are significant challenges to our business that must be dealt with. We are on a path to become less carbon-intensive as our generating capacity shifts from 61% coal and 23% natural gas in 2014, to 49% coal and 28% natural gas in 2026. We continue to work with regulatory and government officials to ensure that any regulations achieve the right balance between environmental protection, fuel diversity and cost to our customers. At the same time, we are actively engaged in securing our facilities from physical and cyber attack.

As an electric power company, AEP provides an essential service, and our social responsibilities extend beyond our employees to our customers, communities and the general public. We are making the electric grid more secure, resilient and capable of handling modern-day electricity demands.

Having a national energy strategy would help us to achieve the balance we need on these issues. Electricity impacts people’s lives deeply, and so does the lack or unreliability of it. The electric grid is a social safety net providing the foundation for progress in our society. It can be strained by uncoordinated government policies and actions. We must correctly weigh environmental stewardship measures with the need for a balanced resource portfolio that provides energy security and affordable electricity prices for our customers. As a country, we must address how we deal with the social safety net of our electric power grid. AEP will continue to be actively and positively involved in developing sound public policy for the benefit of our customers and the US.”

To advance provision of access to electricity, strong leadership and focus on immediate priorities are needed within the world development community. Unless a concerted action is undertaken by national governments and the international community, the 1.2 billion people currently estimated as having no access to electricity and 2.6 billion without access to clean cooking facilities will remain largely the same until 2030.

To provide electricity to these people by 2030, a global investment of around US\$1 trillion is required. This means an increase of more than 50% in annual investment compared to 2009. However, in the historical context, this amount is in line with past investments, as generally the energy sector investment accounted for 3–4% of the world gross domestic product (GDP) which in 2009 was US\$49 trillion.



**Dr Leonhard
Birnbaum**
Member of the
Executive Board
E.ON AG, Germany

“The future will be completely different from anything we know today. Not only in Germany, but globally we will see many more renewables, more decentralised generation and a higher degree of customer-producer interaction. The generation mix in various countries will certainly differ from each other – depending on natural resources, on the existing generation portfolio and the willingness of customers to pay. And it will have a strong integrative focus, i.e. also covering increasingly transport and heat. Finally, numerous new players will enter the value chain driven by opportunities of new technologies. Whoever neglects or misses these trends will find his/her position threatened. Whoever can adapt to these changes will have a sustainable competitive edge.”

The two main solutions used in electrification programmes across the world are grid extension and off-grid generation located in or near the place where energy is consumed. Off-grid generation is often used in conjunction with renewable energy sources but can also be used with conventional sources.



Hervé Machenaud
Group Senior
Executive Vice
President, Generation
EDF Group, France

“Today’s world is facing three energy challenges: the strong growth in energy demand; the security of supply; and environmental protection.

To tackle these challenges, we have to bear in mind that electricity is a basic commodity for everyday life which cannot rely merely on market rules or on public subsidies.

In the coming years, the construction of new coal plants using clean coal technologies will remain the main response to the growth of electricity consumption. Nuclear power plants and large hydraulic facilities will also keep their key role for low-carbon power generation.

At the same time, the development of decentralised energies, mainly renewable, requires rethinking of the electrical system in a more local approach by taking into account the intermittent power and changing consumption patterns, for example, in transport.

Meanwhile, subsidised and intermittent energies are relevant if they can cover the peak demand or associated storage capacity. Otherwise, they only lead to more CO₂ emissions and falling wholesale tariffs.

To address these issues, EDF, the first electricity operator in the world, is betting on innovation and expertise to promote low-carbon and competitive energy, relying on nuclear power, renewable energies and energy savings.”

There are a number of other issues which are impeding the attainment of universal access:

- ▶ Inadequate policy and regulatory frameworks
- ▶ Poor coordination of electrification programmes
- ▶ Lack of purchasing power in rural communities to pay for the cost of services
- ▶ Insufficient technical capacity and shortage of skilled workforce
- ▶ Poor road infrastructure in project areas.

The GEI utilities which operate in countries that have an electricity access gap are working hard to bridge this gap and usually have either urban and/or rural electrification programmes in place. These programmes demonstrate solutions that have been developed to overcome the current challenges. Examples of the solutions are:

- ▶ Working together with governments, participating in the development and implementation of enabling regulatory frameworks.
- ▶ Establishing purpose-specific funds to finance electrification programmes and to mitigate tariff impacts on the poor.
- ▶ Pooling of funding from various sources, including government, financial institutions, utilities and other funders.
- ▶ Developing and establishing social tariffs.
- ▶ Training and using skilled local workers.
- ▶ Supplying electricity at no cost to low-income consumers in rural areas.

Best practice examples

Aboitiz Power – off-grid solution

SN Aboitiz Power partnered with the De La Salle University's Center for Micro-Hydro Technology for Rural Electrification to build a 15-kilowatt pico hydropower plant for the local government unit and community members of Barangay Parina, Calanasan in Apayao Province.

The joint project was handed over to the customer in May 2014. It serves 50 households in Barangay Parina and is managed by the community to provide electricity to small, remote, off-grid areas and also support the national government's energy programme. A pico hydro project generates about 5 to 10 kilowatts of electricity and is generally used in remote communities that need only a small amount of electricity. This project serves as a secondary but important power source to support socioeconomic activities in the area.

Électricité de France (EDF): decentralised rural electrification programme

Given South Africa's fast urban and economic growth, off-grid rural areas need to develop as well. Founded in 2002 during the Johannesburg Earth Summit, KwaZulu Energy Services (KES) provides energy to the populations of KwaZulu-Natal and Eastern Cape, helping to reduce poverty and promote education and public health. The aim is to:

- ▶ improve the quality of life in remote villages by bringing electricity to sites that cannot be connected to the grid
- ▶ develop rural economies while protecting the environment (provide clean, safe and affordable energy to rural dwellers living in areas where the provision of grid supply is uneconomical)
- ▶ help reduce carbon emissions from the use of gas for lighting and cooking
- ▶ promote the development of sustainable small businesses and the creation of employment opportunities, especially in areas where opportunities are currently scarce.

Since 2002, the company has installed nearly 22,000 photovoltaic (PV) kits, benefiting around 135,000 people and creating about 100 jobs. Funding has been provided by customers, investors (for example, the German development bank KfW Group), the South African government, global energy producer Total, and Calulo Investments. The two main rural electrification projects are:

- ▶ KwaZulu-Natal project launched in 2002, installing about 10,000 solar home systems (contract with the government was signed on 15 August 2002).
- ▶ In 2007, the project was expanded to include the province of Eastern Cape where about 30,000 homes benefitted from the installation of solar home systems (contract with the government was signed on 17 July 2007).

KES is a rural electrification services company owned by EDF (50%), Total (35%) and, since December 2009, the South African firm Calulo Investments (15%).

Customers are provided with 50 watt-peak (Wp) and 65 Wp PV kits to use for lighting, radios, televisions, recharging mobile phones, and other purposes. KES installs, maintains and manages these kits under 20-year concession agreements. Most solar panels are manufactured locally by Tenesa, Tenesol's South African subsidiary. Customers pay a monthly fee that is partly subsidised by the state (under the Free Basic Electricity policy), which varies from one municipality to the next. Customers buy energy services as they need them.

EDF is engaged in other rural electricity services companies (RESCO concept); this concept was created by EDF together with ADEME – the French Environment and Energy Management Agency – to enable a wide variety of services to be provided through locally registered companies managed by locals. EDF identified five strategy drivers:

- ▶ **Partnership:** A number of factors make partnerships with local communities necessary: the magnitude and diversity of needs; the complexity and wide range of solutions needed; and the need to understand local cultures. EDF systematically seeks out local private and public partners, with a focus on the ability of projects to be easily replicated.
- ▶ **Continuity:** Knowing that cycles are long in the energy sector, EDF commits to long-term energy access projects.
- ▶ **Innovation and experience sharing:** EDF participates in projects that are sufficiently large and offer adequate visibility, making contributions in the form of innovation, training and development. Regardless of the type of model, EDF emphasises training, because all energy access projects require the sharing of knowledge and experience to become established and successful.

- ▶ **Profitability:** The goal is for companies to become financially profitable to guarantee their own viability and attract other investors.
- ▶ **Learning from experience:** EDF reports on its successes and failures alike, considering both to be learning experiences. The group regularly evaluates its efforts and this helps to enhance its expertise.

EDF has identified key success factors including having a clear programme framework, developed by public authorities. Also important is training of local staff on all business aspects (commercial, technical, and so on) with a properly integrated health and safety strategy for the local population and the use of local manufacturers.

China Shenhua Energy Company: access projects in China

China Shenhua's aim is to supply the 2.73 million people who are currently without electricity in China by end of 2015: connecting 1.54 million people to the grid and supplying 1.19 million people with solar power. The company has investment plans for 583 projects to make this happen. Provincial people's government is the main body responsible for solving the problem of people without electricity in the region. To help, the provincial government set up a leading group to implement relevant action plans. Each project has a unit that is responsible for project implementation, operation and maintenance management.

Resources and technologies

Highlights from the survey

- ▶ 100% of GEI utilities believe that fossil fuels, mainly coal and natural gas, will for decades remain the dominant energy source for power generation.
- ▶ 62% of GEI utilities are developing solutions to the intermittency challenge of renewables and some are already successfully integrating renewables into their electricity systems.
- ▶ 96% of GEI utilities agree that energy storage technologies are a crucial success factor, especially for growing the share of renewable energy sources.

Fossil fuels today account for nearly 70% of the total electricity output and are widely used by utilities to meet a significant part of power demand, especially in economies with large coal reserves. While developed economies are moving towards less energy-intensive economic structures, developing economies are increasing their industrial production which leads to growing demand for electricity. This poses a challenge with regard to carbon emissions.

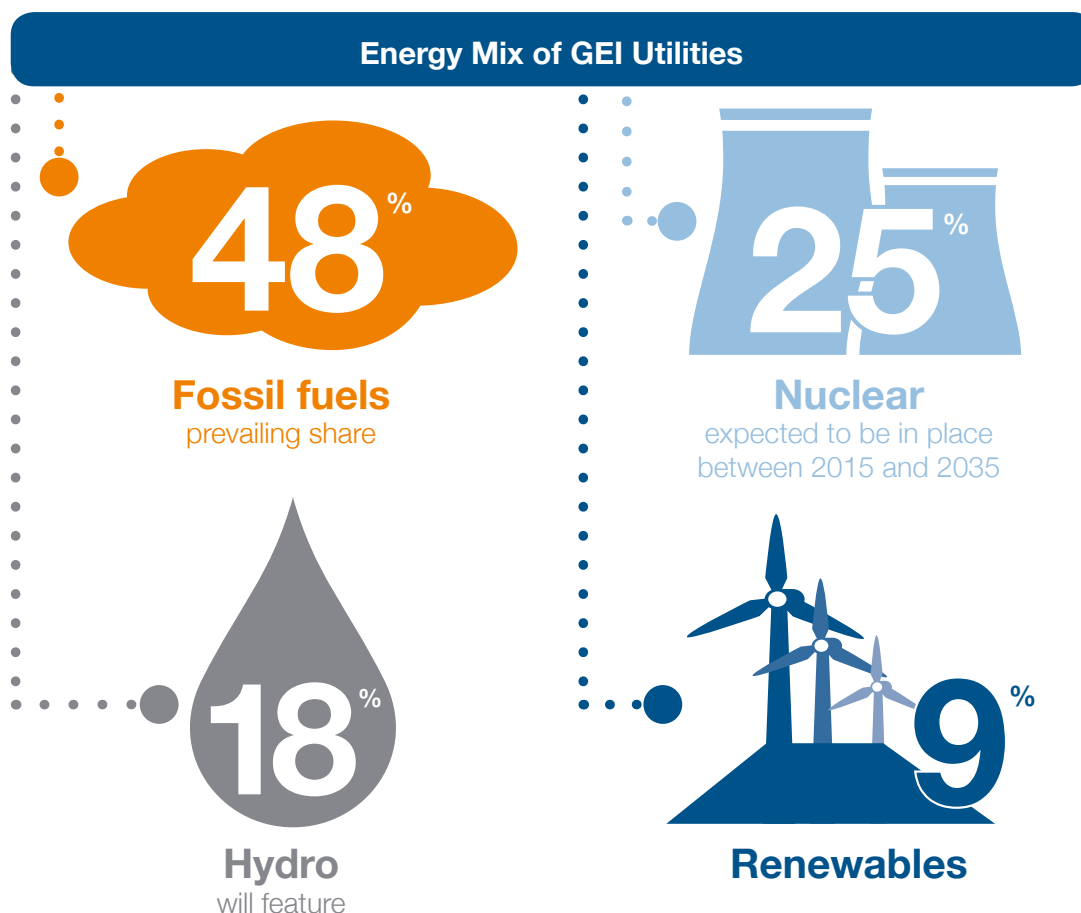
Power plants belong to the most capital-intensive investments and are designed to run for decades, therefore, any transition to low-carbon or carbon-free sources will take decades. An accelerated phase-out of conventional thermal power plants would leave many utilities with stranded assets.

In developing countries in particular, energy policies have to take into account a number of factors related to the total capital cost of electricity generation options which should include the cost of maintaining safety, resettling of communities and the availability of local skills to construct and operate the plants. New, smaller hydro and nuclear plants are being designed to reduce their high capital costs and to address the impact on communities and safety risks.

Utilities have made progress in integrating renewable energy such as wind and solar into their systems. More development is needed to achieve the full benefits of these carbon-free but intermittent energy sources which today are not suitable for base load generation.

Work is being done on meteorological forecasting, controlling renewable energy generation output, flexible dispatch plants, transmission lines that have the capacity to decrease variability, demand-side response measures and electricity storage. The ongoing technology developments are supporting the integration of renewables into grids by introducing voltage limits for the current required by the grid, when excess generated energy is available from renewable sources. Another possible solution is distributed generation, since it can soften the impact of the variability of renewables on the grid.

Figure 2: GEI utilities energy mix



Strategic decision-making in corporations takes into consideration a number of factors, including:

- ▶ the way in which availability of resources influences generation technology selection
- ▶ deployment of new, more efficient technologies which are being developed to reduce greenhouse gas emissions, to improve the integration of renewables and to build resilience
- ▶ the development of electricity storage.

Many countries have few resources that can be used for generation of electricity and this means that they have limited technology choices. For instance, in countries that are semi-arid, the potential for hydropower generation is low. The availability of primary energy resources can also vary within a country. In addition, the type of resource that is used for generation depends, not only on its availability, but also on other factors such as the technologies that are used, the availability of infrastructure, finances, professional skills, secured reliable electricity, public opinion and other factors.



Zhenya LIU
Chairman
State Grid
Corporation of China

“State Grid Corporation of China (SGCC) has devoted itself to developing state-of-the-art transmission technology, such as Ultra High Voltage transmission and smart grid technology, to accommodate large-scale transmission of renewable energy, encourage electricity penetration transmitted from afar to replace coal and oil consumption, thereby cutting carbon emission and reducing current excessive dependence on coal transmission and local power balance. SGCC also envision in future a global energy internet that consists of backbone grid interconnection across continents, within continents and countries worldwide, therefore delivering bulk clean energy from the North Pole and the Equator to customers worldwide.”

A variety of technologies are required to build and operate different electricity generation plants. New technologies are being developed to create electricity systems that are flexible and resilient and to reduce greenhouse gas emissions. These new technologies are oriented towards balancing a more diverse energy mix which is necessary due to the deployment of renewables and for maintaining the reliability of supply.

Technological developments are also taking place within the transmission, distribution and end-user segments of the energy value chain. On the distribution side, the design of the optimal system monitoring and control are examples of the recent technological developments. This is complemented by improved safety and asset protection procedures and the compliance with safety rules for the remote grid access. The building of resilience is another key aspect of the technological development, for example, building the resilience of grids so as to minimise damage during extreme weather events, meeting customer expectations of service reliability. On the end-user side, technologies are being developed to improve customers' use of electricity, achieve savings and improve customer understanding of price-setting mechanisms that are linked to the time that electricity is used. Utilities are also researching and developing electricity storage solutions at the point of use by consumers. The GEI utilities are actively tackling the challenge of integrating renewables in electricity systems by developing appropriate technologies.



Evgeny Dod
Chief Executive Officer
JSC RusHydro, Russia

“RusHydro is the largest power generation company in Russia, a country which ranks among the top five hydropower producers in the world. Our company is strongly committed to the promotion and maximisation of the use of hydropower in electricity generation. This commitment is well reflected in an ambitious investment programme which aims at a significant increase of our annual output of hydropower, mainly in the Far East of Russia. Developing the energy infrastructure in remote territories, along with promoting a smart and efficient use of energy, will enhance industrial development and lead to economic growth and social prosperity.”

In the last few years, we have accelerated the pace and commissioned 8 GW of new hydropower, which is nearly three times more than the volume of hydropower that has been launched during the last decade. Moreover, we are undertaking an extensive modernisation programme of our existing hydropower plants. With its robust hydropower supply and capacity, RusHydro is uniquely positioned to help Russia adapt and mitigate climate change, while ensuring a balanced energy generation matrix that is at the core of sustainable development. Hydropower is not only a non-emitting technology but also the most efficient source of electrical energy, making it a powerful ally in the reduction of the country's carbon footprint and the global fight against climate change.

Moreover, in a context where utilities are defining comprehensive adaptation strategies towards potential severe weather events due to climate change, hydropower offers a wide range of reliable solutions to minimise their impact on the economy, ensure safe living conditions for the population and protect the environment.

I believe the GEI is playing an important role in helping disseminate best practices such as those used in our industry to address climate change.”

Figure 3: GEI utilities technologies

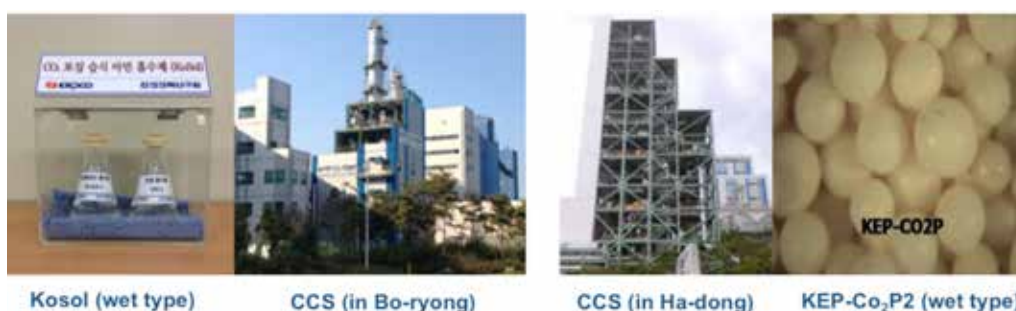


Best practice examples

Korea Electric Power Corporation (KEPCO): carbon capture and storage (CCS)

Korea Midland Power Company (KOMIPO), a subsidiary of KEPCO, has a 10 MW CCS test bed plant, the first of its kind in South Korea. This is a positive step towards thermal power plant operation without the accompanying greenhouse gas (GHG) emissions. The project is run by KOMIPO, South Korea's Ministry of Trade, Industry and Energy and other Korea Electric Power Corporation generating companies. The pilot project won the National Green Technology Award in 2011 and 2012.

Working with the Korea Electric Power Research Institute (KoSol), the project developed the wet-scrubbing type amine absorbent KoSol which can remove nearly 100% of CO₂ from a 10 MW post-combustion CCS plant. KoSol is considered to be the world's highest functional carbon dioxide absorber. Using exhaust gases from thermal power plants, the research institute plans to increase the capture function of the CO₂ absorber and enhance the reliability of the process through long-term, continuous operation. The tests will provide basic design data that can be scaled-up from 100 to 300 MW, widening the practical application of the absorber.



Tata Power: carbon emission project

The 4,000 MW Mundra Ultra Mega Power Project (UMPP) is near the port city of Mundra



in the State of Gujarat in India. This is the first UMPP in India with five units of 800 MW each of supercritical technology and is considered to be the most energy-efficient, coal-based thermal power plant in India today. It will outperform existing, traditional plants in lowering greenhouse gas (GHG) emissions. The GHG emissions generated per kWh will be about 750 grams of CO₂ per kWh, as

compared to India's national average of 1,259 grams of CO₂ per kWh for coal-based power plants. The world average is 919 grams of CO₂ per kWh, while the average for OECD countries is 888 grams of CO₂ per kWh. The plant will emit 23.4 million tonnes of CO₂ per year, less than the 27 million tonnes that a plant of similar installed capacity would emit if using conventional, less efficient energy technology.

Compared to any other subcritical power plants in India, this project will avoid burning 1.7 million tonnes of coal per year, thus averting carbon emissions of 3.6 million tonnes per year.

Kansai Electric Power Company: CO₂ recovery pilot plant

In collaboration with Mitsubishi Heavy Industries, Kansai developed a technology for separating and recovering CO₂ from the exhaust gases produced by the thermal power plants using a process of chemical absorption. The research resulted in the successful development of the world's most efficient CO₂ absorption solvent, KS-1, a superior replacement for the conventional chemical absorption solvent generally used, monoethanolamine.



The CO₂ recovery pilot plant is based at liquefied natural gas (LNG)-fired Nanko Power Station, Osaka Prefecture, Japan. The plant was constructed with a capacity of 2 tonnes of CO₂ per day by Kansai in 1991 to develop a proprietary technology for CO₂ recovery from flue gas. The company's partnership with Mitsubishi Heavy Industries resulted in the development of KS-1. The solvent has been used in a high performance CO₂ recovery process called the Kansai Mitsubishi Carbon Dioxide recovery (KM CDR) process in 11 commercial plants with the capacity to process up to 500 tonnes of CO₂ per day worldwide.

CO₂ recovery pilot plant at LNG-fired Nanko Power Station

State Grid Corporation of China (SGCC): strong and smart grid

Since 2000, SGCC has developed clean energy by creating what it calls a 'strong and smart' grid. By focusing on technical expertise and research, the company has established itself as a world leader in technologies such as Ultra-High Voltage (UHV) AC/DC overvoltage control, transmission technology, bulk integration of renewable energy, large-grid cooperation security and coordination control. The company initiated and participated in the formulation of 20 international standards. Some of its projects (two AC and four DC UHV) have become the main channels for large-scale, outgoing transmission of hydropower in southwest China and the thermal, wind, and solar power in west and north China. To date, these projects have delivered over 200TWh of electricity through safe and stable operation.

The group has completed 298 smart grid pilot projects in 29 categories, including 14 projects on smart grid dispatch and control, distribution automation, and power data collection. For example, the company's demand response system demonstration

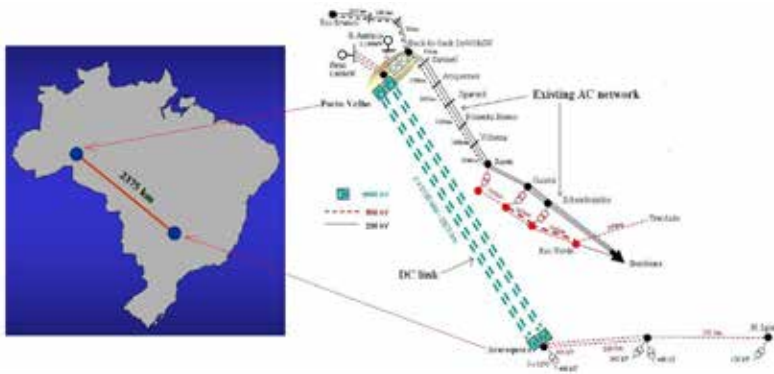
and feasibility study examined the role of the demand response of the smart grid in energy conservation and emissions reduction. It helped to significantly increase energy efficiency in China and reduce the total carbon emissions from coal-based power generation.

This pilot project involved three buildings and three industrial enterprises. The results show that 15% of load reduction can be achieved through demand response (mainly air-conditioning load); and 20% or more by optimising the production processes. With similar projects in Tianjin, it is estimated that 5% of peak load reduction can be realised with substantial economic benefits.

With the support of foreign funds, the project encourages domestic enterprises to cooperate with renowned enterprises to achieve breakthroughs in energy efficiency (for example, demand response) by introducing internationally advanced concepts and critical technology in energy efficiency.

Demand response has been widely implemented in many countries and has achieved good results by 'peak shaving' (reducing energy use by the utility during peak hours when the tariffs are highest). As it is restricted by many factors, such as China's basic national conditions, demand response has just emerged in China, so the country lacks the relevant technologies and expertise. Cooperation between domestic and foreign enterprises is key to the country learning best practice and cultivating the talents and technologies to help it develop in the demand response field, and maximise peak shaving and energy efficiency improvement.

Eletrobras: transmission project



Eletrobras participates in major generation and transmission projects under construction in Brazil – sometimes through special purpose entities (limited companies or partnerships). Many are hydroelectric plants found at the main tributaries of the Amazon river, such as the Santo Antônio and Jirau power plants in the Madeira river, and the Belo Monte power plant in the Xingu river. The company also participates in studies regarding the hydro potential of the Tapajós river basin, the São Luiz do Tapajós dam and Jatobá power plant (around 8 GW of installed capacity).

The Brazilian National Interconnected System is a large hydrothermal interconnected transmission grid that allows the transfer of bulk power/energy between the various river basins of the country over large distances to cover all geographical areas. This ability to transfer energy across regions, with diverse hydrologic dynamics of the various river

basins throughout the year, allows savings in terms of installed generating capacity of 20%. Research and development of technology are also important for managing the system in a sustainable form.

Since 1984, Eletrobras has operated a high-voltage, direct current (HVDC) system for the integration of the Itaipu 50Hz hydroelectric generator into the grid, with a total length of 1,612km, consisting of two bipoles of 806km with a voltage level of 600 kV DC. In 2013, another HVDC system was added, connecting the national grid to energy coming from the Madeira river hydropower plants complex – Santo Antonio and Jirau large hydro run-of-river power plants (7,200 MW of total installed capacity from those two power plants in their final configuration). This HVDC system will have a total length of 4,750km, consisting of two bipoles of 2,375km. This is the largest HVDC system in the world operating at this voltage level. The system started operating in 2013 and was developed as a public-private partnership (PPP).

Also under a PPP framework, in 2017 a new set of HVDC systems, using the ultra-high voltage (UHV) level of 800 kV, will start operating to integrate the Belo Monte hydropower plant (11,230 MW of installed capacity, also in the Amazon rainforest region) into the national interconnected grid. In its final configuration, this 800 kV HVDC system will consist of two bipoles, one to the south eastern region and the other to the north eastern region of the country. The first one is the Xingu-Estreito HVDC system (2,100km), the first HVDC system in the Americas to use the UHV level.



State Grid Corporation of China (SGCC): energy storage

SGCC has the National Wind and Solar Energy Storage and Smart Transmission Demonstration Project with an installed wind power capacity of 500 MW, photovoltaic (PV) capacity of 100 MW and an energy storage system of 70 MW.

It is designed to develop a large-scale combined wind power, PV and energy storage power generation system to address the problem of using single wind or PV power generation. It is difficult to predict and control an unstable and intermittent supply. By making renewable sources more reliable, the project hopes to encourage their wider use in a mixed power grid.

The combined power generation strategy stabilises the power supply, allows multiple-mode operation and reduces the volatility and intermittent nature of renewable power generation. The combination of active power sources helps enhance the efficiency of transmission lines. Under certain operation modes, it can regulate the differences in supply, reduce power curtailment when supply is at a low, and provide more economic benefits. The fast response has contributed to safe and stable operation of the entire power grid.

An integrated high-precision wind and PV power forecasting technique contributes to the stability of power generation, helping to deal with wind shortages and improving confidence that the power grid can accommodate renewable energy and reduce the reserve capacity needed for peak load supply.

To date, the project has produced a smooth output of renewable power generation.

If this technology is widely applied, the capacity reserve for peak load units can be significantly reduced, providing a strong case for the use of renewable energy



resources. The application of monitoring systems will help ensure reliable battery storage of the scale required by the power grid. This will encourage the use of 100 kW battery storage equipment and mega volt (MV) battery energy storage systems.

Overview of the National Wind and Solar Energy Storage and Smart Transmission

Economics and policies

Highlights from the survey

- ▶ Economic development and population growth are the primary drivers of increasing energy demand.
- ▶ Protection of the environment in some countries is not a top priority in the assessment of project costs.
- ▶ Ensuring security of supply is a paramount priority to utilities

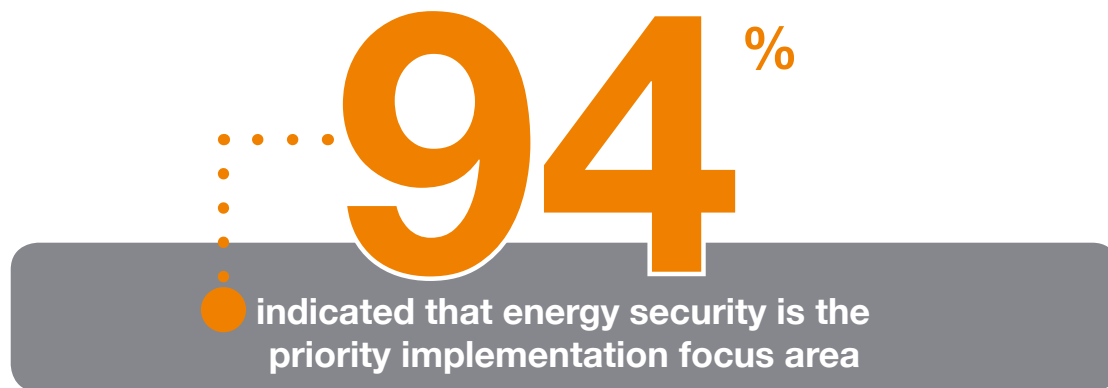
Some experts believe that developing countries will benefit most from the development of renewable energy technologies as they will be able to leapfrog several technological levels and directly meet energy supply and energy access requirements in a sustainable way.

The economic situation in the countries of operation is a key indicator for utilities when they develop business strategies and make operational decisions.

Economic considerations tend to be the main driver of many efficiency initiatives. These initiatives, however, often remain secondary due to the cost considerations.

In countries that have liberalised electricity markets and that are experiencing economic downturns, many utilities are affected by decreasing demand, growing competition from alternative energy sources, resistance from customers and regulators when it comes to price increases and the significant cost of the mandatory obligations to deploy renewable energy as a priority. Therefore, utilities are reviewing their business models, now focusing more on regional integration.

Figure 4: Security of supply



All utilities operate under some form of regulation and/or policy guidelines. This is true even to those that operate in liberalised markets. Many utilities are experiencing policy and regulatory uncertainty which can be divided into two categories.

- ▶ Utilities operating in the countries with significant growth in the deployment of renewable energy are particularly exposed to policy and regulatory uncertainty regarding the **price of carbon**. The countries with unbundled markets set a carbon price, taking into consideration its affordability.
- ▶ Studies indicate that, in countries that achieved the highest growth in the deployment of renewables, **successful policies** were a defining factor.

They demonstrate that, in order to be effective, the regulatory framework should be based on target setting and clear and simple renewables guidelines. Another success factor is development of incentives and rules that create a stable operating environment and thus security for investors. However, to succeed in future, the carbon price should be internalised by utilities and therefore become the key driver of investment decisions. In Europe and Brazil for example, utilities are now required to auction quotas to be able to purchase allowances.

When introduced to minimise the adverse impacts on the market, subsidies should be targeted to those who need them and for a limited time only. These restrictions will help keep subsidies at an acceptable level and avoid developing dependence on handouts and also help with the balance of payments. India offers an example of adverse consequences where, a few years ago, government subsidies for energy were as high as the annual investments required for the entire Indian energy sector.



**José da Costa
Carvalho Neto**
Chief Executive Officer
Eletrobras, Brazil

“Eletrobras generates, transmits and distributes electric power, always researching technologies that might make our business ever more sustainable. On the global scale, new perspectives arise all the time. Shale gas exploitation, ultra-high voltage transmission, renewable energy integration, distributed generation and smart grids are some of the main challenges towards the future. In this context, I believe regulation and corporate governance will play a decisive role in the incorporation of new technologies in our everyday life. We are thinking and working on it. After all, that is what will maintain our position as one of the best and largest electric power companies in the world.”

Best practice example

Eletrobras: sustainability challenges in hydropower projects

One of the greatest challenges for energy companies is the need to reinvent themselves and to grow and develop in a sustainable way – for business, the society, and the environment.

The Eletrobras companies operate and manage 180 power plants, including 45 hydroelectric plants, 125 thermoelectric plants, eight wind farms, and two nuclear power plants. These power plants account for 34% (42,987 MW) of the Brazilian's total generation – 89% of which comes from sources that emit low levels of greenhouse gas.

Eletrobras is committed to working responsibly to generate, transmit, and distribute energy, causing minimum interference to the environment and the surrounding areas where it operates. All its projects are based on studies that identify the compensation, mitigation or remedy actions needed. Projects have environmental licences and work in consultation with local groups that benefit from integrated social responsibility and improvement programmes related to housing, sanitation infrastructure, and urban mobility.

One of the main challenges for Eletrobras is to tap the energy of the Amazon's rivers while preserving the ecosystem of the region known as the 'lungs of the Earth'.

Tucuruí is the largest plant and is 100% Brazilian. It is an innovative project that includes several social-environmental actions that benefit the surrounding communities. More than US\$160 million are being invested in public health, education, environment, urban development and family agriculture programmes. The plant established a river lock system that brought progress to the region by making the Tocantins River navigable, reducing the transportation cost of local products.

In the same region, the Belo Monte plant project is a result of more than three decades of studies and social debate to find the best way of reducing environmental, social and economic impacts. In its original proposals, the reservoir occupied an area of 1,200 km². In the final version of the plans, the area was reduced to 550 km², with 300 km² of riverbed. The Belo Monte plant design does not flood native areas; it protects them from the construction work and roads needed at the plant. While energy production will be lower, the environment will stand to gain.

The Belo Monte project also includes a sustainable development plan for the entire basin. The result is a balanced project with more modern technology and a much lower impact on the environment. The project will generate energy and direct and indirect jobs for more than 100,000 Brazilians. The local population, who live in precarious conditions, will also benefit from infrastructure, sanitation and public facilities.

Affordability

The setting of electricity prices by utilities takes into account their impact on customers and the broader socio-economic effect. For most companies, electricity prices are the key cost drivers and affect not only profitability but also the costs that are passed onto consumers through the pricing of products and services and thus impact on economic measures such as inflation. Electricity prices also affect the cost of basic services to the public. If cost-reflective tariffs cannot be set due to affordability considerations, then utilities often require support from governments in order to achieve progress in priority areas such as the deployment of renewables using feed-in tariffs, various incentives and other measures. Sometimes due to insufficient support such initiatives are phased in over a longer time period. In addition, it is often required that utilities build in subsidies and other forms of financial support for specific customer groups.

Some of the factors that will be affecting electricity prices globally and hence affordability and social aspects include:

- ▶ the need for utilities and investors to obtain a reasonable return on their investments in the electricity business
- ▶ regulations that can affect the levels of tariff increases and are based on the regulator's decisions on what can be considered reasonable and fair returns to the utility.

Figure 5: Prices and subsidies



Efficiency

Highlights from the survey

- ▶ 81% of GEI utilities report that energy efficiency programmes are largely driven by regulation.
- ▶ 69% of GEI utilities consider energy efficiency an important component of the solution to climate change.
- ▶ Most of the GEI utilities are implementing end-user energy efficiency programmes for better energy management and the reduction of carbon emissions.

Regulation and climate change policies often require utilities to implement energy-efficiency programmes within their plant operations, buildings and other infrastructure to bring about a reduction in carbon emissions. They often include the establishment of end-user energy-efficiency programmes. These energy-efficiency initiatives are driven either by economic measures, such as taxes, or through the setting of standards that utilities must comply with.



Dr Saleh Alawaji

Chairman
Saudi Electricity,
Saudi Arabia

“Arabia witnesses rapid development with increasing needs for people’s comfort. More than 50% of electricity consumption is residential. Electricity total installed capacity is about 60 GW. The annual average rate of growth for electricity is around 8%. Based on that growth, the forecasted required installed capacity could reach 120 GW by 2032. This situation creates significant challenges for the power sector to finance and operate the service.”

Recently, energy policies in Saudi Arabia focus on energy efficiency on both supply and demand sides. On the supply side, the best possible energy-efficiency standards are imposed, and the latest technologies are used for the new generating facilities, such as super critical steam boilers and highly efficient, new combined cycle blocks. For the existing power generation facilities, a carefully planned programme is executed to enhance power generation efficiency through implementing a retirement programme, converting the simple cycle gas turbine units into combined cycle. In addition, energy policies aim to diversify the primary energy sources to achieve the best mix by considering all the possible options, including renewable and nuclear energy resources.

On the demand side, aggressive energy-efficiency programmes are implemented to reduce annual peak demand and energy consumption. That includes load management programmes, such as time-of-use tariffs, direct load control, interruptible tariffs, and load management. Efforts include mandatory standards and a labelling system for household appliances to ensure better efficiency, enforcing thermal insulation in buildings, as well as conducting awareness campaigns for energy conservation and efficiency.

In the next two decades, these efforts are expected to contribute effectively to huge saving in energy consumption and reduction of the peak load. Consequently, helping to maintain a sustainable environment and clean development.”

A significant proportion of GEI utilities report that their energy-efficiency programmes operate within guidelines that are contained in regulations, government policies and strategies. Figure 6 indicates that regulation is the key strategic reason and driver for GEI utilities' investment in energy efficiency. Responding to the question 'Are energy-efficiency programmes a real solution to climate change?', 69% indicated that this was the case. Utilities' energy-efficiency programmes cover energy efficiency in their operations and reduction of technical losses. In addition, an emphasis is placed on the promotion of energy efficiency to their customers as this is considered to be where the highest energy savings can be achieved.

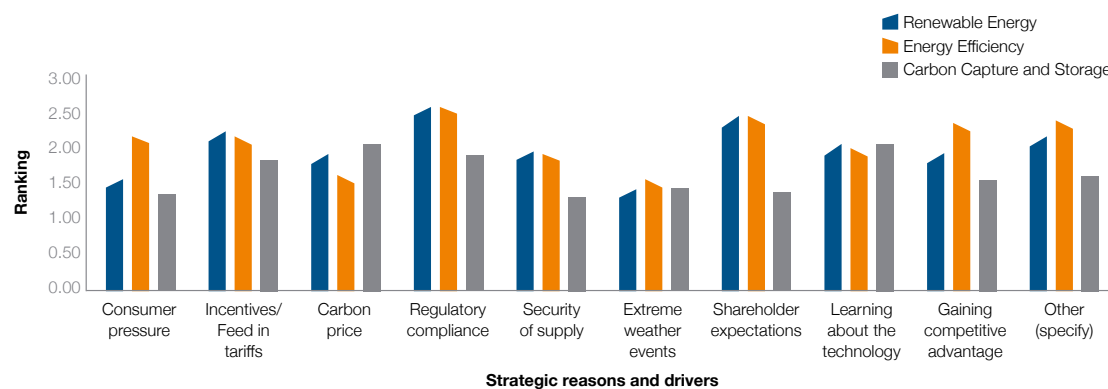
GEI utilities' internal energy-efficiency programmes include measures such as improving the heat rates of boiler units at coal stations, energy audits at power plants and buildings, and the implementation of initiatives that focus on lighting, heating, ventilation and air conditioning. Some of the GEI utilities indicate that construction of new ultra-supercritical coal plants offers the potential for a significant improvement in energy efficiency.

In order to promote the reduction of electricity consumption by customers, GEI utilities are rolling out a variety of programmes (strategic reasons for investments in these programmes are shown in Figure 6). Most of the GEI utilities have voluntary, customer energy-efficiency programmes and they have implemented customer education and awareness initiatives. Examples of the initiatives are the creation of energy-efficiency indexes to monitor energy savings achieved by consumers and it is reported that energy savings are used to motivate further behavioral changes. Other measures include:

- ▶ provision of free energy-efficient appliances and lighting
- ▶ promotion of the replacement of traditional shower units with solar heating systems
- ▶ introduction of intelligent electric meters
- ▶ implementation of school education programmes to educate teachers and students about energy-efficiency concepts
- ▶ execution of free, in-home energy assessments that are designed to help customers learn how their homes use energy and how they can save on monthly bills.

Demand-side management initiatives are used by GEI utilities to manage peak demand and are aimed at customer segments that contribute to peak demand pressures. Often the demand-side management programmes contain incentives to encourage customers to reduce their demand during the peak period so that GEI utilities can more easily manage supply and demand during times of peak demand.

Figure 6: Strategic reasons and drivers for utility investment programmes





Emmanuel V. Rubio
 Chief Executive Officer
 SN Aboitiz Power,
 Philippines

“I envision a competitive and efficient electricity sector that provides reliable service at reasonable cost to households and businesses towards powering national development. SN Aboitiz Power is strongly committed to contribute to that by operating and investing in renewable energy facilities using an integrated approach that factors in economic, social, and environmental impacts. In the short term, we ensure our power plants operate sustainably by complying with environmental regulations and engaging communities in environmental programmes such as watershed management and efficient water use. As a responsible investor, SN Aboitiz Power contributes to local taxes and voluntarily provides funds that go to host community projects, including missionary electrification, livelihood and health.”

Best practice examples

Edison SpA: energy efficiency

Edison SpA was one of the first utilities in Italy to invest in the promotion of energy efficiency at an industrial facility. Usually, when the industrial group finances the construction of a generating facility and assumes all related risks, Edison manages the facility at the group's location, selling to renewable energy on terms that are competitive to the market.

In 2010, Edison worked with MAPEI (a company that supplies products for the building industry) on the construction of a photovoltaic (PV) system on the roofs of three industrial buildings at MAPEI's Latina facility. This system supplies about one-quarter of the customer's energy needs, avoiding polluting emissions equal to about 11,000 tonnes of CO₂ over the system's useful life.

Construction of this facility was entirely financed by Edison, which is in charge of the operations and maintenance for the plant's useful life (20 years). The system's 4,708 PV modules occupy about 140,000 square feet. The facility's total capacity is close to 1 MW (at peak), for an average annual production of 1,100,000 kWh. Almost all of this energy is used to power electrical equipment at the MAPEI factory. The PV system covers about 25% of total requirements, as MAPEI's own average consumption is about 850 MWh/year, compared to the site's total consumption of 3,300 MWh/year.

TAQA: Abu Dhabi waste-to-energy

Waste-to-energy is one of the cleanest sources of energy and one of the most efficient ways to treat municipal solid waste. TAQA (Abu Dhabi National Energy Company) is developing Abu Dhabi's first waste-to-energy power plant, capable of generating enough electricity to power more than 20,000 households. The plant is expected to process approximately 1,000,000 tonnes of municipal solid waste a year and convert it into 100 MW of clean alternative power.

The development of sustainable energy and waste infrastructure technologies, as well as diversion of waste from landfills, are goals identified in the Abu Dhabi Economic Vision Plan 2030. TAQA works alongside the government of Abu Dhabi and the Center of Waste Management – Abu Dhabi to provide a solution to the increasing volume of waste produced each year in the capital. The plant will have stringent anti-pollution controls with emissions falling well within globally recognised guidelines such as the Waste Incineration Directive.

In 2013 TAQA began inviting companies to pre-qualify for the engineering, procurement and construction contract, due for tender in 2014. The plant is expected to begin operations in 2017/18. Key figures are:

- ▶ One million tonnes of municipal solid waste will be diverted from landfill sites per year.
- ▶ Seven million vehicle kilometres will be saved each year from reduced road haulage of waste to landfill sites.
- ▶ The plant will employ 100 workers.
- ▶ One million tonnes of CO₂ savings per year (taking into account emissions released from waste buried in landfill, transportation to dumps, and the size of the plant if it was powered by fossil fuels).



Adaptation and mitigation

Highlights from the survey

- ▶ Increased climate variability presents a growing challenge to utilities.
- ▶ Extreme weather events are expected to become more frequent.
- ▶ Adaptation techniques and building resilience are a key goal for utilities.
- ▶ Greater investment by utilities in adaptation and resilience is required, including research and development.

From the responses of some utilities, it appears that the carbon price has not been the main factor that the utilities have used to make decisions regarding their generation mix and investment programmes. This is because their fuel mix already has a significant proportion of clean or lower-carbon energy or because other factors are considered to be more important and are used to determine their investments in lower-carbon or clean energy, including feed-in tariffs and fiscal incentives, energy security and land restrictions.



Dr Arup Choudhury
Chief Executive Officer
NTPC, India

“Meeting the environmental performance expectations of the regulator and the society without compromising the interest of customers and shareholders is the demand of the day from the utilities. Resolving these conflicting demands calls for a proactive response from all the stakeholders.”

GEI, as a global community of utilities committed to sustainability, can emerge as the foremost platform for sharing best practices and strategies towards balancing the ‘energy trilemma’.

While continuing to focus on mitigation and adaptation strategies of the utilities, GEI could strive to work with the willing utilities to engage in benchmarking, leading to higher efficiencies and greenhouse gases mitigation.

As a leading power producer, NTPC is committed to adopting clean technologies and integrating multiple energy sources with innovative and eco-friendly technologies.”

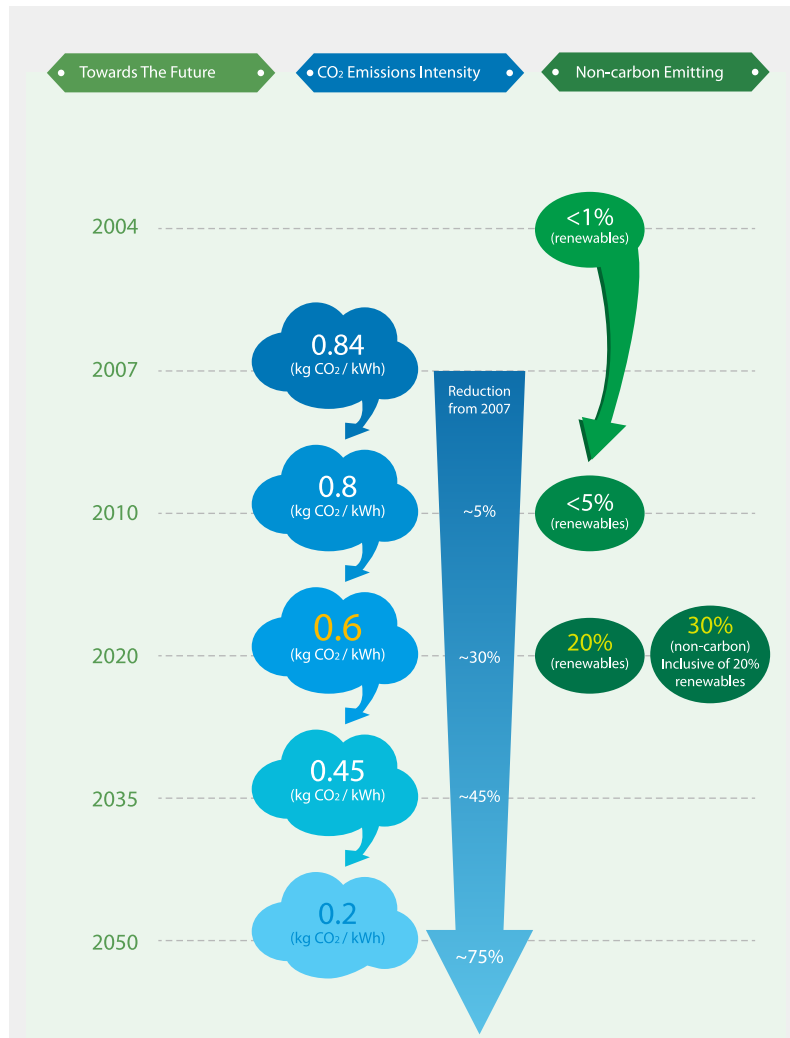
The GEI utilities that operate in Europe indicate that they have to buy the entire requirement of carbon credits through auction. The right price should be the price aligned with market fundamentals and with the abatement costs able to guarantee the remuneration of investments in low-carbon technology.



Richard Lancaster
 Chief Executive Officer
 CLP Group,
 Hong Kong

“If the world is to achieve a low-carbon energy future, businesses can take the initiative in setting carbon reduction and renewable energy targets as a best practice as CLP has done with our Climate Vision 2050, which sets us on a path to diversify our portfolio of energy investments. Nevertheless, governments must play their part in setting clear policies and providing strong support for businesses in achieving these targets.”

CLP Group’s Climate Vision 2050



Initiatives to develop resilience entail developing the electricity systems to withstand the impact of increasing weather variability and extreme weather events. In other words, reduce the vulnerability of infrastructure and other assets and minimise and mitigate risks to reliability of supply.

Changing climate conditions and weather patterns present an increasing challenge to utilities. Introducing adaptation techniques and building resilience into the network to maintain reliable power supply remains a fundamental goal for utilities. Initiatives by utilities to address climate change have traditionally focused on mitigation, use of nuclear, clean coal technologies or combined cycle gas turbines. Studies have found that increased emphasis is also being placed on adapting to climate variability and climate change and integrating forward-looking information about climate change into decision making.



Dr Steve Lennon
Group Executive
Sustainability
Eskom Holdings,
South Africa

“The terms ‘fast-changing’ and ‘electricity sector’ were hardly synonymous in the recent past but that has completely changed. The indisputable business case for sustainable development is the underlying factor for this revolution. No longer can the sector simply consider only least-cost technology. Electricity solutions need to tick many boxes – affordability, reliability, low carbon, social upliftment and resilience. The sector is pivotal in determining the success of global climate change aspirations and socio-economic development. The enablers include the right combination of policies, technologies and courageous decision making. As a leading utility in Africa, Eskom’s vision remains firmly ensconced in shifting performance and growing sustainably. Our involvement in national and international activities in this regard is but one way of making sure this happens. To this end, the GEI remains an excellent platform for utilities to share best practice and together tick all the boxes mentioned above.”

According to some observers, extreme weather events, such as Hurricane Sandy in 2012 which inflicted about US\$60 billion in damages in the North East of the United States, is the evidence of the need for an increased focus on adaptation. There has thus been a growth in interest by many electricity utilities in shaping a business adaptation response to climate change and, to this end, electricity utilities are engaging in a broad dialogue about adaptation with a variety of stakeholders, including local residents. It has been found that utilities are also increasingly implementing adaptation-related initiatives. However, compared to mitigation actions, adaptation initiatives are not as numerous and have lower investment levels.

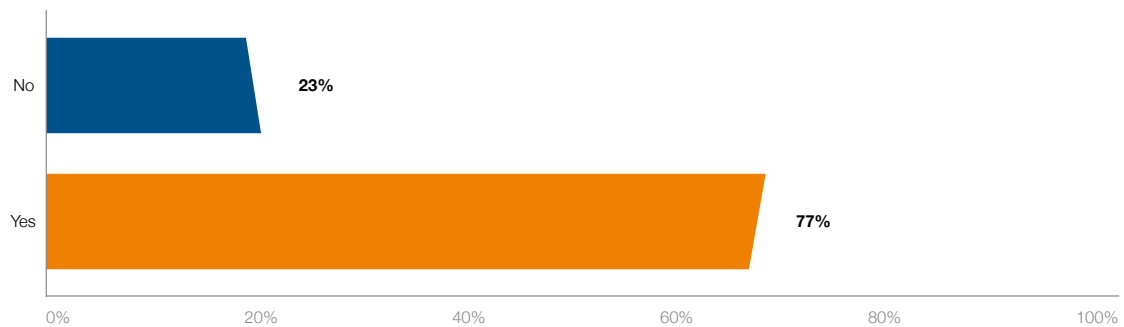
The lower rate of actual implementation of adaptation strategies and initiatives is compounded by high uncertainties relating to the probability, impact and timing of the extreme weather events. Researchers have generally found that adaptation initiatives are more evident in utilities that are operating in developed countries compared to those in emerging economies. However, even in the case of those utilities that are in advanced economies, adaptation measures are not planned or implemented in an effective, coordinated manner and investment levels in adaptation appear to be significantly lower than those pertaining to mitigation.

Although most GEI utilities view adaptation as being equally important as mitigation, 67% of the utilities that responded to the survey provided a ‘no’ to the question: *Is a significant portion of your utility’s R&D budget directed towards adaptation and resilience?*

Despite the lower focus on adaptation research and development (R&D) by GEI utilities, it is evident from their responses that adaptation is becoming part of their business strategies. Of the utilities that responded to the question *Has your utility experienced extreme weather conditions in the past 10 years?* 71% of GEI utilities indicated that they had, and that the extreme weather events have severely affected their operations and infrastructure and have caused power outages.

Weather and climate forecasting, either in the short or long term, is considered to be a key measure to build adaptation into a utility's operations. Most GEI utilities use weather and climate forecasting to ensure reliability of supply and continuity of operations. Partnering with national weather agencies seems to be a common development among GEI utilities so as to increase the robustness of internal forecasting measures. Issues such as timeliness, quality of forecasts and relevant data presented in an accessible format for use by electricity utilities have become crucial, for example, for demand-load forecasting and maintenance purposes. Most of the GEI utilities use weather and climate forecasting to ensure reliability of supply and continuity of operations (see Figure 7).

Figure 7: Percentage of utilities utilising weather and climate forecasting to ensure reliability of supply and continuity of operations



Being able to adjust rapidly and effectively to climate variability and climate change is a key feature of what are termed more resilient approaches to climate change. Most GEI utilities are following a risk management approach by assessing the physical vulnerabilities of the network, or specific plants. In other cases, utilities have undertaken significant investments to increase the robustness of systems and lines previously damaged due to extreme weather conditions, and to incorporate this practice into future infrastructural concerns. They are also working on changing the design and technical specifications of infrastructure and investing in climate change research, including forecasting systems, climate modelling and the introduction of early warning systems.

The level of preparedness with respect to business continuity when an extreme weather event occurs is high for GEI utilities across all regions. Of the utilities that responded to a question relating to the level of preparedness, 58% indicated a high level because they have early warning systems and emergency plans in place, they conduct regular simulation exercises, and provide training to staff on methods of protection and responses to emergencies.

For some utilities, government funding is available for projects and assessments on how to improve utilities' knowledge of the impacts of climate change and to strengthen the capacity of utilities and decision-makers to respond to extreme weather events, and to address major areas of vulnerability.

Best practice examples

CLP Group: learning from the past to plan for the future

This case study provides a description of the first phase of the initiative.

CLP Group has been experiencing asset damage and operational disruption across its Asia Pacific portfolio due to extreme weather events. In 2009 the company began a programme to assess the cost of this damage and decide how best to adapt.

In one country, a gas-fired power station is vulnerable to flooding. Adaptation measures implemented include:

- ▶ raising the floor level of buildings housing critical infrastructure
- ▶ building flood levees around low-lying parts of the site
- ▶ increasing drainage capacity and diverting cooling water pipes to access fresh water in case of saline intrusion.

A power station in Southeast Asia is vulnerable to high wind speeds and erosion. Coal storage domes and the coal conveyor were designed to withstand typhoon wind speeds of up to 60 metres per second (m/s) for up to three seconds but speeds have exceeded this threshold several times, damaging all the coal storage domes and disrupting supply. Recent research suggests worse is to come, with tropical cyclones intensifying by 2–11% by 2100, which could result in gust speeds of 100m/s.

A pilot study has identified several adaptation options:

- ▶ Commissioning a wave action study to estimate the maximum wave height during typhoons.
- ▶ Inspecting the tower on, or close to, the erosion/landslide risk slope.
- ▶ Reinforcing the base of the towers on, or close to, the landslide risk slope.
- ▶ Strengthening towers and transmission line sections to withstand strong gusts.
- ▶ Investigating emergency coal delivery by rail.
- ▶ Reinforcing the coal conveyor cladding.
- ▶ Protecting domes from water ingress.
- ▶ Reinforcing the fresh water pipeline and securing alternate sources.
- ▶ Increasing the drainage capacity on site.

CLP Group: super typhoon drills to build emergency preparedness

CLP Power Hong Kong conducts regular emergency typhoon drills, particularly ahead of Hong Kong's typhoon season.

More than 40% of its network is carried through overhead lines, while more than 700 transmission towers (at 400kV) form the backbone of its supply system. If a pylon is destroyed by strong winds or collapses because of a landslip, it can take several months for it to be restored to working order. Although a ring circuit design allows for an alternative pylon or supply point to maintain electricity supplies in the event of such

an emergency, the grid would be less resilient and it would be vulnerable to outages as a result of continuing bad weather or lightning strikes.

The super-typhoon drill in June 2013 simulated the collapse of a transmission tower during a typhoon and the construction of a temporary pylon, which would restore electricity 10 times faster than by repairing the damaged pylon. CLP Power has introduced an emergency restoration system for the rapid construction of temporary pylons and has identified 151 high-risk pylons and 74 slopes needing reinforcement.

CLP Power has also implemented a number of other measures to counter the potential impact of super-typhoons. These include installing smart switchgear (pre-programmed to support remote monitoring) on 11kV and low-voltage overhead lines that supply electricity directly to 160,000 customers, installing flood alert systems in substations and creating a typhoon response protocol and coordinating system.

CLP Group: improving climate resilience of power plants in phases

This case study provides an overview of the three phases of a CLP Group initiative to build resilience.

CLP Group has experienced increased asset damage and operational disruptions due to extreme weather events. In Taiwan, coal storage domes have been destroyed by typhoons, while floods have disrupted operations in India. In 2009, the utility began to assess the cost of this damage and interruption and determine how to adapt. The first phase identified some quick wins, including the cost-effectiveness of building resilience into the siting and design of infrastructure. The second phase explored the vulnerabilities of current fossil fuel assets and potential adaptation measures to protect them from extreme weather. In 2013, the utility began looking at renewable energy projects – two wind farms in India and a hydro project in China – to identify how vulnerable they were, and to examine if other renewable energy projects had demonstrated effective adaptation measures.

Hydro-Québec: level of preparedness

Hydro-Québec is a leading hydropower generator in North America. When an emergency affects more than one business unit, or when two units activate their province-wide emergency centres to deal with an incident, the utility deploys its corporate emergency plan and the representatives of all the company's units form the Coordination Committee (CC-PUC). To support the strategies and decisions of the CC-PUC, the Director of Corporate Communication takes charge of internal communications and coordinates public relations and external communications, providing guidelines and maintaining consistency across all community relations and public messages.

In emergencies, as during normal operations, the specialist communications teams handle relations with organisations, partners, and local and regional emergency responders. The corporate emergency plan governs planning and performance of:

- ▶ ongoing information and training on emergency measures for managers and responders
- ▶ drills to test the company's preparedness
- ▶ follow-up on recommendations for continuous improvement
- ▶ annual performance review in accordance with governance rules
- ▶ incorporating the best emergency measures management practices.
- ▶ The company is also responsible for the electricity portion of national civil security plan.

In the event of power outages, the strategy consists of restoring service to a maximum of customers as quickly as possible, considering public safety and a predetermined scale of priorities.

Eletrobras: level of preparedness

Eletrobras is a national, mainly hydropower and vertically integrated utility that operates in Latin America.

The utility has a high level of preparedness for emergency plans, related to large disturbances (partial or total) in the national power grid. In such cases, the emergency plan is provided and managed by the independent system operator in its country. The generation, transmission and distribution companies follow strict guiding principles. Precise and detailed procedures have been developed for emergencies in the national power grid. The emergency plan mitigates the effects of blackouts by implementing special protection schemes, such as load-shedding, to preserve the original topology, and maintain network loads during major unexpected disturbances. The plan also aims to reduce the time delay in restoring power supply.

As the country's interconnected power system has hydropower as its major generation source, the plan starts with key hydropower plants, to reach load centres in the main metropolitan areas as quickly as possible via a minimum secure transmission topology. Restoration procedures are practised in real time by operational personnel using simulated exercises. Back-up restoration options for different geo-electrical areas are tested, providing a guarantee of orderly recovery after an unlikely major system disturbance.

System operational staff are certificated according to ISO 9001 Quality Management standard. Operational personnel receive updated training and are tested regularly. Drills are also held once a year.

How the emergency plan works can be seen in the case of a major disturbance that occurred in the country's interconnected power system in February 2014. The disturbance occurred after the unexpected disconnection of a bulk 500 kV transmission trunk exporting energy from the northern region to the southern and south eastern regions. When the disturbance happened, the power system's automatic special protection and load-shedding schemes took over, recovering supply to most of the grid. Less than 7% of the supply to end-consumers was interrupted, totalling around 5 GW

of supply. The load-shedding scheme interrupted the electricity supply for some pre-selected consumers in 13 states and in the federal district, and this meant that more than 3.5 million end-consumer units had the supply of electricity interrupted by those special protection schemes. On the other hand, more than 92% of the load supplied before the disturbance could be kept under supply during and after the disturbance. The operational measures defined in the emergency plan allowed more than 90% of those 3.5 million or more end-consumers to have their electricity restored within 90 minutes.

Land and water use

Highlights from the survey

- ▶ Both electricity and water demand are projected to increase rapidly by 2035.
- ▶ Managing the energy-water nexus is a growing focus for utilities.
- ▶ The effects of weather variability and extreme weather events impact on this nexus.
- ▶ The availability of water will be an increasing challenge for many utilities.
- ▶ Utilities are putting in place initiatives to minimise their impact on water resources.

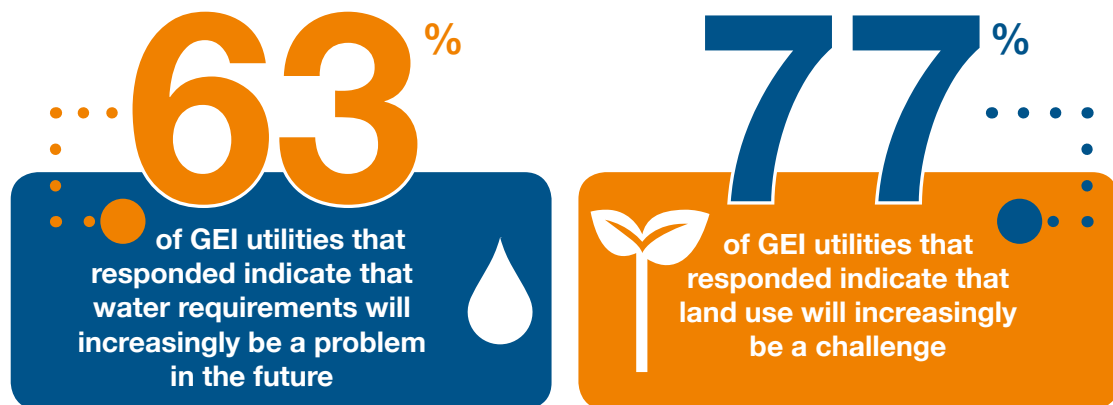
Global primary energy demand is projected to increase by 50% between now and 2030 and fresh water withdrawals are predicted to increase by 50% by 2025 in developing countries, and 18% in developed countries. According to the International Energy Agency (IEA), the energy sector accounts for about 15% of the use of water globally. As land and water resources will face increasing demand and growing limitations on supply, energy and water must be managed together to maintain reliable energy and water supplies.

The global increase in competition for water is the result of the physical scarcity of fresh water, a growing demand for water in the agricultural, industrial and residential sectors and declining fresh water availability. Contributing to these factors are the global population growth, technological changes, changes in consumption patterns and certain economic activities.

In addition to this, the pressure on the already stressed water resources in some areas is expected to be greatly exacerbated by the effects of climate change and variations in natural conditions. However, there are differences in the availability and increasing scarcity of water across regions and within countries. Some regions and countries will experience increasing availability of water and other countries within the same region will have decreasing availability. Regulation, infrastructure, available technologies and operating processes will also determine water availability and requirements for utilities.

Most GEI utilities expect that water requirements will increasingly be a problem in the future, however, the extent of the challenge varies for each utility depending on the local water conditions in the countries where they operate and the type of energy sources that they utilise to generate electricity.

Figure 8: Water and land use



Best practice example

CLP Group: water management

Water-related risk for constructing new power stations is an increasingly significant area of emerging risk management for CLP Group. This is because there are more opportunities to control future water use at the design or acquisition phases of power plant development. Once the plant is built or acquired, few opportunities remain for improvements in water use. For a variety of reasons, including site availability and planning restrictions, it may be difficult to build plants close to adequate supplies of water. For example, the group's most recent plant built in India is inland and several kilometres away from the nearest water supply. This meant a pumping station had to be built, as well as an overland pipeline, an onsite lagoon and a large water treatment plant. Given their anticipation of the potential increased risk in terms of water availability and access, CLP Group is also starting to look at new technologies for power plant water management such as dry cooling.

CLP Group is also exploring how, as water availability patterns change, competition for water could also affect their operations, particularly for cooling the plant. In addition, the potential for site flooding is an increasing concern. Sites located in areas prone to flooding need to take special precautions to mitigate the risk, for example, raising critical plant items on plinths.

CLP Group periodically runs the latest global water tool developed by the World Business Council for Sustainable Development and reports the results in their submission to the Water Disclosure Project (which helps to better understand the business risks and opportunities associated with water scarcity and other water-related issues, by increasing the availability of high-quality business information on this critical issue) as well as their annual, online sustainability report.

Stakeholders

Highlights from the survey

- ▶ Engaging with key stakeholders is increasingly important, especially in matters of financial viability for utilities and affordability for customers.
- ▶ Balancing stakeholder expectations with the obligation of ensuring reliable and secure energy supply is a priority for utilities.
- ▶ Good communication with stakeholders is at the heart of public acceptance and awareness.

Electricity utilities need to show the important role they are playing in society. In other words, they need to show how they are positively contributing to society. They must show awareness about their stakeholders' needs and deliver on these requirements or provide explanations to stakeholders as to why their expectations cannot be met.

The primary responsibility for utilities is to ensure reliable and secure electricity supply. This requires a long-term view and a strategy for activities, investments and technological developments. To be successful, utilities have to establish a dialogue with all stakeholders and develop a shared purpose with society that brings about buy-in, trust and, as much as possible, common action to address challenges that are facing communities and utilities themselves.



Dr Sam Amadi
Chairman and
Chief Executive Officer
Nigerian Electricity
Regulatory
Commission, Nigeria

“Sustaining an efficient and competitive electricity market in Nigeria from the ruins of a public monopoly that could only generate a mere 4500MW at best times is an exciting challenge. If we succeed in this challenge, we will be unleashing the creative potential of more than 170 million people and realising the hope of becoming an economic power that can end extreme poverty in Africa’s largest population and economy. For me, succeeding means: (1) increasing capacity in a sustainable manner; (2) enhancing clarity and efficiency of market structure; and (3) expanding access to millions of the unserved population.”

My conviction that a sufficient but sustainable electricity supply is both possible and essential in the world and Nigeria in particular, has been strengthened since my induction as a GEI (Industry Leaders’ Advisory Board) member and my subsequent interaction and identification with the WEC thematic objectives.

By devising and deploying contextualised and pragmatic smart regulations, Nigerian Electricity Regulatory Commission (NERC) under my stewardship, has been able to create a market structure that is efficient and investor-friendly. My strategic vision is premised on the fact that, through making the Nigerian electricity industry a most attractive global investment spot, we will be able to have the luxury of choices. It is through the availability of options that can enable us to wean the industry off fossil and other unsustainable, environmentally-unfriendly energy sources. This statement attests to my unflinching support to the GEI/WEC objectives and my determination to inculcate sustainability and diversity in the new Nigerian electricity sector which we regulate.”



Datuk Torstein

Dale Sjøtveit

Chief Executive Officer
Sarawak Energy,
Malaysia

“Sarawak Energy is implementing the Sarawak Corridor of Renewable Energy (SCORE) to create new opportunities for Sarawak and its people, by harnessing the state’s abundant energy resources to drive investment and employment by energy-intensive industries from around the world. True sustainability requires the people of Sarawak to secure the same life opportunities and living standards as people in developed countries.”

The full development of hydropower resources in the developing world is central to addressing real sustainability issues – but the imposition of selfish concepts of sustainability by anti-development groups represents a major risk. Significantly, the sustainability problems confronting the world today are mostly the result of exploitation of world resources by developed countries.

World standards of sustainability should not prevent development. It is immoral for developed nations to impose stringent standards of sustainability which they have never met themselves and which prevent local development in developing countries.”

3. Conclusions

Today, electricity can be considered a basic human need, just like water and food. Without electricity, and everything it brings, the world would be a considerably more hostile and less comfortable place to live in. At the same time, close to 1.2 billion people, or nearly 20% of all the people in the world, do not have access to electricity. It is an unacceptable reality for the global energy industry community, national governments, international institutions and multilateral bodies. The GEI is addressing this challenge and is actively collaborating with the UNSE4ALL initiative.

The research and discussions with the global electricity industry leaders undertaken within the GEI framework and summarised in this report indicate that, in many countries, governments have not yet defined their role in facilitating development of their energy sectors and the necessary legal conditions and other regulations that would allow businesses to make sound and sustainable long-term decisions. The real cost of electricity generation and distribution is still often obscured by subsidies, unrealistic carbon prices or other price-distorting schemes.

More cost-effective, low-carbon and carbon-free technologies are now available and this will allow utilities to secure supplies while addressing environmental issues. However, to achieve the final target of universal access to electricity, a much greater effort is required from all – governments and industry alike. Stable regulatory conditions and a realistic as well as transparent pricing system are the necessary prerequisites for developing functioning electricity markets. The main conclusions of the present report highlight the industry priorities identified through the GEI and it is vital for governments and civil society to understand the realities of the energy industry which suggest that:

- ▶ universal access to electricity can be achieved by the target date of 2030 if, and only if, governments, industry and the international community undertake immediate, concerted action
- ▶ renewables and other carbon-free technologies are expected to continue their strong growth and their share in the fuel mix but, at the same time, the world will continue its reliance on fossil fuels, coal and natural gas, for power generation for decades
- ▶ the time for combatting climate change is running short and the focus should now be placed on adaptation as much as mitigation
- ▶ the emerging shortages of water and land for energy should be addressed without delay before the situation gets out of hand.

Acting now

To reach universal access to electricity in an efficient, effective and straightforward way, the GEI utilities stress that governments must create an enabling operating environment for the industry that will support the necessary transformation of the sector. This should include:

- ▶ transparent legal and regulatory frameworks and sustained and effective policies and regulations to facilitate long-term planning and investment, including development and demonstration of new technologies
- ▶ policies promoting price signals to reflect real costs and, when necessary, time-limited and strictly targeted subsidies.

GEI utilities – working together to transform the electricity sector

The GEI utilities are already working on various new and fundamental issues such as electricity storage, smart grids or efficiency of the entire power system. They will be playing an important role in transforming the electricity sector. The GEI utilities consider these technologies as crucial success factors, especially for the integration of a growing share of intermittent renewable energy sources. Existing pump storage hydropower plants, for example, have been in use for many years. In this context, smart grids are important for the integration of intermittent renewables as well as the interconnection of transmission grids. Furthermore, the GEI utilities are looking into the feasibility of CCS and have pilot projects in place. However, they do not consider CCS commercially viable at present, as there is no meaningful price for CO₂. In terms of energy efficiency, the GEI utilities together with their customers are developing and implementing demand-side-management projects. Moreover, the GEI is committed to supporting the achievement of the 2030 goals set by the UNSE4ALL initiative by mobilising the global community of utility leaders and bringing together the key stakeholders to collaborate on joint initiatives and projects. All of these activities could be strengthened, streamlined and accelerated, provided the right conditions are set by the legislator.

The GEI encourages today's global electricity leaders to join forces and help spread a sense of urgency and the need for action now. The GEI utilities call for a better and stronger dialogue and information-sharing with governmental bodies and other stakeholders. Join us in the first global electricity industry leaders' community!

4. List of figures, tables and best practice examples

List of figures

1.	Figure 1: Countries of the GEI participating utilities (in blue)	6
2.	Figure 2: GEI utilities energy mix	17
3.	Figure 3: GEI utilities technologies	20
4.	Figure 4: Security of supply	26
5.	Figure 5: Prices and subsidies	29
6.	Figure 6: Strategic reasons and drivers for utility investment programmes	31
7.	Figure 7: Percentage of utilities utilising weather and climate forecasting to ensure reliability of supply and continuity of operations	37
8.	Figure 8: Water and land use	42

List of tables

1.	Table 1: GEI Industry Leaders Advisory Board	6
----	--	---

List of best practice example

1. **Philippines:** Aboitiz Power – off-grid solution 14
2. **South Africa:** Électricité de France (EDF):
decentralised rural electrification programme 14
3. **China:** China Shenhua Energy Company: access projects in China 16
4. **Korea (Rep. of):** Korea Electric Power Corporation (KEPCO):
carbon capture and storage (CCS) 21
5. **India:** Tata Power: carbon emission project 21
6. **Japan:** Kansai Electric Power Company: CO₂ recovery pilot plant 22
7. **China:** State Grid Corporation of China (SGCC): strong and smart grid 22
8. **Brazil:** Eletrobras: transmission project 23
9. **China:** State Grid Corporation of China (SGCC): energy storage 25
10. **Brazil:** Eletrobras: sustainability challenges in hydropower projects 27
11. **Italy:** Edison SpA: energy efficiency 32
12. **United Arab Emirates:** TAQA: Abu Dhabi waste-to-energy 32
13. **Southeast Asia:** CLP Group: learning from the past to plan for the future 37
14. **Hong Kong:** CLP Group: super typhoon drills to build emergency preparedness 38
15. **Hong Kong:** CLP Group: improving climate resilience of power plants in phases 38
16. **Canada:** Hydro-Québec: level of preparedness 39
17. **Brazil:** Eletrobras: level of preparedness 39
18. **Hong Kong:** CLP Group: water management 41

5. References

Audinet P, Amado JC, & Rabb B, (2014), Climate Risk Approaches in the Electricity Sector: Lessons from Early Adopters, New York, Springer Science+Business Media

Deloitte (2013), Securing Tomorrow's Energy Today: Policy and Regulations, Energy Access for the Poor, India, IEC

Deloitte (2013), Alternative Thinking 2013, Renewable Energy Under the Microscope

Deloitte Centre for Energy Solutions (2013), Deloitte Resources 2013 Study, Today's Informed Energy Customers

International Energy Agency (IEA) (2011), Summing Up the Parts

International Energy Agency (IEA) (2012), World Energy Outlook 2012, Executive Summary

International Renewable Energy Agency (IRENA) (2012), Renewable Power Generation Costs in 2012, an Overview

Organisation for Economic Co-operation and Development (OECD) (2013), Baron, Richard, Renewable Energy: A Route to Decarbonisation in Peril?

University of Cambridge/World Energy Council (2014), Climate Change: Implications for the Energy Sector

World Business Council for Sustainable Development (2012), Empowering Stakeholders

World Business Council for Sustainable Development (2011), Integrating Energy Efficiency

World Business Council for Sustainable Development (2013), Lessons Learned from the Renewable Uptake in Europe in the last 20 years

World Energy Council (2013), World Energy Scenarios: Composing Energy Futures to 2050

World Energy Council (2013), World Energy Perspective: Cost of Energy Technologies

World Energy Council (2013), World Energy Resources

World Energy Council (2013), World Energy Trilemma: Time to Get Real – the Agenda for Change

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