CESI Energy Journal

Issue 01 - September 2013

Vladimir Putin: the times call

The challenge of economic growth and the issues on the G20 agenda under the Russian presidency

Brazil: Energy as a Path to Development

Brazil's success and its abundance of raw materials

World's Sustainable Future

An exclusive interview with the former Italian Minister Corrado Clini

01

CESI
Energy Journal

EDITORIAL COORDINATION
CESI - Paolo Mereghetti
Allea - Communication and Public Affairs

EDITORIAL STAFF
Agnese Bertello

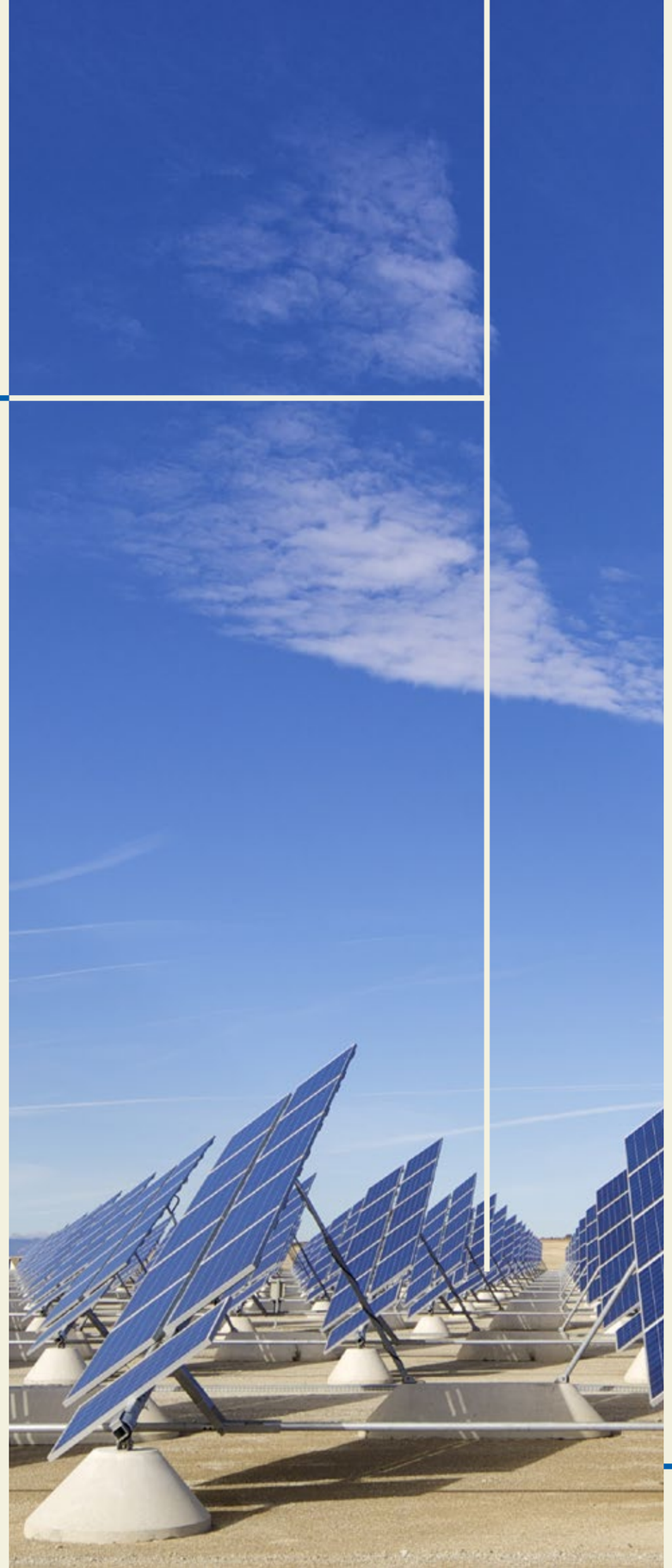
CONTRIBUTORS
Alessandro Bertani
Paulo Cesar Esmeraldo
Paolo Stigliano
Domenico Villani

TRANSLATIONS
Eric Sylvers

ART DIRECTION
alleadesign - Gianluca Barbero

EJ – ENERGY JOURNAL
CESI'S HOUSE ORGAN
Via Rubattino, 54
I-20134 Milan – Italy
info@cesi.it
www.cesi.it

CESI
Trust the Power of Experience



Issue 01 - September 2013

Contents

EJ can be browsed and directly downloaded at www.cesi.it

Editorial

Salvatore Machì - Chairman, CESI
Matteo Codazzi - CEO, CESI

We live in a complex, globalised era that is forcing us to face major challenges including finding a balance between development, energy and environment.
This three-way relationship must be rethought.

Development must be implemented while defending two fundamental rights. On the one hand the right to a better quality of life for billions of people who still live in poverty and for whom access to modern sources of energy has so far been denied; and on the other hand the protection of the environment, a resource that must be defended not only for us, but for future generations as well.

While technology and innovation are the main tools available for resolving the energy dilemma, we must remember that they mean nothing without "knowledge - sharing". And sharing must have a global perspective.
Only by making scientific discoveries and technological advances globally accessible can we achieve our ambitious goals.

THE COMPLEXITY OF THE GLOBAL ENERGY MARKET CALLS FOR EVER MORE EFFECTIVE WAYS TO HELP US UNDERSTAND, ANALYZE AND SHARE KNOWLEDGE. WITH THIS IN MIND WE CREATED EJ

The energy challenge is therefore highly significant because it is both scientific and cultural. It requires us to exchange information and share discoveries being as open and transparent as possible.

Companies in the energy sector must transform this challenge into a high-profile vision of communications that is no longer merely promotion, but is rather based on dialogue, debate and the exchange of information.

This vision, which is deeply ingrained into CESI's DNA, has matured through 50 years of working on complex energy assignments in extremely different social, economic, energy and political contexts in more than 40 countries around the world.
In line with this approach and through the projects we deliver every day for our customers around the world, CESI promotes an innovative culture that draws its strength from applying technology to identify practical solutions to complex problems.

With this in mind, we created "EJ", CESI's new house organ.
"EJ" provides a forum for sharing experiences, insights, questions and visions.
CESI helps businesses, governments and utilities implement innovative solutions to complex energy challenges, whether it be in renewables, more traditional power technologies, efficiency, emissions, transmission, distribution, electric mobility or smart grids.

Sharing knowledge is just as fundamental as excellent R&D for shaping a better energy future for our world.
This magazine is a small contribution in this direction.

We hope you enjoy our first issue.

| TOP STORIES |

The times call

Vladimir Putin, President of Russia

IN HIS ADDRESS TO THE PLENARY SESSION OF ST PETERSBURG INTERNATIONAL ECONOMIC FORUM (JUNE 2013), MR PUTIN OUTLINED THE GLOBAL ECONOMY'S MAIN PROBLEMS TODAY, LOOKED AT THE ISSUES ON THE G20 AGENDA UNDER THE RUSSIAN PRESIDENCY, AND NOTED RUSSIA'S EFFORTS TO STIMULATE ECONOMIC GROWTH AND IMPROVE THE COUNTRY'S INVESTMENT CLIMATE

The Saint Petersburg International Economic Forum has particular significance this year because it is also one of the big events taking palace as part of Russia's presidency of the G20. The cornerstone of the agenda we proposed for the G20 is to take practical and systemic decisions that will clean up the global economy and finance and get them into shape again through growth and development.

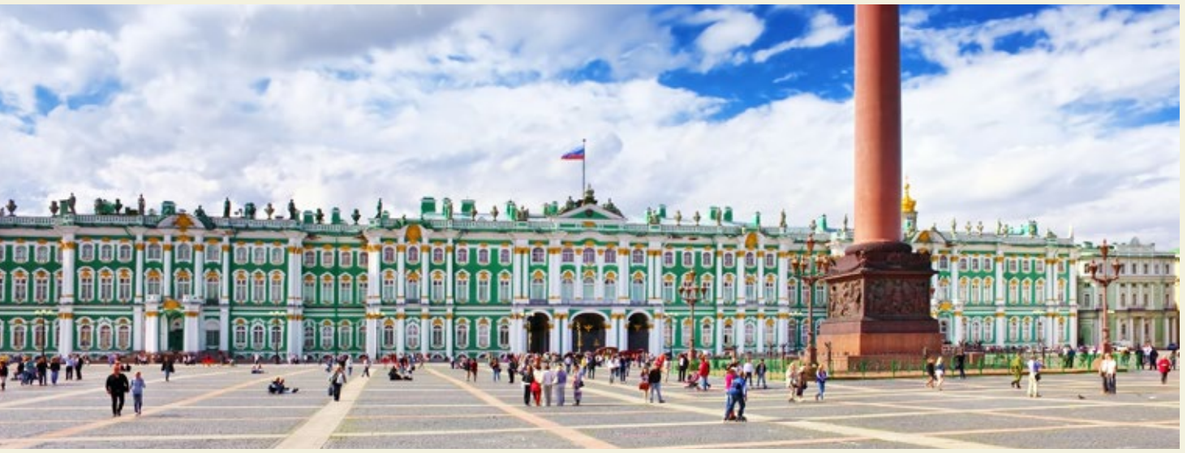
We can do this by making broader use of advanced technology that improve the quality of life, financial investment, above all, investment in people and social development, and developing high value-added industry that will create effective and modern new jobs. These are the Russian presidency's priorities for the G20's work, and they are also Russia's socioeconomic policy priorities.

The times call for decisive action. It was not by chance that this became the motto for this year's forum. Russia's top priority is to create the conditions for sustained economic growth. (…)

There are no simple solutions and no magic wand we can wave to change things overnight. What is needed from us now are discipline, the best choice of priorities, and the right balance between working towards long-term goals and addressing current and sometimes urgent tasks. Economic growth must be based on three pillars – increasing labour productivity, investment and innovation. Progress in all of these areas can be achieved only by bringing

ECONOMIC GROWTH MUST BE BASED ON THREE PILLARS - INCREASING LABOUR PRODUCTIVITY INVESTMENT, AND INNOVATION

down financial, management and infrastructure costs, developing human capital, and creating a genuinely competitive environment for doing business. A comfortable economic environment is also essential for growth. This means macroeconomic stability, further decrease in the inflation rates, responsible budget policy and compliance with the budget rule that we introduced and that is already in effect.



What this budget rule entails is that extra revenues generated by high prices for our energy exports get put into a reserve fund.
(…)

WE TOOK AN IMPORTANT DECISION: TO INVEST 450 BILLION RUBLES [ABOUT $14 BILLION] IN PROFITABLE INFRASTRUCTURE PROJECTS

Our key challenge in the coming years is to remove many infrastructure constraints that literally stifle our economy, and prevent us from unlocking the potential of entire regions of the Russian Federation.
What are the proposals on this account?
We have been discussing the possibility of using our financial reserves. (…) They must not be frittered away or spent on inexistent programmes, but rather channelled to projects that are reshaping the country and opening up new development prospects.
For this reason we took another important decision: to invest 450 billion rubles [about $14 billion] in profitable infrastructure projects; naturally, these investments will yield a return.
In general, about half of the National Welfare Fund will be invested in projects in Russia.
(…)

What are these projects? The first is a high-speed train link between Moscow and Kazan. In fact, this will be a pilot project for the route that will eventually connect the Central, Volga and Urals economic regions.
Second, it is a central ring road that will actually be built anew and run through the Moscow Region and the New Moscow area. Some sections of that road will be 30 to 70 kilometres away from the existing Moscow ring road. In fact, the Central Ring Road is a new project that will change the entire transport logistics in the European part of Russia, connect the country's central regions, open up new development opportunities for them, relieve Moscow of transit transport, and improve the capital's environment.
(…)
About 20 million people live in Moscow and Moscow Region. And if we add those in adjacent regions, regions that will eventually use this infrastructure, the number of people and economic actors increases many times over.

And finally, as a third project, we are going to significantly upgrade the Trans-Siberian Railway and expand its capacity. Let me point out that it is one of the longest railways in the world: nearly 10,000 kilometres. A direct rail route across Eurasia will act as a key artery between Europe and the Asia-Pacific region. It will give a powerful impetus to the development of the Far East and Siberia. Our transport infrastructure is getting very close to fast-growing Asian markets.
(…)

I want to emphasise that these are projects in the economic sense of the word, with concrete plans, and not simply wishful thinking.
I would also like to add that the new pipeline infrastructure in the Far East, with a branch to China, and access to ports in the Pacific, enables us to carry out large-scale projects in the Asia-Pacific market. This infrastructure has made it possible for Rosneft, one of our leading companies, to sign a major contract with China National Petroleum Corporation today.
This provides for oil deliveries of up to 46 million tonnes a year for the next 25 years.

The estimated contract value in current market terms is absolutely unprecedented, $270 billion. There are other figures – such as $70 billion – being bandied about in the media, but that is only the up-front payment. Another important project that gives Russia access to Asia-Pacific markets is the construction of a railway bridge across the Amur. The relevant agreement was signed with our Chinese friends on the sidelines of this forum. I would note that at the first stage the bridge's design capacity will exceed 5 million tonnes of cargo a year, and will then increase to 20 million tonnes.
(…)

We will continue to develop our stock market to bring it in line with all international requirements. Concrete steps are already being taken, and today the Moscow Stock Exchange is all ready for major placements and privatisations. I will stress once again that privatisation of state assets will be done on Russian markets. By the way, VTB share placement [on the Moscow Stock Exchange] showed that it is both possible and appropriate to do so. This public offering was quite successful and the work was conducted correctly. At the same time, we will privatise gradually, focusing on the quality of deals and by selling assets at really competitive, fair prices. In parallel, we will increase the transparency and openness of public companies regardless of their ownership structure, create mechanisms to protect the rights of minority shareholders, and improve the quality of corporate governance.
(…)

Of course, no regulation or performance indicators will replace the main thing, namely competition. Regardless of who owns a company, no preferential treatment in our economy, a normal market economy, will be allowed. We must create a competitive environment in both internal and external markets for goods and services, for both private and public companies. As the first step in the field where competition seemed impossible before, we offer to gradually lower the restrictions on liquefied natural gas (LNG) exports. Increasing opportunities in the Asia-Pacific market, where LNG consumption is expected to double, allows us to make a decision on gradual liberalisation of LNG exports. This will create conditions to fully exploit the potential of offshore gas production as well as that in coastal areas. (…)

NOVATEK, one of our companies, concluded an agreement with the China National Petroleum Corporation on cooperation in the Yamal LNG project. The agreement contemplates that the Chinese party will buy a 20 percent stake in NOVATEK's Yamal LNG project, and a long-term contract for LNG supplies to China will be concluded. Gazprom is also preparing to sign contracts for delivering gas to Japan and the People's Republic of China. Following these contracts, major investments in the development of offshore production will be carried out with global leaders in the oil and gas industries, such as ExxonMobil, Statoil and Eni. There will also be investments in localising production and up-to-date equipment with global technology leaders such as General Electric.
(…)

OUR KEY PRIORITY IS TO IMPROVE THE BUSINESS CLIMATE. EVERYONE MUST JOIN IN THIS EFFORT

Our key priority is to improve the business climate. Everyone must join in this effort, from the mayor of a small town to the federal minister, from the district police officer to the head of law enforcement agency.
The quality of governance at all levels of authority is becoming a decisive development factor, which is why the state authorities and officials at all levels must set objectives that are clear and understandable to the public. The results of their work are evaluated, as in business, in terms of personal efficiency. I stress that our joint actions and motivations fully determine our business environment and the investment image of the country as a whole.
(…)

We are implementing a project aimed at the conservation of the nation, investing in human resources and personal development. (…)
Most importantly, we realise that the social dimension of the economy will play an increasingly important role, and therefore the abstract figures of the gross domestic product and industrial growth, despite their importance, cannot be the ultimate goals of our policy. We must see real changes in the lives of every individual, every family. That is what we are working to achieve.

This text is the result of an accurate selection extracted from Putin's speech at the Plenary Session of St Petersburg International Economic Forum (June 2013). The selection is based on the official transcription, as published on the Kremlin's website

| INTERVIEW |

World's Sustainable future: a conversation with Corrado Clini

Emilia Blanchetti, scientific coordinator, Festival dell'Energia

IN AN EXCLUSIVE INTERVIEW WITH EJ, THE FORMER ITALIAN MINISTER OF ENVIRONMENT TALKS ABOUT ENERGY, GEOPOLITICS AND SUSTAINABLE GROWTH

At the recent Festival dell'Energia (Rome, 24-25 May 2013) you addressed the issue of European development policies towards African countries. Where can the European approach be improved?

The European model has been important for giving direct support to individual local communities. The other side of the coin, however, is the absence of a systemic and integrated policy that allows European companies to seize business opportunities in African markets while at the same time encourages the healthy and structured growth of local economies.

In other words, Europe has a strategy that is "politically correct", but economically inefficient and occasionally aggressive. This is the case with some European countries that have implemented intensive programs based on the exploitation of Africa's agricultural resources and energy. In the medium term, Europe's short-sighted decision not to seek ways to ensure lasting development coupled with the lack of transparency in how African governments manage their economies led to a substantial degeneration in the relations between the two continents.

The more structured development projects carried out by China and Brazil shook up the situation. While no less aggressive than the European policies, those implemented by the two giants were accompanied by infrastructure projects in Africa that allowed the continent to have tangible and permanent benefits in areas such as research and the exploitation of energy resources. In Africa and beyond, the past decade has shown that south-south cooperation works better.

The Chinese and Brazilian development models certainly produced results that were more profitable and forward-looking than the more uncertain and discontinuous European policies. It is likely that the colonial past between Africa and Europe also favoured China and Brazil, which are able to have a more equitable relationship with the continent.

How can European countries turn around this situation?

One must distinguish between the individual countries.

France and Britain have been present in Africa for a long time, but they must now face the fierce competition of Chinese and Brazilian companies. To confront what may become a very penalising "gap", both individual European countries and the EU as a whole must profoundly change their perspective and vision. Europe must get beyond the "hypocrisy" that has proclaimed to put human rights at the centre of its cooperation efforts, while at the same time indulging in aggressive political, economic and social policies.

IN AFRICA AND BEYOND, THE PAST DECADE HAS SHOWN THAT SOUTH-SOUTH COOPERATION WORKS BETTER

The Italian presidency of the EU in 2001, which coincided with the G8 summit in Genoa, mandated that European development projects in Africa could only go forward if the African countries built the necessary infrastructure themselves. This decision was part of a move to encourage African countries to take more responsibility for their development and sought to force them to rely less on aid from Europe. The African countries' reaction, which coincided with the arrival on the international and regional scene of China and Brazil, was nevertheless extremely critical. In a certain sense it was already too late for Europe.

What then can be done?

In broad terms, Europe must be present in emerging markets with an alliance strategy that is able to reconcile cooperation, assistance, development, infrastructure and enterprise. The strategy must be more dynamic and must also be open to the possibility of reaching agreements with China and Brazil. For example, recently at Cape Town Obama announced that the United States doubled its investments in Africa to secure energy supplies, but he said it would be done in a sustainable way that does not damage the African countries.
Africa must accept that the only way to ensure

EUROPE MUST BE PRESENT IN EMERGING MARKETS WITH AN ALLIANCE STRATEGY THAT RECONCILES COOPERATION, ASSISTANCE, DEVELOPMENT, INFRASTRUCTURE AND ENTERPRISE

real growth, whether it is through cooperation with emerging economies or with the great powers, is through a conflict-free growth policy.

You were among the participants at the Rio+20 Conference on Sustainable Development. What conclusions have you drawn from that experience?

Rio+20 was the realistic conclusion of an international negotiation process that must take into account the various countries' economic diversity and differences in governance. The countries should concentrate on finding common objectives and rules that promote economic growth though the efficient use of resources, but that are also inspired by fairness.

ALL EFFORTS MUST BE CONCENTRATED ON DEFINING COMMON ECONOMIC AND DEVELOPMENT STANDARDS: IT MAKES NO SENSE TO IMPOSE THE SAME RULES INDISCRIMINATELY ON ALL PLAYERS

From now on, all efforts must be concentrated on defining common economic and development standards, which are just as fundamental as the car market for controlling emissions and managing climate change. It makes no sense to impose the same rules indiscriminately on all players. Differences must be respected while coming up with a set of shared objectives that lead to realistic standards that can be reached. If the process only includes limits, as is the case with the Kyoto Protocol, there is the risk that it is seen only as a cost rather than an opportunity.

Photovoltaics is an opportunity to implement environmentally friendly energy policies, but also is a testing ground for the trade relations between China, Europe and the United States. How do you see this developing?

Research is of fundamental importance in photovoltaics. It is important to continue to invest in innovation to improve the efficiency of solar as other countries such as Korea and China are already doing. I think protectionism in the way of customs duties does not protect the competitiveness of European countries, but rather can cause pointless controversies. It is important to reflect on the repercussions of the indiscriminate use of incentives, which have been implemented by European countries, including Italy and Germany rather than China. The incentives ended up favouring the importation of solar panels made in China.

The incentive mechanism adopted in Italy between 2007 and 2009, for example, was destined to lead to just this outcome. It was very clear that the Italian production of panels would never have been able to satisfy the demand coming from a market that had grown suddenly as a consequence of the flawed incentive scheme.

We also cannot overlook the fact that China can produce photovoltaic modules at competitive prices not only because of lower labour costs, but also by virtue of the massive investments made in research ($50 billion dollars in five years).

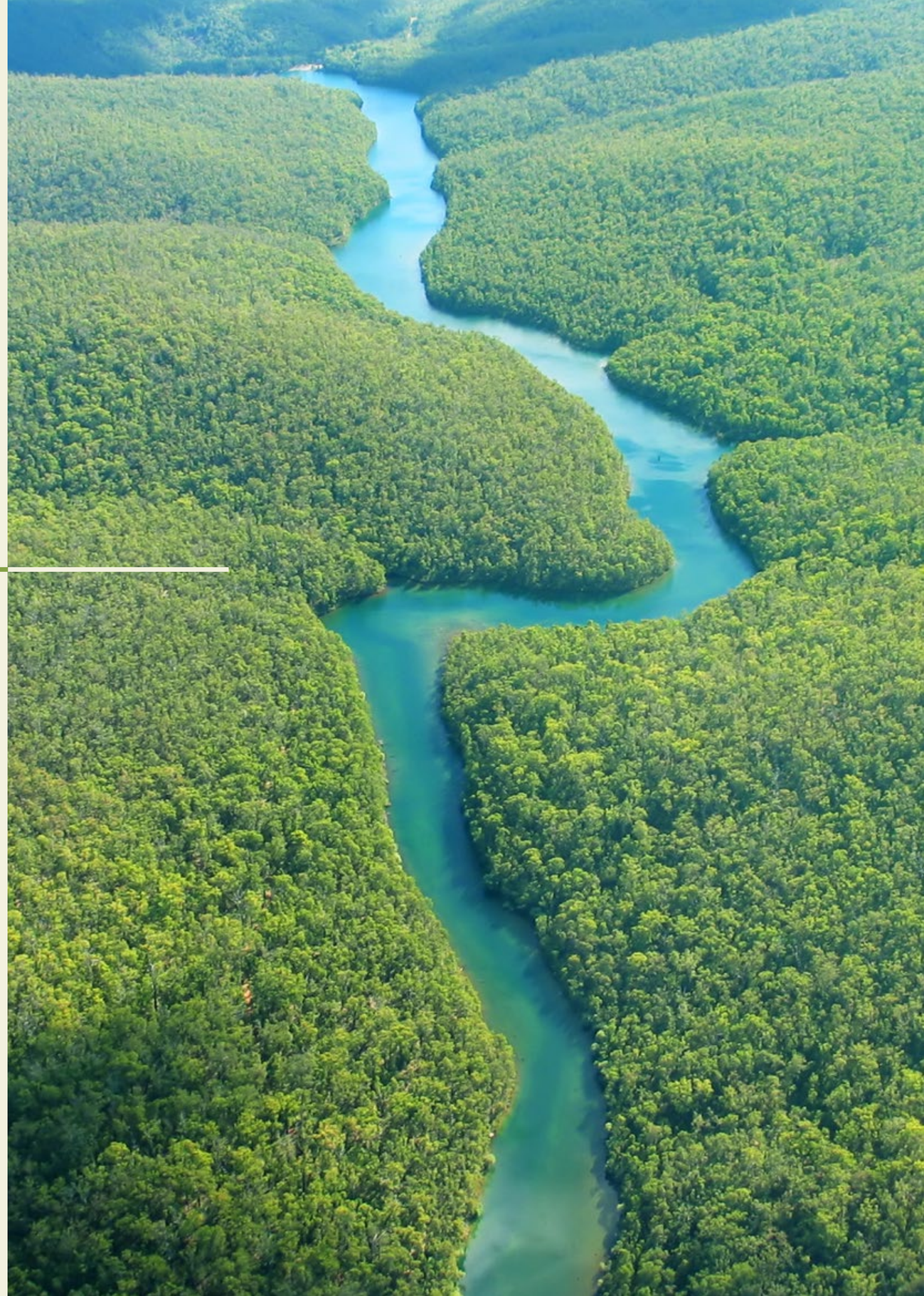
PROTECTIONISM IN THE WAY OF CUSTOMS DUTIES DOES NOT PROTECT THE COMPETITIVENESS OF EUROPEAN COUNTRIES, BUT RATHER CAN CAUSE POINTLESS CONTROVERSIES

China is the world's largest market in the new global context. It is a market that offers many opportunities for growth and development including for many European companies. This is another reason I believe a return to protectionism is antiquated, useless and harmful.

Brazil: Energy as a Path to Development

Agnese Bertello
Paulo Cesar Esmeraldo, Managing Director CESI Brazil

DEVELOPMENT HAS BEEN DRIVEN BY INTERNAL CONSUMPTION, BUT ABOVE ALL BY EFFECTIVE POLICIES PROMOTING REDISTRIBUTION OF WEALTH AND SOCIAL INCLUSION

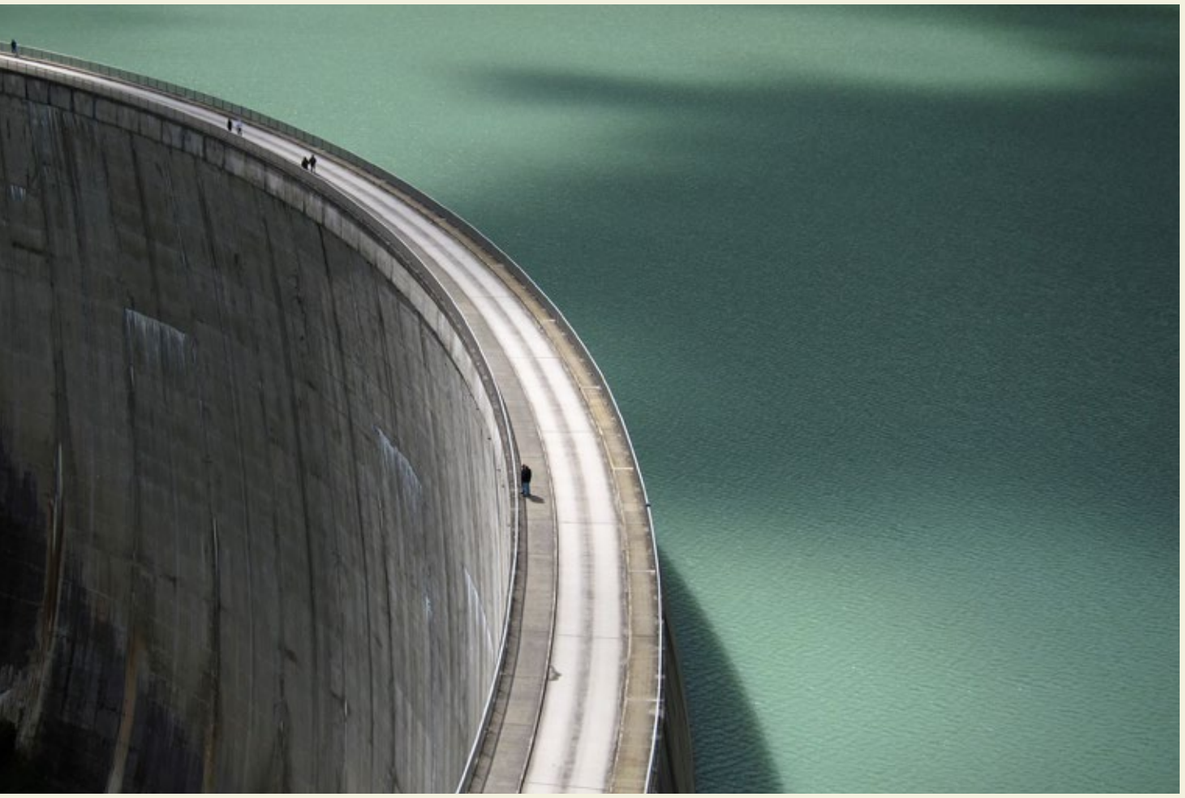


Dynamic and exuberant. In the collective imagination Brazil has always been the land of great potential and possibilities, a land that is at the same time rich, generous and full of life. Today these characteristics are on display in the economic and industrial arenas, so much so that Brazil is easily keeping pace with the western countries and, according to economic indicators, by 2020 will pass the UK and France to become the world's fifth-largest economy.

BRAZIL'S SUCCESS IS LINKED TO ITS ABUNDANCE OF RAW MATERIALS, EQUALLY SPLIT BETWEEN RENEWABLES AND FOSSIL FUELS

It has not been a short climb for Brazil. Industrial growth began during the military dictatorship, which collapsed in 1985 and was followed by the gradual liberalisation of the markets, in particular in the energy sector. Significant structural reforms helped gradually increase the country's role on the world stage until it became a major player. The country has carved out a particular path that integrates creativity and innovation with a long-term outlook and policies that support the welfare state. Development has been driven by internal consumption linked to population growth, but above all by effective policies promoting the redistribution of wealth and social inclusion. These policies have guaranteed that a significant and growing portion of the population have the possibility to contribute to spending and consumption. Today the middle class and upper-middle class account for more than 50% of the population. The ministry of finance's official statistics describe a vibrant market composed of 100 million people and growth consistently at 8%. It is precisely this spending and consumption that have made Brazil one of the most appealing countries for international investors.

But Brazil's success is also linked to its abundance of raw materials, equally split between renewables and fossil fuels, that can be used to produce energy. First and foremost among these raw materials is water, but there is also oil and natural gas. The expectations for growth in Brazil are linked to the exploitation of these last two fundamental resources.



Blue gold

One cannot speak of Brazil and hydropower without rattling off a number of global records. Chief among those records is Brazil's spot at the top of the list of countries with the largest fresh water reserves, which account for 12% of the planet's total. Hydropower supplies about 80% of the country's electricity needs. Overall in 2010 it was 455 TWh, but with an average annual growth of 4.3% the forecast for the end of the decade is consumption of 650 TWh. One-fifth of current consumption is covered by a single dam, Itaipu, built in the 1970s on the Paraná River on the border with Paraguay.

THANKS TO THE PREVALENCE OF HYDROPOWER, BRAZIL HAS THE MOST ECOLOGICALLY FRIENDLY ELECTRICITY PRODUCTION IN THE WORLD

The forecast is for further growth with the current installed capacity, 122 GW, augmented by another 60 GW by 2020 to reach 182 GW. The main project under construction is the Belo Monte power plant, in the state of Pará on the Xingu river, which beginning in 2015 will produce 40,000 GWh making it the third-biggest dam in the world measured by energy production. Sao Luiz do Tapajós and Jatobá, two of the five hydroelectric dams that make up Complexo Tapajos, are considered to be just as strategic.

Here too potential far outstrips production with estimates of 250 GW in hydroelectric power. This is an enormous resource, 70% of which is unrealised, that is concentrated in the Amazon basin.

Thanks to the prevalence of hydropower, Brazil has the most ecologically friendly electricity production in the world. This is a strength that risks becoming a weakness because of the country's reliance on one source of power. The dependence on this source could be detrimental to the whole system of energy production as demonstrated by the 2009 blackout that was caused by a transmission problem originating at Itaipu. The malfunction left millions of people in the dark for hours.
Diversifying by integrating hydropower with other sources of power is essential if Brazil is to keep its lead in renewables in this period of growing consumption. That is why the country's development plans call for a larger contribution from wind and biomass with small amounts also coming from solar and the sea (through the exploitation of wave motion).
While these latter two sources will be important in the long-term, wind and biomass today already account for a small but significant portion of energy production and can grow rapidly. There are 600 wind power projects planned for a total of 16,000 MW. Biomass – which is based mostly on bagasse, the fibrous matter that remains after sugar cane is crushed – should reach 10 MW by the end of the decade. By 2020 the contribution of non-hydro renewable energy sources should double to 16% with capacity growing to 27 GW from 20 GW.

In addition to the increase in production of electricity from renewables, massive investments are planned in designing and building out networks for the transmission and distribution of electricity over long and very long distances. In 2012, President Rousseff launched an important program for public-private investment, the Logistics Investment Program, which is based on strategic partnerships focused on the integration and renewal of infrastructure.

The program has recently been significantly accelerated – a key objective for a country the size of a continent. The network has 100,000 kilometres of transmission lines and in the next ten years another 46,000 will be built with different voltage levels. The main backbones are the north-northwest corridor (3,500 MW) and the north-southeast corridor (4,000 MW). The goal is to connect the two energy sub-systems thereby facilitating regional exchanges. It is through these direct current networks that the massive electricity production from the Belo Monte dam will be fed into the grid and distributed to the main geographic areas of consumption.

These corridors are also an important technological advancement of the country's infrastructure. In effect, even though HVDC links are not a novelty in Brazil – the first one was realized for Itaipu dam in the eighties – this experience will set the standards for further projects and open the way for more interesting horizons.
The government is also planning very significant investments in generation. The talk is that it could be $60 billion. New projects will not be reserved for renewable energy and will also include natural gas, an area, as we will see, where Brazil has recently discovered that it is very rich.

THE GOVERNMENT IS PLANNING INVESTMENTS IN GENERATION. NEW PROJECTS WILL ALSO INCLUDE NATURAL GAS, AN AREA WERE BRAZIL HAS DISCOVERED IT IS VERY RICH

Black gold

The oil shocks of the 1970s were critical in creating the impetus for the domestic production of hydrocarbons.
The search for domestic resources intensifed in this period and led to the discovery of some large oil fields in the Bacia de Campos.

But it was the discovery, in 2007, of the Tupi field in Santos Basin that shook the global oil industry. Between 5 and 8 billion barrels of oil equivalent are located off the coast at a depth of about 7,000 metres under a thick layer of salt.

Blue gold

80%

of the country's electricity needs is covered by hydropower

Hydropower current installed capacity:

122 GW > 2010

182 GW > 2020

Black gold

Natural gas estimated foresee production (m^3)

2010 **23**

2015 **98**

2020 **178**

Sources: **IEA (Hydropower Roadmap, 2012); Ministério Brasileiro de Minas e Energia**

The size of the Tupi field led to more research in the area – in the states of Rio de Janeiro, Sao Paulo and Espirito Santo – that used some of the best and most innovative technologies for measuring the depth of the seabed and resulted in the identification of other oil fields of extraordinary value. Of course, it is still not cost-effective to tap these deposits, but they are more than a promise for the future.

The situation is the same for natural gas, which with oil will in the near future be another important area of development and growth. The Brazilian government estimates the country has 423 trillion m^3 of reserves, more than 80% of which is offshore.

BRAZIL HAS LED THE WAY IN THE BIOFUELS SECTOR, THANKS TO AN EFFICIENT DEVELOPMENT MODEL. IT IS THE WORLD'S SECOND-LARGEST PRODUCER OF ETHANOL AND THE LARGEST EXPORTER

Official estimates foresee production quadrupling in the next few years rising from 23 billion m^3 in 2010 to 98 billion m^3 in 2015 and then 178 billion m^3 in 2020.
To achieve this growth there must be a parallel development of infrastructure for the transportation of natural gas. The distribution network has grown in recent years from 6,000 to 10,000 kilometres and two LNG terminals were built, one in the Bay of Guanabara (in the state of Rio de Janeiro) and the other in the port of Pecém (Ceará).
Petrobras, which is still 33%-owned by the government, is forecasting investments of $174 billion dollars by 2014. That would place it among the five largest companies in the global oil industry.

Biofuels & ethanol

Biofuels is another area where Brazil has been dynamic and creative. The country has led the way in this sector, with some ups and downs, thanks to an efficient development model.
In the 1970s, in response to the oil crisis, the Pro-Alcohol program was launched for the production of ethanol from sugar cane.
Today Brazil is the world's second-largest producer of ethanol, after the United States, and is the largest exporter.
About half of the country's sugar cane production goes to making ethanol (390,000 barrels per day) and the trend is on an upward swing. By 2020 the number of registered cars will go from 29 to 56 million and the demand for ethanol and biofuels will increase from 27 million to 73 million litres. These have been just a few thoughts that paint the picture of a country of extraordinary power and vitality. Brazil seems to have found its own road towards development, a 2.0 growth model that combines sustainability, quality of life, intelligence and innovation.

| Facing up to the Energy trilemma: a Brazilian perspective |

The trilemma between energy security, social equality and environmental impacts has been evident in several forms since the 19th century. Today, challenges posed by the energy trilemma have risen to a global scale. The 21st century energy scenario is associated with excessive social inequalities and generating negative environmental impacts. What steps can we take in the coming decades to implement green and socially-inclusive development in a scenario in which fossil fuel sources still predominate as the primary supply of energy?

What can we learn from the many different examples around the world?

First, there is no single solution when seeking sustainability in energy. Second, specific initiative from several countries may be shared and assessed as national alternatives. Brazil is one of these countries and has experience that can be replicated in other regions around the world, particularly in some specific sector.

Public Policies and Environmental Externalities: the strategy to expand the Brazilian energy grid is associated with the energy auctions for projects related to the National Interconnected System (SIN). The auctions guarantee predictability and stability and, coupled with the long-term Power Purchase Agreements, they make it feasible for private institutions to take part.

Universalisation: to make electricity available in regions where investments in distribution are not attractive, the federal government launched the Electricity for All Programme.

Mitigating the environmental impact of Hydroelectric Plants: the socio-environmental scale has become part of all new projects from their initial conception, when structural elements have not yet been.

Sustainable biofuel production: so that expanding sugarcane production does not impact the production of foodstuffs and native forests, the Brazilian government established Sugarcane Agroecological Zoning, as the inhabited regions expanding their plantations are defined. The growing productin of Brasilian ethanol will not generate negative impacts related to the use of soil.

These are just few examples from the Brazilian case, but there is a wide array of national experiences that can be of great value in making the related and difficult choices.

By *Luciano Coutinho*,
President Brazilian Development Bank
(BNDES).
From *Facing up to the "energy trilemma": a Brazilian perspective, World Energy Insight (2012 - WEC)*

| FUTURES & TECHNOLOGIES |

HVDC: Back to the Future

Agnese Bertello
Domenico Villani, Director of Testing & Certification Division, CESI

THERE ARE ABOUT 80 HVDC PROJECTS THAT ARE EXPECTED TO BE COMPLETED BY 2020, A TRUE BOOM WITH IMPORTANT ENVIRONMENTAL REPERCUSSIONS

The future began in Gotland in 1950. It is here, between this island 90 kilometres off the coast of Sweden and the mainland, that the first direct current connection for the transmission of electricity was made. Though limited in size and power, the project has had enormous resonance. In fact, the prototype developed by ABB showed the world that transmitting energy in HVDC is possible. The technology is there and it works.

Since then it took almost fifty years of research and studies far from the spotlight to refine the technology and materials to the point that HVDC is not only feasible and ever more reliable, but also economically viable.

The break-even point was reached in the late 1990s. Since then, experimental projects and significant investments continued and the technology made substantial leaps forward thanks to the increasing number of concrete projects and the competitive market that was being created. There are about 80 projects using HVDC that are expected to be completed by 2020, a true boom with important environmental repercussions.
The Future will defenitely include HVDC.

HVDC: the reasons for its success

Most of the projects in the pipeline have a common fundamental characteristic: the need to link areas that are very far apart, separated, for example, by the sea as in the case of Gotland. At one end of the network there is an area with a major source of energy. At the opposite end is an area with a big need for that energy, such as densely populated urban areas with very high rates of energy consumption.

When compared to a traditional alternating current network, HVDC makes it possible to carry a higher amount of energy while greatly reducing the losses. Overall, efficiency and performance are much higher. These characteristics make it clear why this technology is ideal for infrastructure projects many developing countries have rolled out to ensure their people have access to modern forms of energy, that can speed up development and growth.

While this is certainly the main reason HVDC has become one of the technologies of future reference, there are other advantages that should not be forgotten.

For example, compared with alternating current, HVDC improves a network's safety. HVDC makes it possible to isolate the section of the network where a malfunction occurs, limiting, if not preventing entirely, the danger that a black-out spreads.

HVDC MAKES IT POSSIBLE TO CARRY HIGHER AMOUNTS OF ENERGY, WHILE REDUCING THE LOSSES

There are positive aspects also on the environmental front. The same amount of energy can be carried in smaller right-of-way and overhead lines. This translates into a smaller direct impact on the ecosystem of the territory crossed by the lines. The overall optimisation of the production process, transmission and distribution also allows for a significant reduction of CO_2 emissions. In addition, since there are no sine waves there are no magnetic fields. Very often, long distance HVDC interconnection projects are linked to energy produced from renewable sources. Without this technology it would be impossible to contemplate realising the projects that aim to exploit the massive solar energy in North Africa or the wind in Northern Europe.

Thanks to all these characteristics, the acceptance of HVDC is higher than other technologies and the permitting process is easier and faster.
Finally, if we want to look at this technology from a political point of view, the introduction of a HVDC system is a prerequisite for a progressive integration of electricity markets and the creation of a single market.

THIS TECHNOLOGY IS IDEAL FOR INFRASTRUCTURE PROJECTS MANY DEVELOPING COUNTRIES HAVE ROLLED OUT TO ENSURE THEIR PEOPLE HAVE ACCESS TO MODERN FORMS OF ENERGY

In Europe, as well as in Latin America and the Middle East, the benefits of interconnections that cross national borders are becoming more evident. Often, however, different countries have networks that work with different voltages or frequencies, making integration complex. The use of HVDC makes it possible to overcome these differences without having to modify the parameters of the different systems.

Worldwide Investment in Transmission System

€ 6/8 billion per year until 2020

Germany	China	Brazil	Middle East
35,085 km electricity grid	**962,000 km** electricity grid	**104,929 km** electricity grid	**89,835 km** electricity grid
152.24 GW Installed (transformer capacity)	**3,538 GW** Installed (transformer capacity)	**219.9 GW** Installed (transformer capacity)	**310.8 GW** Installed (transformer capacity)

Sources: **elaboration based on the Transmission Global Report 2011**

A cutting-edge technology becomes the norm

As we have seen, there are many solid reasons to believe in and invest in the development of HVDC.

Today though the world is still crisscrossed by a dense network in alternating current. While the recent development of direct current has been rapid, it remains a niche technology adopted above all to connect isolated areas or different countries. If direct current is going to become the standard in the future there must be a gradual standardisation of the technologies it uses.

THE GOAL OF GETTING DIRECT CURRENT ACCEPTED IN THE MAINSTREAM WOULD BE FACILITATED BY THE ESTABLISHMENT OF INDEPENDENT LABORATORIES

It is in fact the designation of internationally recognised regulatory parameters that open the way for a technology to jump from being in the avant-garde to being widely embraced. This is exactly what happened in the past with alternating current. The goal of getting direct current accepted in the mainstream would be facilitated by the establishment of independent and authoritative laboratories that could test new components developed by those working in the industry. To date the only recognised independent organisation that aims to define key norms for HVDC is the CIGRE (Conféderation Internationale Grand Réseaux Electriques), though its findings are non-binding pre-standard recommendations.

Yet it is absolutely fundamental, for utilities that must make huge investments to build out infrastructural projects, to be able to obtain the certification of an impartial institution that outlines the real capabilities of products billed as meeting the specific needs of a project. This is precisely the goal CESI has set for itself – to be a partner that utilities can turn to as they choose which technologies, systems and models are best for them as they build out infrastructure projects.

This is a daunting task for laboratories considering the breadth of factors that must be confronted during testing.

Each project is a new challenge. From time to time, for example, the various elements – above all the cables – are subjected to different environmental and climatic conditions. In general, the bar for the level of voltage seems to always be rising – today it is from ± 600 kV / ± 800 kV. In underwater projects, maximum attention must be paid to the pressure and mechanical stress, while at the same time the cables' response to the different temperatures they are expected to be subjected to must be tested.

In a situation always in rapid evolution, the key factor is precisely the correct definition of the methodology and specifications used in the tests. This is a role that can only be played by accredited and independent laboratories, which in time accumulate a sufficient amount of experience regarding very different products in specific test conditions. CESI, which has more than 50 years of experience testing high voltage parts, has what it takes to be the market leader in HVDC testing.

| INDUSTRIES & COUNTRIES |

The Kingdom of Smart Grids

Agnese Bertello
Alessandro Bertani, Head of Networks Automation and Smart Grids, CESI

BY 2032 SAUDI ARABIA COULD BECOME ONE OF THE WORLD'S LARGEST PRODUCERS OF RENEWABLE ENERGY, A REVOLUTION THAT WILL COMPLETELY CHANGE THE COUNTRY'S PROFILE. THE KINGDOM IS NO LONGER MERELY AN EXPORTER OF FOSSIL FUELS AND MUST NOW BE CONSIDERED A PLAYER IN THE WIDER GLOBAL ENERGY MARKET

Saudi Arabia's skyline may soon change. Alongside the oil and natural gas wells, the "symbol" of the country, we will soon be able to admire modern solar energy plants, photovoltaic parks, wind farms, geothermal plants and incinerators.
A white paper presented in February 2013 outlined the country's plan to install 54 GW of renewable power by 2032, a move that would make Saudi Arabia one of the world's largest producers of renewables.

THE DECISION TO INVEST HEAVILY IN RENEWABLE ENERGY COMES FROM SAUDI ARABIA'S DESIRE TO MAINTAIN ITS ROLE IN THE GLOBAL ARENA

Saudi Arabia is no longer merely an exporter of fossil fuels and must now be considered a player in the wider global energy market. Important challenges without simple solutions lie ahead, particularly in the electricity market.
Some telling data helps to paint the picture. The country's rapid economic growth (more than 4% in 2011) led to a jump in annual energy consumption (more than 7.6%) and peak demand (more than 8.4%). Residential demand has grown more quickly, in part due to the growth in population and in part due to a lifestyle that is inherently energy intensive.
The new energy strategy is based in economics and stems from the desire to meet internal demand with renewable energy thereby freeing up more crude oil for export. The economic reasoning is flanked by Saudi Arabia's desire to continue to play a leading role in a rapidly changing energy market.
The decision to invest heavily in renewable energy therefore comes from the country's desire to maintain its role in the global arena by transforming itself from solely an exporter of crude oil to an exporter also of electricity and above all of avant garde technological solutions for alternative energy.
This is in effect a revolution that affects all walks of society – universities and research, companies and the energy sector – and will redraw the entire electrical network's infrastructure, services and regulation.

A "tailor-made" electrical system

The Electricity and Cogeneration Regulatory Authority (ECRA), aware of the complexity of the challenge, collaborated with key players in the national energy sector to launch a series of initiatives aimed at studying possible solutions to cope with the changes. In 2012 Saudi Arabia chose CESI as its technology partner to make this happen. The objective is to quantify the potential of smart grids and smart metres, develop a global strategy for their introduction and analyse available technologies and the possibilities for applying them. The cost-benefit analysis reached a very important conclusion: the plan would make it possible to increase the efficiency of the electrical system by reducing waste (-5% during peak demand) and it would offset the huge investment costs fairly rapidly even without incentives.
Redesigning an electrical system to meet a country's needs and the objectives the energy sector has set for itself requires a tailored approach. The current structure of the national transmission network is a product of the kingdom's particular geographical, climatic and historic characteristics.
Cities and villages have organised themselves around natural oasis. Each of these communities has over time structured its own power network to meet its gradually increasing energy needs. There are big differences between these various networks, including in efficiency.
The primary objective for a country seeking to implement a smart grid is to increase interconnections and adopt performance standards. The strategy developed by CESI foresees changes to both the transmission and distribution networks.
The project calls for the creation of high voltage connections (in direct and alternating current) and the use of electronic devices (FACTS) that can regulate the power flow. At the same time there will be a general improvement in the quality of service through improved network security and a reduction in technical losses.

THE PRIMARY OBJECTIVE FOR A COUNTRY SEEKING TO IMPLEMENT A SMART GRID IS TO INCREASE INTERCONNECTIONS AND ADOPT PERFORMANCE STANDARDS

Analysing the specific characteristics is even more important when redesigning a distribution network and rationalising consumption. To this end, the proposed strategy foresees the introduction of electronic metres (smart metres) and apparatus that make it possible to remain in contact with clients while coordinating and regulating consumption to allow a levelling of the general energy load. However, introducing these mechanisms in Saudi society is not trivial. In a society with a strong desire to protect privacy a smart metre, which records the consumption of individuals and families, could be considered an invasive technology.
A policy that seeks to facilitate the penetration of a system for the intelligent reading of consumption must pay particular attention to the issue of protecting privacy.
What awaits on the horizon, therefore, is a period of profound transformation, including social changes, as always happens when strategic technological innovations are introduced in a country.

| The Kingdom of Smart Grids & Metering |

CESI Middle East has been selected by the Electricity & Co-Generation Authority of The Kingdom of Saudi Arabia, ECRA, to develop policies, specification requirements and an implementation plan for a smart metering and advanced metering infrastructure.
This new mandate, which is the first kingdom-wide project of its kind to be undertaken in Saudi Arabia, not only increases CESI Middle East's leadership position in the area, but also gives further impetus to the development of future plans based on renewable energy across the Middle East, as the implementation of smart grids allows a switch from conventional energy to renewable energy.
CESI will be working on this project with global management consulting firm A.T. Kearney.

| FACE TO FACE |

Energy Tech: the Future is Here

Interview with Matteo Marini, Director Power Product Division, ABB, and Domenico Villani, Director of Testing & Certification Division, CESI

THE CRUX OF THE QUESTION IS NOT THE GROWTH IN DEMAND FOR ENERGY, BUT RATHER OUR CAPACITY TO EFFECTIVELY TRANSMIT AND DISTRIBUTE ENERGY. IT WILL TAKE STRONG POLITICAL WILL AND LARGE INVESTMENTS IN R&D TO MEET THE CHALLENGE

Where should investment be concentrated if we are to adequately address the challenge presented by the evolving energy market?

M. Marini
Currently the real problem is not the growth in energy demand, but instead how to use the energy surplus and how to keep inherently inflexible traditional power plants working. One of the problems is the low level of technology used in building the infrastructure, which makes it impossible to fully exploit the grids' capabilities to manage supply and demand. Deficient infrastructure has proven to be a factor limiting the development of an economical method for producing and using energy derived from renewable resources. We have fantastic technologies. We can easily transport enormous quantities of energy using continuous current while at the same time consumers can monitor and regulate their demand based on the available resources. Now more than ever, relatively small investments make it possible to render buildings energy independent. The future is here, but large investments and a clear political will to go forward are necessary to make it happen.

D. Villani
The heart of the question is not merely the growth in the demand for energy because we know this is not a homogeneous trend. From my point of view, the question is linked to our capacity to transmit and distribute energy more efficiently. New technologies allow us to better use natural resources, but we STILL do not have the appropriate infrastructure to manage those resources. Concerning infrastructure, we must take important steps forward. A progressive integration of the national electrical grids, similar to what happened in Europe with monetary union, would bring significant economic and political advantages. Clearly there is no panacea.

How to effectively store surplus energy is one of the questions we are still seeking to answer. What is the most promising research at the moment in this area?

M. Marini
In the near future, the contribution of renewable resources to the overall energy scenario will continue to grow. An intelligent way to best exploit these sources of energy will be, for example, to adapt our routines in a way

to use renewable energy as much as possible when it is available.
The technology already available today allows us to reach important goals and the availability of better infrastructure would change our lives in a positive way. Today it is possible to exploit solar and wind energy and transmit it easily to where it is needed. The surplus energy can be used in pumped storage hydroelectric systems. Research is going ahead in developing battery systems, but they are still a long way off. Rapid recharge systems exist and some countries have already planned to build a recharging system grid to facilitate the development of electric cars. This can be seen as an additional complexity when managing the system, but it can also undoubtedly improve the system's flexibility by operating the electric flow in both directions. I think, there are three keywords for the future: opportunity, adaptability and versatility.

THE FUTURE IS HERE, BUT LARGE INVESTMENTS AND A CLEAR POLITICAL WILL TO GO FORWARD ARE NECESSARY TO MAKE IT HAPPEN

D. Villani
Energy storage is actually a theme where technological research is now focusing, as it could definitely make it possible to improve our capacity to manage renewable energy. Nowadays a lot of different storage systems are under study: chemical, battery, air compression and hydroelectric pumps. In some cases, pilot projects have already been launched. Testing these possible solutions must be a priority and we must concentrate on building more flexible electric grids. Also in this area I don't think there is a unique and mature solution.

Regarding transmission, there is a need for grids with higher and higher performance levels. Can HVDC technology be the solution? What product innovations are needed to achieve better efficiency?

M. Marini
As a manager in one of the most important electro-mechanical companies in the world, I believe that HVDC systems represent the greatest source of opportunities for energy transmission. This technology has proven to be highly effective, with hundreds of kilometres of power lines and both land and undersea crossings.
It is not possible to reach a level of "zero loss", but the extremely high tension of the direct current lines reduces losses drastically. Nowadays, high voltage switches are available, so it is actually possible to simplify direct current connections and make them more accessible.

D. Villani
This solution is not an absolute novelty. Today, however, we have technologies that come from electronics, that enable us to better capitalise on HVDC. Power transmission through high voltage direct current connections has overcome previous technological barriers, but more progress must be made. Industry fully exploits the HVDC grid just for point-to-point connections, while implementing a proper direct current network is still being studied. The same applies to the components that must be inserted in this grid to manage the interruptions. Innovations are advancing very fast and we are just beginning to test new components that will surely be of interest to industry for future applications. The voltage levels implemented in these devices are increasingly high with innovative cable materials and new solutions to reduce losses. HVDC technology is certainly a fast growing area. Even the big, independent test laboratories are working to develop new solutions, fostering technological progress while safeguarding functionality.

In a global system, defining standard features for products and establishing common procedures is of the utmost importance. What would make it possible to reach this goal?

M. Marini
Products must be made according to clear requisites so they meet the installation requirements and they must comply with regulations. This is possible thanks to suitable planning and through the tests that each producer must run in proprietary laboratories or in certified independent ones.
The lack of shared standards reduces the possibility that competitive devices will be produced. For instance, a product will be tested according to different sets of rules depending on the market where it is being sold. This definitely increases costs without enhancing the products' features. Looking to Europe, I believe the time has come to think on a grand scale, unifying the national legislations and aiming to find solutions to the problems.

D. Villani
The key point is to test components that will later enter the grid as parts of the electric system. Considering the fundamental role they play, it is critical that these components work properly.
Tests must be carried out by independent labs that are proficient in technique and technology, but also, and above all, they must build trust. In other words, it must be clear that the test has been carried out by a lab that has no direct interest in the commercial development of a related product. Only an independent laboratory can guarantee these standards.

What answers can new technologies provide to consumers regarding energy conservation and what can we expect in the future?

NEW TECHNOLOGIES ALLOW US TO BETTER USE NATURAL RESOURCES, BUT WE STILL DO NOT HAVE THE APPROPRIATE INFRASTRUCTURE TO MANAGE THOSE RESOURCES

M. Marini
Energy efficiency is an extremely interesting topic because it offers a variety of possibilities and applications. Today, it is possible to improve the efficiency of systems by selecting products accurately and by applying proper controls. All these solutions are "smart" and easily connectable between themselves and with the monitoring systems. In all my experience I have always seen that increased efficiency leads rapidly to savings and a quicker return on investment. If consumers are able to easily monitor their electricity needs in relation to the availability of energy, they can save on their energy bill. On the other hand, smart metres, above all for domestic use, inherently lead to a loss of privacy. This is definitely a problem that utilities need to address and try to solve.

THERE ARE THREE KEYWORDS FOR THE FUTURE: OPPORTUNITY, ADAPTABILITY AND VERSATILITY

D. Villani
I would distinguish between the two problems because we need to incorporate ever more the levels of measurement and how we protect information. To lower consumers' electricity bill it is important to make them aware of (THEIR) energy consumption. To achieve this we need tools that enable more detailed and user-friendly information with qualitative and quantitative data on the consumption of energy. Tools like smart metres allow third parties to enter our house just as happens with a social network or a blog. How this information is handled is therefore very important. The attention to privacy and the management of users' personal information is widespread to the point that utilities already using smart metres have adopted measures to limit the use of the data collected. This is fundamental if we want to see this technology penetrate everyday life and change the way we consume energy.

| IDEAS AND VISION |

Dam Safety for Hydropower Development

Paolo Stigliano, Head of Structural & Civil Engineering
CESI Engineering & Environment-ISMES Division

HYDROPOWER PROJECTS CAN ACTIVELY CONTRIBUTE TO POVERTY REDUCTION AND LIFE QUALITY ENHANCEMENT IN LOCAL COMMUNITIES

Hydropower is renewable because it draws its essential energy from the sun which drives the hydrologic cycle that, in turn, provides a continuous renewable supply of water. Hydropower accounts for more than 92 percent of all renewable energy generated and continues to be one of the most viable sources of new generation for the future. It also makes it possible to store energy and optimise electricity generation.

Hydropower projects can actively contribute to poverty reduction and life quality enhancement in local communities. In fact, families with little access to water and energy services are exposed to higher health risks and spend a disproportionate amount of money and time procuring these basic resources. On the other hand, access to electricity promotes new economic activities, empowers women and reduces menial domestic chores such as firewood collection. It also improves health and education services and provides a cleaner and healthier home environment, such as indoor air quality.

Hydropower can be developed on a wide range of scales to meet diverse needs and market or power conditions. While small-scale, decentralised development can bring power to remote and rural communities, large-scale hydropower infrastructure with reservoirs often provide multiple-use benefits, particularly through increased availability, reliability and quality of fresh water supplies and reduced flood risks.

Globally, there are more than 11,000 hydroelectric power plants operating in 150 countries, accounting for about 20% of total energy generation. Hydropower's share of national power generation in Norway and many African countries is as high as 99% while in Brazil it is 84%, Venezuela 74% and Canada 59%. So far, only about 30% of global hydropower resources has been developed.

Hydropower's advantages

Compared to other energy sources, hydropower offers some important advantages:

> hydropower is a well-proven form of power generation;
> hydropower contributes significantly to the reduction of greenhouse gas emissions;
> hydropower is a clean form of energy and leaves no environmentally harmful residues;
> hydroelectric power generation is cost-efficient and not sensitive to fuel price increases;
> in many regions of the world, hydropower reservoirs are also vitally important for water supply, irrigation, and flood protection;
> civil construction work for hydropower plants creates local jobs and supports the regional economies;
> hydropower conserves fossil fuel resources.

THE ECONOMIC LIFESPAN OF A HYDROPOWER STATION IS BETWEEN 40 AND 80 YEARS WITH ANNUAL OPERATIONAL AND MANTEINANCE COSTS EQUAL TO ABOUT 4% OF THE CAPITAL COST

Risks and safety

The overall failure rate of dams is about 1%, but a time-related analysis shows that it has been reduced by a factor of four or more, over the last 40 years.

The precursor to dam failure is overtopping, which can be due to inadequate spillway design, debris blockage of spillways, or settlement of the dam crest. Foundation defects, including settlement and slope instability, are another cause of dam failures. "Piping", that is internal erosion caused by seepage, is the third main cause. Other critical factors include inadequate maintenance and the structural failure of the materials used in the construction. Furthermore, natural deterioration is associated with the prolonged use of dams, consequently it is necessary to carry out specialised checks to verify their structural soundness and good working conditions.

Two of the most significant past failures were the Saint Francis Dam (California, USA) in 1928 and the Vajont Dam (Italy) in 1963. Safeguarding human life is the main motivation for the improvement of evaluation and monitoring techniques for dam safety. It is also worth remembering that these improvements can also make an important contribution towards a more effective management of the power plants so as to exploit the water resources to their maximum potential.

The growing number of dams makes it essential to evaluate rigorously the problem of their safety from a social and economic point of view. This problem is highlighted by the high density of people living downstream from the majority of the dams around the world.

Brazil and Guatemala: Latin America's best practices

Monitoring and data analysis are primary parts in managing the safety of dams with a risk assessment methodology. At the Itaipu Dam, for example, the online data analysis and the surveillance management have become a part of the current safety procedures.
The Itaipu Dam is a hydroelectric structure on the Paraná River located on the border between Brazil and Paraguay. It is the largest operating hydroelectric dam in terms of annual energy generation and produces a fifth of Brazil's electricity.

THE ITAIPU DAM IS THE LARGEST OPERATING HYDROELECTRIC DAM IN TERMS OF ANNUAL ENERGY GENERATION AND PRODUCES A FIFTH OF BRAZIL'S ELECTRICITY

Since the beginning of construction in 1975 it was clear a comprehensive instrumentation program would be necessary, not only to support the design of the structure itself, but also to monitor the behaviour of the foundation upon which the dam is situated. As a result, a widespread monitoring plan was designed and installed. By the conclusion of the construction in 1982, more than 4,000 instruments had been installed and were read manually.
In 1995, the number of measuring points was reduced to 2,383 and there were 5,239 drains. After in-depth analysis of the recorded data, the Itaipu engineers carried out an exhaustive feasibility study for partial automation of the dam safety instrumentation and identified 206 instruments as being the most significant measurement points and which would, in turn, be included into a dedicated automatic data acquisition system (ADAS).
The ADAS, commissioned in December 2005, was the result of close cooperation between Itaipu and the ISMES division of CESI that produced and installed the system.
The monitoring system consists of close to 2,300 instruments installed in the structure and their foundations, plus close to 5,200 drains whose data are collected according to a pre-established frequency for each phase of the project.
The main purpose of the automatic data acquisition system for the civil instrumentation of the dam is to supervise the behaviour of the concrete, rock fill, and earth fill dams and of their foundations in real time, through a system of "online" monitoring of automated instruments and sensors with a view to acquiring the readings at the periods of frequency set by the user. Various groups of sensors are connected to remote acquisition units (RAUs), in which the readings by the sensors will be processed, stored and transmitted to a system of treatment, storage, processing and presentation of the collected data by means of the data cluster and of the client station of the ADAS. Another relevant case history is a recent hydroelectric project in Guatemala: the Palo Viejo plant is characterised by extremely varied and complex geological and geomorphological conditions. The site is also characterised by the widespread occurrence of different types and sizes of landslides.

| CESI: a comprehensive approach |

Ensuring dam safety requires a particular focus in two parallel areas:

- a static and dynamic monitoring system – designed, implemented and managed by CESI-ISMES –customised to the structural characteristics of each dam;
- a static and dynamic structural analysis and verification, with mathematical models on finite elements (FEM).

CESI monitoring system takes into account both the dam structure and the related basin through a suite of proprietary software:

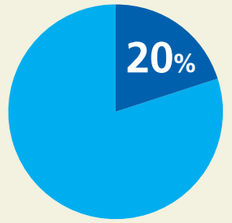
- ADAS© (Automatic Data Acquisition System) for the civil instrumentation of the dam. It provides information aimed at supporting the supervision activities of the behaviour of the concrete, rock fill, and earthen dams and their foundations;
- INDACO© for the online data acquisition of environmental and geotechnical instrumentation;
- MIDAS© (Management of Information for Dam Safety), a solution for management and processing of information. It is aimed at the analysis and interpretation of the behaviour of structures;
- MISTRAL©, an advanced system for evaluating, explaining and filtering alarms generated by automatic monitoring systems of civil engineering structures.

The following structural analysis uses advanced tools, such as FEM, for the static and dynamic analysis of complex structures in order to – among other things – design the rehabilitation of the dam. The methodology applied in dam safety is a complex combination of the following aspects:

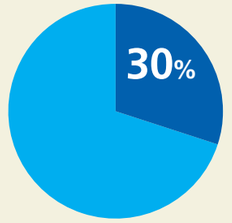
- the collection, organisation and interpretation of measurements;
- the real-time monitoring of the dam structure's behaviour ("online monitoring");
- the periodic check of some significant parameters of the dam and its foundation;
- a complete Dam Safety Assessment ("check-up") carried out time to time by specialists to evaluate the structure's current state of health;
- in situ and laboratory tests in order to verify the consistency of the materials of the dam structure and the foundation;
- emergency action plan downstream from the dam.

Hydropower global development

11,000
hydropower plants in **150** countries around the world



total energy generation



global hydropower resources actually exploited in the world

Sources: **IEA (Hydropower Roadmap, 2012)**

Basically, risks can originate from three main causes: weather events (intense tropical storms and hurricanes), relevant hydrological and hydraulic conditions affecting rivers and intake structures (dams), and earthquakes related to the tectonic features of the area.
One of the issues related to the project was that the construction was ongoing and the deadline for starting energy production was fixed.
The Risk Analysis began at the end of the last year with geological, geomorphological and hydrogeological surveys. It was defined for operational conditions that considered the vulnerability, risk and criteria for the assessment, the surveillance activities in operation and the threshold levels for the activation of Emergency Conditions.
The final result of the job was not only a risk assessment of the whole area and the entire hydroelectric project through numerical and graphical reports, but also the design, implementation and filling of a geographical information system, that allows users to add and control new measurements during the period of operation.

Dam Safety Assessment: a complete check-up

The Dam Safety Assessment, which also considers the risk assessment, is a complete "check-up" performed from time to time by experts in order to verify the current safety conditions of the structures and the related basins. The assessment identifies any interventions needed to achieve satisfactory safety conditions and defines improvements that must be implemented for effective routine surveillance.

THE DAM SAFETY ASSESSMENT IS THE MAIN TOOL THAT DAM OWNERS HAVE TO ENSURE SAFETY

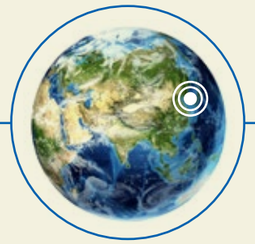
This "check-up" is carried out through the expert's analysis of all the data gathered by the monitoring system, which is the main tool that dam owners have to ensure safety.

World Smart Grid Forum 2013

Date > from 23th to 25th September 2013
Venue > Berlin, Germany
http://worldsmartgridforum2013.org/

The World Smart Grid Forum 2013 brings together leaders and technical experts of the global Smart Grid scene to discuss the future of this technology, its practical applications and their benefits.

Matteo Codazzi, CEO at CESI, will take part at the conference on day 3 - Session A4: Evolution of the distribution grid - with the following speech: “Smart distribution grids: different local conditions affect the priorities”.



WEC Daegu 2013

Date > from 13th to 17th October 2013
Venue > Daegu, Korea
http://www.daegu2013.kr/eng/summary/summary_2013.jsp

This Congress will mark the 90th anniversary of the world’s largest and most prestigious energy event. Hosted by the World Energy Council (WEC) and the WEC Korean Member Committee, the event is organized by the WEC Daegu 2013 Organizing Committee.

Under the theme of “Securing Tomorrow’s Energy Today,” the 22nd World Energy Congress will welcome 5,000 government and business leaders and other delegates from more than 100 countries.
CESI has been asked to make 2 presentations during the Congress.

Seminário Nacional de Produção e Transmissão de Energia Elétrica 2013

Date > from 13th to 16th October 2013
Venue > Brasilia, Brazil
http://www.xxiisnptee.com.br

The Seminário Nacional de Produção e Transmissão de Energia Elétrica (SNPTEE) is the most important technical event in Brazil. Experts from different companies, universities and research institutes will meet into the Centro de Convenções Ulysses Guimarães in Brasilia. SNPTEE aims to share experiences, information, expertise and technical know-how for improving quality, productivity and competitiveness of the electrical sector in Brazil.

Shaping a Better Energy Future

CESI is a leading global technical consulting and engineering company with over 50 years experience in several areas including: Transmission and Interconnections, Smart Grids, Power Distribution, Renewables, Testing, Certification and Quality Assurance. CESI also develops and manufactures advanced multi junction photovoltaic solar cells for both space and terrestrial (HCPV) applications.

With an annual turnover of more than €120 million, CESI operates in more than 40 countries around the world, with a total network of 1,000 professionals. The company's key clients include Governmental Institutions, Regulatory Authorities, major Utilities, Transmission System Operators (TSOs), Distribution System Operators (DSOs), Power Generation companies, Manufacturers, Financial institutions and International electromechanical and electronic manufacturers. CESI is a fully independent joint-stock company with main premises located in Milan, Berlin, Mannheim, Dubai and Rio de Janeiro.

www.cesi.it

Milan • Berlin • Mannheim • Dubai • Rio de Janeiro

CESI

Trust the Power of Experience

Testing • Consulting • Engineering • Environment