Preface

Mr. Vicente González Loscertales,
Secretary General of the Bureau International des Expositions

This year’s edition of the BIE Bulletin is dedicated to “Future Energy”, the theme of Expo 2017 Astana.

I am both happy and encouraged to see the theme of energy featured so prominently in an Expo. In recent years, Expos have placed sustainable development at the core of their agenda. It has become the objective underpinning a significant aspect of the communication and education efforts vis-à-vis the public of visitors and citizens. It has driven many innovations in the site design. And, last but not least, it has guided choices for the intangible legacy of the event.

From Aichi to Yeosu, Expos have demonstrated their commitment to low-carbon emissions and energy sustainability. Each Expo has explicitly connected the different themes to our global challenge of ensuring availability of energy resources while reducing the footprint generated by our energy intensive activities. These most recent Expos have shown how organizers and participants alike have leveraged the event as an opportunity to experiment with innovations in the supply and distribution of clean energy resources as part of the site management and operations.

Today’s world energy landscape and balance are changing quickly. Understanding the implications for climate change and the environment, the international community is called upon to make better use and more use of renewable energy sources, to diversify its energy supplies and de-carbonise them. Within this context, Expo 2017 provides an invaluable opportunity to reunite all actors present in an EXPO to explore critical issues related to sustainable energy development, programmes and policy responses, as well as energy security and efficiency, and renewable energy sources.

We have invited a number of personalities from different domains, all passionate and knowledgeable about “Future Energy”, to enrich our bulletin with their ideas and proposals drawn from their vast experience and knowledge.

Mr. Bertrand Piccard, Director of the “Solar Impulse” project, highlights in his article the effectiveness of clean energy technologies and explains the reasons for their current limited use. Mr. Sergei Ivlev, Science and Innovations Director at the Coalition for Green Economy and G-Global Development, looks at the most advanced energy technologies
based on new physical paradigms and at how these could be presented at Expo 2017. Mr. Gerd Leipold, former Executive Director at Greenpeace International, underlines the fundamental role of energy in the evolution of societies and human development, and refers to “the triple challenge” of the 21st century. Mr. Jeremy Legget, Founder of the Solar Century Aid, analyses the systemic risks in energy markets and answers questions related to the mobilisation of renewables on a large scale.

Further on, Mr. Talgat Yermegiyayev, Chairman of Expo 2017 Astana, stresses the importance of Future Energy and talks about the necessity to address this theme in EXPOs. Mr. Stephen Stec, Consultant PNU, CCE-ONU, OSCE, OCDE and the European Commission, gives an account of the current and future energy production and consumption and its social and environmental impacts. Mr. Nurlan Kapparov, Minister of Environment and Water Resources of the Republic of Kazakhstan, underscores the importance of Kazakhstan’s transition to clean energy and green economy as reflected in Kazakhstan’s “Strategy 2050” and its developmental objectives.

The theme proposed by Astana 2017 is of tremendous universal interest touching on poverty issues, climate change, economic development, policy and innovation to name just a few. EXPO 2017 will be a real opportunity for all stakeholders to come together and contribute to the global quest for solutions to the challenges we face. I am very proud to see the extent to which EXPOs are taking a role in advancing progress today.

I sincerely wish to thank all the contributors to this bulletin for their very valuable insights on Future Energy and for sharing their expertise. “Future Energy” will be a new challenge for the governments, local authorities, companies, NGOs and all citizens of the world at EXPO 2017.
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FUTURE ENERGY AS AN ELEMENT OF THE STRATEGY
“KAZAKHSTAN-2050”

Nurlan Kapparov
Minister of Environment and Water Resources of Kazakhstan
Over a very short period of time Kazakhstan has achieved unbelievable results. The country has established itself as an economically powerful state with great development potential. In twenty years Kazakhstan has gone from gaining global recognition to becoming an active full-fledged participant in world affairs. Today we have even more ambitious and complex tasks lying ahead.

Until now economic growth has been largely powered by natural resource exports. Thanks to new production sectors developed through the implementation of a new industrial policy we have succeeded in overcoming our dependency. For the first time the share of the processing industry in the Gross Domestic Product has increased.

Of course, the main future challenge is the availability of energy. In this regard Kazakhstan has promising opportunities.

The Republic of Kazakhstan is richly endowed with fuel and energy resources.

Our coal industry is one of the largest sectors of the economy. It terms of coal reserves we are among top ten leading counties. We rank third among the former Soviet Republics in terms of reserves, second in mining and first in per capita coal mining.

Despite significant fuel reserves Kazakhstan finds it important to ensure a step-by-step transition to clean energy so as to maintain environmental balance.

This conviction is reflected in the Expo 2017 bidding theme.
«Future Energy» theme touches upon general energy-related issues and problems that have immediate impact on all aspects of human activity. This theme encompasses a wide range of questions relevant to the future of energy resources. It stems from growing concerns of the international community about climate change and sustainable development. This topic is so important that deserving utmost attention from all countries, organizations, and companies. It must be discussed because dialog will expose various viewpoints and that might ultimately yield specific solutions to the worldwide energy challenge.

Undoubtedly the Expo 2017 theme will be appealing to the participants. This issue gives food for thought to the whole world not merely to Kazakhstan. For many decades economic progress and sustainable development are everyone’s concern. Transport, production and all amenities of our everyday life depend on energy.

Global experience shows us that the success of World and International Exhibitions largely depends on how well the event was organised and held. But that alone is not enough. The overall success is also determined by the theme and by how well the hosting country achieved its goals and objectives.

The world energy system has yet to make a transition to a sustainable path. According to new strategic scenarios, global energy demand will grow by more than a third by 2035.

Many counties are moving away from nuclear energy toward the rapidly developing wing and solar power, extracting more natural gas, including by alternative methods.

Kazakhstan’s energy sector is faced with a need to create a stable and effective foundation to enable a transition toward an innovative development model through the modernization of the existing infrastructure and the implementation of the planned investment projects.

Energy security and environmental safety alongside with energy efficiency and cost effectiveness are among strategic objectives of our long-term energy policy.

At present society clearly understands the necessity to adopt a new development model with a balance of economic and environmental interests.

One of the ways to achieve this is to ensure a step-by-step transition to sustainable development.

To achieve this transition, Kazakhstan adopted the Strategy “Kazakhstan-2050” (“Strategy 2050”) in 2013 as a new policy direction for a developed country.
Strategy 2050 is a long-term plan for a new stage of development, setting policy priorities characteristic of a mature state. It opens new horizons and opportunities for the future. It certainly is a milestone that shows how much headway we have made. It also shows that we are on the right track.

Strategy 2050 sets clear objectives for the creation of a sustainable and efficient economic system based on a transition to a «green» development model.

The development objectives were further detailed and specified in a conceptual document (the "Concept"), which was drafted and approved in May 2013.

A «Green Economy» is a complete opposite of what is called a «brown economy». The latter is a traditional economic system in place from the start of the industrial era. It is characterized by high carbon intensity, resource wastefulness and social stratification. A «green economy» can be described as carbon and resource efficient. Energy efficiency and smart resource management are among key concepts of a «green economy»

A «Green Economy» is not merely an opportunity, it is the only way to go for all countries wishing to ensure a reliable future for the people. It is quite possible that the traditional way will last for a couple decades more, but it will come at a dear cost, harming the environment and lowering the quality of life, taking a heavy toll on future generations.

We all know that fossil fuels are finite. We know how detrimental they are to the climate. Fossil fuel combustion efficiency is only 20% in cars and 35% in oil fuel power plants. It is not only extremely harmful for the environment but also socially irresponsible with respect to future generations. We have all it takes in terms of scientific, financial and technological capabilities to transition toward reliable energy supply in the future.

There are three main elements to these efforts: energy saving wherever possible, maximum energy efficiency and a shift from fossil fuel to renewables as soon as possible.

The approved Concept provides for a comprehensive policy response in all resource intensive sectors of the economy, including the following.

1. Sustainable water resource use.

This chapter of the Concept provides for a resolution of water supply problems by 2050, providing sufficient water to the public and to agriculture by 2020 and 2040 respectively and eliminating water shortages in each water basin individually by 2030.
According to the Strategy 2050, water shortages are a global threat. The government is aiming at ensuring uninterrupted water supply for the public (by 2020) and for agriculture (by 2040). It is planning to resolve all water related issues altogether by 2050. Environmental dimension of water resources, such as healthy ecosystems, fish farming, ecotourism, protection of unique natural reaches, should not fall prey to industrial development.

If shortages increase the cost connected with the lack of water reassures will grow. Financial losses are estimated to be 6-7 bln US dollars per year by 2030. Whereas the cost of a transition from a water-intensive economy to a water-efficient model are quite small (0,5-1 bln). Investments would total up to 10 bln US dollars by 2030. Additional 1-2 bln US dollars will be required for building and updating water purification facilities.

2. Sustainable high yield agriculture.

The Concept provides for a threefold increase in agricultural labor productivity with additional objectives to increase wheat yields to reach 14 c/Ha by 2020 and 20 c/Ha by 2030. One more objective is decreasing irrigation water consumption to 450 m3 per ton of wheat by 2020, and to 330 m3 per ton by 2030.

Kazakhstan will follow the 6 principles of green agriculture that will ensure its development and help protect and improve the environment by:

Preventing land degradation and restoring damaged land: introducing more effective methods of farming, including low till and no till agriculture and rotation of, preserving organic matter and moisture in the soil preventing soil erosion and protecting it from wind and precipitation

Preventing further loss of grazing land by making remote pasture available and by restoring pasture land, planned rotation of pastures and locking moisture in the soil

Effective water use in farming: drip irrigation, spray irrigation, narrowly targeted irrigation and the use of greenhouses;

Smart resource use: transition to user and environment friendly agrochemicals and fuels, thus minimizing environmental harm, reducing or preventing pollution of soil, air and water through comprehensive pest control efforts, using of fertilizers based on soil study and increasing fuel efficiency of agricultural machinery;

Minimizing and reusing waste: processing methods maximizing added value and minimizing waste, including by recycling leftover biomass, for example composted and biogas;
Carbon Capture: planting continuous crops, soil protecting plants, trees, multiannual and perennial crops, carbon capturing plants that are soil salination-resistant or facilitate adaptation to climate change.

3. Waste management system.

In the waste management section the Concept provides that complete removal of SHW and sanitary garbage disposal will be universally ensured by 2030, the share of recycled waste will be 40% by 2030 and 50% by 2050. The Concept provides for the following approaches to the creation of a waste management system:

a) a coordinated waste recycling system with a full range of services and a comprehensive landscape protection scheme;

b) reduction of a number of landfills with a transition to a wider use of treatment, recycling and recovering useful material and substances as well as use of waste as fuel;

c) development of a closed cycle economy with multiple reuse of goods even if it’s not profitable;

d) improvement of the environment by reducing negative manmade influence.

4. Decreasing air pollution.

In order to decrease air pollution pursuant to the Concept Kazakhstan will fully comply with European levels of SO and NO emissions by 2030.

Based on current industrial and power generation emission levels we need to take the following measures:

draft a set of principles and a road map to adopt new emission standards similar to European standards by the end of 2014. This work should be carried out jointly with electricity and heat producing companies and other large industrial producers;

draft and implement European-like standards;

update and install dust and gas capturing equipment at power plants and production facilities located in the vicinity of large cities. Achieve emission levels set in the roadmap;

where the infrastructure is available, gas supply is sufficient and if economically viable – switch coal power plants to gas;

large boilers of coal-fired electric power plants must be modernized as soon as possible.
equip large power plants, boiler and industrial facilities with emission meters;
continuous monitoring and supervision of pollutant and greenhouse gas emissions on behalf of the designated environment protection agency of the Republic of Kazakhstan;
the following measures must be implemented in the transportation sector:
replacing older equipment with modern equipment, improving operational methods, and raising the effectiveness of fuel use and operations;
enacting of rules effective starting June 2016 limiting vehicle emissions in accordance with European standards;
conducting regular annual inspection of vehicles for emissions quality with the completion by 2020 of a one-time audit of vehicles in service;
transition of public transportation in Almaty to compressed gas; transfer of public transport to gas in other large cities (Astana, Karaganda, and Shymkent) by 2020 depending upon gas resources and the adoption of decisions on gas price subsidization.

5. Energy saving and energy efficiency

There is enormous potential to increase energy efficiency with a «green» scenario that includes measures additional to the baseline scenario, which only provides for energy efficiency gains through natural replacement of buildings, production facilities and vehicles.

The «green» scenario leads to a 26 % reduction in energy use by 2030 and a 41 % by 2050.
At present Kazakhstan’s energy intensiveness is two times higher than on average in the OECD countries and 12% higher than in Russia. Energy intensiveness of the GDP depends on the development trends and on energy consumption models. It is forecast by the IMF and DIW that our GDP will almost triple by 2030 and grow by a factor of five by 2050. The structure of the GDP will change accordingly accommodating the increased share of the services sector.

Analysts project that under the baseline scenario energy consumption will only double by 2030 and increase 2.5 times by 2050. In terms of energy consumption industry, housing and utilities, energy supply services and transport will remain the leading sectors. Energy intensity of the GDP will decrease by 25% by 2030 and 40% by 2050 compared to present values.

There are several arguments in favor of energy efficiency measures.
Firstly, it is often profitable because the cost of energy saved is greater than the investment needed to achieve this saving. In fact, Kazakhstan can lower demand in the main energy consuming sectors by an additional 10% by 2030 and 15% by 2050 compared to the baseline scenario. This will lead to 35% less GDP energy intensiveness by 2030 and 50% less by 2050 compared to 2010.

Second, more energy efficiency means less capital costs; depending on the level of generation development various energy efficiency measures help save from 6 to 15 billion. US dollars.

Third, minimizing environmental impact is a strong argument in favor of such efforts. Lower energy consumption means lower CO2 and other pollutant emissions.

Thus the Concept provides for the following energy efficiency measures:

energy saving and energy efficiency efforts in the housing and utilities sector and heating systems, such as:

providing support to the most disadvantaged social groups;

monitoring of new construction standards and taking measures to increase energy efficiency in the construction and thermal energy sectors.

energy saving and energy efficiency efforts in the industry;

d and energy efficiency efforts in transport.

6. The electric power industry.

The existing generating and transmission facilities are seriously worn out. Power plants run mainly on coal. There is not a sufficient reserve for load factoring.

Economic development coupled with energy efficiency measures will lead to a 2.3% annual increase in energy consumption by 2030 to reach 136 billion Kw/h and to a 1.2% annual increase by 2050 to a total of 172 billion. Kw/h. GDP energy intensiveness will decrease by 50% compared to 2010.

There are several determinants of energy sector development in Kazakhstan:

1. Reduction of electricity consumption thanks to improved energy efficiency.

2. Updating the existing capacity.

4. Kazakhstan's commitment to CO2 emission reduction projects and prices of CO2 emissions.

5. Availability and price of gas for electricity generation.

The Concept provides for 3 energy sector development scenarios:

The Baseline scenario – electricity demand at a baseline, gas infrastructure development in Akmola and Karaganda regions, gas prices remain low, 30% of the energy mix comes from alternative sources by 2050.

The «Green» scenario – gas is expensive: electricity demand changes as we transition to a «green economy», gas infrastructure development in Akmola and Karaganda regions, high gas prices, by 2050 50% of the energy mix comes from alternative sources by 2050.

The «Green» scenario – gas is cheap: electricity demand changes as we transition to a «green economy», gas infrastructure development in Akmola, Karaganda, Pavlodar and Eastern regions, low gas prices, 50% of the energy mix comes from alternative sources by 2050.

Figure 2. Scenarios for the development of electric power industry
Figure 3. The total installed capacity scenarios

Figure 4. Share of electricity production scenarios
The Concept provides a timeframe for building a sustainable green economic model in Kazakhstan.

**First stage 2013-2019** – Improvement of the existing situation:

Water resources: drafting a Program to increase irrigation efficiency and to implement monitoring and management systems, introduction of quotas and supervision mechanisms;

Agriculture: land fertility recovery project and crop-based arable land management approach.

Electricity generation and energy efficiency: streamlining coal power plants and reducing pollution levels, maximum boost to energy efficiency.

Transportation: introducing fuel efficiency norms for road vehicles and fuel standards for retail fuel sales.

Waste management: ensuring effective landfill management so as to eliminate leaks and prevent further pollution, disposal of previously accumulated waste.

**Second Stage 2020-2030** – Transition economy: towards the third industrial revolution:

Water resources: creating a world-class water body management system, streamlining water utilities.

Agriculture: increasing agricultural productivity through modern work methods.

Electricity generation and energy efficiency: developing alternative energy and optimizing energy consumption, developing energy storage systems.

Transportation: developing electric transport infrastructure, setting objectives for electric cars and fuel cells.

Waste management: building recycling infrastructure.

**And, finally, the Third Stage** – the « Green economy »

All water resource-related issues are resolved.

Agriculture provides high long-term income through the creation of new value-generating industries.
Wind and solar power potential is fully tapped through the use of gaz infrastructure.

Kazakhstan’s economy and industry has comprehensive recycling capacity.

It is worth noting that the transition process it will be gradual and well thought through.

Undoubtedly, developing a «green economy», in particular future energy – clean energy, is at the top of Kazakhstan’s agenda.

We pin our hopes on the opportunity to host the Expo in Kazakhstan. We attach particular importance to hosting the Expo in Astana – the heart of Central Asia.

Hosting a recognised international exhibition in 2017 will help Kazakhstan encourage innovation in business and energy-related research. The Expo will help create conditions and environment favorable to "green" technology not only in Kazakhstan, but also in the Central Asian region, that has yet to enjoy broader spread of such technologies.

In this context the initiative of President Nazarbayev to create a "Green Bridge" partnership program is both relevant and timely. He voiced his proposal at the 67th Session of the UN General Assembly. This initiative will ensure transfer of « green » technology from developed to developing and the least developed states. This Program will help tackle environmental problems as the regional level because many of them are too big for any single country to handle. For example, resolving environmental and energy-related issues in the Central Asian region, which is directly linked to the concerns of trans-boundary water apportionment, climate change and wasteful use of natural resources.

This Program gained support in the Final Declaration of the UN sustainable development conference "Rio+20", which took place on June 21-23, 2012. In particular, section on «Sustainable development institutional framework» reads: We welcome regional and cross-regional initiatives for sustainable development, such as the Green Bridge Partnership, which is voluntary and open for participation of all partners.

We are convinced that hosting the Expo in Astana will give a new impetus to the successful implementation of the Green Bridge Partnership Program, as well as to the international cooperation in tackling environmental challenges.

World-class expert recognize that the " Future Energy" theme chosen by Kazakhstan is and will remain relevant in the near future.

The world energy system has yet to make a transition to a sustainable path. According to new strategic scenarios, global energy demand will grow by more than a third by 2035.
Many counties are moving away from nuclear energy toward the rapidly developing wind and solar power, extracting more natural gas, including by alternative methods.

Expo-2017 will undoubtedly become an international platform for dialog and Kazakhstan is perfectly positioned to ensure just that. Our country is among the richest in terms of natural energy-related reserves, however this is not preventing the government from contemplating the risk their depletion and the development of new alternative sources of energy. This theme will help attract new technology and know-how to Kazakhstan. It will also give a new impetus to technological innovation and scientific research.

Global leaders, politicians, experts and researchers in the field of energy will get together in Astana to discuss the most pressing issues and look for new solutions.

At present Kazakhstan has a huge untapped potential for the development of clean energy, including renewables.

Experts estimate that Kazakhstan has substantial potential for renewables.

Wind power potential is in the ballpark of 920 billion Kwh/year, technically exploitable hydroelectric power potential is estimated to be 62 billion Kw/h/year and solar power potential in southern regions of the country reaches 2500-3000 solar hours per year.

Development of renewables will be sustained by the legal framework with the public support mechanism imbedded in the draft law.

We are making specific steps in this direction.

First, we are drafting and fine-tuning legislation to attract investments to this sector and to ensure safe and unrestricted inclusion of renewables in the overall energy mix.

However in real life it became clear that there were a number of issues that needed to be resolved in the law.

One of the main sticking points was setting the price of sales by the renewable energy facilities:

Under the old system each project had its own timeframe to pay for itself and was considered individually at the stage of technical and economic justification. It was than subject to agreement with the authorized or local executive body. This was an administrative burden.

In order to ensure the success of renewables development in Kazakhstan, on 4th July we adopted a revised law “On support for the use of renewable energy sources. This was
done with due consideration of global best practice and national circumstances. The revised version of the law covers two main areas:

1. State support for investors building industrial scale renewable energy generation facilities.

2. Subsidies for renewables consumption.

Thus the law provides support to both investors and ordinary consumers.

The law provides for:

1) The introduction of fixed tariffs – a set rate for energy generated from renewables.

Fixed rates will serve as a guarantee for investors that they will recover invested funds, and will also ensure greater predictability of the renewables tariffs. This is important because renewables are extremely capital-intensive and thus additional incentives are necessary to attract potential investors.

Under the law, tariff will be set by the government for a 15-year time period. The rate will differ depending on the type of renewable. It has been proposed that fixed rates be revised every 3 years depending on whether the set objectives have been achieved or not. For finished projects, there is a guarantee that set rates will apply for 15 years.

Fixed tariffs will be approved by the following resolutions of the Government of the Republic of Kazakhstan: «On the approval of fixed tariffs», «On the approval of rules for setting fixed tariffs». This work is already underway at the Ministry.

2) The distribution of electricity generated from renewables through a specialized renewables support centre to all consumers. This implies the creation of a clearance centre under the umbrella of a System Operator. The center will guarantee the purchase of electricity from renewables generation facilities. It will also ensure that the costs of supporting renewables will be evenly distributed among conventional power plants. The clearance centre will purchase electricity from renewables generation facilities at a fixed price, based on the electricity supply contract.
3. Promoting the uptake of renewables by consumers:

1) The concept of targeted assistance

In order to incentivize wider renewable use, the government will reimburse individuals without access to the grid 50% of the cost of purchasing generation facilities. This applies to facilities with a maximum generation capacity of 5KwT.

A specific regulation will cover the modalities of targeted assistance.

2) Making it possible for individual users to sell surplus electricity back to the grid.

Currently the Ministry is revising existing renewables rules and regulations.

We will not be able to hit our energy targets without renewables use projects. The key projects are outlined in the Alternative and renewable energy development plan for Kazakhstan 2013-2020 (№43), adopt on 25 January 2012.

Under the plan, 31 renewable generation facilities with a total capacity of 1040 MwT will be commissioned by 2020. This includes 13 wind farms with a capacity of 793 MwT, 14 hydroelectric power plants with a capacity of 170 MwT and 4 solar power plants with a capacity of 77 MwT. All of the projects have been added to Kazakhstan's renewables map. The plan contains information that is needed for investors to decide on the most promising sites for renewables facilities.

The Ministry is already cooperating with a number of investors who have already begun work on their projects.

Wind power, small-scale hydropower and solar power projects are already underway. Investor interest in small-scale hydroelectricity and windfarm projects is also growing.

A lot of work has gone into the drafting of this law. We have factored in the wishes of investors already active in renewables, technical specialists and engineers, as well as sustainable development and climate change experts. We believe, that the new draft of the law will make renewables more attractive for investors and will also propel renewables development in rural areas and by individual households.

Furthermore, Kazakhstan ratified the IRENA Charter. This is a clear indicator of just how developed the sector is. In January 2014 in, at the 4th session of the IRENA Assembly, Kazakhstan was one of 65 countries to sign the Global Atlas. Signatories included Ministers representing the 43 states which joined the organisation in 2013, and also over 50 organisations.
IRENA promotes wider use of renewables for sustainable development. It supports both national and international efforts to transition to a sustainable and secure energy supply model.

The Agency's dialogue platform will allow Kazakhstan to actively and effectively take forward the renewables agenda.

It is clear that policy of the Government of the Republic of Kazakhstan is aimed at promoting renewables development. We are taking systematic measures to develop renewables in response to global challenges. This is being done with Kazakhstan's long-term strategic interests in mind. These measures will put Kazakhstan at the forefront of Green Energy development and will help us to achieve strategic green economy objectives.

We are convinced that thanks to the successful development of the renewables sector in 2017, we will be able to showcase our «secure and balanced future energy model».
THE IMPORTANCE OF FUTURE ENERGY AND ON THE NECESSITY TO ADDRESS THIS THEME IN EXPOS

Talgat Yermegiyayev, Chairman of Expo 2017 Astana
THE IMPORTANCE OF FUTURE ENERGY AND ON THE NECESSITY TO ADDRESS THIS THEME IN EXPOS
How Astana EXPO 2017 will set the agenda for world energy
*Talgat Yermegiyayev, Chairman of Expo 2017 Astana*

**Introduction**

Energy is invisible. It is almost indefinable. And yet it is so essential to human existence that it can change the fate of nations. We use it at every moment of every day. And the way it is used, and the consequences of its use, are among the most important challenges facing humanity today – or perhaps the most important challenge of all.

The choice is clear. We need energy to survive and to thrive, but we cannot continue to source and harness it as we have done for the past few hundred years. Our main existing energy sources, fossil fuels, are becoming depleted, and their use also endangers the planet through the emissions and subsequent climate change it creates.

From their inception, EXPOs have celebrated and showcased new technologies; the legacy of EXPOs is wide-ranging and ever-influential, from the Eiffel Tower in Paris to technology parks and transportation showcases around the world. All new technologies either harness energy or in some cases involve new ways of sourcing and distributing energy.

Astana EXPO 2017 synthesises these developments into a ground-breaking showcase of how new sources of energy – renewable, meaning they do not deplete, and with minimal carbon impact on our planet – can not only replace our old energy sources, but catalyse a transformation in the technological, industrial and human landscape. Astana EXPO 2017 will be an opportunity for the world to show, and to see, how future energy will drive a future world.

Kazakhstan’s hosting of Astana EXPO 2017 is no coincidence: for many years a key supplier of fossil fuels, Kazakhstan has committed to an acclaimed programme to
transform to a Green Economy, and to be one of the enlightened nations helping drive the world to a sustainable future through use of renewable energy and the technologies and human developments that arise from them.

1. The importance of future energy

We cannot doubt the importance of energy. «Energy is essential for sustainable development and combating poverty,» the United Nations Development Programme says. «It affects all aspects of development —social, economic and environmental—including livelihoods, access to water, agricultural productivity, health, population levels, education and gender issues.»

Energy is central to our 21st century civilisation. There is not a society on Earth that doesn't need it in some form or another. Developed countries are particularly reliant on energy: its use underpins the smooth running of almost every aspect of life. Economists will all attest that no government can create a stable economy unless it has a reliable, robust strategy for sourcing energy and using it as efficiently as possible. But - and here's the problem - using energy means losing energy.

A basic law of physics tells us we can't create or destroy energy, we can only transform its character - and in doing so, some of it always gets away. We can't put energy to work for free; we always have to invest in finding new sources of energy. This, future historians may one day write, has been the defining task early 21st century governance - try to find a public good that doesn't involve the use of energy and you will fail.

Transport is energy use. Making cities safe and habitable involves the provision of raw materials for heating and lighting. No one runs a home without energy; no one runs a business such as manufacturing without a solid plan for using energy at maximum efficiency. Owning an energy source is a passport to wealth and security. It is also often an unspoken invitation into conflict; wars - whether verbal, political, economic or military - have been and will be fought over access to energy sources. We can now add to that mix the realisation that our energy use is affecting the processes that power life on Earth, causing climatic changes that could severely affect the habitability of many areas and significantly alter the major economies of human civilisation.

The vast populations of the developing world - China and India, in particular - are now creating ever more demand for limited energy resources. It is no longer safe to assume energy will always be there when we need it, whether to start our cars or light our homes. Thinking hard about energy - where we will get it in the future, how we can use it responsibly and for the benefit of as many people as possible - has never been more urgent.
That is why there has never been a better time to stop and consider the broad issue of our relationship with energy. The Astana EXPO 2017 Future Energy project will do just that, addressing this important topic from several perspectives and offering a broad and thought-provoking theme for addressing the challenges we face as well as anticipating solutions to those challenges. It will explore strategies, programmes and technologies aimed at sustainable energy development, consider the issues of energy security and efficiency, and examine the role of renewable energy. Visitors to Astana EXPO 2017 will be encouraged to embrace and adopt an active role in the design and execution of a responsible and sustainable plan for our future energy production and use.

Perhaps, when trying to get to grips with energy, it is best to start at the beginning - the very beginning. According to modern science, energy is the fundamental, underpinning constituent of our universe. The fundamental tenet of physics that says energy cannot be created or destroyed hints at some pre-existing source of energy; but it is beyond the scope of science to say where the energy of the so-called «big bang» came from. Nonetheless, we have robust and reliable evidence pointing to the idea that the moment of cosmic creation involved an outpouring of energy that still powers our existence today.

Whatever its source, that initial cosmic energy remains with us. It takes many forms now. There is the chemical energy locked up in the molecules of our DNA, in the cereal crops that constitute our food and in the fossil fuels we remove from the earth’s crust. There is the radiation that comes to us from the stars in the form of light and heat. The sun’s heat provides the kinetic energy for the movement of air in the various layers of Earth’s atmosphere. Uranium atoms forged in burning stars contain the nuclear energy, held within the protons and neutrons at the atoms’ cores, provide the energy that can be released to create electricity in the world’s nuclear reactors.

DNA, the building block of life and a fundamental store of energy
Human ingenuity has forever been deployed in learning how to convert these various forms of energy into heat, light and mechanical work, and in learning how to store the energy in ways that allow us to distribute it for widespread use. Gaining expertise in these processes has always been a central issue in the development of civilisation.

For early humans the simple act of cooking food harnessed the release of chemical energy from plant matter in the form of fire, to make the energy locked up in foodstuffs more accessible.

From here, the story of human energy use gathers pace. Big brains gave us big ideas for exploiting energy even further: we invented and constructed water wheels that would mill our grains to release even more energy, for example. We also invented technology to exploit energy for transportation - sailing boats that harnessed the energy of the wind, for example. Military technology - ever more complex weaponry - also followed in the form of slings, catapults, bows and arrows. We transcended the restrictions of the natural environment by using energy to bake mud into bricks to construct housing, then villages, then cities. We took animal fat - a stored chemical energy - and formed it into candles that would give light to extend the working day.

History progressed and we used ever more refined and complex processes, gaining light and heat from oil, gas and coal taken out of the ground. Energy use in the built environment fundamentally changed the kinds of environment that humanity could inhabit; its use in transportation did the same, allowing us to move food around the planet. Then came the control of electrical energy, creating another revolution. First, there were batteries - a portable energy source. There was the new reliable electric light. And, perhaps most revolutionary of all, there was almost instantaneous communication: the electric telegraph made it possible to send signals across the world in the blink of an eye.

Meanwhile we had got to grips with the internal combustion engine, a source of mechanical energy that has had an impact like no other. They all have the same principle at heart: they take the chemical energy locked up in biological materials - most often the fossilised plants and animals in coal, oil and gas - and release it in an explosion that powers a mechanical movement. The end result might be a car moving along a road, or a giant turbine creating electrical power to be distributed to homes and factories.

This has changed everything. During the industrial revolution - the dawn of low-cost mass production in vast factories - those who could liberate and use energy the fastest soon became the richest people (and nations) on Earth. The combustion engine also
shrunk the world by enabling the creation of fast, long-distance transport networks on land, sea and air.

The end result of this was the energy-dependent economies we have today. The biggest players are those who can source and transport the base fuel to gain power and influence. The raw materials of energy production are, essentially, the bricks of the path towards political and economic independence. All this, however, comes at a cost. As we consider the future of humanity’s interactions with energy, we must acknowledge that some own the raw materials of energy production, while some must buy them - or the finished product, the useable energy itself. There are, in energy terms, haves and have-nots, and this will matter ever more in a globalised world.

Between 1991 and 2011, world energy consumption per capita increased by 13 per cent according to figures released by the US Energy Information Administration (EIA). By 2035, the global demand for energy is expected to increase by more than one-third. Between now and then, India’s demand will double, and China’s will grow by 60 per cent. OECD countries, currently considered huge energy consumers, will demand less than half the energy of the rest of the world. So where will it all come from?

At this time in human history our main resource is still fossil fuels: oil, coal and gas created over millennia by the slow crushing of buried plant and animal matter. Take the United States, for example. There, the US Energy Information Administration says, fossil fuels account for around 82 per cent of energy use, including 66.4 per cent of electricity generation and 95.4 per cent of transportation energy.

From a supply perspective, there is no urgency to move away from fossil fuels. An assessment of global coal reserves in 2012 indicates that there is enough to meet more than a century of production at current rates. Though coal has the best reserve-to-production ratio of all the fossil fuels, there is little sign of panic elsewhere. Gas reserves are considered sufficient for a further 55 years of production if today's production rates hold steady into the future. In 2011, world oil reserves were 2.8 times their level in 1971. Getting oil out of the ground requires ever more ingenuity and engineering prowess, but we seem to be able to meet the challenge: in 2040, the EIA says, we will be producing 28.3 million more barrels per day than we were in 2010. However, our current reliance on high-carbon energy sources is certainly not something we can afford to continue. That is primarily because burning fossil fuels produces carbon dioxide.

Since the time of the industrial revolution, when we first started burning fossil fuels on a massive scale, the percentage of carbon dioxide in the atmosphere has increased dramatically. There is now a broad consensus among the world's climate scientists that
this has caused a significant rise in the average temperature of the planet. That is because the thermal properties of carbon dioxide mean that it traps heat in the atmosphere that would otherwise escape out into space. In other words, it acts as a blanket. Scientists also agree that the temperature rise is having significant effects on the climate of our planet, changing the areas that are habitable by humans and other animals, and causing shifts in weather patterns.

It is generally agreed that the concentration of carbon dioxide in the atmosphere needs to be kept under 350 parts per million (ppm) if the global temperature is to be kept under control. However, the monitoring station at the Mauna Loa Observatory in Hawaii indicated in May 2013 that the average daily level of carbon dioxide in the atmosphere had reached above 400 parts per million. This is a milestone that scientists believe has not been reached for millions of years, and is so far above the safe level that drastic action may be required. Keeping to the non-binding agreement to limit average global temperature rise to 2 degrees Celsius over 2009 levels, reached at the 2009 Copenhagen Summit, will be tough with carbon dioxide levels so high.

Climate change due to carbon emissions will have - and is almost certainly already having - profound economic and social impacts. Natural ecosystems and human societies are both complex and closely interconnected, and can be highly sensitive to factors such as changes in global temperatures and weather patterns. The IPCC has warned that failed harvests, frequent catastrophic flooding and significant loss of biodiversity are all a likely consequence of climate change.

This will create a wider variety of problems than might initially be expected. Although industrialised countries must shoulder the largest responsibility for the climate-warming carbon dioxide emissions (at the moment, China, the United States, India, Russia and Japan are the top five emitters of carbon dioxide), but the issue is a problem for everyone. The sea level rise caused by rising ocean temperatures, for instance, makes flooding more likely, and thus affects low-lying countries. The effects of carbon emissions are felt everywhere, and particularly by smaller, poorer nations with less developed infrastructures. These typically have fewer resources and less flexibility, creating the potential for humanitarian crises and civil unrest leading to outbreaks of war and other adverse consequences, including the rise of extremist political regimes.

The spectre of such global problems is why the International Energy Agency has said we need to have cut carbon emissions to half of their 2009 levels by 2050. The IEA is not the only body to be addressing the problem. The global think tank known as the Club of Rome has met a number of times to find solutions, for instance, and the issue is always on the minds of national leaders as they meet in various contexts, with guidance
provided by the scientific reports from the Intergovernmental Panel on Climate Change (IPCC). That is why, while fossil fuel production and use continues, a slew of other energy sources are being added to the mix.

Around 12 per cent of global energy needs are now met by nuclear power. That is set to increase, with 71 nuclear reactors currently under construction (30 of those are in China). Worldwide, renewable sources such as hydroelectric, wind and solar power account for 10 per cent of energy consumption. That is expected to grow to 14 per cent by 2035. Renewables accounted for 24 per cent of electricity production in the European Union in 2012 (but only 12 per cent of primary energy consumption).

The World Energy Outlook 2013, published in November, suggests that in 2035, around 40 per cent of the growth in global energy demand will have been met thanks to low-carbon energy sources. However, that is only the growth in demand: fossil fuels will still meet 75 per cent of our energy needs in 2035. That means carbon dioxide emissions remain a serious problem. The problem is exacerbated by the fact that coal, the most carbon-polluting of the fossil fuels, will remain the main fossil fuel energy source.

The most obvious way forward for all nations is to both increase energy efficiency and reduce our dependence on fossil fuels by developing ever more efficient and cost-effective renewable energy resources. There are many such projects in development around the world, focusing on solar, wind, wave, tidal, geothermal and other renewable sources of energy. However, the path is a steep one. According to the IEA, if we want to halve global energy-related CO2 emissions by 2050, it will require a doubling of today’s renewable generation by 2020. It will also mean taking a long, hard look at the transport sector.

Renewable Solar energy being harnessed
Hydroelectric power is a key pillar of renewable energy policy

Wind power is renewable and uses the kinetic energy in the earth’s atmosphere to generate electricity

Mobility plays a vital role in the economic growth, employment and social inclusion of any population, and has its own unique energy footprint. Almost 55 per cent of world oil consumption is down to the transport sector, according to the International Energy
Association. By 2030, transport’s energy use and emissions of carbon dioxide are set to increase by more than 50 per cent - possibly heading towards a doubling. If the international transport sector were a country, it would be the sixth biggest emitter of carbon dioxide, so it is certainly worth ensuring that our transport policies ensure that future solutions for our transport needs are efficient and sustainable.

Perhaps the most problematic of all transportation modes is shipping. This sector uses nine per cent of transport fuel, mainly « heavy fuel oil », a cheap but highly polluting option thanks to its high sulphur content. There have been some explorations of wind and solar-powered shipping, but these have so far not been seen as viable alternatives for an industry that relies on reliable, low-cost energy. Developments in the production of biofuels could reduce the carbon emissions due to maritime transport quite significantly - as much as 85 per cent, according to the IEA.

This is a prospect for emissions reduction that shipping has in common with aviation. Future air travel will account for the largest increase in travel by those living in OECD countries. Aviation already accounts for around 11 per cent of transport energy use, but IEA figures suggest this figure will almost double by 2050. Aviation is a significant contributor to climate change, responsible for 12 per cent of CO2 emissions in addition to producing other potent greenhouse gases. Though always likely to be reliant on liquid fuels, investigations of low carbon-emitting biofuel use are under way. Novel construction materials will make planes lighter and thus more efficient. And revisions to the way air traffic is managed - changing ascent and descent flight paths, for instance - can reduce fuel use significantly.

Similarly innovative solutions are already being put to work in the rail transport sector. Rail is a relatively energy-efficient mode of surface transport. It produces less than 2 per cent of the transport sector’s carbon dioxide emissions, which makes the predicted 50 per cent increase in freight volume over the next four decades a very welcome prospect. What’s more, measures taken to improve fuel use in that time are expected to give 20 per cent efficiency gains. Using electricity rather than diesel provides a significant 15 per cent gain in energy efficiency, and measures such as lighter rolling stock, gentler acceleration and regenerative braking, where electric motors are boosted by power harvested from the vehicle’s brakes, will also help.

According to the IEA, road travel will be the major contributor to transport growth over the next few decades.
Scientists have developed roads able to store kinetic energy created by cars driving over them.

Car ownership is set to at least triple by 2050, with roughly two-thirds of the global vehicle fleet in non-OECD countries. Electric vehicles produce significantly lower CO2 emissions than traditional transport, make less noise and reduce our dependence on fossil fuels. In order to decarbonise the transport sector a goal would be for electric vehicles to obtain their power from renewable energy sources. Electric transport includes all kind of vehicles from hybrids that plug into the grid to entirely electric vehicles whose engine is powered by a battery. Some of these vehicles can use solar panels. Hydrogen fuel cells and bio-fuel powered vehicles are also options when needed.
All-electric cars like the Nissan Leaf, which have zero tailpipe emissions, are an increasingly common sight on the roads.

The convenience of personal car travel is matched by the convenience for businesses when it comes to road-based delivery. Transporting goods by road provides a highly flexible delivery network for businesses in the developed world, but the flexibility comes at a price. In the US, as an example, road haulage by heavy duty trucks accounts for almost one-fifth of the transport sector’s carbon emissions. Even state-of-the-art high efficiency large trucks have much lower fuel efficiency than viable alternatives such as rail transport. Though fuel efficiency improvements are sure to come, it is still an unavoidable fact that sending goods by rail is roughly four times more fuel efficient, and thus produces far lower carbon emissions.

But if the diesel truck is seen as one of the problems in fighting climate change, perhaps it is worth pointing out that Rudolf Diesel demonstrated the first diesel combustion engine at the 1900 EXPO in Paris. It is becoming clear that Astana EXPO 2017 could well be known as the place where the solutions to the unintended side-effects of our love affair with the internal combustion engine were first put on display.
Astana EXPO 2017 will be uniquely placed to help find solutions for the problem of future energy. It will take place just two years after the international community adopts new Sustainable Development Goals, to replace the Millennium Development Goals. These SDGs are currently in the early stages of development, but will certainly include one or more goals related to energy access and energy efficiency. So Astana EXPO 2017 will take place at an opportune moment, when nations, communities and societies around the globe will be looking for answers about how to meet their new energy goals - and an EXPO has always been the ideal place to showcase solutions.

EXPOs have always been great drivers of global change. Their wide reach across cultures, social divides, people working in different industrial and social sectors and those of every age means that the message they transmit has unparallelled reach and impact. This can be seen in some of the inventions and innovations that have been premiered in EXPOs of the past.

From the mid-19th century until the beginning of the World War I, Expositions and fairs were the spectacles that best represented traditional Western society and its achievements. Universal Expositions, especially, helped demonstrate that the process of industrialisation didn't have to result in alienation of ordinary people but could unite all of humanity in the march of progress. Pavilions were even initially built in the style of temples, conveying the grandeur of the machines and commerce of modern industrial civilisation.

Energy has always been central to this role of EXPOs. New and more powerful machines for industry, agriculture and transport play a leading role in the kinds of progress EXPO celebrates, for instance, and these machines always had to be driven by ever more efficient and inexpensive energy-consuming engines.

As an example, the Great Exhibition of the Works of Industry of All Nations (London, 1851) and the Exposition Universelle des produits de l'Agriculture, de l'Industrie et des Beaux-Arts (Paris, 1855), demonstrated how the energy from fire could produce steam that was capable of moving many powerful machines that were at the forefront of the Industrial Revolution.

Later on, during the Universal Expositions in Paris in 1867, 1878 and 1889, electricity began gaining a wider presence and replacing steam power. The 1900 Paris Exposition Universelle was the setting for the showcasing of Alternating Current and, as we have
mentioned, the newly-invented Diesel engine. The Exposition Universelle et Internationale de Bruxelles in 1958, demonstrated the possibilities of nuclear energy, with the symbolic Atomium in place as its icon.

Today, the opportunity to engage in a transnational conversation about energy that EXPO offers has never been more important to humanity. Despite the importance of energy, more than 20 per cent of the world's population has no electricity at home - a total of 1.3 billion people have no access to electricity. 85 per cent of these are in urban slums or rural areas. The greatest challenge lies in sub-Saharan Africa, where the electrification rate is 31 per cent. Residential electricity consumption, excluding South Africa, is roughly equivalent to that of New York State (including New York City): in one year, the 19.5 million people living in New York consume the same amount of electricity as the 791 million people living in sub-Saharan Africa.

In sub-Saharan Africa, 80 per cent of the population rely on non-renewable traditional biomass. Across the world as a whole, around 40 per cent of the world's population have no means of cooking food other than biomass. This method of cooking can create toxic air pollution if the biomass is inefficiently burned; such pollution kills nearly 1.5 million people per year, many of them young children.
No wonder the UN Advisory Group on Energy and Climate Change has called for all countries to adopt the goal of universal access to modern energy services by 2030. Access to modern energy technology is essential to ensure proper water supplies, sanitation and health care. An efficient and reliable energy supply ensures basic cooking, lighting and heating for households. It also provides energy for mechanical power, transport, telecommunications devices and education.

This all helps spur development. In fact, there is a strong correlation between access to modern energy services and income levels: as income levels increase, access to electricity rises at a faster rate than access to modern cooking fuels, largely because governments priorities electrification. Access to electricity is essential to ensure the development of enterprise and thus long-term increases in GDP per capita around the world, but electricity plays a particular role: lighting and communication are key to better education, for instance.

Making clean electricity accessible to more people will require the involvement of the international community and the private sector, as well as many other stakeholders at regional, national and local levels. This process is one of many that Astana EXPO 2017 has in its sights.

Astana EXPO 2017 is an opportunity for the world to realise we are living in a time of unprecedented opportunity, with new technologies transforming the way we produce and consume energy. We manage our use of energy at all levels, from industrial factories to smart distribution networks to home heating, lighting and cooking using increasingly sophisticated information and communication technologies. Our innovations in construction and material technologies, including insulation, miniaturisation and lighter materials, have allowed us to cut specific energy consumption in electricity, heating and transport.

New semiconductor technologies are providing opportunities to produce distributed electricity at low cost: photovoltaic electricity generation from sunlight is becoming cheap; power electronics and computerised control allow for efficient micro-management of electricity; and power electronics, sophisticated control programs and new materials make wind turbines competitive and fuel cells an interesting option. What's more, new storage technologies will allow for widespread storage of electricity at both small and large scales within a few years, providing a high degree of flexibility.

These developments will fundamentally transform the energy business. Private end-users - houses, buildings, trades and factories - will be more actively involved in producing and managing energy. We will gain more efficient and networked ways of distributing the -
mainly renewable - energy we generate. Integrated local management of energy supply for electrical appliances, heating, cooling and transport will become more important and strengthen the role of electricity.

Not only will these measures meet growing energy demand, they will also provide energy security at a time when nations are increasingly sensitive to this issue. No country wants to be reliant on another for such a vital resource as energy, but the reality is that total energy independence is unlikely to be possible for every country. Astana EXPO 2017 will provide an opportunity for nations to talk to each other about these issues and reach agreements and understandings about how interdependence can work and be of benefit in international relations, rather than a source of conflict.

A global strategy is unlikely to materialise in the near future, of course, but change - fast and deep change - can still happen. International dialogue between people involved at all levels is vital for spreading existing technology and energy solutions, as well as for exploring future technology in these areas. The range of professions that will visit and participate in Astana EXPO 2017 is vast: architects, city planners, engineers, transport policy designers, landscapers, politicians, climate scientists, leaders in implementation of renewable energy strategies, cultural and sporting icons with great influence over public opinion. The list goes on. All these people play a role in ensuring the energy future that is needed can begin to materialise right now. Thanks to the opportunities Astana EXPO 2017 affords us, we can start to effect change, even before the event, establishing sustainable energy solutions, showcasing new distribution systems, increasing energy efficiency, promoting world energy access as an issue of equity, a basic need and a right, increasing the percentage of renewable energy and reducing the carbon footprint of electrical power and transport industries.

Astana EXPO 2017 offers myriad ways for the necessary conversations to take place. One of the main features will be the Future Energy Forum, a high-level, multilateral international platform for vigorous debate on the Future of Energy. The existence of the Forum will help the general public get involved and give rise to new forms of collaboration and involvement.

Specialised international agencies, the scientific community and academia, as well as other stakeholders such as NGOs and the private sector will all have a presence at the Forum, which will provide an outlet for examining and enriching, at the highest scientific and intellectual level, the themes addressed in the Astana EXPO 2017, and stimulate the cooperation and joint efforts of the international community in the area of energy. Governments, specialists and researchers from international agencies and from the scientific community, universities and think-tanks will share their opinions with leading
companies in the energy sector, and with strategists and consultants, research centres and NGOs.

This vast collaboration will take place with the aim of contributing to the key objectives set out in the Astana EXPO 2017 project. There will be panels, conferences, symposiums, debates, thematic weeks, open tables and workshops, all addressing aspects ranging from technology review to the analysis of policies, strategies, programmes and specific projects. Delegates will discuss best energy practices for reducing greenhouse gas emissions and promoting energy efficiency and universal access to sustainable electrical energy in an environment founded on the principles of cooperation and the exchange of knowledge. The conclusions reached in the Forum will create a significant step forward in the formulation of common objectives for future energy, and will inform the debate on energy that will take place over the coming years.

But Astana EXPO 2017 aims to do even more: it aims to seal an alliance between governments, organisations, business people, environmentalists and consumers with a « Manifesto of Values and Principles » that serves as a model for the entire planet. This series of directives and recommendations, focused on cooperating to reach the goals of energy efficiency, reduce carbon emissions, generate more clean energy and invest in the energy futures of developing nations, will be Astana EXPO 2017’s intellectual legacy. Consequently, the Astana EXPO 2017 Future Energy Forum will play a crucial role in promoting a new code of social and technological innovation needed to tackle the energy challenges facing humanity.

Astana EXPO 2017 is not just about the « big » solutions. It will operate on a very human scale, providing the individual visitor with the tools to engage with the world's energy issues. It will offer visitors the opportunity to measure their energy impact and seeks to encourage citizens to take positive action - action that can make a difference.

This is vital. According to a report by the Swedish Consumer Agency consumers who are properly empowered by information can « contribute to furthering competition and innovation in consumer markets ». That is because consumers who are prepared to change their provider of goods and services are a prerequisite for effective competition between market players. “Competition keeps businesses under pressure and makes them more effective, - as the Swedish Consumer Agency report says. — Consumers who are active in the market and act consciously foster competition, save money, and receive better goods and services.” That means an informed public can have a positive impact on economic growth.
An EXPO gives a unique opportunity for people to become empowered and get to grips with the realities and the grass roots of an issue they might otherwise never get the opportunity to explore. At Astana EXPO 2017, everyone will have a chance to see first hand how energy resources are extracted and distributed, how their use impacts the environment, which enterprises they enable and the kinds of markets in which they are used. They will also be able to investigate the international regulations and policies governing our use of energy resources, be they fossil fuels, renewable energy technologies, hydrogen or nuclear energy. It is also an opportunity to look closely at carbon capture and storage technologies, smart grids’, and the concept of efficiency.

Visitors will see maps of the world’s energy resources and information on important reserves of existing and potential energy resources. There will be educational materials on the technologies required to extract and manage these resources and the processes by which the energy resources are obtained, stored, distributed and transported. They will not fail to notice that many renewable sources are much more evenly distributed over the world than fossil resources. This will help raise awareness of the wisdom of shifting towards making the most of these local opportunities.

Astana EXPO 2017 will help us look at energy from a common, global viewpoint which takes into account the concerns and challenges facing humanity: caring for the environment and boosting economic and social development. This balance depends on many elements and is everyone’s responsibility.

As well as these direct influences on the world’s energy debate, Astana EXPO 2017 will also contribute to learning through art, culture and entertainment and create a platform for the transfer of technology and skills to help, create a greener, healthier, sustainable future. The overall aim is to create an overarching global awareness, at institutional, corporate and individual levels, about the need to develop responsible and sustainable energy policies and platforms, to ensure the future of our planet.

The exhibitions at Astana EXPO 2017 will contribute to public empowerment, making the invisible visible, revealing how energy is omnipresent in our day-to-day lives, focusing in on responsible consumption and recycling, as well as on civic engagement, and promoting good habits and behaviours. There will be opportunities for individuals to see the importance of his or her choices, behaviours, actions and/or inaction in energy issues. Astana EXPO 2017 will have a strong educational element, teaching visitors about the basic but important and effective steps to take to consume and use energy in a more efficient and responsible way.
Astana EXPO 2017 will put a spotlight on individual responsibility regarding conscious and efficient energy use, awareness of our consumption footprint and the link between energy and our everyday lives. Its exhibits will bring home the fact that not all people have the same way of life, explore the interrelationship between economics of energy and the environment; the reduction of carbon emissions; the promotion of renewable energies and energy efficiency systems; the environmental impact of everyday actions; the importance of energy access together with energy conservation and energy use reduction; along with other questions regarding health and quality of life.

Here, the host nation is in many ways acting as a leader by example. Kazakhstan is currently a significant player in the production of fossil fuels. However, it is also emerging in the international arena as a country with a credible and coherent commitment to promoting green energy sources. At Astana EXPO 2017 Astana, Kazakhstan will promote best energy practices towards sustainable development, foster research and technological development of clean energies, exchange knowledge on Future Energy among all stakeholders - participants, academic institutions and scientific societies, business and industry and civil society - and raise awareness about the opportunities, challenges and demands for the future of energy.

3 - Kazakhstan’s Unique Position

Though only a little more than two decades old, Kazakhstan already has a history of taking the high ground. When it emerged as an independent state, it relinquished its nuclear weapons and closed and later destroyed the country's nuclear testing site. Having become a leader in nuclear non-proliferation, the nation sought to establish itself as an environmental leader, putting in place a strong effort to reclaim the Aral Sea, which had been critically depleted by irrigation projects. That project, too, is bearing fruit, with the Aral Sea now slowly returning to its former glory.

These two examples of the country’s dedication to creating a more sustainable future make it all the more exciting that Kazakhstan has now turned its attention to improving the local and global energy environment. President Nazarbayev has made it clear that the best way forward for Kazakhstan is to implement a Green Economy, and measures are already in place to begin this process. Astana EXPO 2017, when Astana will host a showcase of achievements in energy, will play a part in the outworking of this aspiration.

It would be easy for Kazakhstan to rest on its resources and continue to focus on growth as a major producer of petroleum-based energy. Kazakhstan could continue to harvest its resource wealth, thrive on its low costs of energy, land, water and minerals at a moment in which other nations are facing the end of cheap resources. With around 13
per cent of the country's Gross Domestic Product coming from petroleum, oil, gas and mineral resources, Kazakhstan is well positioned to sit back and enjoy its natural wealth. It is now the world's leading producer of uranium, with 12 per cent of the world's resources and more than one-third of world production to its credit. It has the 11th largest proven reserves of petroleum and natural gas. It has none of the secrecy or issues of inflated claims sometimes associated with nascent oil-producing states: in October 2013 it was declared compliant with the requirements of the Extractive Industries Transparency Initiative, meaning that Kazakhstan is fully and properly disclosing the revenues it gains from natural resources.

Though this is all an impressive achievement for such a new nation, the country's government has declared an intention to go further and become an example of «best practice» that others will follow. Despite outgrowing other economies and continuing to move up in the ranks of the most developed nations, Kazakhstan is committed to becoming a leader in resource productivity, stewardship of its environmental assets, and resilient growth. Kazakhstan has decided to become a leading green economy and demonstrate that there is a new model of wealth creation that can be applied to resource-rich countries.

Perhaps most importantly of all, Kazakhstan has the political will to create this new, green nation. The government has committed to ensure that 1 per cent of GDP is dedicated to the goal of greening Kazakhstan's economy right up to the year 2050 and has stipulated that future decision-making must adhere to a set of principles designed to ensure the greening of Kazakhstan stays on track through the next few decades.

The first of these principles is that resources must always be used wisely and effectively. The country has identified that it currently wastes somewhere between 7 billion and 14 billion US dollars worth of energy resources that could otherwise be exported or used as a future reserve. Decisions by companies and authorities must now use all resources productively. Second, future construction projects will utilise the most efficient and flexible technologies available. Social return is being prioritised: measures that offer a high value return to the most vulnerable members of Kazak society will be given priority.

Furthermore, resource subsidies must be aligned with the vision for a green economy; all subsidies are undergoing review to make sure that desirable new technology and energy solutions are not being put at a disadvantage but are gainers from the subsidy system. Finally - and perhaps most importantly for future decades - Kazakhstan's education systems are participating fully in the country's green revolution, with measures being put in place to ensure future generations have the mindsets and the capabilities needed to run and sustain a green economy and are raised as good stewards of their natural
environment and resources. The government is launching a national education and awareness program focussed on the Green Economy. A key part of that program is the inclusion of «resource productivity» topics in all levels of the country's education system.

The deliberate creation and promotion of these principles has outworkings in many areas of the country’s resource management; there are programmes in place to apply them to water management and use (a major issue in a large landlocked country), and to waste management and agriculture. When it comes to applying the principles to energy, Kazakhstan has implemented specific action plans in two key areas: energy efficiency and energy supply.

Energy efficiency has been described as the low-hanging fruit. Around the world, there are myriad cases of heat lost through insufficiently insulated buildings, inefficient heaters or air-conditioning units, unnecessary cooling of poorly-designed buildings, lights that are left on through all hours of the day and night - the examples are as endless as they are depressing. Kazakhstan is aiming to avoid these pitfalls when creating new infrastructure and retrofitting existing buildings. Finance has been put aside to allow district heating companies to upgrade their infrastructure and for consumers to install modern metering and thermostatic controls, and to replace old boilers and insulate pipework. There will also be careful increase in heat tariffs - large enough to encourage responsible energy use but implemented in a way that protects vulnerable members of the population. It is not just about heating, however. The government is committed to monitoring electricity consumption and ensuring that energy use audits are regularly carried out. In the transport sector, imported cars will have to meet strict efficiency standards.
Energy-efficient housing which is carbon-neutral or carbon-positive will become the norm
Commercial buildings are being designed with consideration for all aspects of environmental efficiency.

Despite being in a strong position to benefit from fossil fuel supply, the government is committed to embracing renewable energy sources, constructing «smart grids» for electricity distribution and finding and implementing new ideas in energy storage. To this end, a programme of innovation is already under way. The renewable energy sector is being grown aggressively, and the country expects a 3 per cent rise in volume by the time Astana EXPO 2017 comes around, with a further 10-15 per cent growth by 2030 and 50 per cent growth achieved by 2050. If investment in green energy accelerates discovery and innovation beyond expectation, growth could be even bigger and even quicker.

While the renewable sector grows, Kazakhstan will invest in new gas infrastructure in many regions of the country. Gas is a useful bridging technology between coal and renewables. Though still a fossil fuel, it is far cleaner than coal in terms of carbon dioxide emissions and other pollutants. Large domestic gas reserves make this a sensible and environmentally prudent move. In major cities, coal-based combined heat and power plants will be converted to burn gas, improving urban air quality and giving the energy delivery system more flexibility.
Of course, Kazakhstan is not the only country seeking to diversify its energy sources. The movement away from reliance on coal, and towards other sources of energy, is a global trend. In most places, however, this is for economic, not environmental reasons. The discovery of abundant reserves of shale gas in the United States has driven down the price of electricity generation; its new focus on burning shale gas rather than coal is a simple result of the gas being cheaper than coal.

China's plan to replace many of its coal-burning plants with plants that burn shale gas resources is similarly pragmatic.

As a major exporter of uranium, it also makes sense for Kazakhstan to look at expanding its nuclear power generating capabilities. The country is committed to doing this with the utmost care: the first step will be to strengthen the Agency for Atomic Energy to give it independent control of safety in the nuclear industry and ensure the highest possible safety standards are met.

All of the measures Kazakhstan is implementing will be explored through two pilot projects, sometimes described as « periscopes to the future », that will demonstrate how the exciting new technologies fit together to create a new possibility for future energy. One of those pilots will be built at the Expo area in Astana. Another will be developed in a new city district, potentially in Almaty, the former capital of the nation.

For all the excitement of this new vision, Kazakhstan has not lost sight of the details. The government has developed a « score-card » that will measure resource use and provide the vital statistics for regular reports to parliament on the progress being achieved. All ministries have been asked to adopt the various initiatives into their programs within a year; the mood of the government is that the right time for transition to a green economy is right now. That is why a « Delivery Unit » for the green energy transition has also been set up with the express purpose of supporting the different Ministries involved in the transition and co-ordinating their efforts. The Delivery Unit, which follows a model used in several countries to support large-scale change, began its operation in October 2013, and has 20 staff. The government has also established an inter- ministerial co-ordination committee that reports directly to the Presidential Administration.

At its birth, Kazakhstan inevitably went through a period of « brown growth » where it followed the economic development path of other nations. But while following that path took centuries for most nations, it was a matter of two decades for Kazakhstan. The country is now ready to go green - and it can afford to do so.

By 2050, the Green Economy Strategy is expected to give a 3 per cent increase in GDP, more that 500,000 new jobs, and the creation of new industries and services. There will
be social benefits: cleaner air in big cities that will reduce respiratory diseases, and a
general improvement in the quality of life. It will help Kazakhstan take its place among
the 30 most developed countries of the world.

But it will also benefit the whole planet. Part of this new nation’s plan is to show the
world how best to live, and help other nations to follow its example of sustainable,
responsible nationhood. The American Naturalist Edward O. Wilson once said, « If
everyone consumed the same amount of energy as is the case in affluent countries, we
would need resources equivalent to four planets like Earth to survive. The trouble is that
we humans, unlike ants, termites or bees, do not operate as a single cohesive super-
organism. » Astana Expo 2017 aims to change that: it will be the event where
Kazakhstan encourages a human super-organism to form, ensuring we become good
stewards of our resources and create a better world for future generations.

To ensure the Earth remains a viable habitat for generations to come, we must act now
to ensure we do not deplete its resources or cause catastrophic change to the
atmospheric balance
EXPO 2017: FUTURE ENERGY

Gerd Leipold, former Executive Director of Greenpeace International
Kazakhstan will host the Expo 2017 in its capital city Astana dedicated to the topic of Future Energy. Kazakhstan is a country rich in oil and gas, its reserves are big enough to be a major exporter of oil and gas and still leave sufficient reserves for the country’s own energy needs for many decades. So, Kazakhstan could sit back in view of its huge fossil fuel reserves and not worry about future energy. However, this enormous asset is a double-sided sword. The author Richard Auty coined the phrase “resource curse” to describe the situation that countries rich in natural resources often have a much worse economic development than countries with a poor resource base. Paradoxical as it may seem, there are some sound reasons why this may be the case. Among these are the danger of neglecting innovation and competitiveness, neglecting other sectors of the economy, overdependence on fluctuating commodity markets, unfair distribution of wealth and corruption. Rather than relying on the easy wealth that abundant and eventually limited natural resources promises a responsible country needs to think, how it can build a sustainable economy less dependent on natural resources.

Kazakhstan’s decision to make “Future Energy” the topic of the Expo 2017 is therefore a wise and timely move, the more so as most of its neighbours either have the same abundance of fossil fuels or are poor in terms of energy resources.

World and International Expos with their proven records of showcasing a country’s ambitions, allowing an overview of state of art of technological, exchanging of ideas and reaching a mass audience are probably the best platform for such an important subject.

It is not an overstatement that energy is one of the most important if not the most important driver for the evolution of our societies.
Energy as a driver of human history

When we look behind the big changes in human history we will often find that they were caused or expedited through a major change of the way people used and produced energy.

For a very long time, nearly 2 million years, humans lived by gathering plants and hunting animals. Then, around 10 000 years ago a revolution happened. Humans discovered that they could grow food – the energy that sustains humans - agriculture was invented. The change that came with that invention can hardly be overestimated. Before the agricultural age, the world population was probably at most 10 million; 5000 years later it had grown to 15 million but around the year 100 there were 25 times as many people on Earth. Such a growth of population would not have been possible without agriculture. Agriculture did not just allow to provide food for so many more people, it also facilitated the development of new skills, crafts and trade.

In preindustrial times, the energy in agriculture, in the construction of houses, the production of goods and in the home came from human labour and animals. Life was often tedious, labour often forced. Most people until the 18th century spent their lives providing labour, water power and windmills were rather exceptions to humans being the main provider of energy. Scientist have estimated that in the early stages of the United State, one third of the agricultural land was needed to feed the animals that provided transport and agricultural labour.

For a long time, wood was the most important material, tools were created from it, it was used for buildings and for heating. As the population grew, wood became scarce, so people turned increasingly to a new source of energy, coal. Coal was not new, it had been used in Europe on a minor scale for example for heating purposes since the thirteenth century. But impurities in the coal made it very difficult to use it for a number of processes that utilized wood or charcoal. Only the increasing price of wood forced innovations, which would then allow using coal in glass and brick production, brewing or the smelting of lead, copper and tin.
Yet, it took a long time for coal to become cheaper and more efficient than wood. This is quite typical during an energy transformation when the newcomer is initially more expensive and less effective than the established source of energy. Therefore the comparison between established and newer forms of energy can often be misleading. The learning curve – the fact that new technologies become more effective and cheaper over time as they are deployed on a larger scale – is a fact but hard to predict. We can see that today with renewable energy, where especially photovoltaics has shown an amazing learning curve, which has made it today competitive with conventional energy sources. Only 10 years ago it had been more expensive by factors ten or so.

Getting coal out of the ground was dangerous and difficult; the biggest challenge was to pump water out of the coalmines. Already in 1698, the English engineer Thomas Savery had designed a simple steam engine. But it took until 1765 that James Watt came up with a much improved and more efficient steam engine. Watt’s steam engine did not only make coal mining cheaper and safer, but it quickly became the driver of the industrial age as it was used not just to pump water out of coal mines but allowed the development of powerful machinery and of the railways as a much more powerful and effective form of transport. This dynamic interaction between energy technology and industrial development is typical for the history of energy, and it is another reason to look at energy not in isolation but in connection with technological and economic development.

One of the important uses of coal was kerosene for lighting. Lighting is a basic human need, so kerosene made from coal was a much thought after product. In 1859, Edwin Laurentine Drake, known as the “Colonel”, used a simple drilling machine and found oil in Erie, Pennsylvania. Oil, which had been known before but not in sizable quantities, became easily accessible. The coal-oil refineries, who had produced kerosene, were out of business. Producing kerosene from oil had proven to be simpler and much fashioned a make shift drilling machine and struck oil at a depth of 69.5 feet. Within days, 20 barrels of cheap oil were coming to the surface daily.

Within ten years, the coal-oil refiners who were the major manufacturers of kerosene could no longer compete with the low production cost of oil based kerosene and went out of business. Another decade later, they themselves were threatened and eventually driven out of business by a new invention: Thomas Edison’s light bulb. The light bulb was hugely superior to the kerosene lamp, it provided better lighting, it did not smell, it was no fire hazard. And as soon as electricity could be provided to homes the electric light bulb was a winner. For hundred years it dominated lighting and it is only in this century that it is about to be replaced by the much more effective LED lighting that provides an equal quality of light with only ten per cent of the energy required.
Electricity seemed for a while also the preferred source of power for the newly invented car, even Henry Ford’s wife preferred the electric car as it was easier to start. But once the electric starter motor had been invented, the internal combustion engine became the clear winner over the electric engine. And with the mass production of cars, oil became the number one energy source.

So, it is not too much to say that we have experienced quite a number of energy revolutions in human history. Sometimes these revolutions were driven by sheer need, for example when too much deforestation had reduced the supply of wood. Sometimes the ability to mine in large quantities energy resources like coal and oil allowed a transformation of the economy. Sometimes technological innovations as the steam engine or electricity paved the way for an industrial revolution.

The central role of energy in the development of human society and the intimate relationship between energy and technological advances can be demonstrated in many examples from history. This offers a great opportunity for an exhibition like the World Expo. Fascinating examples from history can teach us, how new and better sources of energy has helped to serve basic human needs, how energy has allowed more and more people a life in dignity and how it has spurred technological inventions. When we look to the future of energy, then we understand through the historic lessons that the key challenge is not the production of energy but how it interacts with technology and how it influences societies.

**Energy – the triple challenge of the 21st century**

So, it is neither surprising nor new that energy has once again become a decisive factor. Again, need, opportunity and invention can come together to produce a new energy revolution in the 21st century.

And a revolution we need, for three big challenges are for us to overcome.

The world population is still growing. Present predictions assumes that by the end of this century the present population of 7 billion people will have increased to 9 or even 10 billion. And it is not just that many more people will live on our planet. Many of these people will be born into poverty and they have every reason to expect that their life should become better. For that reason the economies in the poorer countries will have to grow to provide more essential goods for more people. The growth of industry, the growth of population and the growth of consumption cannot be achieved – even if the best energy efficiency is being used – without more energy. Even cautious estimates assume that the global energy demand could be twice as high in 2050 as it is now. And
this is a huge task in itself, because one should not forget that this requires also a
doubling of the energy infrastructure like power plants, gas networks, electricity grids.

And while the world is very energy hungry, one and half billion people still do not even
have access to electricity; they lead arduous lives as a consequence of it. It is well
known that electricity is a fundamental requirement for a decent life in a modern society.
Without it, one is excluded from modern communication. Education and health suffer,
economic development is severely impeded. Like everybody else on Earth these one and
a half billion people have a right to live a life in dignity, and that means they must be
provided with access to the most modern form of energy, electricity. However, this is
also an example, where the solution is not just to be found in the past. Electrification in
the past meant that a large, nationwide electricity grid had to be installed. Today, that
may no longer be the best way. For parts of Africa, for example, a decentralized
electricity network that can distribute renewable energy from windmills and solar panels,
is the faster and cheaper option. There is little reason that this modern form of providing
electricity could not spread nearly as fast as mobile phones have all over the world.

And if these two challenges were not enough, climate change adds a further dimension.
Human caused emissions of CO2 and other Greenhouse gases into the atmosphere have
already increased global temperatures since the beginning of the industrial age. There
are strong indications that glacier are melting, the Artic Ice is retreating, the oceans are
acidifying, droughts and floods are increasing and storms are intensifying and becoming
more frequent because of climate change. What’s worse, the effect of climate change
are stronger where the climate is already more extreme. And poorer societies are less
prepared and less resilient to a changing climate. Megacities, which are springing up all
over the world, offer very little protection and safety for people in case of extreme
weather, the housing structures are inadequate, emergency services already now
overstretched. Climate change has already affected agriculture and it is to be feared that
the effects will be much stronger in the future. Previous fertile lands will become infertile,
the supply of food for a growing world population will become an even bigger challenge.

Energy production through the burning of fossil fuel is the biggest contributor to climate
change. Over the past thirty years, the scientific community and governments across the
world have devoted significant resources to collecting and analyzing data on greenhouse
gases and their relationship to human activities. The results of that scientific efforts have
been collected and summarised by the Intergovernmental Panel on Climate Change
(IPCC) which was set up to provide the world with a clear scientific view on the current
state of climate change and its potential environmental and socio-economic
consequences.
Some places will be more affected than others. Nicholas Stern in his “The Economics of Climate Change”, a report written for the UK government in 2006 argues that India and South East Asia will be amongst the areas most impacted by climate change. The report stated that costs of climate change for that region could be as high as 9-13% of GDP.

The solution according to the IPCC is to keep the human induced climate change below 20 °C, which would mean to stabilize the atmosphere CO2 levels between 450 and 550 parts per million. Achieving this is a daunting task however as it would require emissions to be 25-40% below 1990 levels. With a business as usual scenario, the IPCC would expect annual CO2 emissions to double by 2050.

What is clear is that we have to rethink, rebuild, expand, improve, innovate and decarbonize our energy system to meet these challenges. It is a task of huge complexity, it is of a scale never tried before and it is of utmost urgency. In spite of these difficulties, we have no other option than to try and to succeed. The consequences of failing would be catastrophic for humanity.

Fortunately, human invention and human solidarity grows with the difficulties we face. And indeed, we have plenty of reasons to be hopeful that will eventually provide energy for all without releasing carbon into the atmosphere and ruining the climate in the process. It is a huge transformation we will need to undertake, but it is within our capability.

The Expo 2017 in Astana could play a crucial role in convincing its visitors of the urgency of acting on climate change. But together with the urgency, it can also provide ideas, suggestions, inspiration for this big task. Seeing what options we already have to produce energy without adverse effect on the climate, learning about the ideas for the future can be a tremendously inspiring experience for visitors.

**Solutions for the 21st Century**

There is not yet a comprehensive master plan, how we can transform our energy system so that we can secure the future of humanity. But there are already enough practical examples, where progress has been and can be achieved, an exhibition is the ideal space to make people familiar with these good examples.

Furthermore, we know what the building blocks for a sustainable energy future, namely a global climate treaty, energy efficiency, smart energy (digital energy) and renewable energy for that secure future.
For many years now the world community has negotiated a global climate treaty. In 2009 people were hopeful that world leaders would make a bold step in Copenhagen, but were thoroughly disappointed. The only result was a general statement reaffirming that the world should stay under the 20°C target. And today, the prospect for a fair, ambitious and legally binding treaty seems even more remote in spite of the fact that the urgency has become even stronger. With every year that passes without proper action, it will be more difficult to prevent dangerous climate change. Yet, that bleak prospect does not change the fact that such a strong treaty is important. Only through a global treaty can a fair burden sharing be achieved between those who have mostly caused and are causing climate change and those who are suffering from it. Only a global treaty can facilitate the technology transfer needed so that developing countries and emerging economies can make a fast switch to low carbon technologies. Only a global treaty can assure that the damage done through the release of Greenhouse gases is realistically assessed and a price is put on carbon. Such a carbon price and the associated carbon market or a carbon tax system will send a strong signal to the markets, provide additional resources for the mitigation and adaptation efforts and create incentives for the development of new low carbon technologies.

The recent climate conference in Poland at least identified the course for the negotiations till the big conference in Paris in 2015. Hopefully world leaders will then agree on a fair, ambitious and legally binding climate treaty.

Information technology has transformed modern industry, modern communications and most parts of people’s daily life. In the energy sector, information technology is just beginning to make itself really felt. The ability for much better sensor, monitor and control systems, the opportunity to reduce hardware expansion through software improvement, the complex and joint modelling of weather developments, demand prediction and customer behavior, the progress in analyzing large amounts of market and customer information (big data), the versatility and controllability of modern machinery and appliances can all be used to move to smart energy. Smart energy means we are switching from a mode of focusing on energy production to one of energy services. Such a move uses available energy resources much better, it provides better service and lower cost for customers and it fosters innovation in the energy industry leading to better economic outcomes and jobs for people.

A World Expo offers, of course, an excellent opportunity to showcase these technological innovations.

As it is sometimes said, the best energy is the one you don’t use in the first place. Energy saving and efficiency are indeed fundamental, if we want to decarbonize the
energy system. If the increase in global energy demand is kept as small as possible we can spend valuable resources in reducing Greenhouse gas emissions rather than expanding capacity. Quite a number of economies have shown, that it is possible to decouple economic growth from growth in energy consumption. Emerging economies, however, typically increase their energy consumption in line with their economic growth. This decoupling requires a strong focus on energy saving and efficiency. To achieve them one needs a combination of governmental regulation and standard setting, price signals, behavioral change and technological innovation. Good examples for a successful transformation in this respect is lighting, where the switch from the old incandescent light bulbs to LED lighting can save nearly 90% of energy. This is also a good example that energy efficiency can be of enormous benefit to poorer people who often spend a disproportionate part of their small income on energy. It will be crucially important that progress with respect to energy efficiency is made in emerging economies where the biggest increase in energy consumption is going to happen. In this respect co-operation between the industrialised worlds, emerging economies and developing countries is especially important. Through provision of funding, technology transfer and co-operation countries can achieve the so called leapfrogging meaning that they can jump from their present state of technological developments to the most advanced technology without going through the in between steps.

All energy on earth comes from the sun. Fossil fuels are nothing else than the accumulation of millions of years of sunshine. But since we are using the accumulated energy of millions of years in just a few centuries, fossil fuels are not a sustainable form of energy, quite apart from their effect on the climate and other polluting effects. They need to be replaced by energy that is renewable. It is only in recent times, however, that we have been able to use renewable energy on a large scale. And the progress has been phenomenal. Only a decade ago, many experts doubted that renewable energy could ever compete with traditional forms of energy. In the meantime, however, renewable energy has shown an amazing learning curve. Photovoltaics in particular have nearly followed Moore’s law – originally formulated for the computer industry – of doubling the performance while halving the price in 18 months. In many regions and situations photovoltaic has now reached grid parity that is it can produce electricity at the same price or even cheaper as electricity supplied through the grid. Similarly, wind energy is now a mature technology providing substantial amounts of energy in many countries. More investments go into photovoltaic and wind nowadays than in any other form of energy worldwide. Off shore wind and Concentrated Solar Power (CSP), while not as advanced, offer the prospect of large scale centralized electricity production. Bioenergy has also progressed though there are concerns about energy production happening at the expense of food production. What all the renewable energy forms have in common is that
they are not releasing Greenhouse gases. Therefore they are the ideal replacement for fossil fuels. And they have an additional major advantage. Many of them can be deployed in a decentralized manner. This is a huge advantage in places where no electricity grid exists. It offers the prospect of bringing quickly and cost effectively electricity to people who are without or insufficient electricity supply. However, decentralized power production is not just an option for poor regions and countries. It is just as attractive in industrialized countries. It allows people to have their own, independent power supply, which when coupled with advanced storage options, gives them more energy security, it allows for private financing of the electricity system and it reduces the need for large scale extension of the electricity transmission and distribution systems.

That decentralization is modern, efficient and effective can be shown with so many already practical examples. The Expo 2017 can use the opportunity to make people see that the future of energy in the form of renewable and decentralized energy has already began and that this future is highly exciting and attractive.

The laws of thermodynamics tell us that energy cannot be created or destroyed, it can only be changed into another form. As someone said, there are only two exceptions from these universal laws: the human mind and the human spirit. Both grow, when they are spent.
RENEWABLE ENERGY: A KEY SOLUTION TO THE MULTIPLE SYSTEMIC RISKS IN ENERGY MARKETS

Jeremy Leggett, Founder of Solar Century Aid
Neuroscientists and psychologists tell us that we humans have a very worrying collective tendency for blindness to the systemic risks in the systems that prop up our civilisation, including in markets. The shocking recent history of the financial industries lends weight to their view.

Do we need to be concerned about the energy markets in this regard? In my book, The Energy of Nations: Risk Blindness and the Road to Renaissance, I argue that we do. I describe and analyse four systemic risks.

The first and biggest systemic of these is climate change, a threat fuelled primarily by the burning of fossil fuels. The second is the risk of a carbon bubble in the capital markets, which arises because the capital markets are allowed to operate without recognising efforts being made internationally to abate the climate-change threat. The third is the risk that the "shale boom" in gas and oil production may be either a bubble, or if it not a bubble, that it will prove to be a phenomenon essentially unexportable from North America, against the expectation of so many policymakers to the contrary. The fourth involves the risk of unexpectedly fast oil depletion.

I conclude in my book that each of these systemic risks entails major problems for society. I further suggest that denial of systemic risk-taking has become entrenched across the energy incumbency in multiple countries. Given this, I conclude reluctantly that a crisis is now probably inevitable in the years ahead.

I also argue, however, that there can be a road to renaissance in the rebuilding after the crisis, provided we make the right decisions come the event. Renewable energy plays a
key role both in that scenario, and of course in our chances of softening the risks so that they do not end up in crashes.

Let me begin with a closer look at the risk themes, and then address three vital questions about renewables: How quickly can they be mobilised? What would it cost to mobilise them at scale? And what changes would be needed in society for mass mobilisation of renewables?

What follows is a series of extracts from my book, edited to make a stand-alone essay. Source references can be found using the word-search facility on my website, www.jeremyleggett.net.

**Systemic risks in energy markets.**

By way of necessary background, let explain my history concerning the risk issues in question. As a geologist on the faculty at Imperial College in London between 1978 and 1989, I researched shale deposits - oil and gas source rocks - among other aspects of earth history. My research was funded by BP, Shell and others. Towards the end of that phase of my career, I became worried about society's overdependency on fossil fuels, and acted on my concerns. In 1989, I quit my life of lecturing and consultancy in earth sciences to become a climate campaigner. A decade later I set up a solar energy business. In 2000 I co-founded a private equity fund investing in renewables. In these capacities, I have watched many key players in the energy and financial industries at work as the financial crisis has played out and the oil price continued its inexorable rise. I have concluded that too many people across the top levels of business and government have found ways to close their eyes and ears to systemic risk-taking. Denial, in my analysis, has become institutionalised.

Climate change provides perhaps the most spectacular example. The World Energy Council’s latest scenarios offer an insightful recent example of what I see as the dysfunctional group-think at work in the energy industry. The starting point for viewing them is the conclusion of the Intergovernmental Panel on Climate Change that keeping global warming below a 2 degrees Celsius - a target danger-ceiling for many policymakers, including the entire EU - requires very deep cuts in emissions of from fossil fuel burning. The WEC's “Jazz” scenario envisages total primary energy increasing by 61% to 2050, amid little multilateral effort to co-ordinate fossil-fuel reductions. The “Symphony” scenario envisages an increase of 27%, with a degree of policy coordination. In 2010, fossil fuels provided 79% of the world’s primary energy. Their share by 2050, by which time climate scientists tell us they must be all but phased out in the
energy sector, would be 77% in the Jazz scenario and 59% in the Symphony scenario. In both scenarios, gas expands significantly from its current share.

And the climate implications of this? A likely chance of staying below a 2°C temperature increase requires returning CO2 equivalent concentrations below 400 parts per million (ppm). At present the figure is more than 420 ppm. The Jazz scenario would take us to 590-710 ppm of CO2 equivalent. The Symphony scenario would take us to 490-535 ppm. Both would make a stable climate impossible, threatening economies and ecosystems grievously, in ways many analysts think will imperil the future of civilisation. In short, we would risk losing viable water supplies and the ability to feed ourselves.

The heart of the problem is this. We have very much more unburned conventional fossil fuel than is needed to destabilise the climate system. Yet much of the energy industry is discovering and developing unconventional deposits – shale gas and tar sands, for example – to pile onto the fire.

The second risk is that we may be creating a carbon bubble in the capital markets. If policymakers are to have an 80% chance of achieving their goal of limiting global warming to 2 °C, between 60 and 80 per cent of proved reserves of fossil fuels will have to remain in the ground unburned, according to the latest research from the International Energy Agency, the Intergovernmental Panel on Climate Change, and others. If they did, the value of oil and gas companies would fall dramatically.

I am chairman of Carbon Tracker, a financial think tank that aims to draw attention to the risks of inflating the carbon bubble still further. Some financial institutions have begun withdrawing investment in fossil fuels after reading our warnings. The latest report from the Intergovernmental Panel on Climate Change should spread appreciation of how dysfunctional it is to have energy markets that are allowed to account for assets as though climate policymaking doesn’t exist.

The third systemic risk is that we face an unpleasant collective surprise in the US boom in shale gas production. That, too, may prove to be a bubble, maybe even a Ponzi scheme. Production from individual shale wells in America declines rapidly, and large amounts of capital have to be borrowed to drill replacement wells. This will surprise many people who make judgement calls based on the received wisdom that limits to shale drilling are few. But many people now doubt the shale narrative-of-plenty, including in and around the oil industry, as I describe in my book.

Even if the US shale gas drilling isn't a bubble, it is unprofitable as things stand, and environmental downsides are emerging seemingly by the week. According to the Texas Commission on Environmental Quality, whole towns in Texas are now running out of
water, having sold their aquifers for fracking. For these and other reasons, I doubt that this is a boom that is going to appeal to the rest of the world. Many others agree. They include the CEO of Shell, a company that has recently written of $2 billion of investment in American shale, having suffered disappointing results in US shale drilling.

The fourth systemic risk involves common assumptions about oil depletion. Most people believe the oil industry narrative that there will be adequate flows of just-about-affordable oil for decades to come. A minority doubts it. Crude oil production from existing fields peaked in 2005, and such fields are depleting at more than 6 per cent per year, according to the International Energy Agency. The much-hyped 2 million barrels a day of new US production capacity from shale needs to be put in context: we live in a world that consumes 91 million barrels a day, wherein existing crude fields are depleting 4 million barrels a day and more.

I conclude in my book that the prevalence of risk blindness in society, overlain with the pervasiveness of oil dependency in modern economies, means a crisis is probably inevitable within a few years. I think the most likely trigger for crisis will be a widely-unexpected failure of global oil supply to meet demand. But there are other possibilities.

Mine is a minority position, but it is important to remember how few whistleblowers there were in the run-up to the financial crash, and how they were vilified in the same way "peakists" – those who fear unexpectedly early peak oil – are today.

And so to renewable energy: a key family of technologies and industries that could abate all of the four systemic risks described above, to a greater or lesser extent. Moreover, they which would have to be the backbone of any effort to rebuild beyond a global energy crisis of the kind I foresee.

I look at three key questions about renewables, the first involving the speed with which we could deploy them.

**How fast could renewable energy be mobilised?**

Let me consider the historical mobilisation of renewable generation and renewable fuels by governments, the military, industry and communities; scaled experimentation using renewables at the national level; and modelling studies at the global, national and state levels. All these suggest that modern economies can be 100% powered by renewables, including in the transport sector, and far more easily, quickly and less expensively than many people think. Then I shall consider energy efficiency, which can be mobilised even faster and of course holds huge potential to shrink the amount of new renewable generation and renewable fuel use needed.
Among nations, German renewables provided more than 13% of energy and 29.9% of electricity in 2012. Renewables may provide only some 9% of the global energy mix, if we exclude traditional biomass, but they are growing fast even without the additional impetus that an oil crash would bring: 8.5% in 2012, a year in which almost 70% of new EU electricity generation was renewable, mostly wind and solar. Global investment in renewables, though it declined 12% from the record year of 2011, was still in excess of a quarter of a trillion dollars, and in terms of new generating capacity added, ahead of fossil fuels for the third successive year.

In Germany on October 3rd 2013, solar power produced up to 35% of German electricity, and wind almost a quarter: together over a third of all electricity for the entire day.

By displacing expensive peak power from fossil fuels, solar and wind have together cut the wholesale price of German power to such an extent that the business models of big utilities are now under threat. The top 20 European utilities were worth $1 trillion 2008. Today they are worth half that. It is in large part the growing success of renewables has done this to them.

In the USA during October 2013 almost all the new electricity capacity added nationwide was solar. There are more solar workers now in Texas than there are ranchers. Solar roofs are being installed one every four minutes across California and other states, creating the first billion-dollar solar installer, SolarCity, a current Silicon Valley and Wall Street solar poster child that is now raising the first "sunshine bonds" for solar roof financing, opening market participation to pension-fund investors at essentially the multi same hundred-million-dollar scale as conventional energy.

Similar spectacular growth stories can be heard in China, Japan, and many other countries. The price of a solar module has fallen 80% since 2008, and the US Energy Department projects a further 75% further price reduction by 2020. Solar is set to become the biggest single energy source in the world. Do not take my word for this. This is Shell’s opinion, even as they try to transform themselves into a gas company, having given up on solar, like BP.

The US military has recently instigated a domestic programme for renewable fuels and power. On land, the army and air force are procuring renewables at scale. At sea, the navy has an ambitious biofuels programme. This programme faces opposition in Congress, but US Navy Secretary Ray Nabus claims: ‘The whole navy is committed to pursuing alternatives to foreign oil and the whole navy believes it is critical to our national security and combat capability. We simply have to figure out a way to get American-made, home- grown fuel that is stably priced, that is competitive with oil.’
Such bullish sentiments are increasingly common in industry too, and across multiple sectors, some of which outperform governments in emissions reductions achievements and targets. The retail sector can claim the best record to date. A major consideration in the business world is globalised trade, for which the future is questionable even in a high-oil-price world short of crisis. After an oil crash, oil prices would rise so high that transport costs would render much current trade uneconomic. Supply chains would need to be reconfigured in a hurry, to the extent possible in extremis. Companies with a high proportion of hydrocarbon-based products would face unprecedented supply problems.

Some who are currently planning for shortened supply chains may already be acting on the basis of such strategic considerations. IKEA is procuring solar roofs for all its stores worldwide – almost 300 of them in 26 countries – with the intention of being 100% renewably powered in all its global operations by 2020. The company owns and operates 14 wind farms in six countries already. Others with active global programmes to shorten and decarbonise their supply chains include P&G and Unilever.

As for communities, there is huge potential to accelerate procurement and deployment of renewables. In the rebuilding of economies and societies after the crash, local economic activity will need to be powered by locally sourced energy supply to a much greater extent than today. For those without significant domestic carbon-fuel reserves, most oil, gas and coal imports will become prohibitively expensive.

In Germany, in an economy pressured by over-reliance on Russian gas, with a voter-imposed nuclear ban, nearly 55% of the land area today comprises regions with declared energy-autonomy targets, intentions and processes in place. In this, the seeds of a localisation megatrend can be detected. Almost half all German renewables are owned by individuals and communities. They offer not just freedom from utility bills but an opportunity for people to make a good investment return simply by watching the light fall on their solar roofs.

Even for those countries with significant domestic carbon-fuel reserves, other options will be needed. For example, the Saudi Arabian government currently faces a huge threat that it freely recognises: massive and growing consumption of oil in its domestic electric power plants. If current trends of rising domestic oil consumption and falling exports continue, there will be no oil left at all for export from the Kingdom by 2030. The Saudi government professes that it will solve this overconsumption problem in the interim by rapid development of massive new home-grown industries in solar and nuclear.

The locally sourced energy of the post-crash world will probably need to be predominantly renewable, not nuclear. Supply chains can be built for renewables far
faster in-country, or by pooling resources with near neighbours. In any event, nuclear is proving increasingly expensive, is being dropped as an option by key nations, and entails huge cooling-water challenges for countries – like Saudi Arabia – facing a water crisis as things stand. Finally, it is commonly thought that one more major accident will surely be the end for this industry globally, and in this context a recent review of the 12 main nuclear reactor meltdowns shows that on average one has happened every three years.

In Germany, a 2006 national real-time scaled experiment using elements of then-available renewable infrastructure showed that all German electricity could be provided, throughout the year, by solar photovoltaic and wind generation (78%) with some biogas generation (17%), and only a small amount of pumped-water storage of energy (5%): this without even factoring in hydropower, solar thermal, geothermal or marine power. This experiment suggests that Germany would need 55 gigawatts of photovoltaics for an all-renewables supply; some 30 gigawatts have already installed at the time of writing.

Encouraging as this discovery is, a trio of British, German and Italian scientists from solar research centres have recently shown that it would actually be easier to achieve in the UK the solar component of a 100% renewable supply. This is because wind variation matches demand better. The UK has a peak electricity demand of about 60 gigawatts, with more than 12 gigawatts of renewables already on the grid. The all-renewable requirement for photovoltaics would be 37 gigawatts, 18 less than in Germany. Britain currently lags far behind Germany at little more than 1 gigawatt installed. But if the British installed photovoltaic capacity at rates Germany has already achieved, they could build enough to achieve solar’s share of a 100% renewable supply by 2020. Britain, of course, also has significant largely untapped renewable assets in offshore wind, biogas, geothermal, hydropower and marine power. Based on these conclusions, the scientists have called for an immediate moratorium on all new non-renewable power plant construction in the UK. And this is a country with a Treasury planning generous subsidies for gas fracking, intending the nation to be turned into a gas ‘hub’, and calling for active suppression of renewables in the process.

With renewable electricity installation on such a scale, the spillover into non-carbon-based transport would surely not lag far behind. With the potential to charge vehicles at home or a place of work, automakers could reasonably expect sales of electric vehicles to explode. Cars themselves would become small mobile power plants, powered by batteries and fuel cells that would be charged by day in car parks and discharge into the grid by night. Growth of ‘smart grid’ technologies – use of computers to maximise the efficiency of electricity use and cut the need for supply – would be evolving in parallel. This scenario has the same decentralised modular attributes as the Internet, and the
same redundancy: knock out a part of it and the whole thing does not crash. This is why many people now speak of the ‘energy Internet’.

If all this is feasible in cloudy countries like Britain, or huge countries with much bigger hinterlands than coastal areas like Germany, then it might be easier still for sunny countries and countries with long coastlines.

Modelling studies have suggested that a modern global economy could be entirely powered by renewables in this way. The consensus view of the Intergovernmental Panel on Climate Change is that the global economy could be 80% renewable powered by 2050. Other studies are more bullish. Notably, a study by a team from Stanford University and the University of California at Berkeley demonstrates that wind, water and solar technologies could provide 100% of the world’s energy as soon as 2030. This could be done, crucially, without mobilising any one technology any faster than technologies have already been mobilised historically.

In Germany, a real-life experiment is being run today in the speed at which renewables can be mobilised. This follows a near-unanimous parliamentary vote in June 2011 to transition the power sector from coal and nuclear to renewables within 40 years. The main targets of this national project, called the Energiewende, include 40% greenhouse-gas emissions-reductions by 2020 and 55% by 2030, en route to 80-95% by 2050. The share of renewables in electricity consumption should be >35% by 2020 (up from almost 30% today), >50% by 2030, and >80% by 2050. The share of renewables in final energy use should be 18% by 2020 (up from 13% today), 30% by 2030, and 60% by 2050. Efficiency improvements in primary energy use (vs 2008) should be 20% by 2020 and 50% by 2050.

A German expert group set up to analyse progress and prospects, Agora Energiewende, recently published twelve insights on what it will take to hit these targets. The first insight is that the focus would have to be on wind and solar. By 2015, wind power and photovoltaic power plants will produce electricity at the cost of seven to ten (euro) cents per kilowatt hour, placing a power system based on wind, solar, and conventional backup capacity in the same price range as a system based on new gas and coal-fired plants. No other renewable technology can go this low in price so quick. Wind power and photovoltaic technologies could have a share of renewable energy electricity production in 2020 of around 70 percent, en route to 80 to 90 percent of Germany’s renewable electricity supply.

The other insights on the Energiewende emanate from the first one. They include the following. "Baseload" power plants will become a thing of the past. The shortfalls of wind
and solar will initially be met by gas and coal plants operating only part time, and increasingly become filled by CHP and biomass plants with rapid switch-on times. Flexibility options such as demand side management and pumped storage can help considerably. So too can grid expansion and active use of the grid in the wider EU to sell surplus wind and solar electricity when plentiful in Germany, and import electricity at times of low wind and / or low solar.

The targets and the progress of the Energiewende give us a feel for what is possible, given the kind of political consensus that exists in Germany. But no out-of-ordinary assumptions are being made in the setting of the targets. Suppose we were actually to mobilise clean-energy technologies, and societal strategies, as fast as my parents’ generation mobilised warplanes, warships and tanks in 1940? Suppose we were to do that under a regime of unprecedented multilateral co-operation outstripping the regime that governments put in place to bail out the banks? How quickly could we then re-engineer the energy of nations?

That is an open question, but one that could be answered quickly by major governments serious about an emergency global clean-energy mobilisation in the face of a global oil crisis, given the exigencies of their situation. We have to bear in mind that world leaders, and their citizenry, would at this time be thinking in a different context. They would be able to take collective decisions within the 'power of context'.

Let me give an example of what I mean from the 1930s. In that decade, Winston Churchill was warning the UK that the country should be preparing for war because a certain politician in Germany was up to no good. Few were prepared to listen to him at first. The context for their thinking was the party atmosphere of the times, and a pervasive dread of even mentioning war so soon after a conflagration that had killed millions. Churchill was offering a very uncomfortable narrative without any power of context. Once Hitler actually started invading neighbours, and his ruthless plan of conquest was clear, people had the power of context to aid their thinking. The choices became more obvious. And so my parents’ generation began mobilising at speed. They found that they could churn out fighters, bombers, tanks and ships at a rate that took many of them by surprise.

This is the opportunity that world leaders will have, for a while, in the immediate aftermath of an oil crash.

The answer would confound the current energy commentariat, I submit, thinking as they tend to do outside the power of context, and assuming as they so often do that history equals destiny when it comes to market penetration rates.
The energy world is rich in opportunities, along with the threats, for those prepared to lace their analyses of the future with the power of context. One obvious example is provided by solar PV manufacturing. At the time of writing, around half the world’s 60 gigawatts of production capacity stands idle. This is a highly dysfunctional situation, especially given that even Saudi Arabia now regards solar PV as a strategically vital industry. It could yet worsen. The US and EU are both currently involved in complex trade disputes with China that have already damaged the industry and risk doing so even more. If we collectively mismanage crises like this, the question arises as to whether there will be enough survivors in the cleantech industries to provide a viable infrastructure for the renaissance.

Stephan Dolezalek of Vantage Point Capital Partners puts it like this: ‘Unless some portion of us survive the trip across the valley of death, there will be too little at scale for the transitioners to pick up on.’ But at the time of writing there is every reason to be optimistic, he thinks.

‘The last six months have seen the stock prices of companies like Tesla, First Solar, SolarCity and SunPower rise so much that among other things Total’s investment in SunPower suddenly looks smart, unlike the disaster it seemed a year ago. With Tesla now at a $10 billion valuation, we are seeing the first Googles, Ciscos and Microsofts of the CleanTech era emerge.’ To avoid trade wars capable of derailing promise such as this, how difficult would it be for the leaders of the major nations involved – the US, China and Germany – to sit down together and work out a treble-win rapprochement? Difficult perhaps today, in the light of grim realpolitik, though certainly not impossible. Very much easier after the oil crash, given the power of context.

**What would it cost to mobilise renewables at scale?**

The first point to make is that cost is going to be viewed through different lenses after an oil crash. Value is going to enter play much more than it does today. But even where today’s price structure is used as a basis for like-for-like comparison, renewable generation and fuels still win. Major authoritative studies that calculate it would be cheaper to go the low-carbon route than to maintain course with fossil fuels are numerous. Among those that do so are the 2006 Stern Review, the 2011 IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation, and the Stanford/Berkeley study mentioned earlier.

For solar PV, a recent McKinsey study spells the potential out graphically. It estimates that solar PV will be cheaper than any other alternative in many markets by the middle of
this decade, reaching an economic potential of 1,000 gigawatts by 2020, eight years from now. This, as McKinsey say, will change the face of the global energy industry.

As for energy efficiency, and its ability to force-amplify renewables and renewable fuels, the guru of that discipline Amory Lovins and his Rocky Mountain Institute team were arguing compellingly that it was cheaper to save a barrel of oil than to produce it as long ago as 2004, the year the oil price began its extended climb.

In the 2012 World Energy Outlook, the IEA makes the crucial point that four-fifths of the energy efficiency potential in the buildings sector and more than half in industry still remain untapped, that these gains could be achieved without any major or unexpected technological breakthroughs, merely by taking actions that are economically viable and using investment that would be more than offset by reduced fuel expenditures, accruing huge GDP gains, especially in India, China, the United States and Europe.

Of course the incumbency tables its counter-narrative on a regular basis. For example, a coalition of gas firms told the EU in February 2011 that the EU could meet its 2050 carbon targets more cheaply with gas than renewables. Gazprom, Centrica, Qatar Petroleum and others told the Commission it could save €900bn and still hit its 2050 carbon reduction targets if it built fewer wind farms and more gas plants. This just a few weeks after the Centrica CEO had predicted that gas prices would go nowhere but upwards in the long term, because the shale gas glut in America was unlikely to prove exportable.

The log on my website will give the reader looking for more detail in the ebb and flow of the 'We Are Cheaper / No You’re Not’ debate plenty to dig into. The main point I want to make here is that, after the crash, this manifestation of the energy debate will look very different. Policymakers will have far more room to manoeuvre within the power of context. They will not be thinking about energy in the same way they do today.

The entrenched self-defense of the incumbency, in response to the great changes sweeping energy markets even ahead of any crisis, are perhaps to be expected, given the patterns of history. The horse traders tried to resist the advent of the internal combustion engine. The mainframe computer manufacturers tried to undermine the introduction of the microcomputer. And so it is with energy. Big utilities across Europe are arguing today not for fast change to their business models, but for more extreme versions of the strategies that have created the mess that is European energy today.

Defenders of the energy incumbency tend to represent the cost of solar and other renewables unfairly. Every single form of energy receives subsidies, and as the
International Energy Agency regularly points out, conventional energy worldwide receives far more in subsidies than renewables. But many fossil-fuel subsidies come in tax write-downs. Renewables subsidies tend to be market-building schemes, such as so-called feed-in tariffs, that are added to energy bills. They are more visible, and easy to dismiss unfairly and out of wider context as “green taxes”.

In wider context, the cost of the feed-in tariffs in Germany has been offset by the gains in avoided fossil-fuel use and the taxes paid by the hundreds of thousands of workers newly employed in the job-rich renewables industries. As China has increasingly grasped its huge opportunities in renewables, some German manufacturing jobs have disappeared overseas. But most renewables jobs are in installation and services, not manufacturing.

What changes would be needed in society for mass mobilisation of renewables?

For years now I have watched the armed forces react with general concern to climate change, wondering why they don’t speak out more, and that when they do, governments don’t seem to be listening. My experience began back in 1989. In October that year, shortly before the Berlin Wall fell, I held a seminar for an entire morning with senior British armed forces officers at a retreat of theirs. The major part of my brief was to talk to them about the then understanding of risk from global warming. I needn’t have bothered about the risk. All they really wanted to do was talk about solutions to the problem. They needed no persuading that there was indeed a problem.

My hypothesis is that this was because there were ballistic missile submarine commanders in the room. They would have known even then that the Arctic ice cap was thinning worryingly. But of course, the data were all classified at the time.

It took the British armed forces years to speak out forcibly in public. In June 2007, chief of the UK armed forces Air Chief Marshal Sir Jock Stirrup told a conference in London that climate change will increase competition for scarce resources and plunge many into desperate poverty, fanning conflict and terrorism across the world. ‘It seems to me rather like pouring petrol onto a burning fire’, he said.

In April 2008, the US Air Force took a similar view. William Anderson, an assistant secretary, called for an effort to combat climate change equivalent to the Apollo missions to put a man on the moon.
A major setback in climate policymaking happened at the Copenhagen climate summit the following next year. The energy incumbency, it seemed, knew better even than the armed forces on both sides of the Atlantic. Many lobbied hard to neuter the Copenhagen process, as I describe in my book. And they largely succeeded. In essence, if one believes the climate scientists, in keeping a society on a road to ruin: a road to a six-degree world.

And yet it is not that difficult to evoke a counter-narrative, rooted in the real world, at the other end of the spectrum. Some have done so compellingly. Jeremy Rifkin weaves a wonderful vision of an increasingly empathic civilisation. He analyses the discoveries of neuroscientists about a more encouraging aspect of the human mind, what researchers of brain science describe as pro-social tendencies. Experimental studies show that the great majority of us tend to abhor violence and favour community. They show that groups who co-operate consistently do better than those wherein the individuals do not. They show that people tend to work harder when united by non-monetary social norms than they do for payment.

In Rifkin’s analysis, every step change in energy use and means of mass communication has created greater opportunities for humans to exercise this tendency for empathy. In his view, modern social media serve to spread empathy outside historical in-groups at the same time that decentralised forms of renewable energy spread a greater propensity for community, and sharing, via the energy internet.

Let me paint on that same canvas from a personal perspective, beginning with the transformative power of a simple solar light, and extrapolating upwards in scale from there. In February 2013, BBC Newsnight filmed an interview with a young Kenyan, from a poor rural background, who had come 55th in the whole nation in his exams. He put his success down to the purchase of a single solar lantern, and the extra hours it gave him to do homework in the former darkness of his home. What does he want to do now? He wants to be a doctor.

More recently, a Kenyan shopkeeper was asked by a journalist why she no long sold kerosene in her shop. Nobody wants it any more, she responded, now that I sell solar lights.

The allegory here needs no labouring. We think of this, and it is an easy next step to think of other elements of a zero-carbon narrative: the buildings rapidly 100% powerable by solar and other renewables, the communities that are already en route to 100% renewable energy, the nations that think they can achieve the same, or nearly so. We think of the model-based studies that show how quickly the whole global economy could
be run by renewables. We think of the transformative power such a new energy paradigm would hold: renaissance of community, improved human health, enhanced local and national security, and on and on – all made possible by the innate pro-social character of renewable energy, over and beyond its ability to cut greenhouse-gas emissions and eradicate oil dependency.

Then we imagine how world leaders, synergising and sharing in the emergency room of the global energy crisis, emboldened by the power of context – intent finally on individual and collective bids for true greatness – could work with these building blocks to break the mould of human history and its grubby endless repetition of past mistakes.

Here is how I think the power of context might come to our rescue as we endeavour to fashion a renaissance. As I write these words, I appreciate that there is a risk I harbour my own version of cognitive optimism bias. But I do think a good case can be made. It is rooted in five main premises, all interconnected and all feeding off each other in a way that makes the sum much greater than the parts.

My five premises for the Road to Renaissance are as follows. First, the readiness of clean energy for explosive growth. Second, the intrinsic pro-social attributes of clean energy. Third, the increasing evidence of people power in the world. Fourth, the pro-social tendencies in the human mind. Fifth, the power of context that leaders will be operating in after the oil crash.

Premise One on the Road to Renaissance entails the readiness of clean energy for explosive growth. The next crash will lay bare all the incumbency’s story of a new era of fossil fuels and of a wealth-creating financial system in need of only light-touch regulation. They will have left themselves at the mercy of a society that will be looking back in anger, and a political class that will feel impelled, given the state of their streets, to project the will of the people. Society will be being swept with a realisation that energy needs must be met in large measure at home, as fast as possible, and in a climate wherein modern financial institutions cannot in general be trusted with either individuals’ money or the provision of financial services to viable economies.

The outcome will be much shaped by the extent to which people can believe, come the crash, that alternatives to the status quo are viable. Here the current state of play with clean energy will offer encouragement. For decades, the energy incumbency has – on the whole – been persuading society that alternatives to their wares are not for grown-ups. In recent years, as we have seen, the fast growth of many renewable technologies is proving otherwise for growing numbers of people.
In my day job, I encounter the ‘seeing is believing’ effect of hands-on experience of renewable energy ever more frequently. When neighbours see that a solar roof really works, even under cloudy skies, they tend to want one for themselves. A study at Stanford University has shown that Californian solar roofs are quite literally contagious, in this sociological sense.

In Germany, the seeing-is-believing effect is clear for all to see. One day in July 2013, the nation’s 1.3 million solar installations generated nearly 40% of its daytime electricity demand. Millions of Germans are building retirement plans via individually or collectively owning a share of the solar power plants they can see working so effectively, and wind as well. Polls show that three quarters of Germans want to maintain a focus on “citizen-managed, decentralized renewable energy.” When asked if the nation should get to get to 100% renewable energy “as quickly as possible,” fully 84% answered yes. This is unstoppable politics. It also speaks volumes for the credibility of Germany’s renewables vision, on the ground. Discerning voters would not vote "yes" to such a question in such numbers otherwise.

Energy-efficiency practitioners have even more encouraging stories to tell. One of my favourites involves a respected professor of energy studies in the UK, Catherine Mitchell. She hadn’t fully understood the potential of energy efficiency, she claims, until she retrofitted her own home – a leaky ancient cottage. By fixing her windows and insulation, she saw her energy bills more or less disappear. In doing this, she came to realise that she was dealing not just with a challenge to the status-quo business model of the giant energy utilities, but also with a harbinger of their complete extinction.

Premise Two on the Road to Renaissance entails the intrinsic pro-social attributes of clean energy. They begin with the promotion of community interests. The inherent attributes of carbon fuels have done much to dismantle community, as any suburb and shopping mall shows. But in being more suited to local economic activity, clean energy favours the renaissance of community.

Within communities, local job creation will be vital as the economic damage caused by the oil crash is repaired. Clean-energy industries are significantly more job rich than the conventional energy industries, as the International Labour Organisation and the United Nations Environment Programme have shown: in solar’s case, up to ten times more jobs per megawatt than gas.

Premise Three on the Road to Renaissance entails the increasing evidence of people power in the world. The Arab Spring leads the evidence for this premise, and gives a foretaste of what to expect after the crash. People will be looking back in anger in many
theatres, and the exploding use of digital media will undoubtedly fan the forces of change. Of course, this will apply not just to the good, but also to the bad and the ugly. How that balance plays out will in turn depend on the other elements of the renaissance. The success of an organisation like Avaaz offers grounds for qualified optimism.

In the world of economics, the Occupy movement provides clear evidence of growing people power. The experience of politicians in handling the 2011 Occupy Wall Street demonstrations is perhaps instructive of the things to come. After initially roundly condemning the movement, many politicians had to adjust their messages once opinion polls showed how many ordinary Americans shared the protesters’ concerns, which the financial incumbency had sought to cast as extreme rabble-rousing.

We can expect people power to come into its own in the world of finance. Who would have thought that we would see a deputy governor of the Bank of England suggest that peer-to-peer lending and all the rest of the people-power innovations proliferating after the 2007 credit crunch and 2008 financial crash might disintermediate the main banks.

As for people power in the creation of autonomous resilient communities, there are over 2,000 Transition initiatives in 40 countries today. Many of them are already beginning to take concrete steps towards making their local economies more resilient, seeing community resilience as a vital form of economic resilience. In Germany between 2007 and 2012 more than 230 municipalities either founded their own utility or took over the infrastructure from private firms.

These may seem at first impression to be trivial examples, not likely to be much more than a sticking plaster on the dire injuries that society can expect to sustain in the wake of the oil crash. But when we sum this kind of evidence with trends in the corporate world, I suggest otherwise. For example, Google sought regulatory approval as an energy supplier as long ago as January 2010, and within less than a year was talking about investing in green energy as a ‘mission-critical need’. Mission critical.

That is a good place to add the fourth and fifth premises on the Road to Renaissance. The fourth entails the pro-social tendencies in the human mind, and the fifth the power of context that leaders will be operating in after the oil crash. Add a grass-roots megatrend favouring the energy internet, add a corporate equivalent, brew them in a rising tide of empathic thinking, add the power of context, and transformative change can surely emerge, with the potential to proceed surprisingly fast. Just think how quickly Google emerged from a garage somewhere, in the course of the Internet revolution.

Then imagine the leadership of Google and other giants of the corporate world, seeking to survive and prosper in the new world order, sitting with the American and Chinese
leaderships not in an arena of trade bickering but one of urgent co-operation within a holistic international plan. Many things might be possible in that environment that today might be unimaginable, absent the power of context.

In an ideal scenario, nations will collaborate to such an extent in emergency mobilisation of clean energy that a whole new era of common security will emerge in the wake. In this narrative, growing numbers come to believe the view that their own security – whether at the national, communal or family level – is best guaranteed by guaranteeing the security of their neighbour. Strong leaders can do much to help that happen, and here I do not just talk of the leaders of nations, but the leaders of companies, institutions, communities and citizen organisations.

If we get the renaissance right in this way, then common security thinking spreads with the speed of a viral infection, and today’s vast military budgets begin flowing into social themes. If renewables are mobilised as fast as I suggest is possible, then the current vast subsidies for conventional energy can be redeployed in more socially constructive ways.

Could it happen? Much will depend on this tendency to empathy in the human mind, both in the minds of leaders and in the minds of the ordinary citizens, and the pressures they put on their leaders in the days that will decide whether we take the Renaissance Road, or the alternative.
LE PROJET SOLAR IMPLUSE

Bertrand Piccard, Aéronaute, Aviateur, Médecin-Psychiatre, Conférencier
Les conférences internationales sur le climat me dépriment. Tous les chefs d’États viennent dire exactement la même chose : « Les changements climatiques sont un gros problème, ça va coûter très cher pour les résoudre et on ne sait pas où trouver l’argent. »

Comment pouvez-vous motiver des gens quand vous leur parlez de problèmes et de coûts ?

Comme médecin, j’ai toujours appris qu’un problème s’appelle un symptôme, qu’un symptôme a une origine et que l’origine a un traitement. Quand on parle de changement climatique, quand on parle de CO₂, on n’est pas dans la source du problème, on est seulement dans le symptôme, dans la manifestation d’une origine très claire. Cette origine, c’est notre dépendance aux énergies fossiles. C’est le fait que nous brûlons beaucoup trop d’une énergie non renouvelable, chère et polluante. Et là, il y a un traitement qui s’appelle CleanTechs, technologies propres, et qui comprend toutes les solutions qui permettent maintenant de diminuer notre consommation d’énergie et de produire des énergies renouvelables, tout en créant des emplois, en faisant du bénéfice et en garantissant notre excellent confort de vie.

Ce que nous faisons avec le projet « Solar Impulse », c’est de démontrer concrètement l’efficacité de ces technologies en poussant leur utilisation à l’extrême, en leur faisant faire des choses à priori impossible, comme de voler jour et nuit sans carburant. Tous ce que nous utilisons sur notre avion, vous pouvez l’utiliser aussi. Il n’y a aucune technologie secrète. Non, c’est de la technologie accessible à tout un chacun : les mêmes
panneaux solaires, les mêmes batteries, les mêmes matériaux de construction ou d’isolation ultra légers, les mêmes ampoules, les mêmes moteurs électriques, vous pouvez les utiliser également dans votre vie de tous les jours. A condition toutefois qu’ils sortent des startups et des projets expérimentaux pour arriver sur le marché… C’est là qu’est le problème.

On entend beaucoup trop de gens affirmer qu’on ne peut pas encore diminuer la consommation d’énergie fossile avant d’avoir investi davantage dans la recherche et l’innovation. C’est complètement faux. Les technologies existent déjà, mais elles ne sont presque pas utilisées.

Si toutes les technologies existantes, toutes les CleanTechs utilisées par Solar Impulse, étaient utilisées massivement dans le monde, nous pourrions déjà aujourd’hui diviser par deux notre consommation d’énergie fossile et produire la moitié de ce qui reste avec des sources renouvelables. Il resterait 25 % pour des énergies non renouvelables, ce qui serait acceptable à court terme.

Pourquoi ne le faisons-nous pas ? Nous ne le faisons pas, à mon avis, pour trois grandes raisons :

1) La première, c’est que beaucoup trop de gens confondent encore les notions de prix et de coût. On entend que les énergies renouvelables sont beaucoup plus chères que les énergies fossiles. C’est un malentendu lourd de conséquences. Dans le prix des énergies renouvelables est compris l’entier de leurs coûts, alors que dans le prix du pétrole, du gaz ou du charbon, vous ne payez pas l’entier du coût : vous ne payez pas pour les 200
millions d’années qu’il a fallu pour constituer le stock, vous ne payez pas pour les marées noires, pour les guerres qui ont déjà commencé et qui s’aggraveront encore pour s’approvisionner en pétrole, et vous ne payez pas non plus pour la charge environnementale catastrophique produite par ces énergies fossiles.

On compare donc des choses qui ne sont pas comparables. Évidemment le prix du pétrole est toujours moins cher que le prix de l’énergie solaire, mais le coût du pétrole est beaucoup plus cher que le coût équivalent d’une énergie renouvelable. Ce qui veut dire que vous payez en quelque sorte à crédit lorsque vous consommez des énergies fossiles.

2) La deuxième est notre obnubilation à vouloir produire davantage d’énergie au lieu d’économiser celle que nous utilisons. Notre société est comme un homme dans une baignoire dont le bouchon fuit. Plutôt que d’étanchéifier la fuite, il ouvre tout grand le robinet pour garder la baignoire pleine. Le paradoxe dans le cas qui nous concerne, c’est que les économies d’énergies sont nettement plus rentables que la production, pour celui qui investi comme pour la société en général. L’isolation d’un bâtiment comme la rénovation d’une usine rapporte plus de 10% par an, soit un placement plus fructueux que la bourse, sans même parler des emplois créés…

3) La troisième raison, c’est que les sacro-saintes lois du marché ne fonctionnent plus dans la réalité d’un monde globalisé et spéculatif. Autrefois, dans des évolutions linéaires, vous auriez très bien pu attendre que les lois du marché permettent une égalisation du coût des différentes sources d’énergie pour obtenir une transition spontanée. Aujourd’hui ce n’est plus possible. Notre monde ne fonctionne plus comme ça. Notre monde fonctionne par accélération, par crise, par spéculation. La crise des subprimes est un exemple typique d’une loi du marché qui s’est emballée.

Par conséquent, le grand paradoxe est qu’on ne peut plus simplement prendre une doctrine de droite ou une doctrine de gauche et l’appliquer. Il y a dans chaque doctrine, à droite comme à gauche, des combinaisons absolument nécessaires pour arriver à un résultat efficace. Pour résoudre les défis actuels, vous avez besoin des entrepreneurs et d’interventions de l’Etat ; vous avez besoin de rentabilité et de protection des ressources naturelles, tout cela à la fois. Et les partis politiques refusent de s’allier sur les grands sujets par peur de donner des voix à leurs concurrents !

Le problème, en l’absence de législation claire, c’est que chaque entrepreneur attend que les autres fassent le premier pas, car il y a un certain risque à être un pionnier, à investir dans des énergies renouvelables, dans des économies d’énergies, quand on est le seul à le faire. La masse critique n’est pas encore atteinte et on ne sait pas exactement quelles
vont être les technologies les plus immédiatement rentables, ni les lignes politiques de demain. Alors en attend. Et de l’autre côté, les politiciens rétorquent que c’est aux industriels de faire le premier pas et de prendre leurs responsabilités. Ainsi rien ne bouge, ou si peu…

Imaginez cette situation il y a 150 ans, quand la Suisse était un pays agricole pauvre. On traversait les cols alpins à pied ou à dos de mulet, et on s’éclairait à la chandelle. Tout à coup, des pionniers, industriels et politiciens confondus, se sont mis ensemble pour percer des tunnels, construire des ponts et des barrages.

Personne n’a dit à l’époque que c’était trop risqué et plus cher que le mulet ou la bougie ! Et heureusement, car cela a permis à la Suisse, en quelques années, de devenir un pays riche, industrialisé, plaque tournante des transports européens. Un pays dont le monde entier a eu besoin.

Aujourd’hui on parle d’une révolution permise par les technologies propres, on parle d’isoler les bâtiments, on parle de nouveaux types de chauffage, de voitures hybride, de sources renouvelables d’énergies pour notre pays. Et qu’elle est la réaction ? On entend que c’est trop cher ! Le passé a bien été jusqu’à maintenant, alors pourquoi changerait-on quoi que ce soit ? C’est vrai qu’on peut se demander pourquoi changer quelque chose qui marche ? Et ça, c’est le grand danger pour un pays qui a réussi, un pays riche, sûr, où la vie est confortable. Je pense que c’est justement parce que nos ancêtres ont été des pionniers que nous devons continuer à l’être. C’est parce que nous sommes riches aujourd’hui qu’il faut investir pour le futur.

Il est aujourd’hui heureusement interdit de jeter ses ordures dans la forêt, mais il reste autorisé de gaspiller l’énergie et de rejeter autant de CO2 que nous voulons dans l’atmosphère. Le Conseil Fédéral a trouvé le courage pour lancer une nouvelle politique énergétique dans notre pays. Il faudra maintenant que le cadre légal suive, pour obliger notre société, industrie et consommateurs réunis, à utiliser les technologies qui permettent aujourd’hui déjà de diminuer notre dépendance aux vieilles sources
d'énergies. C'est cela qu'il faut désormais encourager si nous voulons dynamiser notre industrie, créer des emplois, augmenter notre pouvoir d'achat et améliorer notre balance commerciale, tout en protégeant l'environnement.
WHAT THE WORLD COULD SAY ABOUT FUTURE ENERGY IN 2017

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"What the World could say about future energy in 2017"

Wouldn’t it be wonderful if tomorrow a new energy source were discovered that is limitless, inexpensive to produce, clean and environmentally friendly? This kind of energy utopia has been promised many times before (such as in the early days of nuclear and solar power) and continues to drive research in areas like fusion power, catalysts to extract carbon from the air, and biological power generation. Steady advances in technology promise new and better sources of energy on the horizon. Investment into alternative energy resources has risen by leaps and bounds in recent years. The United Nations Environment Program has reported that in 2011 alone, investment in renewable energy resources amounted to $279 billion. These major investments, in turn, drive research and development budgets, such as the long-term International Thermonuclear Experimental Reactor, a fusion-energy project, the budget of which recently increased to €15 billion.

But for the time being the world is fully invested in the exploitation of fossil fuels in a global economy that has produced great advances in human prosperity and the availability of goods and services. If current trends continue, only a quantum leap in technology offering the same benefits as fossil fuel dependency, but with demonstrable savings in other areas, could break the status quo.
However, current trends are not continuing. Despite efforts to deny the ever-accumulating evidence of human-induced climate change, public confidence in a fossil fuel-based global economy is eroding. Recent perturbations in global markets can be attributed at least in part to recognition that the market does not fully account for negative effects of energy use and the impacts of global environmental change, particularly on food security. The impact of extreme weather events on markets is somewhat a matter of speculation, and investors might even sense opportunities as well as threats. But extreme weather events do affect agricultural commodities, and yield shocks could have a devastating effect on food prices, particularly for poor and vulnerable communities in the developing world. Moreover, climate change is not the only issue connected in people’s minds with energy use. Changes in land and crop usage, localized pollution, impacts on indigenous peoples, destruction of habitat, impacts on cultural and historical sites, disruption of markets – the list of issues that have people around the world asking questions and looking for alternatives goes on and on.

The race to secure future energy supplies goes on unabated, with the usual effects. Exploration of the Arctic threatens indigenous communities and sensitive ecosystems, resource-dependent economies in the developing world undergo periods of civil unrest or outright civil war, and wrangling over prospective resources such as the deep seabed gets in the way of progress on urgent issues of common concern. Governance issues including access, justice and equity cannot be separated from any debate about the future of energy.

Against this background of discomfort and a growing sense of urgency, it is not surprising that the future energy challenge -- in terms of production, consumption and social and environmental impacts -- continues to be one of the most compelling and significant areas for policy development and research. It also is one of the most dynamic fields providing opportunities for businesses to participate in the development of solutions.

In 2017 the world has an opportunity to take stock of the power of energy as a tool for humanity and to explore options for harnessing energy for the future development of humankind, at Expo 2017 Astana, Kazakhstan, where the theme will be “Future Energy”. Expo 2017 will explore the “World of Energy” – the physical potential of energy as power; “Energy for Life” – the transformative power that energy has in the hands of humankind; and “Energy for All” – the issue of fair and equitable access to power.
The World of Energy

In the forty years prior to 2011, annual world electricity demand grew from about 5000 TeraWatt hours (TWh) to over 20,000 TWh. In 1973 fossil fuels made up 86.6% of the total primary energy supply globally. By 2011 the proportion had only been reduced to 81.6% with most of the difference taken up by nuclear energy. Natural gas – which, prior to raised awareness over greenhouse gases was perceived as less polluting than other fossil fuels – nearly tripled in production over the same time, while coal production increased by over 250%. Projections by the oil industry predict a growth in renewables, but still show that fossil fuels (including new forms such as tight oil and shale gas) will represent three-quarters of primary energy production up to 2035.

Total global reserves of fossil fuels, according to BP’s 2014 Energy Outlook, could fuel the world at current rates for half a century for oil and gas, and for a full century for coal. Increases in alternative energy sources, new discoveries of reserves of conventional fossil fuels, and the potential of new forms of hydrocarbons will naturally extend that timeline. Another important factor is the leveling of demand rates in the developed world, a phenomenon that is also expected to occur in the developing world as it becomes more prosperous.

Hydropower production has kept pace with fossil fuels, nearly tripling in capacity between 1973 to 2011, but still represents just 2.3% of primary energy supply, where it is especially significant in electricity generation. The potential of hydropower is ultimately limited, however, by various other demands on water usage that compete with energy demands. BP predicts that the proportion of hydropower in the energy mix will remain virtually unchanged through 2035.

While other forms of alternative energy, including wind, solar, and geothermal, have developed exponentially, they still altogether take up only about 1% of the energy mix. This is a major growth area, but even with nearly half of all new production capacity coming in this field, by 2035 its share is predicted to remain under 10% of primary energy production.

While it is a carbon technology, bioenergy is by far the most significant alternative to fossil fuels, representing over 10% of primary energy supply in 2008. While bioenergy is relatively insignificant in industrialized countries, it makes up about a third of energy use in the developing world, and up to 60% in Africa.

Despite major incidents such as Chernobyl and Fukushima, the real explosion in capacity over the last several decades has been in nuclear energy production, from 203 TWh in 1973 to 2584 TWh in 2012. Most of the growth has come in Asia. China, which had no
civilian nuclear energy plants in 1973, now has a capacity of approximately 86 TWh, representing over 3% of global production. But new nuclear power generation is only expected to keep pace, as geological, climatological and other constraints limit the siting of nuclear power plants, and popular attitudes are shaped by occurrences such as the tsunami that caused releases of radioactive contaminants at Fukushima in Japan. In the wake of Fukushima, the estimated per unit cost of new nuclear capacity increased by 40%.

As overall energy demand continues to rise the search for new energy sources takes up much of the political energy of nation states around the world. Meanwhile, the thinking of experts, politicians and the public about the energy mix has evolved dramatically during the last decade, as the impact of our consumption of energy on quality of life and the environment has risen to the forefront of policy debate. The often conflicting roles of energy both as an engine for development and as a threat to the future have to be taken into account.

**Energy for Life**

Human mastery of energy resources has played a major transformative role, from the campfire and the employment of beasts of burden to a modern interconnected global community. Every advance in the forms of energy that humankind has mastered has offered promise for the future, reflected in visions of technological progress and prosperity. Exhibitions such as the 1939 Futurama (New York) and 1962 World of Tomorrow (Seattle) provided attendees with contemporary visions of a future made possible through energy. While not always predictive of actual developments, many of the predictions have in fact come to pass. The automated highways of Futurama for example are now just around the corner.

When we think of future energy we are inevitably drawn to the idea of “future living” - how we hope and expect lifestyle enhancements, products and technology to improve the quality of life through application of energy. In contrast to past ideals that focused on more, better and larger mechanization, a new image of the future has emerged in which sustainable lifestyles make efficient use of sustainable energy resources – the “greening” of the economy. One of the key changes over the past few decades has been the shift in focus from a single, utopian view of progress to an idea that diverse local conditions demand diverse local solutions.

While future visions from the last century were somewhat utopian, today’s exhibitions on future energy must reflect on what we have learned about the negative consequences of energy use. Many of the technological wonders of the past are technically feasible – who
wouldn’t want a jetpack? – but at what cost? In the same way that policymakers tackled the problems of acute industrial pollution in the 1970s and 1980s, a large part of our current strategies for energy use and the future energy mix are aimed at taking into account diffuse and long-term effects on quality of life, and offering solutions to problems related to global environmental change.

**Climate change**

Hanging over the energy debate is the global policy response to climate change. Author Bill McKibben has pointed out that an estimated 565 gigatons of total carbon emissions by mid-century would put the world on the infamous 2 degrees C track, whereas an estimated 2795 gigatons of carbon emissions are in the ground with an estimated current value of $27 trillion. In the face of the fact that carbon fuels will be with us for a long time to come, the question is whether the world wants to burn up all that carbon – and for most the answer is no. One thing those large numbers say is that we will never run out of fossil fuels before we find a substitute for them because the ultimate costs of extraction in terms of climate change effects and environmental degradation would be too great. Stretching out exploitation over time doesn’t solve the problem either as there are limits to the globe’s ability to absorb carbon without deleterious effects such as ocean acidification. At the moment, there is no real alternative policy to decarbonization. In effect, the current global policy response is asking investors to write off about 80% of their potential fossil fuel assets, to the tune of $20 trillion.

With such huge investment by society as a whole in carbon energy, is it any wonder that people take comfort in attacks on the science behind global warming? Wouldn’t it be great if the doomsayers were wrong? The climate change debate is perhaps not over, but 97% of climate scientists worldwide now agree that humans are the cause of global warming. And carbon reduction has been global policy since the adoption of the UN Framework Convention on Climate Change in 1992.

But policy and reality are often two different things. The transformation of energy markets and patterns of production and consumption is an immense task. Some low-hanging fruit have been picked, but overall carbon emissions have proven stubbornly resistant to efforts at reduction and with few exceptions have in fact continued to rise. Meanwhile the academic community has begun to shift focus from arguments about the science of climate change towards examining innovation and the means for increasing it in the energy sector. Rebecca Henderson and Richard Newell, for example, have focused on the role of public policy in encouraging investment. Subsidies can play an important role. The biofuel revolution in Brazil, for example, is credited to government programs aimed at diversifying markets for Brazil’s sugar production, including credit guarantees,
low-interest loans, price controls and government buying programs. Government programs can be somewhat fragile - the recent financial crisis in Europe has claimed at least one alternative energy victim – Spain slashed its subsidies and abandoned its ambitions to be a leading player in solar energy.

Quantum leaps in technology are inherently unpredictable, while both the dramatic increase in energy needs and the negative effects of reliance on fossil fuels are immediate concerns. The reliance on fossil fuels cannot be changed overnight, so energy policy considerations generally include a range of solutions to the problems of rising demand and external environmental and social costs. These measures are aimed among others at increasing the proportion of renewable energy, introducing efficiencies in energy production and use, and minimizing carbon dioxide and other greenhouse gas pollution.

The Intergovernmental Panel on Climate Change (IPCC) conducted an in-depth study of renewable energy sources and their potential impact on climate change mitigation in 2012. The report evaluated bioenergy, solar energy, geothermal energy, hydropower, ocean energy and wind energy. If the developing world is to adopt an energy mix that is an alternative to the major reliance on fossil fuels, bioenergy will play an important role. Particularly in the transport sector, biofuels have fueled economic expansion in countries such as Brazil, where more than 90% of new vehicles are now flex-fuel, capable of running on either gasoline or ethanol.

One of the frontlines on reducing carbon emissions has been increasing energy efficiency. Pricing has already prompted the shift from cheap, taken-for-granted energy towards a precious commodity that cannot be frittered away. Carbon intensity in electricity generation has been a major success story. Smart grids that monitor and manage the flow of electricity from all available generation sources to meet the varying electricity demands of end users are instrumental in avoiding losses through peak demand and ageing infrastructure, and can be deployed for buildings, industry and transport. Smart grids are also important for integrating and expanding the use of a number of low-carbon technologies, including electric vehicles and renewables such as wind, solar, tidal, and wave generation, that do not produce constant energy streams.

Energy efficiency has driven a revolution in the construction industry. Green buildings alone, according to IEA estimates, could save in the range of 20 exajoules (EJ) per year by 2030, which is the same as the current annual electricity consumption of the United States and Japan combined. Led by the French trade commission UBIFRANCE, French industry has taken up the issue of sustainable cities as a potential boost to its international trade in the energy and environment sector. In developed real estate
markets, green certified buildings can command a premium in rents and long-term returns on investment.

Green building is just one means of increasing the resilience of urban landscapes to respond to modern stresses. The world is becoming increasingly urbanized. At the beginning of this century a major milestone was passed when global urban population passed global rural population for the first time, and 60% of global population is expected to live in cities by the year 2020. Put another way, the UN estimates that the number of people living in cities will increase by 72 percent between 2011 and 2050, to 6.3 billion, which was the total number of human beings on the planet in 2002.

Urban planning has long taken into account proximity to flood plains, coastal areas, and earthquake faults. With an increase in extreme weather events, however, planning horizons have changed, as the 500-year flood has become a 50-year flood. The prospect of even greater change has been raised in projections related to major climatic systems such as the Gulf Stream, the Jet Stream and El Nino, with a consequential impact on emergency preparedness and response. Sixty percent of urban areas with at least one million inhabitants are in areas of high risk to exposure of at least one natural hazard, representing 890 million people. Manila, with a population of 12 million, is the riskiest place on earth with a combination of a high population and substantial risks from cyclones, earthquakes and floods, according to the UN study. More resilient systems of energy distribution are needed in the face of potential natural disasters. If fossil fuels contribute to additional risk of extreme weather events, that is further ammunition to those who advocate a radical shift away from carbon-based energy.

Renewable energy sources have the advantage of theoretically lasting forever. But with a global infrastructure dedicated to fossil fuel exploitation a main issue has been cost. Further growth in alternative energy depends on several factors. One of the advantages of fossil fuels is in the way energy can be distributed. There is nothing as portable as a gallon of gasoline, a hopper of coal, or a barrel of diesel. At the moment, renewables and energy from alternative sources cannot compete, particularly in the field of transportation. Quantum leaps are needed in the field of energy storage – this is a key issue in making energy from renewables and alternative energy affordable.

Yet the potential is there. The IPCC noted that the total global technical potential of renewable energy – that is, the amount of energy obtainable by full implementation of currently demonstrable technologies – outstrips global energy demand. This means that the right mixture of policies and investment could in theory transform our carbon-based economic model into a renewables-based economic model. However, the report also noted that sustainability concerns, public acceptance, system integration and
infrastructure constraints, or economic factors could limit deployment of renewable energy technologies.

People respond to prices, so bringing down the relative costs of favored technologies will get results. Markus Wrake, Head of the Energy Supply Technology Unit of the IEA, has brought attention to the relative prices of renewables and fossil fuels. While prices for fossil fuels have risen dramatically in recent years, they still do not reflect the true costs of energy. If the costs in terms of pollution and global environmental change are taken into account, prices for fossil fuels will rise, and currently “unprofitable” renewable technologies will become relatively inexpensive. To get to that point, however, not only does fossil fuel pricing need to be adjusted, but governments have to help alternative technologies get over the “infrastructure hump” through various means of stimulation. Recent policy failures such as efforts to impose a carbon tax on transcontinental flights entering the European Union have highlighted the difficulties in obtaining international consensus on financial measures.

**Future Energy**

Can we have our cake and eat it too? Could we fix the problem without doing away with a global fossil fuel infrastructure? Can we clean up our act enough? Can carbon be “clean”? Some say yes. These carbon optimists fall into two camps – those advocating carbon capture and storage, and those who see the solution in closing the carbon loop and establishing closed carbon cycles or adopting “carbon negative” technologies.

The first camp has received the greatest attention and the largest proportion of investment up to now. Carbon sequestration in particular has gotten a lot of attention. Advances in technology have largely solved the problem of carbon capture from large point sources and numerous small-scale projects aimed at capturing and burying carbon from coal-fired power plants have been implemented. But politics has gotten in the way of larger projects. In 2011, for example, American Electric Power abandoned its plans to build a $668 million carbon sequestration project at its Mountaineer power plant because it feared that state regulators would not allow it to raise rates to its customers.

The second camp sees all that carbon being put into the ground and thinks of it as a “stranded asset.” Their focus is on finding ways that all that CO2 might be put to use economically rather than burying the carbon. One obvious product where the carbon could be used is fuels. Physicist Peter Eisenberger has said, “Imagine a future where the major inputs for fuel are water and CO2.” But capturing carbon from diffuse sources - in effect mining carbon from the atmosphere – is still on the technological frontier today. To reach this goal, major innovations are required to bring costs down below the
estimated $600 per ton that is currently feasible. That cost is about seven times the cost of carbon capture at point sources. Projects are at the very beginning stages.

The US Department of Energy’s Sandia Laboratories has embarked on a project to use solar energy to power chemical heat engines that would suck carbon out of the air. This project thus confronts one of the major obstacles in the field – the need to minimize the use of energy from fossil fuels to extract the carbon. A UK demonstration project aims to use wind energy to produce fuel from atmospheric CO2. The demonstration project will produce one liter of fuel daily. Scientists at Columbia University’s Earth Institute, however, are working on synthetic trees, scrubbers and sorbents that could bring costs down significantly. They also point out that captured carbon destined for reuse should be valued differently from carbon that is captured for burial. Reduction of carbon intensity also has the potential to go beyond “carbon neutral” to “carbon negative.” Projects are in the planning stage in India and Japan that would use residual heat from power plants to power CO2 sequestration and use the carbon in algae-based biofuel.

If a technological solution could be found that would enable us to recover and recycle carbon, the demand for fossil fuels would go down since the atmosphere would become a competing source of carbon. However, assuming there would still be a demand for fossil fuels, where would they come from?

Tight oil and shale gas represent already developed resources. The share of tight oil and shale gas as a proportion of the total fossil fuel market is projected to increase as conventional deposits tail off. Close to half of new gas production is projected to come from shale over the mid-term. By 2035, according to BP’s outlook, tight oil (dominated by the US) and oil sands (dominated by Canada) will together represent 12% of the global primary energy market. They have also emerged as a game-changer in international energy relations. From its peak in 1970, U.S. crude oil production decreased every year up to 2008, but with tight oil it has begun to increase again. Tight oil will soon represent half of all U.S. crude oil production. Total production will reach over 9 million barrels per day by the end of the decade, close to the historical peak. The IEA is predicting that the US could even surpass Saudi Arabia as the world’s biggest oil producer. US law, however, prevents American producers from exporting crude oil. Unless that is changed, increased US production will have only an indirect effect on global markets by reducing US demand for imports.

Potentially an even more significant source of hydrocarbons is the deep seabed. When Japan started the world’s first experimental seabed mining of methane hydrate in early 2013, the New York Times called it an “energy coup.” Methane hydrate is a solid, ice-like crystalline substance containing methane and water, which is naturally formed in marine
sediments. Apart from its methane content, it also acts as an impermeable layer that traps methane gas beneath it. Conservative estimates indicate that methane hydrate reserves represent at least 500 gigatons of carbon, more than all known current conventional natural gas reserves, while some estimate that total reserves of methane hydrate far outstrip all other carbon-based energy sources combined.

Non-conventional hydrocarbon technologies continue to be controversial. Hydraulic fracturing as a technology for recovery of tight oil and shale gas has been banned in several countries. Some experts fear that drilling in hydrate deposits could cause catastrophic releases of methane that would greatly accelerate global warming. Advocates of methane hydrate mining have taken an apologetic approach, touting it as a way to “buy time” while renewable and alternative energy sources are found. Critics point out that a major new source of greenhouse gases is the last thing that is needed in the transition to sustainability.

Of course other forms of energy also carry risks, from the well-known and potentially catastrophic risks of nuclear energy to the wastes, toxics and other aspects of the use of certain alternative energy resources, such as solar panels and batteries. Large dam hydropower and bio-energy are other examples.

So the search for a benign and innocuous long-term alternative energy source continues. Barely considered in industry projections for the energy outlook is an experimental technology that could turn the energy market on its head. Harnessing energy from fusion will most certainly be one of the matters under discussion in 2017. Humankind already gets the vast majority of its energy indirectly from the fusion power of the sun. Scientists are seeking to emulate the sun’s fusion of hydrogen atoms into helium through controlled reactions that would produce heat. Cheap energy from fusion may not be just around the corner – the ITER demonstration project has been ongoing since 1983 and a pre-industrial demonstration power plant called DEMO is scheduled for completion only in 2037 – but fusion does offer hope and promise for the long term, as well as unknown risks.

An even more out-there idea is mining energy from space. Helium-3, an isotope suitable for fusion that is rare on Earth, is plentiful on the surface of the moon. Fusion fuel is one of the only feasible materials for space mining, as the cost of bringing back materials to Earth will be prohibitively expensive for the foreseeable future. Space mining has better prospects, however, for fueling space-based activities, for example through orbiting refueling stations. Imagine that someday the energy-intensive hop from the Earth to the Moon would be the most difficult and expensive part of the voyage, followed by cheap and easy fusion-powered travel in Space.
**Energy for All**

Fusion and space mining are of course the stuff of science fiction, for now. Meanwhile, back on Earth, policymakers are addressing the issue of fair and equitable access to power, making affordable and efficient energy available to humans everywhere. The internet – made possible within the last generation thanks to the spread of global energy networks – has brought the world closer together. Yet it is easy to forget that nearly one fifth of the world’s population does not have access to electricity, let alone the internet. That’s 1.3 billion people, mostly living in rural communities. At the same time, it is by no means certain that the ultimate goal of everyone is inter-connectivity, since in the developed world there is a small but growing movement towards achieving energy self-sufficiency by going “off the grid.”

John P. Holdren of the Harvard Kennedy School has brought attention to the complex and sometimes contradictory goals that a successful energy policy must meet. They include economic, environmental and national and international security aims. Economic aims consist of ensuring reliable supplies of fuel and electricity for basic needs and economic growth; limiting the costs of energy to firms and consumers; and limiting balance-of-payments impacts and macroeconomic vulnerabilities from energy imports. Environmental aims include improving urban and regional air quality; limiting impacts of energy development on fragile ecosystems; avoiding nuclear-reactor accidents and waste-management mishaps; and limiting energy-supply contributions to global climate change. National and international security aims involve minimizing dangers of conflict over oil and gas resources; avoiding the spread of nuclear weapons from nuclear-energy technology; reducing the vulnerability of energy systems to terrorist attack; and avoiding energy “blunders” that perpetuate or create deprivation and lead to conflict.

Energy security for the poor and disadvantaged should be an element of every country’s energy security policy. Extending energy sustainably to the poor undergirds the transformative power of energy towards living standards, job opportunities, health, education, and social welfare. Energy has the potential to power innovation and ingenuity and to harness the potential of groups currently underrepresented in markets and in political life, as well as extending the reach of market forces. Energy is one of the keys to educating, empowering and connecting the public, ultimately with the potential to improve quality of life for all.

Globalized energy networks are part of the solution. On the macroeconomic level, electrification is one of the success stories of the last 40 years. Today, electricity use and distribution reach a much larger proportion of the world’s population. The OECD used to represent the vast majority of electricity generation worldwide. In about 2010
the rest of the world had a larger share of global electricity generation than the OECD states for the first time in history. From less than 6% of global electricity generation in 1973, Asia now represents nearly a third of global generating capacity.

On the microeconomic level, initiatives take aim at the estimated 1.3 billion people living without regular access to electricity, applying an incremental approach. Innovative funding mechanisms such as micro-financing, international assistance mechanisms including technology transfer, public/private partnerships, and other methods aim at inclusion of the poor and disadvantaged into modern energy distribution systems.

Practical considerations sometimes interfere with the goal of universal access. It is also necessary therefore to improve access to energy off-grid, with a focus on low-cost solutions for the poor, emphasizing cleaner options for energy needs in decentralized energy systems. Specific difficulties encountered by the rural poor in gathering and burning fuel require attention to clean cooking solutions, biogas and composting, various micro-tech applications including those based on solar, small hydropower, wind and waste, and the “micro-grid” concept. Micro-solutions generated by local entrepreneurs deserve special attention. One micro-solar project alone is projected to equip five million rural homes in Bangladesh with solar generators by 2015 through its existing distribution and service network. Wind for Prosperity is a business model that hopes to bring wind-based energy to marginalized rural poor on a commercial basis. Other examples can be found in efficient cooking pots, micro-solar energy, and more efficient use of biomass.

The high stakes in energy sometimes lead to weak institutions and poor governance, but potentially affected communities have a right to participate in decisionmaking that may have a direct effect on them. Long-term values cannot be sacrificed in the interests of short-term profits, as has happened so often before. Access to energy is a fundamental part of reducing poverty worldwide and achieving sustainability. Similar to water and food security, access to energy is more than just a matter of fairness – it approaches a right. Consequently, good governance of “energy frontiers” such as the Arctic, the deep seabed, and even the rural backyards where hydraulic fracturing takes place, is an imperative.

**The post-2015 development agenda**

Future Energy as a theme has been at the top of the global agenda for some time and this shows no signs of abating. Major international conferences and negotiations can be drivers for new thinking and stocktaking, helping to achieve critical mass in the formation of effective working constituencies behind ideas and initiatives. The 2013 World Future Energy Summit in Abu Dhabi attracted over 25,000 attendees including 91 official
delegations, viewing exhibitions of over 650 companies from 40 countries. The opening ceremony included heads of state of France and Argentina, the Queen of Jordan, and the Crown Prince of Abu Dhabi.

On the political level, the major upcoming opportunity in this field is the negotiation process leading up to the UN General Assembly’s adoption in 2015 of a set of Sustainable Development Goals (SDGs). This political declaration will take off from the Millennium Development Goals adopted in 2000, and will express a global development agenda with sustainable development at its core.

The SDGs will include one or more goals related to sustainable energy. In the participatory process providing input to the drafting, a number of proposals have been made in the field of “Energy Access and Energy Efficiency.” For example, the UN Secretary-General has proposed that goals be adopted to ensure universal access to modern energy services by 2030, to double the global rate of improvement in energy efficiency by 2030, and to double the share of renewable energy in the global energy mix by 2030. The UNCSD Major Group for Youth and Children and the UNCSD Youth Caucus have proposed goals of achieving universal access to affordable and efficient energy services in all countries, doubling the global rate of improvement in energy and resource efficiency from 1.2% to 2.4% per annum, doubling the share of renewable energy in the global mix from 15% to 30%, and establishing and distributing universal energy planning tools and frameworks. In connection with the latter issue, education and empowerment - how to raise awareness of impacts and to motivate and reward entrepreneurship of the kind leading to micro-solutions – help to lay the necessary foundations in society to create an enabling environment.

With the adoption of the SDGs in 2015, the global community will be expecting government, industry, academia, NGOs and the public to step up to the plate with new ideas, policies and programs aimed at the achievement of the SDGs.

**Expo 2017 Astana**

On the scientific and non-governmental level, international themed expositions provide one of the most excellent opportunities to generate innovative thinking from the public and private sectors in ways that are difficult to achieve in a political setting. Astana, a spectacular and stunningly modern city built on the riches of oil and gas, provides a perfect setting to discuss the way forward towards the next energy paradigm. The famous hospitality of the people of Kazakhstan will be experienced in the context of the transition from a fossil-fuel dominant paradigm (that incidentally has greatly benefited the Kazakh nation) to a world in which the relative power of oil and gas is waning. It is
remarkable and commendable that an oil and gas exporting country has the foresight and vision to host such an event.

The 2017 Astana "Future Energy" Expo will come at an opportune time. It will take as a major reference point the outcomes of the SDGs as adopted in 2015. The intervening period will enable the hosts, participants and the private sector to react to the priorities set under the SDGs and to prepare exhibitions and projects that are directly related to those priorities. Architects and designers are working on ways that the Expo will convey the idea of energy through the physical arrangement of the pavilions. But particularly in the expo’s handling of access to energy – “energy for all” – there will be substantial input from stakeholders, experts and civil society.

Unlike past expos in which a utopian world of the future was shown, Expo 2017 in reflection of the times in which we live will present a more complex and nuanced understanding of the future, based on a different energy mix that may vary from place to place depending on local circumstances, taking into account new mechanisms such as smart grids, smart buildings, smart cities and the like, new sources of energy, and new horizons for grappling with the effects of our past energy policies.

Developments in the energy field are rapidly unfolding. Many of the elements surveyed in this article will already have shifted in the next three years. The conceptual framework on future energy will need to be under constant review to take new developments into account. In particular, the drafting process of the Sustainable Development Goals in relation to future energy has to be kept under close watch in order to ensure the Expo’s maximum relevance to international policy developments. The monitoring of the SDG process will be an important element of Expo planning with specific benchmarks assigned in the timeline. Proper linkages will help ensure that Expo 2017 Astana will be a memorable, influential and groundbreaking international specialized exposition marking a substantial contribution to the world’s transition to sustainable and equitable energy solutions.
EXPO-2017: HOW TO PRESENT "NEW PHYSICS" ENERGY TO THE WORLD?

Sergey Ivlev, Science and Innovations Director of the «Coalition for «green» economy and G-Global development»
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1. DESIGNING THE NEW TECHNOLOGICAL ORDER – THE FEATURE OF EXPO-2017

In the entire history of international specialized exhibitions, the theme of EXPO-2017, i.e. Future Energy, is the most topical for humanity. It can also be called the most enigmatic and unpredictable, as a big number of staggering discoveries and inventions have been made, not yet understood and accepted by the official science or introduced for industrial implementation.

The international annual forum “World Future Energy Summit” has been taking place in the international exhibition centre of the UAE capital Abu Dhabi in late January, starting from 2007, and brings together over 30 participating countries. Here, in the proximity of Abu Dhabi, the first future city with zero emissions and full waste recycling, called Masdar City, has come into existence. In fact, it is an ecological technology park for the research of renewable energies with an investment of $22 billion.

However, even such an impressive initiative does not always touch on the issues of the most advanced energy technologies of the future based on new physical paradigms, such as zero-point energy or the quantum vacuum, the "ether wind", or cold fusion, continuation of the discoveries of Nikola Tesla, the engines on water, antigravity, superconductivity at room temperature, etc.

More than two dozen low-carbon cities and settlements of the future, some floating in the ocean, are being designed and built in the world; however, these projects make no mention of such technologies.
Towns and villages of the future, such as Sherford in the UK, Auroville in India, the City of Arts and Sciences in Valencia (Spain), Dongtan near Shanghai, New Songdo City in South Korea represent a huge step forward. They are zones of advanced development but not necessarily examples of the rich knowledge accumulated by mankind.

The real “peace of the future” has not been revealed yet, not even by the famous Jacque Fresco in “The Venus Project”.

The model of the future should not start with the cities but with houses and apartment complexes equipped with a full infrastructure of services, recreation, rehabilitation, sports, etc. Two main features of the society of the future are represented by the nature of its energy and that of its residential buildings. Moreover, the buildings themselves shall provide all the necessary energy.

The minor “pieces of the future” are the autonomous “green skyscrapers” in the style of organic transformational architecture, i.e. the “future buildings” representing man-made ecosystems of highest natural comfort. The “Adrian Smith + Gordon Gill Architecture” from Chicago who won the tender for the Expo-2017 design has also undertaken similar projects (please see the pictures of their project below).
The analysis of leading innovation shows that new environmental nanomaterials for construction (primarily of hollow microspheres) allow to create ultra-light modular housing with full thermal and sound insulation. An unassembled apartment could be easily "taken off" a building or moved with the aid of an airship. For therapeutic purposes, the walls should be covered in a few minutes with nanocoating of bioactive materials (nanoclay, shungite, dried spirulina, etc.). Skyscrapers will serve as “containers” for apartments as hives for the bees.

The great height of the building gives an opportunity to install columns of water to generate electricity and heat based on hydroblow in hydraulic ram. The price of the generated energy is just $0.1 cents per 1 kWh. Weighing less than 35 kg / kW, the device costs less than $ 15 USD per 1 kW of installed capacity. 1 megawatt is obtained on the square-section of the tube of 8m² at a height of 15 meters, and 30 megawatts at a height of 300 meters. The building can be entirely circled with the pillars of water in transparent polycarbonate. These figures can be multiplied by 30 or more. The authors of this project are the Russians Vyacheslav Marukhin and Valentin Kutyenkov, living in Spain, the only place where they were able to create this experimentation centre.

The most profitable is to set such electric stations in the mountains, in the mines, in unused oil wells and pits, close to lakes and seas.

*Bahytzhan Almenov from Astana obtained the European patent on a similar invention (photo on the right)*
Humanity is about to adopt a new development strategy, the Post-2015 Development Agenda. One of the first goals among the renewed Millennium Development Goals will be the increased access of populations to new, clean and cheap sources of energy.

The European Renewable Energy Council together with Greenpeace International have recently published a report entitled “Energy Revolution: A Sustainable World Energy Outlook”. It substantiates the possibility of reducing world greenhouse gas emissions by 80% by 2050. However, it does not mention energy technologies based on new physics such as the UN “Sustainable Energy for All” initiative.

But only the reduction of energy costs by a dozens of times will make profitable the activities of restoration of ecosystems and degraded land, water purification and desalination.

The paradox is that if poverty were to be eliminated in China, India, Pakistan and other countries with a large population, under the existing technological structure it will cause such a growth in consumption that the capacity of the Earth's biosphere will be exhausted.

Moreover, the only way to recycle all types of waste and turn to waste-free production is the safe nuclear transmutation, which is very profitable commercially and allows the transformation of the most toxic and radioactive waste into raw materials with additional energy emission. This was achieved on the installations of A.V. Vachaev “Energoniva” (Magnitogorsk, Russia), of B. Bolotov (Kiev), and of Yu. N. Bzhutov (Moscow).

Depletion of mineral deposits can be compensated only by cold nuclear transmutation. Finally, only new low-cost electropulse devices which can correct weather, wind flows and cloudiness thanks to the atmospheric energy use, might help restore the dwindling mountain glaciers, reduce the damage from extreme weather events, escape droughts and floods. This is due to the fact that the power of the magnetic field of the planet is $10^{24}$ watts.

These are the orgone energy installations of Wilhelm Reich, «Urania 2M» (Alexey Smirnov), «Lidar» (Semen Novoselov), installation of Oleg Martynov («Prognoz» enterprise at the General Staff of the USSR), etc.
Therefore, the whole world wonders to which extent Kazakhstan will address these issues during the Expo-2017. Indeed, the transition to the third industrial revolution is stipulated in the recently adopted Strategy "Kazakhstan-2050".

According to the President of Kazakhstan Nursultan Nazarbayev, the initiator of the global initiatives "Green Bridge", "Global energy and ecological strategy", World Anti-Crisis Plan and the Strategy of Mankind transition to the sixth technological order, "The country itself should demonstrate commitment to an idea of Future Energy transition... During the five years to come Kazakhstan should accomplish an innovative breakthrough in the sphere of development and introduction of clear energy sources." "It will be a turning point for Kazakhstan to start a new page in economic development."

On October 11th, 2013, an enlarged meeting of the Government took place in Astana, Kazakhstan, during which the head of state Nursultan Nazarbayev proposed to unite enthusiastic researchers of the new alternative energies and create the work conditions in Kazakhstan for this purpose.

"Around 5% of people are now thinking of completely new energies. New energy is now being created in the minds and in laboratories by a small number of people in the world,
and here, probably. Cold nuclear synthesis. The device works in a suitcase... The great physicist Nikola Tesla proved a century ago that energy was everywhere around us... Let us become extraordinary. Let's gather in Kazakhstan the ones who are already thinking of this, of extraordinary things, let's give them opportunities.”

Kazakhstan's President may be called “the most innovative President”, persistently pushing his country away from raw power and forward to the latest exploration of technologies and development. In his book “The strategy of radical renewal of the global community and partnership of civilizations”, he raises the question of identifying the basic “absolute” (or landmark) innovations for the new (sixth) technological order for mankind.

It is thought that, first of all, we are heading to the bionics and «nanocivilization» of nanomaterials such as graphene, carbon nanotubes, composites of ultra-crushed natural materials and waste. The new energy is based on them, as well as the new catalysts of chemical and nuclear reactions, high capacity accumulators and self-charging batteries.

“Eternal” clothing of synthetic cobwebs will be produced soon by the Japanese company Spiber. This material was obtained by recombining proteins of natural silk, it is five times stronger than steel and can be stretched up to 40%.

Jeremy Rifkin became head of the Technical Board of the international architectural competition of sketches for the EXPO 2017 complex. It speaks volumes. Rifkin is the most active protagonist and lobbyist for green innovations in the world, as well as a “designer of the future”.

He visited Kazakhstan in October of this year, met President Nursultan Nazarbayev and conducted a workshop for governmental officials.

Mr. Rifkin proposed to make Astana and Kazakhstan all in all a showcase of the “Third industrial revolution” based on the EXPO-2017 (www.youtube.com/watch?v=KgNWhlSVXxA, www.youtube.com/watch?v=q_yPyj_HY)

He also proposed to create the so-called “biosphere valley” in Astana, i.e. an agglomeration which will unite scientists and developers with the intention of creating an elaborate power system for the formation of an industrial model based on a new development paradigm. It is advisable to create an associate center for biosphere research which will bring together social scientists, engineers, economists, physicists, chemists in order to establish a new «brain lab» where the new kernel for the human
development will be created, not only from a technological point of view but also from a philosophical, ethical and moral standpoint. He stressed that the biosphere research is a relatively new trend in science and that Kazakhstan could become an international hub for this research.

Jeremy Rifkin appreciated Kazakhstan’s intention to construct in the center of the exhibition the world’s largest spherical building that will concentrate the most advanced technology in the world of “green economy”. Up to now, several multinationals have expressed a desire to participate in the creation of this biosphere center called “Elbasy”.

This Expo will differ greatly from all preceding Expos since the 360 acres where it will be located represent a development zone that will function after the end of the Expo. The EXPO-2017 area will be the first area of the Third Industrial Revolution development in the world as stressed by J. Rifkin.

The most complicated question is the accelerated and complex development of Astana, which is already becoming the new Global and Open City according to its objectives as well as a platform for global dialogue and cooperation. Much remains to be done. The capital’s infrastructure is not ready yet, the services are not set up and the innovative involvement of the citizens in urban development is not yet sufficient.

But the mood for change brings optimism. The Mayor of Astana was the first in Kazakhstan to join the European “Energy for Eastern Mayors Project” for the reduction of greenhouse gas emissions and an increase in energy efficiency by 20% by 2020.

2. EXPO 2017 GOALS
The goal of Expo 2017 is not only to show how to decrease the clean energy costs and not only to demonstrate radical innovations that will need political will and the legitimacy
of revolutionary scientific discoveries to be implemented. Its goal is also to conduct a world opinion poll on the legal support for new energies, for the reform of science, education and metaphysical thinking.

We need to organize professional discussions on the most controversial discoveries, inventions, projects and brands of inventors. For instance, Boris Bolotov from Kiev claims an overturn in the big number of fields of industry, physics, chemistry and biology. He recommends the production of metals by electrolysis instead of blast furnace use, including precious metals, through the use of catalysts of cold fusion; the transmutation of chemical elements; unique new materials; metal foam; dry electrolysis for minerals processing; a new generation of catalysts, etc.

Victor Petrik from St. Petersburg suggests new sources of energy based on graphene; nano-accumulators for cars; electric cars with remote recharging; glass with a special coating that converts solar energy or any heat into electricity; a new ecological method of obtaining silicon; solar cells based on photochemical systems with nano-oxyde semiconductor materials that produce electricity for 10 cents per 1 kWh, etc.

The 85-year old Japanese Naka Mats is the author of over 3,300 inventions and claimed as early as 2000: “I have found the alternative source: it's the energy of space. Theoretical research is already accomplished and next year the energy station model will be created. It will be possible to use it both for industrial and household needs... Moreover, I created a small engine working on water (“Dr.Nakamats Nostradam vs Engine II”). It is patented under the name "Eneriks" and may be installed on a car. The question on when these engines will really be produced depends on the automobile companies.”

- We should organise regular video-conferences involving the interested TV channels of different countries powered by the G-Global dialogue platform, on-line competitions for the innovators, informal investors, grant providers and private charitable foundations.
- We shall create a roadmap for the implementation of the Kazakh-Russian project “Global Energy-Ecological Strategy”

- We need to provide recommendations to the countries having voluntarily accepted enhanced environmental commitments. For instance, Sweden, Germany, the UK, Brazil, Australia and Norway will decrease greenhouse gas emissions by 80-100% by 2050.

- We should support the “Mobilizing to save civilization” plan of Lester Brown (Earth Policy Institute President) with concrete technologies. In his famous book “How to escape climate disasters? Plan B 4.0: Mobilizing to Save Civilization” he substantiates the possibility of reducing greenhouse gas emissions by 80% by 2020 through the introduction of advanced technology, gradual introduction of universal carbon tax of $200 dollars per 1 tonne of carbon dioxide, and annual expenditures of only $187 billion.

- It is necessary to intensify and give concrete meaning to the wonderful initiative of “Clean Revolution”. On June 18, 2012, former British Prime Minister Tony Blair, along with other political and business leaders addressed the forthcoming summits Rio+20 and G-20 calling for the “green industrial revolution”.

And on September, 24, 2012, world politicians and business leaders called the future US administration to the “American Clean Revolution” (youtube.com/watch?v=QboTDuKNjXk) and created an international partnership “Clean Revolution” (www.thecleanrevolution.org) based on the Climate Group.

Its participants are big companies (Philips Lighting, JP Morgan Chase, Dell), funds, financial structures (Swiss Re Group, Goldman Sachs, Deutsche Bank), certain regions (State of Baja California, State of South Australia, State of North Rhine-Westphalia,
- We shall introduce the lists of alternative energy technologies to the documents and programs of the UN and other intergovernmental organizations.

- We also need to offer new financial mechanisms to promote the re-orientation of big businesses in "brown" energy to other profitable industries using the cheapest and cleanest energy. For example, through the development of the Arctic and Antarctica, with lots of valuable minerals. In the case of new non-fuel engines creation, the exploration of the Moon and Mars, as well as various asteroids, will be possible too.

In 1997 the nuclear physicist Steve K. Lamoreaux carried out precise measurements of zero-point energy. Theoretically, the flight of a manned aircraft moving with the use of zero-point energy from Earth to Mars should only take from 7 to 40 days.

3. PUBLIC SUPPORT MECHANISM TO THE EXPO

The next technological order will be based on those technologies that are today considered non-traditional and pseudoscientific. Therefore, without the pressure of public policy they will not be recognized.

The goal of the Expos, held under the auspices of the Bureau International des Expositions, is to promote the best scientific and technical achievements in terms of global economic, social and environmental efficiency. The number of visitors to exhibitions and Expos’ profitability cannot be the main criteria of efficiency.

We need to find the levers of influence on the transfer of technologies, changes in the market, global innovation policy, publications in the media, growth of global scientific and technical cooperation based on the principles of "open innovations", etc.

The status of visitors is important, as well their orders at the EXPO, and the amount of the venture capital raised in MOUs with business angels.

This is how EXPOs differ from simple commercial exhibitions where public attention is won by those companies who have more money to rent exhibition space and organize a PR campaign, who have the most reputable scientists in the academia and not those whose products or innovations are really better and more important for the society.
There is no doubt that all the Expos should be preceded by virtual exhibitions in which future participants should take part and by national competitions for the countries to choose the exhibits for their pavilions. And that all the exhibition halls should be equipped with cameras for interactive online broadcasts. All the world should watch the Expo.

Each Expo website should have an online shop for the purchase of exhibits with postal delivery and for the creation of a line of preliminary orders on innovations yet to be mass produced.

Every year the information crisis of consumer choice accelerates as the number of new technologies, industries and goods, increases so quickly that consumers and state customers are simply lost. Advertising is not fair, and a public institution for filtering innovations and facilitating the selection of the best products for consumers does not exist yet.

That is how the idea came up to create the first Virtual World Expo of green technologies and the ratings to be based on public assessment. The exhibited technologies and innovations are shown and discussed by independent experts, and the users’ assessment is studied and recorded in the rating rosters.

The main part of the project is the "Top Green Achievement Registry", a sort of Guinness World Records’ Book on ecology and innovation with over one hundred nominations. We hope this will be a new tool for influencing public opinion, consumer behavior, media topics, the priorities of state support for innovations and subsidies, and customs benefits of WTO member countries.

Earlier this year one of the first coalitions for the "green economy" in the world was created in Astana, Kazakhstan, with the participation of the Eurasian Economic Club of Scientists, named "Coalition for a green economy and development of the G-Global», headed by Saltanat Rakhimbekova. And this is our first "shock" institutional project. Unfortunately, so far the site of the project is only in Russian.
We believe that without the active support and intellectual backing by the professional international community, by the ones passionate about their profession, such broad initiatives as the "Green Bridge", Expo-2017, G-Global, Post-2015 Development Agenda and the Third Industrial Revolution will be ineffective and unviable.

- We need to attract international professional associations and non-governmental organizations, expert networks and international partnerships to sign agreements with Kazakhstan, the Bureau International des Expositions, UN-Energy; Technology Mechanism under the UNFCCC; Clean Energy Ministerial Forum; International Partnership for Energy Efficiency Cooperation; International Renewable Energy Agency IRENA, World Energy Council, C40 Cities Climate Leadership Group, The Third Industrial Revolution Global CEO Business Round Table, Eagle-Research, Russian physical Society, Blue Energy Canada, various institutes for the research of the future, etc.

There is an example of a similar agreement with the public for the Expo Milano 2015 preparation.

- We shall create an information platform to synthesize the activities of research groups on alternative energy, to share experiences; we shall open a digital library with terabyte storing systems and involve inter-university and student associations;

- It is necessary to provide guidance for design of towns and cities of the future, synthesizing all the best and cheapest technologies;

- It is desirable to establish criteria of compliance of new technologies with the "Third Industrial Revolution" and keep the rating registry of green technologies and discoveries updated.

- We shall extend the classification of renewable energy sources to the maximum. For instance, there are examples of cheap autonomous power supply for individual houses through the use of electric charges of the atmosphere. Likewise, there is an example of the use of piezo generators to obtain electricity from the pedestrians' feet pressure, vehicle vibrations and pressure on the train rails.

There is the production of methanol from biogas. We can also cite the catalyst of palladium nanoparticles and iron oxide, which enables the production of methanol directly from the biomass, as discovered by the British chemists.
Air Fuel Synthesis (AFS) Company of Stockton-on-Tees, the UK, has reached good results in the synthesis of gasoline from water and carbon dioxide that is obtained from air.

- We need to introduce voluntary certification of low-carbon technologies, products, buildings, neighborhoods and cities in terms of greenhouse gas emissions, taking into account the full life cycle.

- It is necessary to find synergies of the greatest number of new technologies whose simultaneous use maximizes overall efficiency and economic performance.

For example, the production of biogas from organic waste can be three times cheapened and fastened, being combined with the reclaiming of polluted water with the help of Eichhornia floating plants, possible due to their unique microorganisms. It becomes feasible to disinfect sludge deposits on sewage systems and in water basins. We can add two more components: three times cheaper production of Effective Microorganisms and vermiculture breeding, fed with Eichhornia or sediments. The fifth component is the electric hydro blow device for superfine grinding of waste and Eichhornia before the fermentation.

The Black Sea Energy Company (Novorossiysk) receives electricity from Eichhornia biogas, wastewater and sewage, which is 10 times cheaper than the energy produced in oil-fired thermal power plants.

4. BENEFITS FOR BUSINESS AND THE POPULATION FROM THE TRANSITION TO AUTONOMOUS EXTRA CHEAP ENERGY

World business turnover on oil, gas, motor fuels constitutes about three to four trillion dollars a year. However, if we lower energy and fuel prices by 50-100 times, as possible with the discoveries currently not in use, it will cause a frenzied economic growth and turnover will increase by an additional 30-40 trillion dollars, which means substantially higher than in the case of the expensive traditional energy sector.

Thus unemployment will practically disappear, as a very small capital will be sufficient to start production, land development, landfills' purification from waste, production of feed and fertilizers, etc.
First of all, it means multiple cheapening of transportation costs, because the fuel would be cheap, as would be the vehicles made of nano-composite materials.

It also implies cheapening of drilling, that will give access to the inexhaustible heat of the Earth with the temperature of 300°C at 4-10 km depth (water injection to produce vapour).

Likewise, it signifies cheap water desalination by simple evaporation and distillation, condensation of moisture from the air.

All the deserts and degraded lands could be covered with man-made vermicompost produced from organic waste and sediments, humates from coal.

A new generation of airships with the air temperature inside of up to 1500° and with thermic capsules of refractory silicon hollow vacuum microspheres would greatly reduce their size and their losses from wind resistance and costs.

Traffic jams in big cities will disappear, places of residence will become mobile in the flying homes and cities will be relieved from overpopulation.

There are already many models of wing-in-ground-effect vehicles (WIG), “flying cars”, vibro-planes like dragonflies, paramotors, etc. They will be widely available just like mopeds and cars, as soon as the fuel cheapens.

Flying jetpacks by Martin Aircraft, New Zealand, are now designed for a half an hour flight, but if we supply them with nano-accumulators or supercapacitors, then the flight time will increase and fuel tank can be abandoned.

At very high pressure and temperature, supercritical fluid technologies bring molecules millions of times closer. Thus, all the chemical, food and pharmaceutical productions become substantially faster, cheaper and environmentally friendly. For example, the
profitability of recycling toxic waste increases 10 times. With the cheapening of energy, the new fluid chemistry will come to every home.

All food products will be stored without preservatives in carbon dioxide in supercritical state. Medicines, fertilizers, dyes, chemical products will be several times cheaper.

The coal industry will not cease to exist. There are several technologies for coal processing into coal chemistry products, clean fuel and getting CO2 to stimulate the growth of microalgae and crops in greenhouses. Fast pyrolysis, cavitation, electrohydra blow, ultrafine grinding of coal in a mixture with water will be used for these purposes.

Nanoelectronics and micromagnetic systems: switching power modules on ferrites in a transformer case the size of a matchbox will allow you to convert hundreds of watts.

5. OUTLINES OF THE FUTURE ENERGY

The key theme of the Virtual Exhibition is alternative energy.

Leading researcher in this new area of physics, Mr. Hal E. Puthoff, Director of the Institute for Advanced Studies, USA, states that one cup of coffee contains an amount of zero point energy that is sufficient to evaporate all the oceans and seas.

This was discovered in 1913 by Albert Einstein and Otto Stern. Still, no one has used this energy to the present day. It was not used even in the low-temperature heat generators of nuclear reactions E-Cat by Italian entrepreneur and inventor Andrea Rossi (a plant in Florida is being built for their production with the support of the U.S. Department of Energy.) The cost of the generated heat is roughly equivalent to that of electricity at a price of 1 cent per 1 kWh.

Millions of people saw the work of the fuel-free magnetic pulse motor and generator by Wang Shum Ho at the World Expo 2010 in Shanghai. Wang's 5kWatt capacity motor costs $ 200 at a batch production. It is just $ 40 per 1 kilowatt of installed capacity. The
cost of electricity with the use of these generators will be less than 15 cents per 1 kilowatt / hour.

Since the energy crisis of the 1970s, oil prices rose more than 30 times, which greatly slowed down economic growth.

There are many fuel-less energy devices on the verge of industrial development that will lower energy prices about a hundred times. They are called “free energy” devices. There is a tendency to rehabilitate the terms like “perpetuum mobile”, “perpetual engine”, drawing energy from within, from the zero point energy or from the energy of motion around the center of expansion of the universe.

It turns out that every point on Earth moves in space with the velocity of many hundreds of thousands kilometers per second due to the Earth's rotation around the axis, around the sun, the rotation of the solar system, of the Milky Way, etc. The Earth is electrically charged, so its motion produces “ether wind”.

Rowland's – Eichenwald’s experiments prove that a moving charged body creates around itself a magnetic field exactly similar to an ordinary electric current.

A major discovery in astrophysics at the end of the 1990s was the finding of the supernew Ia-type stars, obtained through redshift-luminosity observations, testifying that the entire visible universe is expanding rapidly and has already reached the speed of 70 km per second. The source of this colossal energy is unknown. This led to the concept of “dark matter”.

Thus, there are no closed energy systems in nature and it is meaningless to talk about the violation of the laws of thermodynamics with regard to “perpetual engines”.

Excessive energy output after the initial expenses for power plants start reaches 1500% on Andrea Rossi devices, and more than 3000% on the plasma electrolysis devices by Philip Kanarev (http://kanarev.innoplaza.net). Kanarev’s electrolyzer reduces hundreds of times the cost of hydrogen production from water.

The concept of “efficiency” itself is changing, and it now exceeds 100%.

Transonic jet devices by V. Fissenko for mass transfer processes (including heat generators) have an efficiency of 300-500 %. More than 15 thousand vehicles worldwide
have already been manufactured. The program of “Fisonic” technology introduction in various industries in Russia has state support by the State Duma and the government.

But this is an exception to the rule. There is such influence of transnational corporations on the governments and parliaments that even certification of industrial models of free energy devices is blocked. And history knows many cases of mysterious deaths of such inventors.

NASA is the pioneer in zero-point energy studies (www.nasa.gov/centers/glenn/technology/warp/possible.html). How could it be otherwise, if all the best scientific developments belong to the military departments; and among the military - primarily to space agencies and special services, studying the secrets of new technologies as part of their everyday business.

Many advanced energy technologies are based on data of secret studies of anomalous phenomena, UFOs, and archives of the “Ahnenerbe” of Nazi Germany. The greatest environmental scientist Viktor Schauberger created a nonfuel vortex antigravity propulsion for the aircraft «Haunebibu-X-Boot» by Hitler's order.

In the center of the photo around the model of a flying disk «Repulsine» by Shauberger you can see grandson of Viktor Schaubger, Joerg Schaubger, who heads the family-owned Schaubger Institute «PKS», located in the Austrian town of Bad Ischl.

Somewhere in the archives of the secret services lies hidden the description of an electric vehicle of Tesla that is powered by the electromagnetic field of the Earth, and that he publicly demonstrated in 1932.

Stunning potential of a zero point has led many scientists to the “new physics”. In 1996, NASA announced the start of the program “Physics of new principles of movement” for the development of new types of fuel-free spacecraft powered by new ways of energy generation.
The energy sector based on “new physics” is dominated by two countries - the US and Russia. It is obvious that the countries that will adopt the new paradigm of science and relativistic energy will quickly race far ahead.

The first generators of free energy will go into mass production at the “X” hour, following an unspoken agreement with the world's elite, and it will be a revolution in the world markets, prices, distribution of spheres of influence of corporations, geopolitics, but first and foremost a revolution in the minds of consumers.

6. OPPORTUNITIES OF KAZAKHSTAN AS THE BIGGEST EXPORTER OF CLEAN ENERGY

Kazakhstan is the ninth biggest country in the world, endowed with huge ponds, creating sediments for biogas production in billions of tons. Kazakhstan has the world’s largest untapped lands of little value that are suitable for the production of second-generation biofuels from non-food raw materials and phyto fuel. Kazakhstan is the third country in the world after Canada and Australia by land area that is not spoiled with chemical fertilizers and pesticides, which gives it an advantage for the production of biomass.

Kazakhstan is able to take a niche in the world of sustainable energy not smaller than the one it now occupies in the world market of “brown” energy of hydrocarbons and uranium, thanks to its rich natural resources, the potential of solar, wind and hydro energy, the existence of domestic and Russian sustainable energy technologies, the potential of phyto fuel and biofuels production from non-food raw materials on unused lands of little value (that constitutes more than 90 mln hectares).

Kazakhstan may create, similarly to the OPEC, a “club of superpowers - exporters of clean energy” with the participation of Russia, Canada (natural gas, coal), Australia and Brazil (biofuels). This is important from the point of view of market sharing, of reduction of unnecessary competition, and of the development of common technological policy.

The renewable energy potential of Kazakhstan, excluding bioenergy, is about 1 trillion kWh per year, i.e.: wind energy - 929 billion kWh; small hydropower stations - 8.0 billion kWh; solar energy - 2500 - 3000 hours of sunshine per year, or 2.5 billion kWh per year. This corresponds to an area of solar cells of about 10 km2 with an efficiency of 16%.
According to the estimates of the Government of Kazakhstan, the total hydropower potential of the Republic is about 170 billion kWh per year, while the potential that is technologically possible to use constitutes 62 billion kWh.

One of the best wind corridors in the world, the Dzungarian Gate, is located in Kazakhstan on the border with China.

2014 is a crucial year for Kazakhstan. The “Green Bridge” programme starts this year, as well as the agreement to be concluded with the Bureau International des Expositions on EXPO 2017; the World Anti-Crisis Plan will be adopted; the state program on forced industrial innovative development will be updated; the Law on green economy will be adopted this year. A year later we shall be able to summarize the outcomes and forecasts - the most optimistic ones.