

The world in 2015 – trends and drivers

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In the globally networked world of today even slight changes of influencing parameters can have a huge effect on the development of society. With the fast changing political scenery, the soaring economic development and ongoing leaps in technology, a forecast into the future is a risky undertaking. Nevertheless, as the future development of the world's energy is one of the backbones of the global society, the need for reasonable planning is obvious. Utilities need to make long term investment decisions for their power generation portfolio as well as the transmission and distribution infrastructure, providers of alternative energy solutions seek a sound decision platform and, last but not least, industrial groups and their suppliers want to know where market and technological development will lead.

A look into the future is obscured by the fact that disruptive events like pandemics, terrorist attacks and technological breakthroughs may have a significant influence on the development of the world, but they are by nature unpredictable.

Forecasts based on the extrapolation of developed or emerging trends seem to be more reliable within a reasonable time span. As those trends are driven by a few major forces, there is a chance of a meaningful prediction by analyzing these drivers.

ABB has looked at six prominent trends with strong influence on the upcoming needs of people and requirements of the industry. These trends address

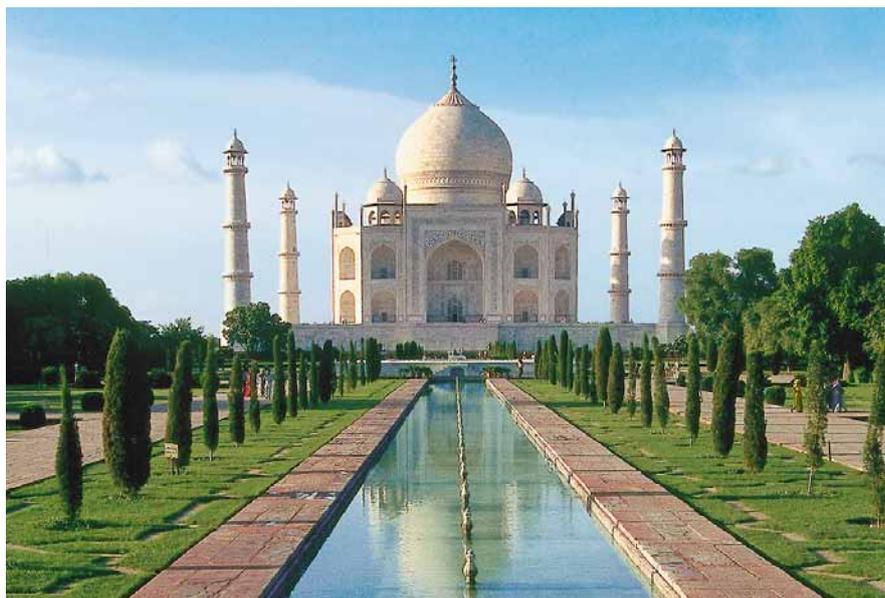
- Changes in the global society
- Globalization
- Energy industry restructuring
- Primary energy concerns
- Electrical energy needs
- Environmental issues

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A rapidly changing global society

Exponential population growth, falling mortality and fertility rates, a shift in the demographic balance between young and old, chronic poverty in much of the southern hemisphere, urbanization and the growth of mega-cities, mass migration within and between countries, the rising influence of religion in some cultures and growing secularism in others, and the worldwide impact of the digital and IT revolutions – these are all factors that are driving societies and individuals towards increasingly rapid change.

With world population currently at 6.5 billion and rising by 75 million a



year, changes in the structure, values and relations within and between societies are the driving force behind all other movements that shape the world we live in.

The population problem is exacerbated in the mature economies by the combination of falling birth rates and longer life expectancy. This is creating ageing populations which could, in time, lead to tension between the younger and older generations **1**.

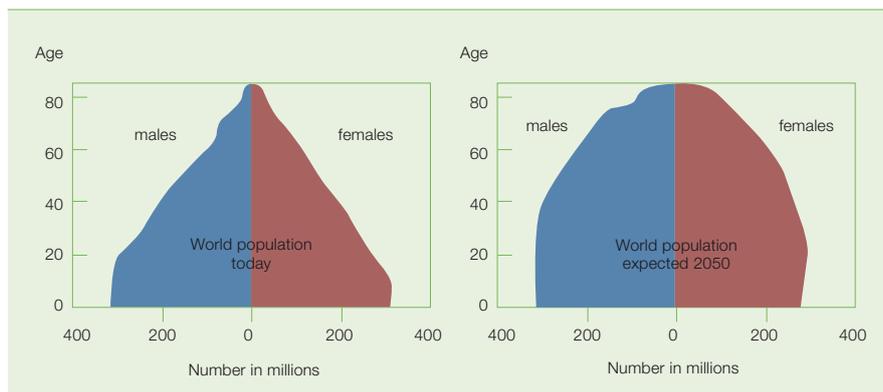
Severe poverty in the least developed countries will remain at a high level, even if the ambitious anti-poverty goals of the United Nations are achieved. The number of conflicts sparked by poverty and injustice is likely to grow, leading to increased social and political instability.

Within the next ten years an additional 200 million people will be living in mega-cities (bringing the total to 600 million by 2015), this urban migration being the traditional way for poor people to gain access to better economic conditions.

People living in urban areas or migrating to developed countries have greater access to global communications platforms like the Internet, TV, and mobile and fixed line phones.

These same technologies are aiding the dissemination of knowledge and taking education into a new dimension. While growth levels of higher education in the mature economies are flattening out, those in the rapidly developing economies are rising steeply. The number of well-trained

1 Projected development of world population



The world in 2015



engineers in these countries is impressive. In the West, on the other hand, traditional disciplines like electrical engineering have declined resulting in severe shortage of skilled engineers.

With the gradual integration of China, India, and other developing countries into the world economy, hundreds of millions of working-age adults will join a more globally integrated labor market.

Globalization

Globalization is driven by new technologies, new economic relationships and the national and international policies of a wide range of actors, including governments, international organizations, business, the media, labor and civil society.

The impact of globalization on individual societies is multi-faceted. The mechanisms by which the flow of trade, capital, ideas and people cause economies and societies to change are highly complex.

The world economy is projected to grow by about 40 percent between 2005 and 2015, and average per capita income by 25 percent. Large parts of the world will enjoy unprecedented prosperity, and a middleclass population could be created for the first time in some formerly poor countries.

With the gradual integration of China, India, and other developing countries into the world economy, hundreds of millions of working-age adults will join a more globally integrated labor market. Existing patterns of production, trade, employment and wages will be transformed.

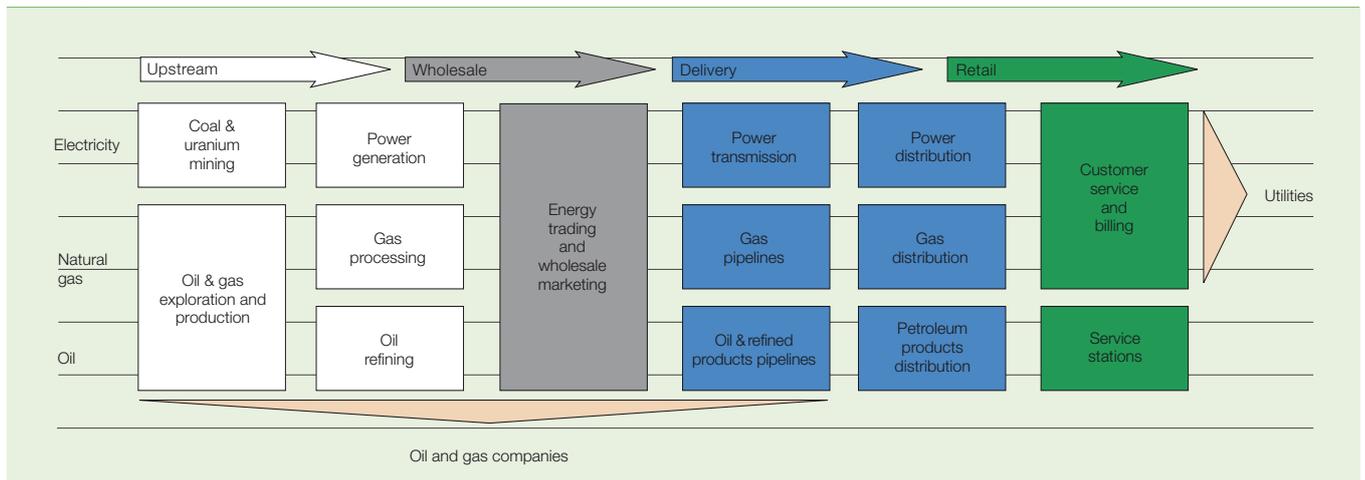
The greatest benefits of globalization will accrue to those countries and

groups that can access and adopt new technologies. The growing two-way flow of high-tech brain power between the developing world and the West, the increasing size of the computer-literate workforce in developing countries, and efforts by global companies to diversify their high-tech operations will foster the spread of new technologies. Information and communication technology (ICT) is an important driver of globalization, facilitating the borderless exchange of ideas, opinions, and data at high speed. It enables multinational companies to work across time zones and obtain an advantage over companies based in only one location.

Continuous restructuring of the energy industry

The global energy industry is undergoing continuous restructuring. Processes like liberalization and deregulation, market consolidation, the spread of wholesale energy trading and the commoditization of electricity and gas

2 Energy industry value chain



are changing the very nature of energy trading. Large-scale investment in renewable forms of energy by oil and gas majors, the development of enabling technologies for ultra high voltage transmission and the storage of electric power, combined with political intervention by governments to stimulate or discourage trends and technologies are all influencing the energy industry across the entire value chain ².

A key factor affecting the structure of the world energy industry is the liberalization and privatization of electricity and gas markets. However even after almost 25 years there is still no clear picture of the effects of these actions. Market liberalization is opening up a new era in wholesale electricity trading. European countries are not liberalizing at the same tempo, which means there is considerable variation in power trading arrangements, ranging from central dispatch to exchange-based models. The ultimate objective is a market in which gas and electricity are traded as commodities with flexible and innovative products and services.

Another factor that drives the restructuring of the energy industry is the need for additional investment in energy infrastructure to meet the growing demand for energy services worldwide. Investment is required to replace capacity that is being retired, expand supply where needed, and cover the cost of cleaner energy systems.

Politicians drive restructuring by using subsidies and taxes, supported by corresponding laws and regulations, to develop and encourage the use of renewable energy, increase environmental awareness and promote energy savings.

However, small-scale renewable power generation is unlikely to have a major influence on the structure of the energy industry in the medium term.

Another driving force is the lack of supply reliability that the various blackouts of 2003 revealed. The fact that energy security has many dimensions such as safe energy supply based on market economics; technological, environmental, social and cultural aspects, as well as being of military strategic importance, adds to the complexity of the restructuring process.

The future of primary energy resources

Most forecasts on future patterns of energy see a continuously rising demand for primary energy in the first two decades of this century. This can best be described as an extrapolation of past development, even though consumption is shifting significantly to emerging economies, in particular China and India.

The primary energy resources of oil, coal, natural gas, and uranium will all still be available in 2020 and beyond. The International Energy Agency (IEA) estimates that a total investment of \$16 trillion will be necessary over the next three decades to meet the expected surge in demand for energy, of

which 60 percent will be required for power plants and transmission and distribution networks.¹⁾

The correlation between primary energy and gross domestic product has been strong in the past but is expected to lessen over time with the increasing use of energy-efficient technologies in some regions. Nevertheless, global economic growth as a whole will still proceed hand in hand with a rising demand for energy over the next 20 years.

Covering almost 38 percent of world energy consumption oil is expected to remain the dominant energy source in the next two decades, even though more than 30 percent of the resources required have yet to be discovered. Natural gas remains an important source of energy for power generation (about 30 percent). Because it produces lower CO₂ emissions, natural gas is an attractive choice for greenhouse gas mitigation.

Consumption of coal will increase in almost all countries except Western Europe. The largest increase is projected for China and India, both of which have huge deposits.

These two countries will account for 72 percent of the worldwide increase in coal consumption.

Nuclear power may again become popular in the mature economies after a period of stagnation. Other primary energy resources like wind, wave, geothermal or solar energy will become part of the energy mix but are not expected to contribute significantly to global energy supply in the next 15 to 20 years. Many of the alternative technologies to fill the potential gap in energy supply are still at the development stage and might not become economically viable for some time. Energy savings, especially in the transportation sector,



Footnote

¹⁾ See also ABB Review 4/2004.

The world in 2015

could significantly extend the availability of oil. Biofuels of different types will also reduce this sector's dependence on oil.

The growth in new business opportunities is compounded by uncertainty about the future of primary energy resources.

In summary, uncertainty about primary energy resources is driven by:

- Limited accessibility to energy resources for political reasons
- Limited availability of economically viable technologies for exploiting future resources
- Limited availability of alternative energy resources to replace traditional sources to a sufficient extent and at an affordable cost
- Limited use of fossil fuels to prevent impacting the environment and at affordable cost.

Changing electrical energy needs

With demand growing at a constant rate and with most of that growth taking place in developing countries, the regional differences in the way electricity is generated, distributed and used are likely to be accentuated. In the mature economies the ageing infrastructure poses a challenge. In emerging economies new installations have to be constructed and the need for technologies that protect the envi-

ronment and reduce energy intensity is high on a global scale ³.

Although the energy mix for power generation is not expected to change significantly, those countries that increase the amount of renewable energy in their mix will need to address grid reliability. Transmission and distribution grids in many parts of the world are operating close to their capacity limits and although new grids are being built in the rapidly growing Asian economies, they are not being built fast enough to meet escalating demand.

The top priority for all countries will be to ensure a reliable supply of electric power with the cost of refurbishing existing grids or building new ones being a major challenge.

In China and India, this is leading to the construction of new power plants in remote locations close to primary energy sources. New transmission lines with the capacity to deliver large volumes of power are therefore required.

Many utilities see reliability as one of their most pressing concerns as the impact of poor reliability on society as a whole can be crippling. The blackouts in the United States are estimated to have incurred costs and lost revenues of more than 10 billion dollars, and are attributed to underinvestment in transmission and distribution capacity and the use of outdated technology and incorrect operating procedures.

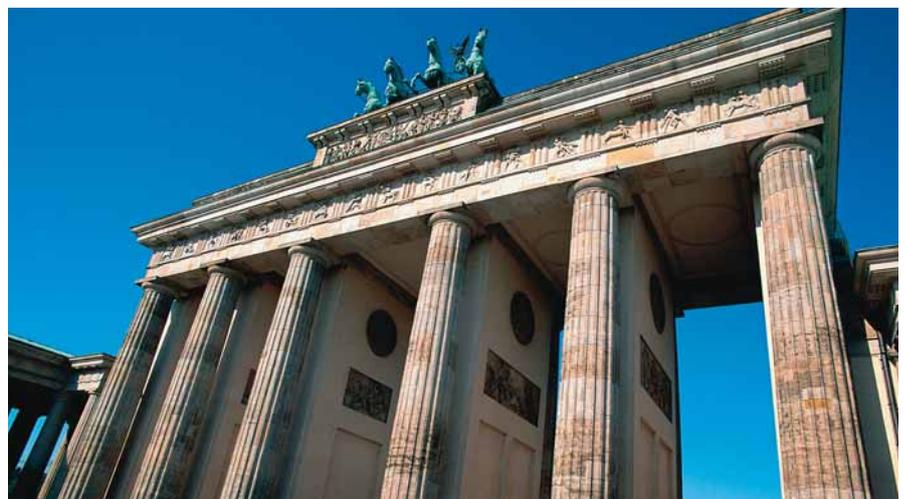
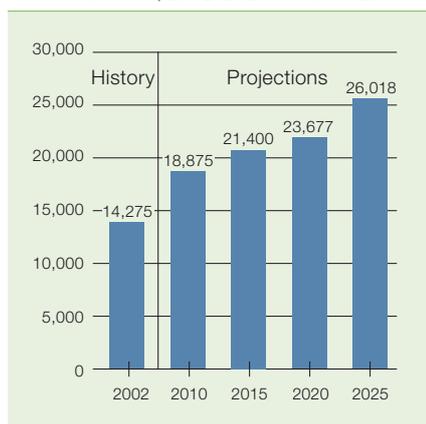
Attempts to reduce system losses are driven by environmental factors as well as the requirement for supply security. Modern transmission and distribution systems tend to lose 6–7 percent of the electricity they transport. Approximately 70 percent of those losses occur in the distribution system, which is more extensive than the transmission system and operates at a lower voltage level.

Not only utilities are keen to reduce losses. Electrical energy savings have a direct impact on the bottom line of industrial plants, commercial businesses and households. This drives the demand for energy-efficient electrical equipment like motors, drives and consumer appliances.

Technology development has opened new ways of managing grids. Progress in static reactive power compensation and power storage technologies enables new sources of electrical energy to be connected to existing grids. Power electronics have made it possible to control grids and new FACTS (flexible AC transmission systems) devices are improving controllability.

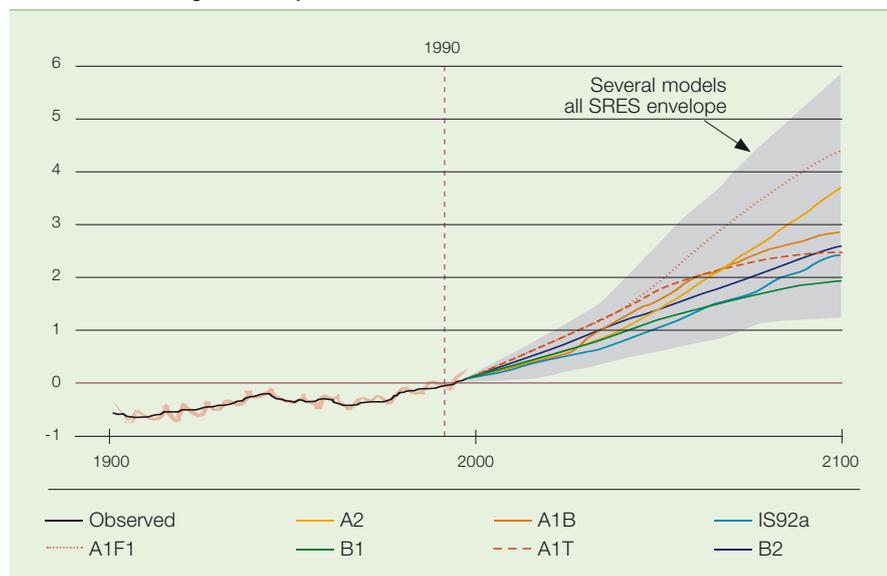
Technologies that save energy or improve efficiency are becoming more widespread. Low-loss and energy efficient power semiconductors are reducing losses in the grid. Continuous reductions in energy loss are being achieved by advanced motors and power-electronics-based variable speed drives.

³ World net electricity consumption in billion kilowatthours, 2002-2025. Source: IEA



4 Projected global temperature change from various models.

Source: Cambridge University Press, 2006



R&D initiatives on “smart” or “self-healing” grids that improve supply reliability are also driven by advances in information and communication technology.

The environment as a business factor

Even though the debate on the scale and impact of environmental change is ongoing, there is a consensus that the world has a set of compelling problems to solve like greenhouse gas emissions, climate change, and the depletion of natural resources ⁴.

The concern, perceived as most pressing in the world today, largely because of the global reach of its potential impact, is the growth in concentrations of greenhouse gases. The increasing importance of emission reducing technologies is a catalyst for new business opportunities. These opportunities lie in zero- and low emission technologies for the power generation and manufacturing industries, and in improving the energy efficiency of industrial processes and equipment by using efficient motors and applying variable speed drives.

The growth in new business opportunities is compounded by uncertainty about the future of primary energy resources. This is likely to intensify research into technologies for generating renewable energy and the use of

alternative bio-fuels in the transportation industry. In recent years, the technologies used to burn fossil fuels of all kinds have improved tremendously. This applies to oil, gas and coal as well as to combustion engines in cars.

Nevertheless, the development of new technologies will most likely be driven by the tradeoff between the cost of these technologies and the various benefits they offer – tax breaks, lower emissions, reduced fuel consumption, and longer service life.

The renewed interest in building nuclear power plants may inhibit the spread of alternative forms of power generation. The tradeoff between clean energy restrictions and economic growth is, however, complicating the implementation of measures especially in the rapidly emerging countries.

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Looking back from 2015

An ABB analysis

Friedrich Pinnekamp

This study was conducted based on interviews, written statements and personal discussions with a large number of external experts, opinion leaders, politicians and members of the scientific community.

The majority of these authorities considered that a closing up of national economies is more likely than a move towards a global society. They further believed that the gap between the emerging and mature economies will continue to close, with both groups seeing some growth.

ABB is taking these indications seriously and is preparing for the various possible scenarios. Even though the uncertainty of the future direction is high, there is one overriding concern in all the scenarios – energy efficiency.

In the global and open society with virtually free access to energy for all, it is the general shortage of primary energy and shared environmental concerns that dictate the careful use of energy. If the world turns towards more protectionism, it is the lack of security in its supply that forbids excessive use of energy.

When the development of the emerging economies gathers speed again, it is once more the shortage of resources that hampers their growth. For a stagnating mature society it is simple economic reality that forces a reduction of energy consumption.

So, in the next decade, energy efficiency is the name of the game.

Looking back from 2015: an ABB analysis

Assumption of growth rate measured at purchased power parity varies from five percent in the first scenario to three percent in the last.

	Open global society	Mature economies become more competitive
Economic growth	Prosperity has been taking hold of most regions over the last decade. Strong trading blocks (for example the European Union) exist, but their purpose is not protectionist – they are well integrated into a global economy.	Growth in the mature industrialized part of the world has been strong for a decade. It has been possible to maintain a balance between high standard of living and international competitiveness. Worldwide growth has not met earlier expectations, hence prosperity has not spread globally.
World characteristics	The world economy is globalized with free flow of goods, labor, technology and finance. The WTO has produced treaties to secure cross-border trade. Multinational companies prosper in this climate.	Governments of the mature countries have benefited from their export strength and secured markets beyond their own economies. Emerging economies have been more protectionist against foreign influence.
Attributes of societies	Societies have become well-integrated into the global market with their flexible labor forces. Most of the world's population has access to knowledge and electricity – both of these are foundations for prosperity.	Strong economic growth has enabled the mature economies to ease the burden of an aging population by attracting young and educated migration workers.
Energy market	Steady price rises for oil and gas have made energy efficiency a global priority. More and more alternative energy sources are becoming economical and the exploitation of previously uneconomical oil and gas finds is gradually being realised.	High energy prices underline conservation and alternative generation is having an impact. Liberalization of the energy market is ongoing. To secure energy in a world of dwindling primary resources, many bilateral agreements have been made between increasingly powerful suppliers.
Power grid	The electricity grid is being expanded all over the world to reach most of the global village. There are no signs of consolidation and power sales remain in the hands of suppliers.	The replacement of outdated infrastructure has had a positive influence on the competitiveness of mature economies. The volume of new grid installations in the developing countries has been lower than expected.
Environment	Climate change, biodiversity and the health of the environment are concerns of more people than ever. Political leaders and large companies in all economies of the world are tackling the issue of energy efficiency and global warming, a concern that has now gathered momentum.	Trading schemes for CO ₂ reduction have been established in most mature economies. Fuel for transportation is increasingly being derived from oil-independent sources (which are mainly promoted in mature economies).
Technologies	The opportunity to develop modern grids has provided impetus for the introduction of new technologies such as ultra-HVDC and ultra-HVAC, current limiters, high power circuit breakers and super conductive systems. New methods for energy storage have promoted renewable generation.	The positive economic climate in the mature economies has spurred R&D investments in both the public and industrial sectors beyond expectation.

Emerging economies get stronger

Having failed to reform early in the new century, the mature economies struggle to keep up with the exceedingly exuberant developing nations, primarily in Asia: China, India, South Korea and to some degree the Middle East have capitalized on their increasingly educated but still cheap labor force.

Globalization has facilitated the full participation of emerging economies on the global market. WTO treaties were sufficiently effective to promote international trade between most regions. Multinational companies have adapted their global footprint to better make use of the strengths of the various regions.

As conditions in the developing nations have improved, migration of skilled labor has slowed considerably. Living standards are improving and these nations are driving global consumerism.

Energy demand has increased beyond what was planned for a decade ago. To meet this great need for primary energy, the development of energy efficiency and alternative energies including nuclear are high on the agenda everywhere. Bilateral energy agreements are sought wherever possible in an attempt to secure access to limited resources.

The mature economies have only partially been able to replace their outdated electrical equipment and networks. Large investments in new infrastructure has, however, gone into the emerging economies in an attempt to redress the imbalance between supply and demand in those areas.

Due to environmental awareness in the emerging economies, these have succeeded in implementing the necessary regulations to control their pollution. The latest technologies are playing an important part in making this possible. The global expansion of nuclear power, promotion of renewable energy and energy efficiency measures have reduced the threat of energy shortage.

The insatiable energy demand of the emerging economies has led to the installation of cutting-edge technologies for high productivity generation and transmission of electricity. Combined with the latest energy efficiency applications in new factories, this has resulted in these young economies gaining further advantages over their more mature competitors.

Retreat into protectionism

Stagnation in the global economy, including recession in some parts of the world, has lasted for a decade. Global trade has slowed significantly and domestic markets have grown in importance. Western economies have been affected by the slowdown in Asia, an area that could not maintain its past growth rate. International cooperation is limited. Nations are becoming introverted and are seeking self-sufficiency.

Asia is affected by social unrest, environmental challenges and over-heated economies. The WTO has failed to provide a foundation for sustained international trade. Disappointed governments have turned to protectionism, resulting in decreasing standards of living even in the mature economies. Movement of people and labor, knowledge and technology is restricted.

A large number of people in the world are still without electricity, a situation unlikely to change due to financial difficulties in these countries and the tough investment climate. Access to information remains restricted in countries with closed societies.

Global stagnation has reduced the expected energy demand compared to forecasts of 10 years ago. The need for primary energy is still acute, but with protectionism and the desire for self-sufficiency in ascendance, energy efficiency measures, alternative energy and nuclear power are prioritized. Difficulties in securing access to primary energy through long-term bilateral agreements have grown as supplying countries are closing ranks to drive up prices. The risk of war over energy is escalating.

In response to the black-outs of ten years ago, the mature economies have squeezed existing infrastructure to its limits without major investments in the electrical grid. Many grid interconnections were planned but only a few implemented. The emerging countries have been installing new grids but not at the pace intended.

As global cooperation has crumbled, so has the worldwide initiative related to climate change issues and CO₂ trading. National initiatives driven more by local priorities for clean air than any global concerns have taken their place. Alternative fuels are slowly entering the markets of the mature economies.

Only few new technologies for generation, transmission and energy savings have been introduced in the energy sector.

