ENERGY BULLETIN

United Nations
Educational, Scientific and
Cultural Organization

Sustainable
Energy
Development

International centre
under the auspices of UNESCO

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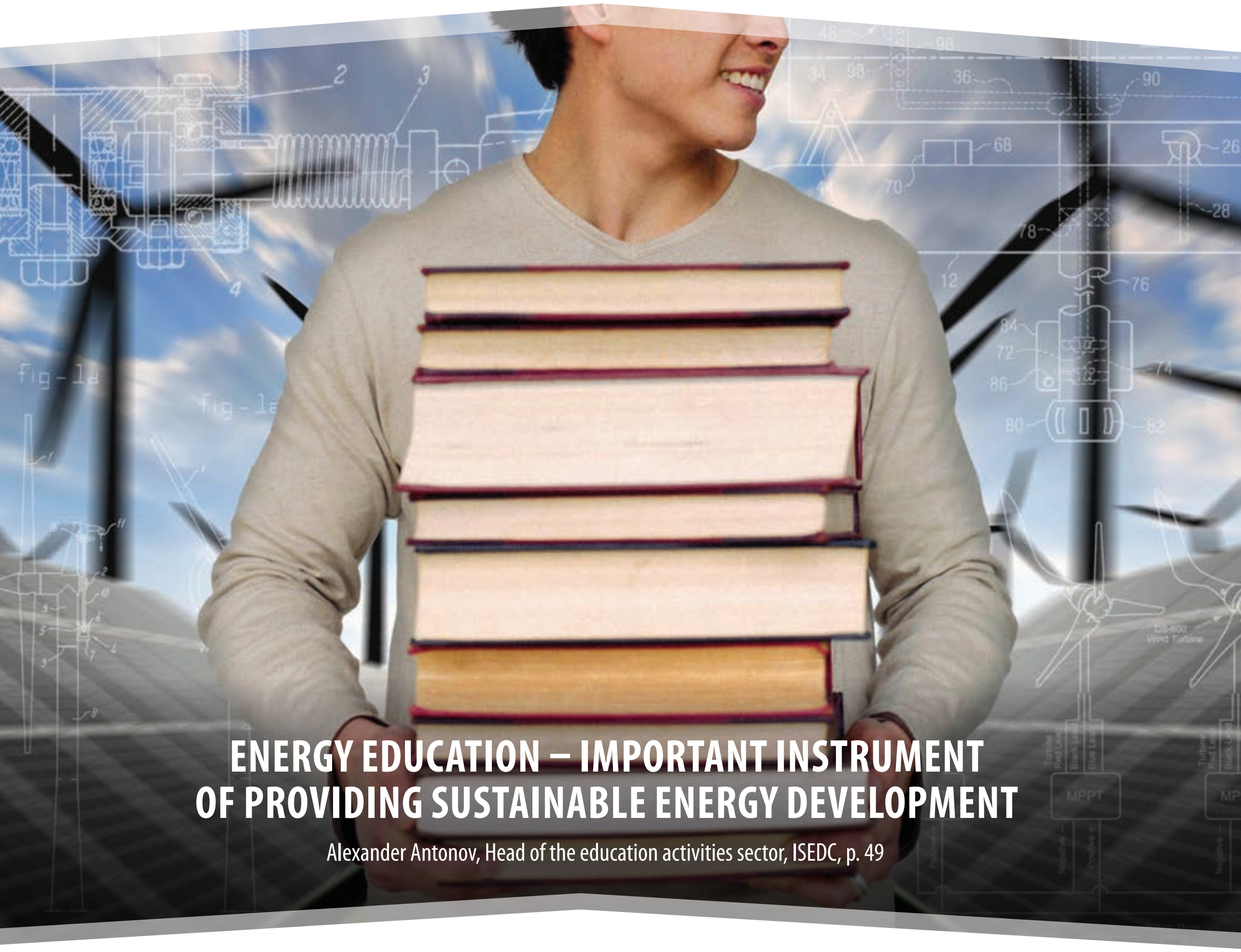

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Address of centre
Kedrova St., 8/1 bld. 2, Moscow, Russia, 117292
Tel. +7 (495) 641-0426
E-mail: info@isedc-u.com

Centre representation in France
17 rue du Colisée, 75008 Paris
E-mail: contact-paris@isedc-u.com

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Address of Editorial Office
Kedrova st., 8/1 bld. 2, Moscow, Russia, 117292
Tel. +7 (495) 641-0426
E-mail: savlyuk@isedc-u.com;
a_gramm@isedc-u.com; info@isedc-u.com

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EDITORIAL

The introductory article of the first issue of "Energy Bulletin", which came out in June 2008, was written by V. Khristenko, at that time the Minister of Industry and Trade of the Russian Federation and Chairman of the Governing Board of International Sustainable Energy Development Centre (ISEDC) under the auspices of UNESCO. In this paper, entitled "Humanitarian principles of sustainable energy development", the author highlighted the exceptional importance of energy education as one of the major instruments of providing the conditions of and, finally, ensuring sustainable energy development. He also brought specific proposals on developing international cooperation in this field and expressed his hope that such cooperation would lead to the improvement of energy education and the solution of numerous problems facing energy industry and our society as a whole, as well as all its individual members in particular. Now such words about energy education can seldom be heard from statesmen or from heads of large international organizations and institutions who, being involved in different discussion of today's and future problems of energy and its development forecasts in the short and long term prospects, «steadily avoid» the questions of education and thus of capacity building in this vitally important field of economy, involving all circles and age groups of people.

Numerous forecast studies of the world energy development and its separate branches, which cover long period of time up to the middle of the 21st century and carefully analyze trends of the scientific and technological progress, which takes place in energy and related sectors of economy, also ignore this important issue and do not try to analyze the state of energy education in today's society and possible ways of developing capacity building in the energy to follow forecasted ways of development. The quite recently published forecast of world energy development «World Energy – 2050 (White Paper)», which was prepared by the group of Russian energy experts in cooperation with ISEDC, contains very interesting and worthy qualitative and quantitative forecasts of the world energy evolution up to the middle of the current century, but it doesn't contain any analysis of potential and necessary changes of educational systems. However, these changes certainly should play one of key roles in these evolutionary processes. This forecast is published in two languages: Russian and English, and its presentation with the detailed analysis of its contents can be found in this issue of "Energy Bulletin".

Unfortunately the issues of energy education aren't properly reflected in national, regional and international energy programs, and no attention is paid to the transfer of general and special energy knowledge to wide circles of the population, in other words to the energy enlightenment and upbringing.

Probably, this particular situation is caused by initial omissions appeared in the United Nations documents which defined the concept of the sustainable development and its particular segments including energy development, as well. Thus, these documents don't contain the definition of the role of education and training in the context of the sustainable development. The Rio Declaration on Environment and Development, which was adopted in 1992 and included 27 principles of creating conditions for the sustainable development, doesn't have any mention of a place of education in accomplishing tasks set by this declaration for the world community. Only one of these principles contains an appeal to capacity building which should be carried out through the exchange of scientific and technical knowledge, and also by strengthening development, acceptance, expansion and transfer of new technologies. In this important paragraph of the declaration the definition of capacity building doesn't even include education while the latter is an integral part of the process of strengthening competence both of society as a whole, and individuals in various areas of human activities, public and natural phenomena. By the way, all these documents give too little consideration to the energy and its role in the sustainable development although the energy crisis of the 1970s was a certain source of new philosophical views on the ways of future development of human society which took shape in building up the sustainable development concept and its acceptance by the international community.

However, only after 25 years of the appearance of the concept of sustainable development in our life and after 12 years of the adoption of the Rio Declaration, education was recognized as one of the most important factor of this strategy of humanity's further evolution , and since January 2005 the Decade of the education for the sustainable development initiated by the United Nations has been taking place. It goes without saying that this Decade will make invaluable contribution to our society's achievement of the goals defined by this concept, and will promote its further strengthening and engrafting in the minds of people. In this connection, it is necessary to recall the words of the former Secretary-General of the United Nations Mr. Kofi Annan, who, speaking about the Decade tasks, told : "Our biggest challenge in this new century is to take an idea that seems abstract and turn it into a reality for all the world's people".

Unfortunately, much time was lost without steps towards full understanding and perceiving new philosophical approach to the present and the future of our planet and human life. There are many good and attractive ideas in the UN activities within this Decade in which UNESCO is a lead agency, but they hardly address the problems of energy education, and are mainly connected with reforming the environmental education, which basis was laid by UNESCO more than 30 years ago and successfully developed by the Organization in its own and other international organizations program activities. What is the reason for it? Why do international initiatives and specific activities connected with the transformation of educational systems according to the evolution of the sustainable development concept stand aside the energy and its problems? Perhaps, it is expected that energy education should be an integral part of the education for the sustainable development? However, a careful study of rather "limited" information on activities within the Decade which is due to end in 2014 doesn't bring hope for it. It also concerns the action program in the frame of the International Year (2012) of the Sustainable Energy for All. The Conference Rio + 20 on the sustainable development which was organized by the United Nations on July 15-18, 2012 emphasized that the energy was central in any problem or favorable opportunity of the contemporary world.

It seems incredible, but a fact that education in the field of energy, present and future development of which is one of the most difficult problems facing humanity, doesn't attract due attention of the international large-scale programs directly or indirectly relevant to it. Probably the main actors of these programs forgot or probably don't know the words of the well-known Norwegian playwright and one of the fascinating humanists of the 19th and the turn of the 20th centuries Henrik Ibsen about the role of education in human life: «Education is an ability to face up to difficulties into which the life has thrown you»? Now the life has also thrown our society into a very difficult situation, as a result of unreasonable consumption of conventional natural energy sources, too slow development of alternative, first of all renewable energy sources (RES), wasteful use of energy and energy carriers, continuous growth of greenhouse gases emissions, causing global and local climate changes, and energy poverty, etc. This list can be continued, but it is already clear that the actual status of energy, its further development and, first of all, accompanying difficulties demand immediate involvement of all levels and types of education which are available in modern society, in their overcoming on the basis of steady capacity building related to energy issues in modern society in which the education should play a key role.

This editorial expresses concern of the actual situation related to energy education and supports all initiatives in this field which number fortunately rises with every coming year.

"Energy Bulletin" has already touched this important subject several times by publishing articles which represented the activities of international organizations and national universities in this field. The carried-out analysis of the published articles and of other information sources shows that there is a positive dynamics of growth and strengthening of these activities. For instance, UNESCO continues to implement the Global Renewable Energy Education and Training (GREET) Program aimed at the improvement of training of specialists for the renewable energy in developing countries. The creation of the International Sustainable Energy Development Centre under the auspices of UNESCO in Moscow has permitted to start important and special work on the retraining of specialists working in energy and related sectors of economy from developing countries and Eastern Europe in the field of rational management of energy resources within the program of cooperation between ISEDC and UNESCO. This program certainly deserves further support and strengthening due to its very important contribution to overcoming the above mentioned problems at least at national level.

The appeal to "energy education for all" should be heard by the international community and its bringing into life will serve as a pledge of involvement of all its members in the creation of conditions for and implementation of sustainable energy development of humanity.

The activities of a number of UNESCO energy oriented chairs established in leading engineering and technological universities of some member-states of UNESCO, which in many cases has become full-fledged educational-scientific departments in the fields of new energy technologies and RES, are successful. Considering these energy educational activities under the auspices of UNESCO, we would like to express our full support of and hope for their further development according to requirements of modern society and its individual members.

If we look at energy educational activities at national level we can note with satisfaction some obvious positive shifts especially in the retraining of specialists for the renewable energy which is carried out on the basis of leading universities. Impressing progress in the RES utilization of Germany presented in this issue of "Energy Bulletin" by Dr. H.-Y. Fell, member of the Bundestag, was accompanied by significant increase in work positions in the field of renewable energy, which were occupied by specialists of various levels of proficiency after due retraining. In some European countries the number of specialized courses mostly for university graduates (master's level) in the field of sustainable energy development is increasing with every coming year. This fact is undoubtedly a very positive sign of changing European universities' attitude regarding energy education. Compared to the situation of more than ten years old when it was difficult to find in Europe a place where it would be possible to get special education or training for work with RES, there have been serious shifts which the above-stated examples testify.

However not everything is as good as it seems, considering the fact that there are very few examples of energy education within the two-level university education, according to "Bologna system". Moreover we can mark gradual disappearance of fundamental energy disciplines from engineering and technology curricular, their integration into other subjects as the result of which they lose their importance and often simply stay unnoticed in the course of training. It leads to sharp decrease in quality of the energy training of university graduates which results in the necessity of their additional specialized postgraduate training.

Generally speaking, energy knowledge should be given to all students of any university regardless of chosen specialties if our society wants every highly educated person to be an active participant in the sustainable development concept implementation, including that of energy. We hope that universities will soon understand the great importance of energy education and will successfully solve this important problem.

Energy knowledge should become part of not only university curricular. It should penetrate all education levels existing in modern society – from primary to university ones and even be presented in preschool education for the purpose of bringing up the youngest members of our society in the ideas of sparing approach to energy from their very first steps on life.

Energy education should be also aimed at the eradication of wasteful habits which almost all members of our society got due to the last decades of relative energy wellbeing. These activities are of extreme importance as they will let each person, family and local community contribute to more effective use of energy, and consequently to energy saving, and through it to the preservation of natural resources and to the environmental protection. That will also enable faster acceptance of energy innovations and alternative energy sources by the society. As appears from the article by Dr. H.-Y. Fell, one of the reasons of the successful renewable energy development in Germany is wide involvement of the population in the process of RES utilization. All these are the main conditions of sustainable energy development and development in general.

Unfortunately, the issues of public energy education are not highlighted in local and international mass media in a proper way, and the positive experience in the field is not generalized and widespread, obviously because due attention is not given to this sphere of educational process, which after all is the pledge of successful acceptance and implementation of the sustainable energy development concept by contemporary society.

Of real importance in this point are methodological and pedagogical developments in this field which should be based on recommendations of the Sub-committee for Energy Ethics of the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) which emphasize that energy education of general public is to be based on the best and freshest information received from the most authoritative sources which should be impartial, exact and clear for everybody. Unfortunately, this valuable advice is often not considered properly by mass media. Due to that often their generally attractive pictures of the use of RES result in a quite unexpected reaction from some social groups and strata. Thus for example, images of wind and solar installations placed on the background of natural landscapes or cultural and historical heritage sites cause fears in some eminent persons of culture in a number of countries – fears that wide use of RES can lead to a certain destruction of cultural and natural heritage in many countries, especially in Europe. These fears are mainly caused by such inaccurately presented information appearing often first of all in mass media which should perform their energy educational work in the society in a more appropriate way.

The appeal to "energy education for all" should be heard by the international community and its bringing into life will serve as a pledge of involvement of all its members in the creation of conditions for and implementation of sustainable energy development of humanity.

"Energy Bulletin" welcomes materials dedicated to energy education issues which certainly will serve not only to the exchange of experience in this important field, but also to the acceleration of creating favourable conditions for the acceptance of a new philosophy of human life, i.e. the concept of sustainable development, by all members of our society.

Germany's energy revolution

Hans-Josef Fell,
Member of the German Bundestag

Hans-Josef Fell is the Spokesperson on Energy and Technology Policy for the Green Parliamentary Group at the German Bundestag. Together with other members of the Bundestag, he created and politically implemented the Renewable Energy Sources Act (EEG) in 2000.

Over the past 12 years Germany has gone through an incredible process. A country whose energy industry was marked by coal, nuclear power and gas is now the site of thousands of wind turbines and photovoltaic plants.

Today 25% of German electricity demand is already covered by the renewable energy, whereas ten years ago the figure was not even 10%, and in recent years especially this growth has increased at a furious pace: the percentage of green electricity rose from 17% in 2010 to 25% a year and a half later, in mid-2012. That means that Germany is well on the way to replacing the old fossil and nuclear energy industry with an efficient and sustainable renewable energy industry by the year 2030.

The switch to sustainable energy represents a major responsibility for Germany, comparable to reunification, but it is feasible. It is making Germany a model for other nations throughout the world. The 'energy revolution' has already become a catchphrase throughout the world.

Renewable growth

By mid-2012 Germany had already installed approximately 30 GW of photovoltaic and the same capacity of wind energy. By 2020 it will no doubt manage to double those figures. Solar module prices are falling all the time. In Germany, even used solar power from domestic roofs has become cheaper than electricity from the wall socket. As a result of the furious pace of technological development and the strong pressure of competition, prices, and with them tariff payments, have been tumbling for years. While in early 2009 the tariff payment for solar power on small roofs still lay at 43 cents per kilowatt/hour, by summer 2012 it had fallen to 18.5 cents and investment remains profitable. Now that solar power is on its way to conquering the world, the competition for leadership in this technology and in the global export markets is in full swing. The question is no longer whether solar energy and other renewables can and will replace conventional energy but simply where the modules will come from in future.

In Germany in particular, onshore wind energy plays a particularly strong role in the energy revolution. But the development of offshore techniques is most important not just for the German energy revolution but also, as an export technology, for the rapid growth worldwide of wind energy markets. Offshore wind energy is an important renewable energy technology and is becoming increasingly important worldwide. About 40% of mankind lives near coasts, where they need a lot of energy. That is why the development of offshore wind energy together with other marine energy technologies is especially important for coastal megacities. Inland wind farms form the cheapest basis of renewable energy. In Germany, wind farms have a total installed production capacity of c. 30,000 megawatts – and that figure is rising rapidly.

Besides solar and wind energy, bioenergy and hydroelectric power also play a key role because they can provide a constant base-load and therefore make up for fluctuations in renewables. Furthermore, geothermal energy and, henceforth, marine energy will also play a small but important role in future energy provision.

The foundation for German success: the EEG

The foundation for the renewable energy development in Germany is the Renewable Energy Sources Act (EEG), a quite crucial factor of the success of the energy revolution.

The EEG is regarded worldwide as the most successful law for the introduction of renewable energy sources in the electricity sector. Further it has been copied by more than 60 other countries. Alongside the electricity sector, however, the EEG has also opened up the thermal energy sector – with the use of waste heat from electricity production in the field of bio- and geothermal energy. It has led in Germany to the creation of large domestic markets and a furious pace of innovative development in the field of wind energy, photovoltaic energy, biogas, wood energy, vegetable-oil block heat and power plants, geothermal energy and small-scale hydroelectric power.

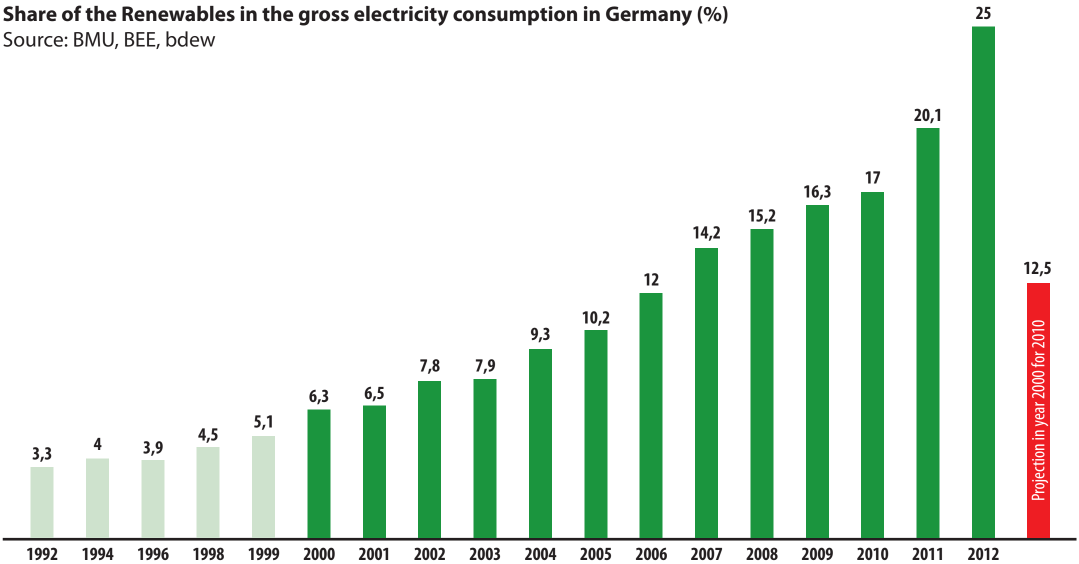
The creation of 380,000 jobs – in 1998 there were only 30,000 work positions in the sector – and the good climate footprint so that the EEG has been a success story in both environmental and economic terms.

We now have the chance in Germany to harvest the fruits of the comprehensive investments we made in the past, when renewables such as photovoltaic energy were still expensive. A new phase now lies ahead, during which photovoltaic energy will achieve its full economic potential. Today, Bavaria already generates 10% of its electricity from solar energy.

Energy 2.0

The development of renewables has brought many changes in the energy sector. In conceptual terms it is comparable to the switchover in telecommunications from landline to mobile, from the dial-up telephone to the smartphone. Tens of thousands of wind turbines are now operating in Germany and more than a million solar plants are producing electricity every day, for several thousand hours a year. Thanks to all these new players, we will achieve a kind of Energy 2.0 standard.

Share of the Renewables in the gross electricity consumption in Germany (%)
Source: BMU, BEE, bdew



Much as in the case of the Internet, citizens will not only consume but also play their own part here. And much as in the case of the Internet, there has to be an infrastructure to manage this cleverly. That means we have to make the system far more intelligent, in order to coordinate the millions of players. We need that intelligence at all levels, ranging from the grid operators, the economic operators and the installations, to the millions of future electricity suppliers and also the power station operators. This trend has already begun, and successfully so. The past few years have seen the emergence of more than 600 new energy cooperatives. Millions of German citizens are personally involved in electricity production. That means the transition to renewable energy is increasingly becoming a citizens' initiative. Many people are involved in the value creation of energy supply. That means it is playing an increasing role in strengthening broad sections of the population economically and thereby, stabilising the incomes of many households instead of, as in the past, the profits accruing only to a few big companies.

The creation of 380,000 work positions – in 1998 there were only 30,000 work positions in the sector – and the good climate footprint so that the EEG has been a success story in both environmental and economic terms.

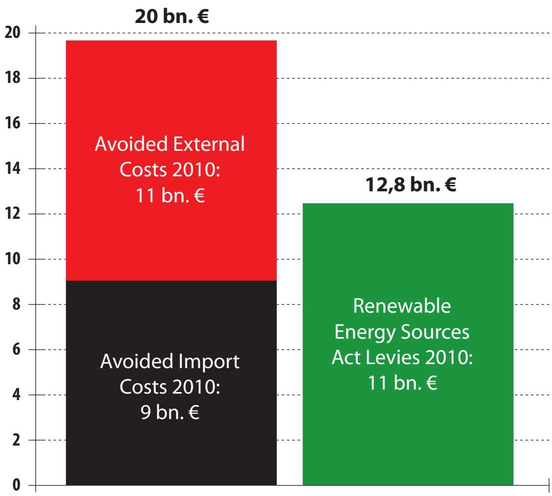
We also need a more flexible system. The supply structure must be able to adjust far more flexibly to fluctuations in solar and wind energy production than in the past. At the same time we need to induce operators of solar and wind energy installations to make them much more intelligent. Already existing solar installations can reinforce the grid round the clock thanks to major system services such as reactive power supplies and voltage stability.

Renewables are developing at a furious pace. Production prices are tumbling, new innovations keep emerging. The time when it was simply a question of developing new technologies is increasingly giving way to market penetration with green power. If the build-up continues at the same pace, we will face the following problem: for many days a year enough PV and wind power will be fed into the grid for a period of several hours to be able to meet basically the electricity demand – that is already the case in Germany for a few hours a year. This means, however, that other renewables, but especially conventional power plants, would have to be switched off or even shut down. Here now, it is becoming increasingly important to convert the energy system, to ensure that in future biogas power and hydroelectric power are used to make up for fluctuations in the supply of solar and wind power.

When the EEG is discussed, especially at international level, people often describe it as superfluous and some even call for it to be repealed and replaced with a quota system. Yet those demands usually come from supporters of the old fossil and nuclear energy industry. First, we should remember that basically the EEG was designed to take account of the market trend. The annual cost reduction and the progress report to be drawn up by the Federal Government every four years were already enshrined in the EEG 2000 to ensure that it followed up the fall in production costs on a continuous basis. The legislator was never aiming at the excessive profits of more than 20% sought in conventional electricity production but considered that 5-10% should be enough. In fact, the main reason why big electricity companies invested little on the basis of the EEG was those low projected returns. Success came with the many new players, companies, cooperatives, municipal utility companies, etc. that regarded the returns expected under the EEG as adequate. No doubt there were a few innovative investors who achieved higher returns even with the given tariff rates. But that was precisely one of the driving forces that paved the way for even more rapid tariff reductions. For the rest, guaranteed tariffs do not, as is often alleged, automatically produce guaranteed returns. Companies are still exposed to risks, as can also be seen from various cases of bankruptcy in spite of guaranteed feed-in tariffs.

Most investments still cannot achieve adequate returns without the guaranteed EEG tariff. That is why the EEG is still necessary. There are signs, however, that investments outside the EEG are beginning to produce returns and we

Avoided Costs by Renewable Energies



Source: BEE

are now seeing the first hesitant but courageous investments of that kind.

Like the fixed feed-in tariff that is guaranteed for many years and forms the economic basis for investing in renewables, preferential access to the grid is another vital factor of the success of the EEG and the basis for investment in green electricity plants. As long as the conventional electricity generators continue to set up barriers to the expansion of renewables, the green electricity will have to be given preferential treatment. Otherwise conventional electricity producers will continue to use their market strength to block the further development of the renewable energy. Anyone who suggests that would mean it is not a free market has failed to realise that when external damage costs are not passed on, there is no such thing as a free market with equal market opportunities. Green electricity, which creates no or only marginal external damage costs would immediately become competitive with electricity generated from coal, natural gas or nuclear power if conventional electricity generation had to bear all the damage costs itself and did not impose them on the general public, e.g. the taxpayer. So long as these external damage costs are not passed on in full to electricity production, the EEG will remain necessary. It is precisely that argument that puts the allegedly excessive costs of the EEG in the right perspective. In many cases, the damage costs of conventional electricity generation are borne by the general public and not by the electricity producer or customer in the conventional electricity sector. At present, the allegedly excessive additional costs of the green electricity are already more than made up for by the damage costs it avoids, simply because it already replaces 25% of conventional electricity. Green electricity is already reducing the burden on the national accounts. In Germany, EUR 11 billion of external damage costs were avoided last year thanks to the renewable energy.

Those, who are now calling for the EEG to be repealed for reasons of competition or are against its introduction in other countries, actually do not want effective climate protection and accept that with their increasing scarcity the prices of fossil raw materials continue to rise, which also drives the price of electricity up and up. In 2011 Germany avoided having to import fossil raw materials at a cost of EUR 9 billion thanks to the renewable energy. That means Germany already has a positive balance sheet thanks to the avoidance of external damage costs and of imports of fossil raw materials. There can be no question of additional costs in relation to renewables, contrary to what is often alleged. As in the past, we will of course continue to adapt the EEG to the market trend of renewables, but only in such a way as to ensure that it continues to form the economic basis for investment.

The EEG is designed optimally. It will become superfluous as soon as we see huge investment in the green electricity outside the EEG. That will happen when higher returns can be achieved outside the EEG tariff than with it. We have come far closer to that point than many believe. However, the point in time will vary depending on the technology in question. Onshore wind, solar power and hydroelectric power will get there sooner than bio-energy, offshore wind and geothermal energy. After all, in Germany we still need to replace several nuclear power stations that have already been shut down.

The exit from nuclear power after Fukushima

After Chernobyl, the Japanese nuclear disaster has shown once again that residual risks are very real, cannot be controlled and can, in fact, arise. For decades the nuclear industry said that all nuclear power stations were safe. There was merely an ‘extremely unlikely’ residual risk. Even the risks of earthquakes were manageable, according to the Japanese nuclear industry. After Chernobyl and certainly since Fukushima the risk is now clear, and Germany no longer wants to take it. Since the radioactive contamination following major nuclear accidents does not stop at borders, it is irresponsible for some states to continue to adhere to nuclear energy. By so doing they endanger not only their own population but also the people of other countries. Phasing out the nuclear energy worldwide is feasible and necessary.

After the Fukushima disaster, Germany has learned the lesson from that second lethal nuclear accident and decided to phase out nuclear power by 2022. All the German political parties have realised that the nuclear energy is now too dangerous to remain acceptable.

The myth of the big black-out

The exit from the nuclear energy has passed its first test. None of the black-outs forecast by the conventional energy industry occurred during the first winter that followed it. Any current issues (Siberian temperatures across Europe, intermittent natural gas shortages in southern Germany, major energy exports to Germany’s friends in France, which was not producing enough electricity in spite of its high share of nuclear power, the wrong market incentives on the electricity exchanges) don’t disrupt our power grid. Rather, it showed where our strengths lie and the lessons we still need to learn.

Above all, however, phasing out the nuclear energy reduces the risks. For every nuclear power station that is shut down, inhabitants are less at risk of losing their home and entrepreneurs of losing their business – if, what the Japanese Government always said could never happen in Japan, were to happen in Germany. Nuclear power companies are still refusing to insure their nuclear power stations. So it is the general public that bears the risks of a worst-case nuclear accident. Nuclear energy is expensive; phasing it out reduces both costs and risks.

Coal-fired power

In the case of the coal-fired energy, German politicians are still not as enlightened as they are in relation to the nuclear energy. Apart from the Greens, there are still advocates of coal in most German parties, however much they say they are committed to climate protection. But coal is clearly on the way out, if only for economic reasons, because coal prices are also rising constantly. Similarly, the question of carbon capture and storage (CCS) scarcely ever arises now in Germany. Primarily that is because people tend not to accept it, because they fear that the CO_2 stored in mines will come back to the surface, possibly with lethal consequences. Even more decisive, however, is the fact that CCS is not very profitable. It is quite inconceivable that a coal-fired power station with an attached CCS chemical factory will manage to compete with the renewable energy in the future.

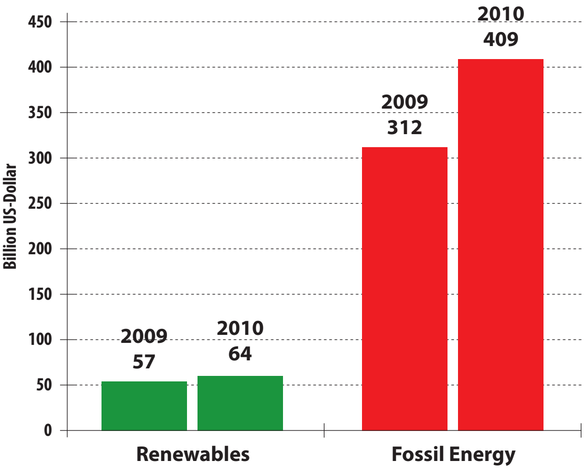
Gas

Many people are now placing their last fossil energy hopes in gas. Here too, however, the costs will very soon call its profitability into question. Aside from the clear rise in procurement costs and the dwindling coal and gas resources, there is the fact that investments can hardly be recouped. After all, a pipeline from Russia to Germany is not financed by itself.

The old system cannot work on zero tariffs

When the sun is shining brightly and the wind is blowing, the remaining old power stations already have to be switched off in Germany. Many of the old energy suppliers such as coal-fired and nuclear power stations are far too inflexible to be able to react to this. And a power station that is not in operation costs money while not earning any. The power station operators face an even worse challenge, however, because solar energy is driving prices down on the electricity exchanges. Solar energy has almost no variable costs and is taking over from electricity generated from coal and gas on the exchanges; that means prices are falling, and significantly so. In Germany, the expensive peak-load midday electricity prices on days with a certain amount of sunshine are already history. So peak-load electricity at midday has not achieved peak-load prices for a long time now. Soon the ratio is likely to tip over and the average price for midday electricity will be lower than for electricity at other times. The power station operators will see their returns melt like ice in the sun.

Global Subsidies for Renewable Energies and Fossil Fuels 2009 and 2010



Data source: OECD/IEA/bearb. VDI nachrichten 45/10; International Energy Agency: WEO 2011

The conventional energy system has already done huge damage to our economy and our prosperity by using up resources and causing massive environmental damage. It is not the energy revolution that is costing the economy and society heavily but the continued use of oil, alongside coal, natural gas and uranium.

It is not surprising that the decline in resources and rising prices of energy feedstock impact on the euro area as the primary strong economic area. More than 50% of Europe's* energy supplies depend on energy imports, and the trend is growing rapidly. Last year energy imports of fossil raw materials cost more than EUR 400 billion. That means raw materials imports were primarily responsible for the EU-27's foreign trade deficit of about EUR 120 billion. The higher oil prices rise, the higher the cost of raw materials imports – and the heavier the burden on both the national budget and private households. Deep down, therefore, the euro crisis is also an energy crisis.

It would be wrong to react to the increasing shortage and increasing cost of fossil raw materials simply by increasing subsidies. Worldwide, the fossil energy has been increasingly subsidised, from US$ 312 billion in 2009 to 409 billion in 2010, because many politicians hope this will avoid any social tensions due to high energy prices. In the long run, however, it will only lead to higher national debts and even national bankruptcies, but certainly not to cheap petrol prices.

The only way out of this price spiral is by a speedy strategy of moving away from oil. That means oil consumption has to fall, for instance as a result of home insulation and regional goods circulation. Above all, however, we need to find a replacement for the use of oil in every sector: e.g. sustainably produced bio-fuels, electrification of transport and the use of green electricity for buses, trains and cars. We also need green chemicals from renewable raw materials instead of oil-based chemicals, and oil-free agriculture. Hydrogen produced within the renewable energy can be an important source of power. It is, therefore, urgently necessary to move rapidly towards 100% renewable energy and away from oil and other fossil raw materials.

A few years ago many economists warned that the global economy could not cope in the long term with a high oil price of US$ 100 per barrel. For the past one and a half years the price was above or around the US$ 100 mark. The global economy is growing ever weaker and the euro area is facing an economic crisis that threatens its very existence. Yet there is little discussion and almost no analysis of the question whether the oil crisis and rising oil prices are to blame. Most economists, financial institutions and political players give little thought to the question whether the euro crisis has anything to do with rising raw material prices. The crisis in the euro area is discussed almost exclusively in terms of a financial, banking and national debt crisis. That has disastrous consequences, because rising raw materials prices play a huge, if not predominant role in the euro crisis.

Of course financial and political analyses are vitally important and we need specific financial and political answers: from the financial transaction tax via safety nets to fiscal union and the debt repayment fund. All this is necessary but not sufficient in order really to resolve the euro crisis*.

We also need, and very soon too, a strategy to make Europe independent of ever-rising raw materials prices and, in particular, independent of fossil raw materials such as oil, gas and coal. The only way to do so is by rapidly moving to-

*Editorial – Here and further the author speaks of the European Union (EU) area.

wards energy provision from renewable sources, together with an efficiency revolution – as ecologists have been demanding for decades. These demands were often rejected because allegedly it would be a burden on the economy and was simply too expensive compared with procuring energy from fossil raw materials. It is now becoming clear that this was a disastrous misjudgement.

The following basic statistics quickly show the massive impact on the euro crisis of the worldwide energy crisis, with the increasing shortage of raw materials and rising prices of raw materials.

Over the 12 months from October 2010 to September 2011 alone, their dependence on imports of raw materials, in particular oil and other energy feedstock, cost the EU-27 countries EUR 408 billion, even after deducting the proceeds from exporting fossil fuels and other raw materials. By way of comparison: over that same period the current account deficit of the EU-27 was EUR 119 billion. That means that the EU would have a very positive overall balance of trade if it could at least halve the bill for imports of raw materials. It is quite clear that the current account deficits in the EU-27, which have risen sharply in recent years, especially in the southern Member States where the economic and debt pressure is particularly high, are linked to raw materials imports: when oil prices rise, so does the foreign trade deficit. And with an oil price of more than USD 100 a barrel even France faced a negative trade balance and even the German surplus is dwindling sharply as raw materials prices increase.

Europe has no influence on global raw materials prices, however. They are governed by the global relationship of supply and demand. Demand is still on the up, but supply has broadly remained stagnant since 2006 when the ceiling of support for crude oil was exceeded. After all, the only reason the price of oil dropped between August 2008 and early 2009 was because the historically high oil price of nearly US$ 150 a barrel in July 2008 had plunged the global economy into a deep recession, triggered by the bankruptcy of Lehman Brothers. Indeed the Lehman Brothers' "toxic" loans to millions of US homeowners soared at the precise moment when those homeowners could no longer service their loans because of the rise in petrol and heating costs. From mid-2009 the global economy started moving again and the price of oil increased again, up to US$ 120 a barrel in March 2012; since then the high oil prices have begun to slide the global economy back into recession.

The high raw materials bills are accompanied by other energy-related factors that increase the national debt. Fossil raw materials are hugely subsidised and are therefore a heavy burden on the national budget. According to analyses by the International Energy Agency, global subsidies for fossil fuels rose from US$ 312 billion in 2009 to 408 billion in 2010. By comparison, global subsidies for the renewable energy came to only US$ 64 billion in 2010. UNEP* Executive Director Achim Steiner even speaks of US$ 600 billion a year in subsidies for fossil fuels. Only the fact that many states want to prevent the kind of social unrest triggered by rising energy prices can explain the escalation of subsidies which is largely responsible for driving up the national debt. It is a noble aim, but doomed to failure because the growing shortage of raw materials will tend to drive all energy prices up and would therefore increase the national debt ever more until it reached the point of collapse, as we have seen in Greece.

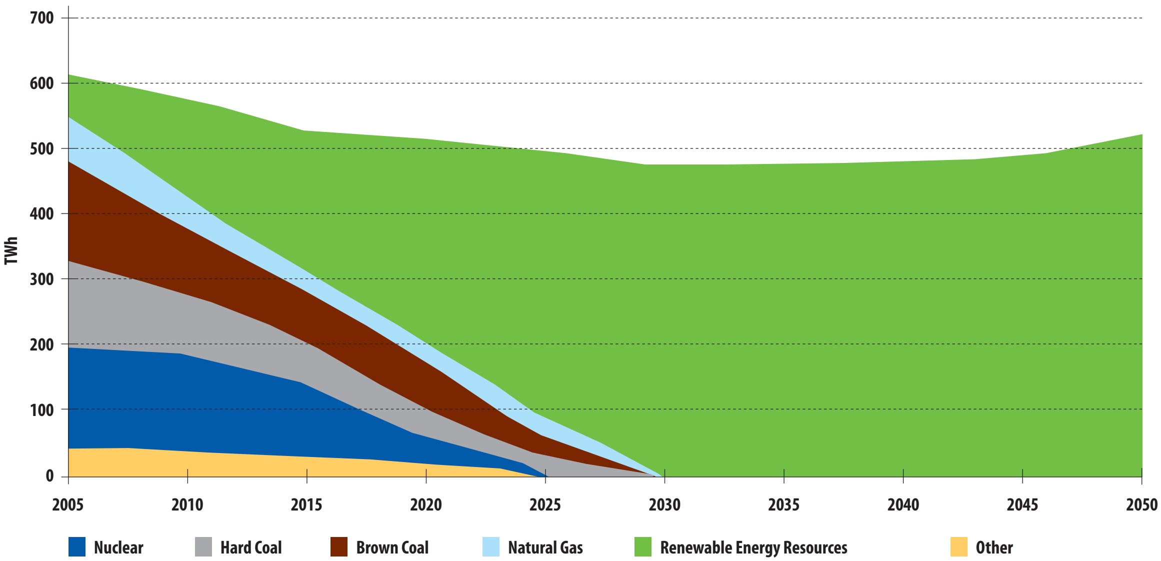
Green New Deal

The fact that Germany is holding its own in the euro crisis has much to do with its successful expansion of the renewable energy. As we said earlier, in 2011 renewables relieved the German economy of the burden of EUR 9 billion in raw materials import costs and avoided EUR 11 billion in external damage costs. The 380 000 work positions created in the renewable energy sector have given an enormous boost to the German economy – positions that the southern EU countries are seeking so desperately. The transition in the supply of energy towards 100% renewable energy, together with energy saving, is therefore making a considerable and vital contribution to overcoming the euro crisis.

The superficial argument that the renewable energy drives up energy prices soon proves to be irresponsible in terms of economic policy

* United Nations Environmental Programme

100% Electricity from Renewable Energies – Resolution by the Green Party



and a hindrance to the rapid readjustment of our energy supply. Investing billions in new gas pipelines, deep-sea oil drilling and coal mines will only exacerbate the economic crisis. Conversely, investment in the technologies of solar, hydro- and geothermal energies will make us increasingly independent of imports of energy feedstock. Apart from the lobbyists of the old energy structures, more and more people are coming to realise that.

A shift in power

Until recently, the German energy sector was controlled by four large energy groups. Their power is now being eroded. At first sight, this seems to be the case because of the nuclear phase-out. In fact it is the photovoltaic energy that represents the biggest challenge to the old electricity monopolists. Citizens are producing more and more electricity themselves and becoming less dependent. The former Minister for the Environment Klaus Töpfer from the Christian Democratic Party had this to say: 'Producing energy is becoming the trigger for democratic participation.' That means it is no more and no less than a question of making a decisive contribution to democratising electricity generation.

Now that energy generated from renewables is becoming cheaper all the time, it will destroy the power of the energy groups in the years to come. In Germany, wind and solar electricity are already making it uneconomic to build coal-fired power stations. After all, new wind farms are already producing electricity more cheaply than new coal-fired power stations, and new solar power stations now produce electricity more cheaply than new nuclear power stations that take ten years to plan and build. The same will very soon be the case in most countries. Solar and wind energy is putting the climate killers and nuclear waste producers out of business and they are losing their economic base. The only way to protect the climate is by using solar energy in association with the other renewables. That energy is now available worldwide at an affordable rate thanks to the example set by Germany.

A global approach to renewables

It has become inexorably clear from the rising CO_2 emission levels and relentlessly rising prices of conventional energy in the foreseeable future that European and global energy policy is basically proving a failure. No wonder, given that the EU Commission, the Council of Ministers and the various Member States are pursuing strategies that either delay tackling the problems or simply exacerbate them.

They are even using opposing strategies to deal with the two challenges. While in the case of climate protection the target is to reduce CO_2 emissions as drastically as possible, the aim of the strategy of security of supply is to preserve as many fossil fuel sources as possible for future exploitation.

The raw materials sources for the renewable energy such as wind, sun, water, wave and geothermal energy are and remain cost-free. The technological costs of renewable energy are decreasing constantly. That means that converting to renewables guarantees affordable energy supplies. From 2020 on, EEG support for the first photovoltaic plants in Germany will come to an end. But those plants will continue to generate electricity for another 20 to 30 years, when the price will be between one and two cents per kWh. That is the cheapest way to generate electricity and no other technology will be able to compete. This is, therefore, above all a technology-policy challenge and must also be seen as such. Most research-oriented politicians have still not understood this, as can be seen from the marginal share of renewables in national and European research budgets. Over the past 50 years some 90% of all public funding of energy research in the OECD* went on nuclear fusion and fission. Since, however, nuclear fission energy covers only some 2% of global energy demand, it is clear that nuclear fusion will be able to make no contribution at all in the next 50 years: research into nuclear energy has turned out to be the biggest research flop the world has ever seen. The gulf between expenditure and results is huge. Conversely, renewables are already covering more than 13% of the global energy demand, a surprisingly high proportion given how little support it has gained in research and political terms.

The raw materials sources for the renewable energy such as wind, sun, water, wave and geothermal energy are and remain cost-free. The technological costs of renewable energy are falling constantly. That means that converting to renewables guarantees affordable energy supplies.

A renewable energy policy means that we must network far more closely at global level too. We need a powerful grid to connect Europe internally and with its neighbouring regions. That will enable us to absorb and distribute the fluctuations of wind and solar energy, whether produced on a decentralised or central basis. For instance, building super grids in the North Sea is an important project for Europe. A strong European and trans-European network would therefore be the cornerstone of a strategy to produce energy primarily on a decentralised basis, which could well be supplemented by other projects such as Desertec (Desertec will connect North Africa with Europe with power lines to bring solar and wind electricity from the Sahara desert).

Thanks to the Rustec project (that will connect Russia, central Asia and Europe with power lines to transport solar and wind power), which has been under discussion very recently, Eastern Europe could also make a considerable contribution to supplying Europe with wind and hydroelectric power. Similarly, enough biogas could be produced in Russian and Eastern European rural regions to allow Europe to switch to climate-friendly natural gas. Russia and its neighbouring countries need not fear losing their energy customers if they now actively offer Europe energy produced from renewables supplies. Here, mutual networking clearly offers an alternative to the kind of unilateral dependence we see in the oil and gas sector today. A European biogas strategy would supplement this in the gas sector. The combination of a biogas feed-in strategy and a targeted gas-saving strategy would make it possible to reduce the unilateral dependence on a few natural gas producing countries. Yet Russia and Eastern Europe will have to decide on this paradigm shift quickly, otherwise Europe will be able fully to supply its own demand for renewables in a few decades' time. Developments in Germany show that this can happen relatively quickly and Europe has the potential to self-supply its entire energy demand with renewable energy.

Over the next few years and decades we can and must strengthen the cooperation between the EU-27 and its neighbours by greatly expanding the use of renewables (renewable energy)

* Organization for Economic Cooperation and Development

Today 25% of German electricity demand is already covered by the renewable energy, whereas ten years ago the figure was not even 10%, and in recent years especially this growth has increased at a furious pace: the percentage of green electricity rose from 17% in 2010 to 25% a year and a half later, in mid-2012. That means that Germany is well on the way to replacing the old fossil and nuclear energy industry with an efficient and sustainable renewable energy industry by the year 2030.

and adjusting the European energy supply system accordingly. Security, economic and environmental interests go hand in hand here, and much remains to be done.

Cooling down the planet

Irreversible changes as a result of climate change now seem almost inevitable. The climate protection targets and measures do not suffice to combat the heating up of the earth. Emission reductions alone are not enough to stop the continued rise in the concentration of greenhouse gases in the earth's atmosphere. Meanwhile, all UN climate protection projects to date have failed.

In my book Global Cooling, I describe a completely new climate protection strategy and make it clear that it is technologically feasible and makes economic sense to cool the planet by reducing the greenhouse gas concentration.

We must now reduce the climate gas concentration to below 330 ppm. That can be achieved by a two-pronged strategy: no more new emissions, together with cleansing the atmosphere of carbon.

We can achieve that aim in the space of a few decades if the entire world community joins forces in pursuing it. We need to consistently convert the fossil and nuclear industry to an industry based on renewable resources and introduce technologies and farming methods that filter carbon out of the atmosphere again. That applies primarily to the energy industry and agriculture, but also the chemical industry and transport, as well as many others.

The total conversion of global energy supplies to renewables makes up an important part of this climate protection strategy. With the plan they presented in November 2009, scientists such as Mark Z. Jacobson and Mark A. De

Lucchi from the Californian universities of Stanford and Davis have shown that this is technologically and industrially feasible and even economically advantageous.

We need a clear-cut policy to implement these measures, one that stops giving preferential treatment to the fossil and nuclear industry, and instead offers new incentives to the solar energy sector.

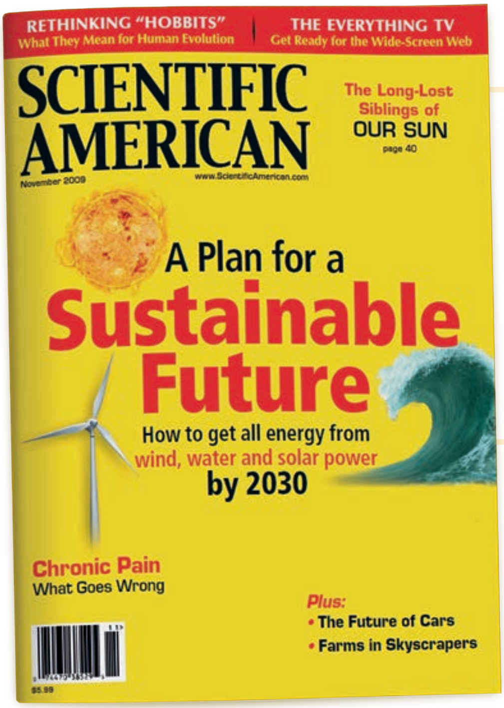
This cannot be achieved by embracing a single approach to climate protection, such as the emission trading that is under discussion. We need to take a variety of consistent political measures. They include, above all, laws on feed-in tariffs for the renewable energy in the electricity and gas sector, along with the lines of the EEG discussed in more detail above, together with the abolition of subsidies and tax reliefs for conventional energy, conventional chemistry and intensive farming. We must introduce tax reliefs for climate protection technologies and climate protection measures, embark on an educational and research offensive, abolish the preferential treatment in the approval system relating to the fossil and nuclear industry and instead introduce the same kind of preferential treatment for developing the solar power industry.

We must also see phoney solutions for what they are and no longer give them political support. Above all, such phoney solutions include the use of nuclear energy and the emphasis on what are known as CO_2-free coal fired power stations with CCS technology.

If those political measures are implemented one by one but rapidly, the self-sustaining forces for implementing climate protection and the solar energy industry will strengthen more and more quickly.

The use of renewables is already growing much faster worldwide than was forecast a few years ago. Since the renewable energy, with the exception of biomass, involves no fuel costs, it has a systemic advantage over conventional fuels, where prices escalate as these fuels become scarcer. For that reason alone it will become increasingly easy for climate protection technologies to establish themselves on the market. If active political measures are taken, the world economy can make the transition to zero-emission technologies in the space of a few decades. Nations that do not support the renewable energy today will face ever growing economic and environmental problems in a few years' time and will be left behind in the global rise in prosperity. Those measures, together with technologies and green farming methods that cleanse the atmosphere of carbon, will make it possible to reduce the CO_2 concentration from the current 385 ppm to 330 ppm.

If the appropriate political measures are taken, the world financial community will find many new investment opportunities with promising returns. That would release the financial community from the need to achieve returns by using technologies that harm the climate. Instead, the aim must be to obtain returns from investment in technologies that protect the climate.



A Path to Sustainable Energy by 2030

Wind? Water and solar technologies can provide 100 percent of the world's energy, eliminating all fossil fuels.

(Mark Z. Jacobson & Mark A. Delucchi)

New Book About Global Cooling

Sustainable Energy Book Series
Series Editor: Jochen Bundschuh

Volume 1

Global Cooling: Strategies for Climate Protection

Hans-Josef Fell
Member of the German Parliament,
Berlin, Germany

"Many Russian regions and sectors of economy have significant niches for the efficient use of renewable energy sources"

Interview with Oleg S. Popel,
Doctor of Science, Chairman of the Scientific Council of RAS for Alternative and Renewable Energy Sources

Pursuant to the order of the Government of the Russian Federation, awards of the Government of the Russian Federation in science and technology with appointment of Laureates of Russian Government Award in Science and Technology 2011 were granted to a large number of Russian scientists, engineers, and economists for the successful completion and practical implementation of large scale research and development projects bearing great importance for the national economy. A considerable part of this work is directly or indirectly related to the sustainable development of the fuel and energy complex of the Russian Federation, improvement of the energy efficiency of individual branches of industry and of the whole economy and energy supply systems of the country's immense territory.

The Editorial Board of the magazine "Energy Bulletin" would like to greet all laureates of the Russian Government Award and especially those who received the award for their great contribution to solving scientific and practical energy problems, and to wish to all the laureates to continue their successful work.

Our magazine is happy to note that the Government of the Russian Federation granted the award for "development and introduction of efficient technologies of using renewable and alternative energy sources in the small-scale energy industry" having the top position in the mentioned Order of the Government, to a team of outstanding Russian scientists which has conducted a number of fundamental and technological developments and applied their results in the renewable energy industry under the guidance of Alexander E. Sheindlin, prominent scientist, full member of the Russian Academy of Sciences (RAS) and a founder and currently the honorary Director of the Joint Institute of High Temperatures of RAS.

Given the great interest of our magazine and the International Sustainable Energy Development Center under the auspices of UNESCO as a part of whose activities our magazine is issued, in the renewable energy issues, we asked Oleg S. Popel, Doctor of Science, Chairman of the Scientific Council of RAS for Alternative and Renewable Energy Sources and the Laureate of the 2011 Government Award, to answer our several our questions in respect of the above matters and the renewable energy in general:

Oleg Sergeevich, please accept our heartiest congratulations upon the award of the Russian Federation Government granted to you and your colleagues for a major contribution to the Russian renewable energy. Is this award a recognition of the importance of renewable energy sources for the further sustainable development of the country's energy industry by the scientific and technical community and the Russian Federation Government or just "a tribute to fashion" as one interviewer said in a conversation with you?

First of all, let me thank you for the congratulations. I am, along with my colleagues, definitely very flattered with such a high appraisal of our work. I would like to note that the team which received the award, includes not only specialists from the Joint Institute of High Temperatures of the Russian Academy of Sciences (RAS), although we were key initiators of the mentioned research and development work, but also from the Institute of Energy Studies of the RAS who conducted important forecast studies of the RF energy industry based on its conditions and prospects of regions' development, from the Geographic Department of the Lomonosov Moscow State University jointly with whom we prepared the first correct and demonstrative maps of distribution of solar and wind energy resources in the RF territory and a respective atlas [O.S. Popel, S.E. Frid, Yu.G. Kolomiets, S.V. Kiseleva, E.N. Terekhova. Atlas of solar energy resources in the territory of Russia. – M.: UIHT RAS, 2010. 84 pages], from the well-known institute Rostovteploelektroproekt where qualified designers in the field of renewable energy sources still work, from the RF Ministry of Education and Science without whose attention to the problem and financial support of basic research projects were unlikely to have been implemented, and from the world-known special Astrophysical Observatory of RAS located in mountaines of the Western Caucasus where we demonstrated in practice that renewable energy sources could be efficiently used nowadays in Russia yielding economic, social and environmental benefits.

By the way, I would like to offer you to publish in your magazine three very demonstrative, in our opinion, maps of distribution of total and direct solar radiation and wind speed at the 50 m altitude, for the first time time compared to similar maps of Europe. When looking at these maps it becomes obvious that Russia has vast territories with renewable energy resources as great as those of other European countries where they are already extensively used.

Replying to your question, I hope that the award is not only a tribute to fashion but also a recognition of the importance of large-scale research in the field of renewable energy sources for the country. Though it is known that there is still no consensus on the matter among leaders of our country. An opinion prevails among authoritative representatives of the Russian fuel and energy complex that Russia will be self-sufficient in such relatively cheap conventional fuel and energy resources as natural gas, oil, coal and uranium, for many decades, therefore there is no point in developing still relatively expensive renewable energy sources in our country. But we, from what I can see, in our highly praised paper could conclusively demonstrate that even today there are significant niches in many regions and sectors of the country for the efficient use of renewable energy sources.

No doubt that Russia has unparalleled own reserves of conventional fuel and energy resources compared to the rest of the world but it is necessary to consider the renewable energy development as a strategic direction of the future energy industry, particularly, at a regional level.

The urgence of the renewable energy development in Russia is caused both by current requirements for maintaining energy security of the country's regions where many technologies of use of renewable energy sources have already become competitive, and for creating a dependable buffer for the innovative development of the country's energy industry for future generations. The energy industry is a strongly inertial sector of economy and new energy technologies make their way to the market for decades. Therefore, technologies intended to have a prominent position in the energy industry in 30-50 years, must be developed and tested today.

It is absolutely obvious that renewable energy sources were included in the energy agenda of many countries and their unions such as the European Union, not only as a result of developing and strengthening a sustainable development concept but also as a result of crisis developments in our community both at regional and global levels. Such surges of interest in renewable energy sources already took place in the recent past as you are well aware. But when the crisis had been overcome the enthusiasm calmed down which, and you admitted it too, hindered developing of the renewable energy and, in some cases, resulted in suspension of promising projects. Is it possible that similar situation will take place after overcoming the crisis in the world energy and economy in general which we have been witnessing for several years already?

The fact that the interest in renewable energy sources is steadily growing at all levels of the world community is beyond any doubts. Renewable energy sources are now relevant not only to energy and environment spheres but also to the world politics. But it is also obvious that countries most interested in renewable energy sources, are strongly dependent on imported energy resources (such as the EU, USA, China, Japan, etc.) and hopeful that renewable energy sources would ensure their secure and sustainable development in the near term. Due to the powerful political, legislative and direct financial support of such countries, since the new century's beginning the alternative renewable energy has been continuously growing at the average pace of dozens of per cents per year against an approximately 2% growth of the conventional world energy using fossil fuel resources. In 2010, world investments in the renewable energy exceeded USD 211 billion including USD 50 billion invested by China, USD 41 billion, by Germany, and USD 30 billion, by the USA. As a result, in 2011, the total installed capacity of units using renewable energy sources, reached 370 GW equalling to the total capacity of nuclear reactors operating in 32 countries. It is noteworthy that despite the financial and economic recession of 2008, the amount of investments in the renewable energy has been remaining at the same level in the recent years. It seems to me that the renewable energy has proved its relevance and occupied its niche in the world economy. It is also worth saying that along with the energy security, the renewable energy development is also driven with environmental considerations.

To date, about 100 countries have set their aims in the field of renewable energy sources for the period through 2020 and for a longer term. In most cases, in the next 10-20 years it is planned to increase the share of alternative renewable energy sources (without large hydroelectric power plants) in energy balances up to 10-30%. The European Union has the most ambitious targets: 20% by 2020 and 40% by 2040.

Perhaps, cyclical development of the world economy will influence the growth rate of the alternative energy in some countries, but it is obvious that it along with the nuclear energy which is, unlike the renewable energy, subject to a powerful public counteraction, cannot be kept away from the main path of evolution. The world acutely needs to diversify primary energy sources. Only this path leads to the future sustainable development of the humanity in harmony with the nature.

In your opinion, what direction for development of the renewable energy in Russia and worldwide is more promising: construction of large power generation facilities or use of renewable energy sources for local and small-scale power supply if they are locally available for the use?

The development should go in both directions. In the long run, the intensive state financial support of projects in the renewable energy provided by governments of a number of countries now (unfortunately, not in Russia) with a view of introducing new technologies to the market, will shrink considerably, and new technologies will be forced to prove their profitability in competition with conventional ones under specific economic and climatic conditions and depending on peculiarities of consumers. I am hoping that the market will set the record straight subject to reasonable state legislative and statutory regulation.

What, in your opinion, do we need in the Russian Federation to consider the renewable energy as an important part of the fuel and en-

ergy complex of the country and not just as a small-scale energy? Russian scientists and engineers have performed a large amount of R&D work which jointly with the foreign experience and expertise can result in an important breakthrough in this field, can't it?

Russia is apparently different from other coutries paying close attention to renewable energy sources. According to experts, nowadays the share of alternative renewable energy sources in the country's energy balance does not exceed 0.5-0.7%, though pursuant to well-known Order #1-r of the RF Government dated 08.01.2009 it should have reached 1.5% in 2010. It is clear that the next modest milestone of 4.5% in the energy balance to be reached by 2020, is unlikely to be met. To do this it is required to put in operation 20-25 GW of power generating facilities using renewable energy sources, and spend USD 50-70 billion. To invest such amounts in the renewable energy development the state and private companies must have strong reasons other than just political will. But inertial minds consider Russia an energy supplying country which is able to supply fuel and energy to consumers within the country and export enormous volumes of energy resources. Please note that today about 60% of produced energy recources (including energy-consuming upstream products such as metal, fertilisers, etc.) is exported from Russia. The oil and gas industry is now the largest economic entity in the Russian Federation accounting for about 20% of the RF GDP and about 50% of the consolidated budget income. It is extremely difficult to cease or reduce using of this resource for both economic and political reasons. According to some expert estimates, the energy complex is subsidised from the state budget by at least USD 10-15 billion per year, and a part of this amount could be alloted to support the renewable energy.

No doubt that Russia has unparalleled own reserves of conventional fuel and energy resources compared to the rest of the world but it is necessary to consider the renewable energy development as a strategic direction of the future energy industry, particularly, at a regional level.

Under these circumstances, top-level authorities and conventional power engineers are quite averse to the renewable energy development. It is generally thought that our country will be able to supply oil and gas to domestic consumers and foreign partners for many decades and it is too early for the development of "some renewable energy sources".

International environment obligations of our country still do not force it to take any decisive actions to reduce "greenhouse" gases emissions as the drop in production in the 1990s led to such a significant reduction in the emissions that the country will be able to reach the level of the 1990s in terms of emissions only after 2030 without taking any special measures (see picture below).

We can add to the above two circumstances a habit to think of the energy industry in our country as only a large-scale centralised industry based on facilities generating dozens or hundreds of megawatts of installed capacity. At this level of energy generation, it is extremely difficult for the renewable energy to compete with the conventional one without significant state support.

There is also a widespread and not quite justified opinion that due to the northern location Russia does not have favorable climate conditions for the efficient use of solar energy and that wind energy is available primarily in areas with no consumers. Economic and bureaucratic barriers and the counteraction of oil and gas companies prevent the technologies of extracting energy from biomass in which Russia is very abundant, from the wide use on the domestic market. Development of small-scale hydro-power and geothermal energy requires support of local authorities whose resources are quite limited. Not feeling pressure from the government large power generating companies are reluctant to include large-scale projects in the field of renewable energy sources in their modernization programmes.

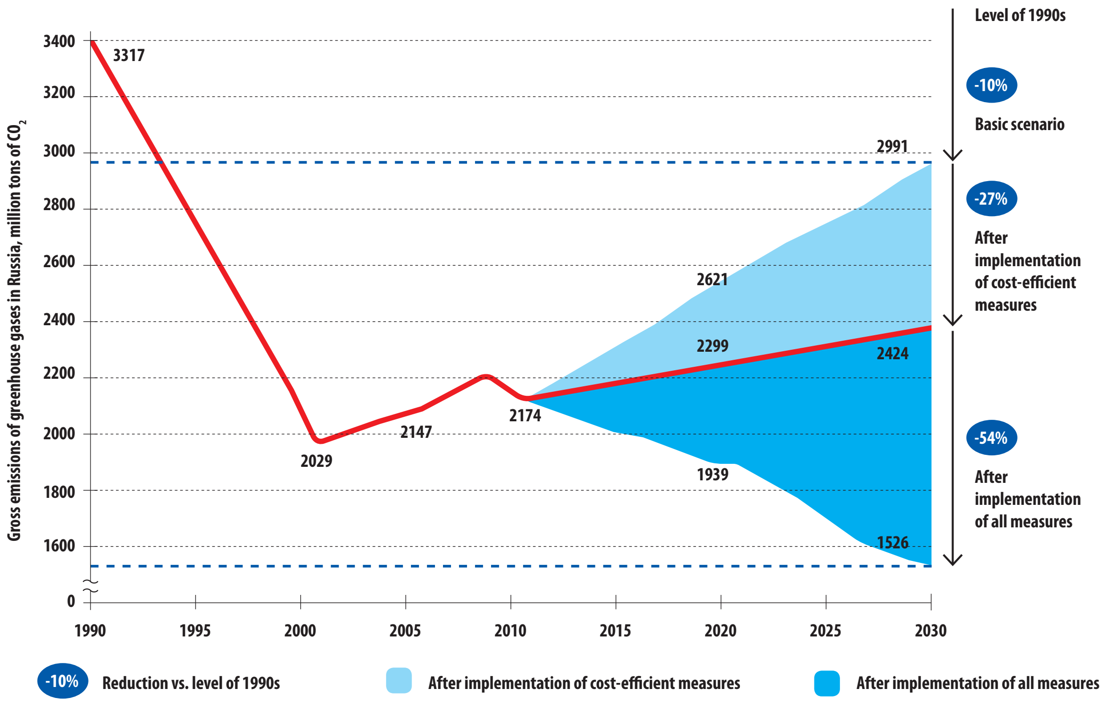
All the above certainly restricts the renewable energy development in our country.

Maybe it is true that the renewable energy is irrelevant to our country and does not deserve attention and serious discussion?

Let us look at the energy situation in Russia not from the macroeconomic perspective but from the perspective of regions and individual energy consumers. Facts show that:

– 2/3 of the country's territory populated with about 20 million people is not connected with centralized energy grids. Such areas have the highest prices for fuel and power (10-20 RUB/kWh, and in some areas the cost of energy generated by diesel generators reaches 100 RUB/kWh);
– most regions have shortage of energy resources and need to be supplied with fuel and electricity. They are interested in solving the problem of the regional energy security as much as countries importing energy resources;
– in our country with huge gas reserves only about 50% of towns and cities and about 35% of villages are supplied with natural gas. In the rest of them coal and oil products are used causing local environment pollution;
– under the conditions of ever-growing rates and prices for electricity and fuel and costs of connecting to centralised energy grids isolated energy generation is growing at an advanced pace. According to data of the Institute of Energy Studies of the Russian Academy of Sciences, the total power of diesel and gasolene energy generators with the unit power up to 100 kW put in operation in the country in the last 10 years exceeded that of large power plants put in operation in the same period. Energy consumers seek to provide themselves with their own energy and heat sources which, as a rule, reduces the efficiency of fuel combustion compared to the combined production of electricity and heat at cogeneration plants and, accordingly, the general efficiency of the country's energy industry;
– natural disasters occuring now more frequently show that areas with centralised energy supply need to develop distributed power generation systems enhancing the reliability of energy supply to small populated localities which are supplied with energy through energy transmission lines and with heat by means of local boiler houses.

Reduction in Greenhouse Gases Emissions in Russia (UN's Framework Convention on Climate Change; McKinsey)



The abovementioned facts and problems show that the current situation with energy supply in the country is far from ideal, and a number of steps is to be implemented to enhance regions' energy security and cut energy supply costs. It is obvious that renewable energy sources can and must play a considerable role in solving accumulated problems. It is extremely important to establish a network of demonstration units with the support of regional authorities which would vividly demonstrate advantages of renewable energy sources and serve as business development centres in this sector of economy.

No doubt that Russia has more own conventional fuel and energy resources than any other country in the world but the renewable energy must be considered as a strategic direction of the future energy industry, especially in regions.

The urgence of the renewable energy development in Russia is caused both by current requirements for maintaining energy security of the country's regions where many technologies of using renewable energy sources have already become competitive, and for creating a dependable buffer for the innovative development of the country's energy industry for future generations. The energy industry is a strongly inertial sector of economy and new energy technologies make their way to the market for decades. Therefore, technologies intended to have a prominent position in the energy industry in 30-50 years, must be developed and tested today.

In case of the isolated energy generation many technologies using renewable energy sources are already competitive but in case of the centralised power generation it is necessary to implement a number of steps requiring the state financial aid, like in other countries.

The fast renewable energy development in Russia must be considered as a key factor of the economy modernization involving, inter alia, innovative technologies, promotion of small- and mid-sized businesses, creation of new jobs, improvement of social conditions and environment, etc.

Our country needs a reasonable state policy stimulating the renewable energy development, which must be pursued in a consistent way.

Which research and development work of Russian scientists in, or attributable to, this field in addition to the work for which the award was granted, is worth mentioning, in your opinion as the Chairman of the Scientific Council for Renewable Energy Sources of the RAS?

With the proud for my colleagues I would like to say that our award is only the second one granted for achievements in the field of renewable energy sources for the last decade. In 2003, the Government Award was granted for fundamental studies in the sphere of geothermal energy and geothermal power plants constructed on the basis of these studies by a team guided by O.A. Povarov, the professor of the Moscow Energy Institute. In the difficult 90-s, they managed to develop own technologies and a unique equipment and to build internationally known Verkhne-Mutnovskaya and Mutnovskaya geothermal power plants in the Kamchatka Peninsula whose operation has been ensuring the reliable energy supply of many consumers in this remote region and, above all, cut down the enormous amount of purchased diesel fuel. The built geothermal power plants proved their feasibility by generating electricity which is several times cheaper than that generated by diesel power plants using the purchased fuel. Unfortunately, O.A. Povarov deceased but the highly qualified team of engineers and scientists created by him and now led by professor G.V. Tomarov, maintains the high level of geothermal energy studies acknowledged worldwide. Currently they are conducting promising studies aimed at the construction of binary geothermal power plants using low boiling media and expanding the geography where geothermal energy and industrial low-potential waste heat can be efficiently used. Now the revamping of the Pauzhetsk power plant where new technologies are to be used is drawing to an end.

It is noteworthy that several private companies made a certain breakthrough in the bioenergy field without any support from the state and brought Russia to a top position in the world in terms of production of wooden pallets (in 2011, over 2 million tons of pallets was produced). Unfortunately, most of them are exported to Europe. But recently several regions (Arkhangelsk and Nizhny Novgorod Regions and Krasnoyarsk, Krasnodar and Stavropol Krai) started using this eco-friendly fuel more extensively in municipal boiler houses.

Certain scientific and engineering achievements can be mentioned in developing and building tidal power plants.

There are interesting developments in respect of original high-efficiency photoelectric cells with concentrators of solar radiation conducted in the well-known Ioffe Physics and Technology Institute of RAS (Saint Petersburg).

Unfortunately, in many other fields, achievements of Russian scientists are less important than that of foreign colleagues.

Could you please briefly describe research, engineering and any other work in which you directly participate, in the field of renewable energy performed with the use of the Special Astrophysical Observatory of the RAS located in mountains in the Karachay–Cherkess Republic of the Russian Federation?

Projects implemented in the Observatory were described some time ago in our article written jointly with Academician V.E. Fortov "Using Renewable Energy Sources for Energy Supply in Russia" published in the 1st issue of your magazine "Energy Bulletin" in 2011. I shall not repeat what is said in the article. I would like just to mention that several units using solar and wind energy and low-potential heat with a thermal pump jointly with energy saving steps and construction of a cogeneration plant (mini-cogeneration power plant) in a boiler house of the village, reduced costs of the Observatory for energy supply of its high mountain facilities by 30% and, what is more important, increased the reliability and quality of energy supply and improved living and working conditions of over 1,000 habitants of the high-mountain research village. From the economic point of view, the projects paid off for 3-4 years. Therefore, the above example demonstrated that a reasonable use of renewable energy sources can be efficient from the economic, environmental and social point of view. The implemented project is unique for the Russian conditions and lays foundation for the establishment of an integrated demonstration centre in the field of renewable and alternative energy sources in the country's southern parts which is extremely important for introducing the well developed technologies to the domestic market.

In your opinion, what is the current situation with scientific and engineering staff required for extensive use of renewable energy sources in the RF? Is there any stable job market for such specialists?

I would like to note that personnel in the field of renewable energy sources is trained by a dozen of highly reputable institutes and universities in Moscow, Saint-Petersburg, Nizhny Novgorod, Chelyabinsk, Makhachkala, Volgograd and other cities. School graduates are quite interested in this profession. But, unfortunately, as far as I know, only about 5% of institute and university graduates find jobs in this field. The job market is now at an early stage of formation. Judging by data from Internet, the number of companies in Russia trying to make business in this promising field and accordingly requiring qualified specialists is growing year by year. Therefore, let us hope…

Could you please briefly describe goals and tasks of the Scientific Council for Renewable Energy Sources of the RAS? Would you agree to cover work of the Council in our magazine?

You understand that the Scientific Council is a public organisation primarily dealing with projects' evaluation and advocacy. It is noteworthy that we managed to establish tight relations with the RF Ministry of Science and Education supervising two state target-oriented programs "Research and Development in Prioritised Spheres of the RF Scientific and Engineering Development in 2007-2013" and "Research and Teaching Personnel in Innovative Russia in 2009-2013". Currently the new RF state programme "Development of Science and Technologies" is being prepared. All these programmes include financing of a great number of research, technologic and engineering projects dealing with the renewable energy. Many members of the Council are involved in the preparation and competitive selection of projects including their implementation and/or scientific support. We are involved in the organisation of and participation in numerous international energy conferences and forums which are held in our country. We annually take part in the well-known Yaroslavl Energy Forum and the occasional

Youth Conference "Youth Ideas and Projects Aimed at Energy Saving and Improvement of Energy Efficiency". In Makhachkala the annual conference and young scientists seminar "Current Problems of Renewable Energy Sources" are held which are named after Evald E. Shpilrain, the former Chairman of our Scientific Council, outstanding energy scientist and thermal physicist and a corresponding member of RAS. In Moscow on the basis of the Geographic Department of the Lomonosov Moscow State University and the Joint Research and Educational Center of the Moscow State University and the Joint Institute of High Temperatures, the Youth Scientific Seminar "Renewable Energy Sources" is takes place once in two years generating great interest among almost 200 participants from different Russian cities and regions and even from foreign countries. By the way, in 2012, we plan to organize the youth seminar with the participation of the International Sustainable Energy Development Center working under the auspices of UNESCO with whom we tightly work.

I would like also to mention another important sphere of work of the Scientific Council consisting in attempts to create the geo-information system "Renewable Energy Sources in Russia" (please visit web-site www.gis-vie.ru). The geo-information system is now at the initial stage and, in my opinion, could be extremely important for summarizing information on the research of renewable energy sources in Russia. We are very interested in engaging highly reputable partners in this work.

What are your plans for the near future? Last year the very interesting book "Energy in the Contemporary World" written by you jointly with Academician V.E. Fortov, was published. It was quickly sold and now is not available for sale. Do you plan to republish it together with Academician V.E. Fortov in the previous or extended version? Our magazine would be happy to present the book on its pages.

We have huge plans. This book written in cooperation with V.E. Fortov [V.E. Fortov, O.S. Popel. Energy in the Contemporary World. Dolgoprudny: Publishing House "Intellekt"; 2011, 246 pages, pictures] was really highly appraised by the public and specialists. It is a pleasure to receive positive feedback from authoritative scientists and lecturers of institutes and universities and to hear that the book was extensively used in courses of lectures in leading universities of the country. It seems to me that we managed to briefly and sistematically describe features of the world and Russian energy and review principal possibilities for improving efficiency of this key sector of economy in our book. Renewable energy sources are reviewed quite concisely in the book that is why we want to develop in this direction. The Russian energy industry acutely needs decent books on this matter. Now we are working on the book where we want to analyse the most advanced technologies of transformation of different renewable energy sources. We hope to present the book for publishing in the current year. At the same time we work on the translation of books written in foreign languages. I would like to note that at the end of 2010 the quite useful book "Fundamentals of Renewable Energy Processes" by Aldo da Rosa, the Stanford University's professor, translated into Russian was published. This year the book "Solar Engineering of Thermal Processes" by professor John Daffie and William Beckman translated into Russian will be published whose third edition is the most fundamental, authoritative and quoted by solar energy specialists scientific tractate describing computational, theoretical and experimental research methods of solar energy thermal transformation.

I am sure that renewable energy sources will be more and more extensively and efficiently used in Russia from year to year. In order to accelerate this process it is very important to provide experts with correct information on both advantages and drawbacks of different technologies to avoid already known mistakes and objectively evaluate expected energy and economic results. In this very case we need a balanced approach in order not to disappoint extreme optimists and not to give extra arguments to skeptics.

Scientific and popular articles are not sufficient and we feel that there is a need to publish a comprehensive book on which we are currently working.

We will be happy to take advantage of the offer to present the book in your magazine once it is ready.

Stumbling blocks to universal primary education: Repetition rates decline but dropout rates remain high

The latest edition of the Global Education Digest reveals the urgent need to address the high numbers of children repeating grades and leaving school before completing primary or lower secondary education. New data from the UNESCO Institute for Statistics (UIS) show that about 32.2 million primary pupils were held back a grade in 2010, and 31.2 million dropped out of school and may never return.

Entitled Opportunities Lost: The Impact of Grade Repetition and Early School Leaving, the Digest presents a wide range of UIS data and indicators to better identify the millions of children that are falling through the cracks in education systems and leaving school, often without being able to read or write. The report is complemented by an online interactive tool allowing users to visualize repetition and dropout rates by grade in the region and country of their choice.

The greatest challenges to the completion of primary school are found in three regions:

– Sub-Saharan Africa, where 42% of pupils will leave school early, with about one in six leaving before Grade 2;
– South and West Asia, where for every 100 pupils who start primary school, 33 will leave before the last grade;
– Latin America and the Caribbean, where 17% of pupils leave school before completing primary education (see regional summaries for more findings).

The Digest also highlights some potentially good news, namely that the global repetition rate has fallen by 7% between 2000 and 2010 even though there were more children in primary school, with enrolment rates rising by 6% during the same period. Yet, high repetition rates persist in many countries: every child starting school today in the Arab States, Latin America and sub-Saharan Africa, risks repeating a year, or more.

In countries such as Burundi or Togo, a child starting school today can expect to spend two or three years repeating a primary grade. In the case of Burundi, if the resources spent on repeating a grade were instead invested in enrolling new pupils, the country's annual gross domestic product (GDP) could grow by 1.3%, according to the Digest. Overall, it is estimated that each year of real education a child receives (not repeating a grade) could increase his/her individual earnings by 10% and lift annual GDP globally by 0.37%.

In general, girls are less likely than boys to start school but boys are at greater risk of repeating grades and dropping out, according to the Digest. The age of pupils can be another determining factor: under-age pupils are more likely to repeat a grade, while over-age pupils tend to leave school early. Yet, according to the data, the most important issues shaping educational opportunities are household wealth and location. In general, poor children living in rural areas are more likely than urban children from rich households to repeat grades and leave school before getting primary education and attaining basic foundational skills.

"We cannot afford to ignore these findings from both a moral and economic point of view," said Hendrik van der Pol, UIS director. "The world has just a few short years to make good on the promise to fulfill every child's right to primary education by 2015. The data in the Digest show that school systems are reaching more children but losing them due to inefficiencies, which lead to grade repetition and early school leaving. It is far more difficult and costly to reach children once they leave school than to address the barriers and bottlenecks in the systems."

REGIONAL FINDINGS

Sub-Saharan Africa – Steady progress but daunting challenges in providing educational opportunities for a growing school-age population.

In 2010, 11.4 million pupils repeated a primary grade in sub-Saharan Africa, representing more than one-third of the global total. The regional repetition rate decreased slightly, from 11% to 9% between 2000 and 2010, even though school systems have been straining to provide education to a growing school-age population.

This progress is clearly seen at the national level.

- In 1999, 15 African countries had repetition rates exceeding 20%, compared to only six countries in 2009.
- The following countries have reduced their repetition rates by more than 10 percentage points since 1999: Cameroon, Congo, Ethiopia, Madagascar, Mozambique and Rwanda.
- Repetition rates are 4% or lower in Ethiopia, Ghana, Mauritius, Niger and the United Republic of Tanzania.
- However, primary education repetition rates remain very high in Burundi (36%), Togo (23%), Chad (23%), Central African Republic (23%), and Congo (23%).

Many of the children repeating grades leave school before completing primary education. The region has the highest dropout rate, which increased from 40% to 42% between 1999 and 2009. This means that more than two in five children who start school will not reach the last grade of primary education.

- Dropout rates are highest in Chad (72%), Uganda (68%) and Angola (68%), where more than two out of three children starting primary school are expected to leave before reaching the last grade.
- In contrast, dropout rates are lowest in Mauritius (2%) and Botswana (7%).

South and West Asia – Modest progress despite the demographic dividend.

Across the region, about 9.1 million pupils in primary school repeated a grade in 2009. The situation is improving slightly. Between 2000 and 2010, the regional percentage of repeaters remained the same at about 5%, even though the number of students enrolled in primary education rose considerably. This modest progress is largely the result of improvements in four countries:

- Nepal, which reduced its repetition rate from 26% to 12% (between 1999 and 2009);
- Bhutan, where the rate fell from 14% to 6%;
- Iran, where the rate fell from 5% to 2%; and
- India, where a slight drop in the rate (from 4.3% to 3.5%) led to a significant reduction in the absolute number of pupils repeating a grade.

While primary school enrolment has risen over the past decade, growth in the school-age population has slowed considerably in the region. This represents an opportunity to not only widen access to primary education but to ensure that children complete it. However, the regional dropout rate remains high at 33% and has decreased by just two percentage points between 1999 and 2009.

The biggest changes occurred in:
– Pakistan, where the repetition rate increased from 30% to 38% between 2004 and 2009;
– Bhutan, which managed to reduce the rate from 18% to 9% between 1999 and 2009; and
– India, where the repetition rate decreased by ten percentage points from 38% to 28% between 1999 and 2006.

Latin America and the Caribbean – Policies yield results but high rates persist in some countries.

Repetition and dropout rates remain high in some countries, but the region appears to be on the right track to meet Education for All goals. At the regional level, the repetition rate decreased from 12% to 8% between 2000 and 2010. Moreover, the absolute number of pupils repeating a grade in primary school has decreased from 8.4 million to 5.4 million over this period. While this is partly due to a corresponding decline in primary enrolment, it also reflects the success of effective policymaking, for instance.
– Repetition rates have fallen in most countries of the region since 1999.
– The greatest progress was made in Brazil (from 24% to 18% in 2006) and Saint Vincent and the Grenadines (10% to 4%).
– However, rates have been increasing in Nicaragua, from 5% to 11%, and to a lesser extent (two to four percentage points) in the Bahamas, Dominica, Dominican Republic, Saint Kitts and Nevis, and Suriname.

The Latin American and the Caribbean region has the third-highest regional dropout rate to the last grade of primary education at 17%. Yet, the situation has been improving over the past decade, especially in Belize, Guatemala, Honduras and El Salvador, although rates remain within the range of 15% to 24%. The lowest rates (below 5%) are found in Argentina, Cuba, Jamaica, Mexico and Uruguay.

Nevertheless, high dropout rates persist in the following countries:
– Nicaragua, where 52% of pupils leave school without completing primary education.
– Guatemala, with a dropout rate of 35%, followed by Saint Kitts and Nevis (26%) and Honduras (24%).

Successful first test of Tsunami Warning System for the North Atlantic and Mediterranean

The exercise organized on 27 and 28 November 2012 to evaluate the functioning of the Tsunami Warning System for the North East Atlantic, Mediterranean and Adjacent Seas has taken place as scheduled. This real-time simulation, based on four scenarios in which earthquakes provoked tsunamis in different regions, demonstrated that the communication system for sending and receiving alert messages to concerned national authorities, worked smoothly.

Of the 39 member countries of the system (NEAMTWS), 18 participated (Cape-Verde, Croatia, Denmark, Egypt, Finland, France, Germany, Greece, Ireland, Italy, Lebanon, Malta, Monaco, the Netherlands, Portugal, Spain, Sweden and Turkey)

The exercise tested the systems used for relaying warning messages and, in some countries (Germany, Denmark, Egypt, France, Malta, Portugal and Turkey) the readiness of civil protection services.

Four regional centres were mobilized for the exercise, each reacting to a different scenario. The National Observatory of Athens, for example, sent five messages by fax, email and by the Global Telecommunications System (GTS), which allows the transfer of meteorological data by satellite or via terrestrial meteorological centers. The scenario was based on an earthquake and tsunami that devastated the Aegean coastlines on 9 July, 1956.

The CENALT (Centre d'alerte aux tsunamis, hosted by the atomic and alternative energies commissariat in France) reacted to a scenario based on a powerful earthquake off the Algerian coast. Four messages were sent by fax, email and GST to NEAMTWS Member States. They were also transmitted to civil protection authorities in France.

The scenario developed by the Kandili Observatory of Istanbul's seismic research institute (KOERI, Turkey) was based on an earthquake that struck Crete on 8 August 1303 which provoked deadly floods in the eastern Mediterranean. Twelve messages were sent to Member States' focal points.

Finally, the Portuguese Sea and Atmosphere Institute (IPMA, Portugal) based its scenario on an earthquake and tsunami that struck the west of Gibraltar in 1755. During this exercise, six messages were successfully sent to NEAMTWS member states.

The tsunami warning system for the North Eastern Atlantic, Mediterranean and Adjacent Seas is one of four such systems implemented by UNESCO's Intergovernmental Oceanographic Commission (IOC). Established in 2005, it has been operational since 2011. The other systems have been set up in the Pacific and Indian Oceans and in the Caribbean. Their function is to evaluate risks, emit and relay warnings and encourage training programmes for vulnerable populations.

The complete evaluation of last week's test will not be available for several months.

Innovative solar energy technologies

Dmitry Strebkov,
Director of the All-Russian Research Institute for Electrification of Agriculture,
Member of the Russian Academy of Agricultural Sciences

The All-Russian Research Institute of Electrification of Agriculture (VIESKh) was founded in March, 1930 as a Russian scientific and production center for power supply, electrification and automation of agriculture, and the utilization of renewable and non-conventional energy sources. The Institute employs over two-hundred highly skilled specialists. The Institute's portfolio includes over three-thousand inventions. The range of developments by the Institute in the areas of bioenergy, power generation, and transmission extends beyond the agricultural sector and can be applied in many other sectors of the economy.

Abstract

In 2010 the renewable energy surpassed the world nuclear power industry in terms of both the scope of development and installed capacity. Solar and wind energy play a leading role in the development of the fuel-free energy sector. The experience of the Czech Republic, where solar power stations of a total capacity of 1.489 GW were put into operation in 2010 alone, shows that neither the size of a country nor the climate nor the absence of technologies is an obstacle to the solar energy development. The single condition is the presence of reasonable laws and regulations to stimulate the use of fuel-free energy, state-of-the-art technologies and the creation of domestic production. To adopt relevant laws, it is possible to use Germany's 20-year experience and laws adopted in the Czech Republic, Bulgaria, Greece, and Spain. Some countries of the Commonwealth of Independent States (CIS) have sufficient scientific, technical and industrial potentials to develop the renewable energy rapidly, as well as to establish commercial production of various elements for power installations that use renewable energy sources (RES). Thus, for example, the Republic of Belarus has a well-developed machine-building sector and experience in semiconductor electronics, which will enable the production of components for solar power stations relying on the Russian innovative solar energy technologies described in this article.

Introduction

Less than 25 years after the Chernobyl disaster the world has witnessed the accident at the Fukushima Daiichi Nuclear Power Plant in Japan, with a restricted zone and consequences comparable to those at Chernobyl. While only one of four units of the Chernobyl NPP was destroyed with the other three being in operation for another ten years, at the Fukushima Daiichi NPP four units were completely destroyed and will never be operable again. One hundred thousand people were forced to leave their homes. The tea factory located 300 km away from Fukushima was shut down due to the contamination of tea plantations with radioactive caesium. The Fukushima disaster has demonstrated once again that nuclear energy is uncontrollable and hazardous [1-2]. As a result, Germany decided to shut down all its nuclear power plants by 2022. China, Italy, Venezuela and some other countries decided to suspend the constructions of new NPPs in their territories.

On 26 May 2010 during his visit to a photovoltaic manufacturing facility in California President Barack Obama said that "the nation that leads the clean energy economy is likely to lead the global economy." [3] The US Government allocated USD 2.36 billion to improve the efficiency of using renewable energy sources and for the government guarantee programme for credits for the development and construction of new solar power stations to the amount of USD 8.4 billion. The funding for three innovative solar energy centres, zero-energy building projects and electric energy accumulation will be continued.

And what about Russia? Rosatom asserts that the Russian nuclear power industry is safe and that nuclear power has no alternatives.

In actual fact, there is an alternative to nuclear power. The difference between Chernobyl and Fukushima is that today we have alternative fuel-free renewable energy technologies.

The dynamic solar energy development based on innovative Russian and world technologies is an alternative to the fossil fuel energy industry and will dominate the market of clean energy technologies in 2050, and will satisfy 75-90% of the total global electricity requirements by the end of the 21st century.

In 2010 the installed capacity of RES power plants (wind, solar, geothermal and ocean energy, bio energy and small hydropower) exceeded the installed capacity of nuclear power stations worldwide and amounted to 388 GW (60 GW growth as compared to 2009). In 2010 the amount of investments in the world renewable energy totalled USD 243 billion, which is a 630% growth in investments from 2004. China ranks first in the world with 25% of global investments (USD 54.4 billion), Germany is second (USD 41.2 billion), and the USA ranks third (USD 34 billion). Wind energy leads among other types of renewables in the amount of investments: USD 95 billion [4].

As for the rate of growth, solar energy ranks first. In 2010 27.2 GW solar power stations were built throughout the world, including 7.0 GW in Germany, 5.6 GW in Italy, 1.489 GW in the Czech Republic, and 1.0 GW in Japan. The rate of growth of the solar power output was 118% as compared to 2009. The installed solar power capacity in the world reached 60 GW by the end of 2011 [5]. No industry in the world, including telecommunications and computers' production, has seen such a growth rate. For comparison, the construction of nuclear power plants of a total capacity of 3 GW in the world took more than 5 years.

The Ministry of Energy established the Russian Energy Agency, whose primary objective is to commercialise the innovative Russian energy technologies and to create an export-oriented industry for the construction of environmentally-friendly fuel-free power stations with a capacity of 10 to 20 GW per annum, which is 15 to 30% of the world production.

The availability of tremendous hydrocarbon reserves is not an obstacle to the development of RES' utilisation. The large energy resources prevent strategic mistakes in choosing optimum technologies and directions of the RES development and enable the creation of innovative technologies and large-scale projects of RES' utilisation in Russia taking account of the experience of the Western countries, China and Japan. The large-scale RES' utilisation should be based on the original innovative domestic technologies. The All-Russian Research Institute for Electrification of Agriculture (VIESKh) has more than 100 patents in solar energy R&D.

1. Innovative solar photovoltaic technologies

1.1. Solar silicon

95% of all solar power stations in the world are made of silicon. The content of silicon in the Earth's crust is 29.5% by weight, which is the second largest content after oxygen, while the content of uranium is only 0.0003%. In spite of the fact that the content of silicon in the crust is 98300 higher than uranium, the cost of monocrystalline silicon is only slightly lower than that of uranium, which is accounted for by the out-of-date chlorine-based production process (the Siemens process). Our institute developed unique chlorine-free processes of silicon generation with low energy consumption, for which 8 Russian and USA patents were obtained.

Another approach is the 100-1000 times reduction of silicon consumption per megawatt of installed capacity, which is presently 6-8 tons, owing to the new types of solar concentrators and matrix silicon solar cells developed in Russia.

1.2. Solar concentrators

VIESKh developed and patented solar-tracking concentrators with 100 to 1000 concentration, and without solar tracking: stationary non-tracking concentrators with 3 to 5 concentration [6, 7]. Both types of concentrators ensure the uniform illumination of photovoltaic modules, which is of paramount importance for operation of solar power stations with concentrators. Non-tracking concentrators concentrate not only direct, but also diffuse (scattered) radiation within the angular aperture, which increases the installed capacity of solar power stations and electricity generation.

1.3. Solar cells

The monocrystalline solar cells created in VIESKh has a 25% efficiency in laboratory and 20% under industrial conditions with 50 to 1000-fold concentration of solar radiation. The monocrystalline solar cells patented in Russia are transparent to the inactive infrared spectrum, which reduces the heating of the photodetector and the cost of its cooling. The advantage of these monocrystalline solar cells is the generation of high voltage of 15-20 V per running centimetre of working area.

The Spanish Euclid solar power station with a 480 kW peak power concentrator for generating a 750 V operating voltage necessary for connecting to a transformerless inverter uses serial planar solar silicon modules of a total length of 84 m [8]. The 750 V monocrystalline solar cells have a length of 0.44 m, which is 191 times shorter. At the same time, monocrystalline solar cells have an operating current that is hundreds of times lower than in planar solar cells of the same capacity, and, as a consequence, low commutation losses. A 84 m long receiver based on monocrystalline solar cells will have a voltage of 150 kV, and a solar power stations can be connected to a direct-current high-voltage transmission line without intermediate transformers, rectifiers and other transforming devices.

Monocrystalline silicon solar cells are hundreds of times cheaper than solar cells based on cascade heterostructures per unit of area; the monocrystalline solar cell technology does not require silver, multistage diffusion, photolithography, serigraphy, epitaxy, texturing and other labour-intensive operations used at foreign plants. The RF patent for the design and technology of monocrystalline solar cells is included in the list of the "100 best inventions of Russia".

1.4. Solar photovoltaic modules

All constructions, materials and technologies for the production of solar modules that exist in the world ensure the service life of 20 years in the tropical climate and 25 years in the temperate climate with 20% power loss by the end of the service life. This is caused by ultraviolet and temperature degradation of optical polymeric sealing materials: ethylene-vinyl acetate and other plastics. The used process of module lamination includes vacuum treatment, heating to 150°C and pressing with energy consumption of 80,000 kW•h for the production of 1 MW of solar modules. The new process developed by VIESKh replaces ethylene-vinyl acetate and lamination with silicone compound filling with subsequent curing of the liquid component in polysiloxane gels. The service life of solar modules increases two times up to 40-50 years, the electric power of modules grows owing to the more transparent gel and a lower operating temperature of solar cells, and the power consumption for producing modules decreases by 70,000 kW•h/MW. In addition, the doubled service life increases the generation of electricity by 20 million kW•h per 1 MW of peak power.

1.5. Cost of solar electricity

The minimum cost of silicon solar modules is € 1000/kW in the wholesale European market, and USD 1000/kW in the Chinese market.

The cost of production of solar power stations on a turnkey basis is USD 3400/kW for network companies and 6500 USD/kW for home owners.

In February 2011, the Nobel prize winner, the US Secretary of Energy Steven Chu declared that the United States Department of Energy allocated USD 2 billion for research to increase the efficiency and to reduce the cost of solar power stations to USD 1 per 1 W of installed capacity by 2017, and the prices for electricity from solar power stations to USD 0.06-00.7/kW•h. Steven Chu said that "this financing will help America win the world race in the production of the most efficient and high-quality photovoltaics". One of the most serious problems to overcome is the rise in the cost of silver for solar cell metallization [9].

The cost of fabricating solar modules is 50% of the cost of solar power stations, another 50% being for the purchase of a network inverter, metal structures, cables and construction and assembly work.

In Italy, some other countries and a number of Russian regions, the parity is achieved at the regional level between the tariffs for electricity from the grid and the price for electricity from solar power stations . For examples, in Kalmykia, in Kursk Oblast, in some places of Yakutia and Chukotka the price of electricity for legal persons is 7-9 roubles/kW•h (USD 0.25-0.32/kW•h), which is comparable to the existing price of electricity from solar power stations. Where diesel power plants are used, the tariffs for electricity are higher than the cost of electricity from solar power stations.

In the near future the efficiency of monocrystalline silicon solar cells will be increased to 25-30% when operating with a concentrator. However, today the new technologies of silicon, concentrators and monocrystalline solar cells allow the creation of solar power stations which are competitive with coal-fired power plants.

According to the Special Report of the Working group 3 at Intergovernmental Panel on Climate Change (IPCC), 30% (pessimistic scenario) to 77% (optimistic scenario) of the world energy requirements will be satisfied by renewable energy sources by 2050. To achieve the 77% scenario, it will be necessary to invest 1% of the world social gross product in the energy sector [10].

1.6. Round-the-clock solar electricity generation

The problem of continuous round-the-clock and year-round electricity generation by solar power stations is the basis for developing the world fuel-free energy industry and ensuring its competitiveness with fuel energy. VIESKh developed and patented regional and global solar power systems that allow the generation and delivery of electricity to consumers irrespective of the time of the day and the season of the year [6, 11].

1.6.1. Russian solar power system

The computer simulation of the Russian solar power system of two solar power stations installed in Chukotka and Kaliningrad (Russian Federation) or in Pinsk (Belarus) and connected to Russia's integrated energy system has been performed. The photoactive area of the solar power stations with 20% efficiency is a square with a side of 25 km. The peak power of each solar power station is 125 million kW. The average annual values of insolation in the locations of the solar power stations were used as source data for calculations. The solar power system allows the supply of electricity to Russia's energy system on a round-the-clock basis for 5 months from the 1st of April to the 1st of September in the amount of 500 TW•h and can satisfy all Russia's electricity requirements in this period. In addition, during two months in March and September the duration of electric energy supply will be 22 hours a day. All fossil fuel power stations will be switched to the standby mode for 5 months, and the saved gas, oil and coal may be exported.

If the solar power station in the Karakum Desert in Turkmenistan is included in this energy system, the amount of electricity generated round-the-clock will be sufficient to supply electricity to all CIS countries for 6 months.

1.6.2. Eurasian solar power system

The Chukotka-Lisbon Eurasian solar power system will provide electricity for all countries of Europe and the CIS on a round-the-clock basis for 7 months from the 1st of March to the 1st of October.

The Eurasian solar power system consists of two solar power stations with a peak power of 1.5 TW. If the solar power station in Tibet (Mongolia, China) and the solar power station in Mauritania (Africa) are included in this energy system, the round-the-clock electricity generation in the annual amount of 6000 TW•h will be sufficient to supply electric energy to Europe, the CIS, and the northern countries of Asia and Africa for 7 months.

1.6.3. Global solar power system

The global solar power system is connected to the national energy systems and consists of three solar power stations installed in Australia, North Africa, and Latin America. The efficiency of the solar power stations is 25%, the peak electric power of each station is 2.5 TW, the dimensions are 190x190 km^2. The global solar power system generates electricity on a round-the-clock basis and uniformly throughout the year in the amount of 17,300 TW•h at a level that corresponds to the world energy consumption. This will allow switching all coal-fired, gas-fired and nuclear power plants to standby mode, help to reduce atmosphere overheating and to stop the climate change.

Not only solar power stations, but also power plants that use other renewables (hydroelectric power stations, wind farms, geothermal power stations, etc.) can be used as a source of electric power in the resonance global solar power system.

Russia is behind the West in technologies of megawatt wind blade turbines. However, in the small-scale wind energy VIESKh's engineer S.A. Bolotov developed and organised the world's first production of 1-5kW noiseless wind farms without blades, which meet all environmental safety requirements and, unlike blade turbines, can work in the range of wind speeds from 3 to 50 m/sec.

To create the regional and global solar power systems, new technologies have been developed in Russia, which ensure the competitiveness of solar energy in the following criteria:

- The efficiency of solar power stations should be at least 25%.
- The life of a solar power station should be 50 years.
- The cost of an installed kilowatt of peak power of a solar power station should not exceed USD 2000.

All constructions, materials and technologies for the production of solar modules that exist in the world ensure the service life of 20 years in the tropical climate and 25 years in the temperate climate with 20% power loss by the end of the service life. This is caused by ultraviolet and temperature degradation of optical polymeric sealing materials: ethylene-vinyl acetate and other plastics.

- The annual output of solar power stations should be 100 GW.
- The annual production of semiconductor materials for solar power stations should be in excess of 1 million t at a price of not more than USD 25/kg.
- Round-the-clock electricity generation by the solar power system.
- The materials and technologies for the production of solar cells and modules should be environmentally sound and safe.

The creation of the regional and global solar power systems has been already commenced. A consortium of companies and Deutsche Bank AG plan to construct a 100 GW solar power plant in the Sahara Desert at the cost of € 400 billion for Europe's energy supply. Solar power stations with a capacity of hundreds of megawatts are under construction in Spain, Germany, Italy, China, the USA and Australia.

The operation of the global solar power system is forecasted to begin in 2050, and full capacity will be reached in 2090. As a result of implementation of this project, the share of solar energy in the world electricity consumption will amount to 75-90%, and the greenhouse gas emissions will be reduced tenfold.

1.7. Ensuring environmental characteristics of energy production

An energy crisis related to the depletion of oil, gas and coal reserves does not pose a threat to the humankind if people master the renewable energy technologies. In this case, the problems of contamination of the environment with emissions from power stations and transport, provision of high-quality food, education, medical assistance, increasing the duration and quality of life will also be solved. Solar power stations create new jobs, improve the quality of life and increase the energy security and independence of the owners of solar power stations owing to the fuel-free and distributed energy production.

Processes for producing components of solar power stations are under development, in which the environmentally unacceptable chemical etching and processing are replaced by vacuum, plasma-chemical, electron-beam and laser technologies. Great attention is paid to the waste disposal, as well as to the processing of components of solar power stations when the service life is expired.

When solar power stations are used, the natural landscapes and the environment are organically combined with power installations. Solar power stations create spatial architectural compositions, which are solar facades or solar roofs of buildings, farms, shopping centres, warehouses, parking structures, greenhouses. Vineyards or rose gardens can be arranged and ecologically clean agricultural plants can be grown in the solar power station area.

1.8. Waveguide methods of electricity transmission

In connection with the development of integrated energy systems in Europe, North and South America and the proposals to create the global solar power system, a problem arose of creating a technology to transmit terawatt transcontinental flows of electricity. A third method may enter the competition between transmission systems based on alternating and direct current: the resonance waveguide method of electricity transmission at a high frequency, which was first proposed by N. Tesla in 1897 and developed in VIESKh in 1995-2010 [11].

Large energy companies in many countries of the world invest huge amounts of money and scientific resources in the creation of the high-temperature superconductivity technology to reduce the Joule losses.

There is another, perhaps, more efficient method of reducing losses in trunk and intercontinental transmission lines: to design adjustable resonance waveguide systems of electricity transmission at a high frequency of 1-100 kHz, which do not use active current of conductivity in a closed circuit. In a waveguide single-conductor line, there is no closed circuit, there are no running waves of current and voltage, but there are standing (stationary) waves of reactive capacitive current and voltage with a 90 phase shift. Owing to the adjustment of resonance modes and the selection of the current frequency depending on the line length, it is possible to create the mode of a voltage antinode and a current node (for example, for a half-wave line). Because of the absence of active current, the 90° phase shift between standing waves of reactive current and voltage, and the presence of a current node in the line, there is no need to create the mode of high-temperature conductivity in this line, and the Joule losses become insignificant due to the absence of closed active currents of conductivity in the line and small values of open capacitive current close to the nodes of stationary current waves [12].

The new physics of electric processes related to the use of not active, but reactive current will allow the three main problems of the modern electric power industry to be solved:

– creating extra-long transmission lines with low losses without using the superconductivity technology;
– increasing the transmission capacity of lines;
– replacing overhead transmission lines by cable single-conductor waveguide lines and reducing the cross-section of the current-carrying core of the cable 20-50 times.

In the experimental resonance single-conductor system for electricity transmission installed in VIESKh experimental hall, we transmitted an electric power of 20 kW at a voltage of 6.8 kV to a distance of 6 m through a copper conductor with a diameter of 80 μm at a constant temperature. The effective current density in the conductor was 600 A/mm^2, and the effective power density was 4 MW/mm^2.

Among other uses of resonance power industry based on open currents, we should distinguish contactless electric transport, creating local power systems using RES, connecting offshore wind farms with onshore substations, power supply to consumers on islands and in permafrost areas, fireproof single-conductor systems of street lighting and lighting of buildings and fire-hazardous production facilities.

VIESKh obtained 15 Russian patents for resonance devices and methods for the transmission and utilization of electricity.

For those who doubt the existence of open electric currents we would like to cite the expressions of two outstanding scientists in the area of electrical engineering and electric power.

"The exceptional difficulty of the agreement of the electromagnetism laws with the existence of open electric currents is one of the many reasons why we should admit the existence of current generated by a change in displacement." J. Maxwell.

"In 1893 I showed that it was not necessary to use two wires in transmitting electrical energy, but that one only might be employed equally well." N. Tesla, 1927.

"The efficiency of the transmission can be as high as 96 or 97 per cent, and there are practically no losses... When there is no receiver there is no energy consumption anywhere." N. Tesla, 1917.

"My experiments showed that it would take several horsepower to maintain electric oscillations all over the planet." N. Tesla, 1905.

N. Tesla also answered the question that is often asked to us: why did the electric power industry not accept his ideas? "My project was retarded by laws of nature. The world was not prepared for it. It was too far ahead of time. But the same laws will prevail in the end and make it a triumphal success." N. Tesla, 1919.

The solar energy needs the support of the government for the legislative provision for the implementation of pilot and demonstration projects; and the private sector capital waits for a new Morgan, the banker who financed Tesla's work 100 years ago.

Conclusions

The dynamic solar energy development based on innovative Russian and world technologies is an alternative to the fossil fuel energy industry and will dominate the market of clean energy technologies in 2050, and will satisfy 75-90% of the total global electricity requirements by the end of the 21st century.

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The 12th European Conference of the International Association of Energy Economics (IAEE)

Venice, 9-12 September, 2012

The European Conference of the International Association of Energy Economics (IAEE) is a valid forum and occasion to assess the evolution of energy issues in a general perspective. Actually, these conferences are by no means limited to Europe: in particular, at the 12th Conference, held in Venice from 9th to 12th September 2012, there was a substantial participation from non-European countries, what made it a truly worldwide meeting. With 20 invited talks, nearly 400 peer-reviewed contributed papers, 500 participants and 80 concurrent sessions it was also a fairly big event.

Energy today meets with four classes of issues: economics, security of supply, climate change and development (of course, interlinked with each other). Priority shifts from one issue to another according to evolution of the situation. There is little doubt that in Venice the main focus of attention was on the economic aspects. This is largely due to the economic crisis. As a consequence of the crisis, energy demand is shrinking; traditional supplies are still widely available and the new non-conventional gas and oil are playing an increasing role. As demand dwindles, so do emissions. The EU Commission representative (Emilio Dalmonte) stated at the Conference that there is little doubt that two out of three of its energy/climate objectives for 2020 will be met and probably surpassed: 20% reduction in greenhouse gases (GHG) emissions and 20% contribution from renewable energy sources (RES) to the EU energy budget. Only the third objective (20% reduction in energy intensity) will be met only half-way: and this again because of the crisis, which discourages investments even when they would be well spent to reduce production costs.

While the main emphasis is on the medium-term objectives (to 2020), long-term targets are being considered for orientation in the Energy Roadmap to 2050 of the EU: reductions on greenhouse gases (GHG) emissions, as deep as 80% to 95%, with respect to the 1990 levels are being considered; the road to be followed includes more electricity, much more efficiency in final energy utilization, much higher share of RES for electricity, for thermal uses and for transport, and during the transition, heavy reliance on natural gas. To reach these goals, essentially market-based mechanisms should be used to facilitate and encourage investments.

In the shorter term, the situation for fossil fuels is rapidly evolving as a new cycle of investments is developing (despite the crisis) making use of new technologies (like horizontal drilling) and extending to new geographical areas (as evidenced by Francesco Gattei, Vice President of Eni, a major hydrocarbon company, Italy). The increase in the availability of LNG (Liquefied Natural Gas) terminals will stimulate the spot market for gas, both in Europe and elsewhere, as underlined by Linda DuCharme, Exxon Mobile Gas and Power Director for Europe and Caspian. More gas will be needed in Europe as a part of the nuclear capacity will be phased out.

The strategic role of a close collaboration of the North and South shores of the Mediterranean in the field of energy was stressed by Manfred Hafner from the Eni-Enrico Mattei Foundation (FEEM), Italy. In addition to the already important development of hydrocarbon resources there are great potentials for energy efficiency, for renewable energy sources and for power and gas networks. The "Arab Spring" evolution of these countries may create some delays in a first phase but is likely to play as a powerful stimulation in the future.

One plenary session in the Conference was devoted to the presentation and comparison of the long-term energy policies of three of the largest members of the EU: Germany, UK and France presented by three key persons in shaping the policies of their countries.

Andreas Loeschel (Centre for European Economic Research, ZEW, Heidelberg, Germany) reminded that the turn in the German energy policy ("Energiewende") had been decided in principle already in the late 90's but had little follow-up until the Fukushima disaster, which accelerated the phasing out of German nuclear plants (to be completed by 2022). The German programme is ambitious and calls for a substantial recourse to RES to replace both nuclear and coal plants. GHG emissions should be reduced (compared to 1990) by 40% by 2020 and up to 80% by 2050. The main problem is coping with networks with a high percentage of aleatory sources, which requires improvements and changes in the transmission and distribution networks, and the development of storage. The turn will, however, involve somewhat greater imports of energy and higher prices for the consumer. No major role is foreseen for carbon capture and storage (CCS).

David Newbury (University of Cambridge, UK) has made the case for the United Kingdom where the main concern is the reform of the electricity market. Stringent objectives are present also in the UK for the reduction of GHG emissions (50% by 2027, much more later on). Problems are identified here too in the high percentage of contribution from RES (electricity networks, back-up generally and reserve power). Nuclear plants should in general complete their useful life, but it is anticipated that the market will choose not to build new nuclear plants. Discussion is ongoing, concerning the failure of the Tradable Emission Permits system, which has had no role in orientating technologies and has a market value, which is much below that of the externalities they should represent. Incentives for RES should also be re-examined, which bring to excessive costs and distortions (the instrument should be specific for the various technologies). CCS could have an important role.

Quite different is the French situation, where the introduction of a competitive market in the electric sector is hampered by the presence of an incumbent operator, Electricité de France (EdF), which produces more than 70% of its electricity by nuclear plants and sells it at much lower prices than its competitors, which use gas or coal as a fuel. Jacques Percebois (University of Montpellier, France), who presented the French case, highlighted this paradox. There is a double system to fix electricity prices: regulated tariffs fixed by the government, mostly on the basis of the production costs by nuclear plants, and the market prices, paid by the clients who exercised their right of option correlated to the much higher prices present on the European market. Therefore, in order to promote competition, either regulated prices are raised to the European market value or competitors of EdF have to lower their prices. In the first case, the "nuclear rent" is taken by the government; in the second, it is shared by EdF with its competitors.

The government has chosen the second option by imposing EdF to sell to its competitors part of the electricity generated by nuclear plants at a price of cost. This should generate a competitive market at prices lower than the European market price. Details on how to enforce this policy are crucial and are being discussed now. The long-term future of nuclear power in France is still under discussion: hypotheses range from gradual phase-out to extension of plant life and even to the construction of new types of power plants.

In the session devoted to climate change Thomas B. Johansson (University of Lund, Sweden) illustrated the completion of the Global Energy Assessment (GEA) exercise. The results of this very extensive exploration of worldwide long-term (2050) scenarios will be published shortly by Cambridge University Press. Starting from visions of possible future energy systems, which respect not only global warming concerns but also a broad range of sustainability conditions, back-casting methods are applied to see whether and how such systems could be developed starting from the present situation. A large number of possible (and desirable) futures have been sorted out together with the identification of policies that may conduct us there.

Further aspects of this GEA study have been presented by another co-author, Shonali Pachauri from the International Institute of Applied Systems Analysis (IIASA), dealing mainly with energy poverty. 40% of the world population has no access to modern forms of energy for cooking food, more than 20% has no electricity; this happens in particular in Sub-Saharan Africa (SSA) and in some regions of Asia. Traditional cooking by biomass has dire consequences on health (due to indoor particulate pollution). Lack of electricity not only limits living conditions but also hampers productive and social activities. The situation is changing, but in SSA the rate of growth of the population is often higher than the rate of growth of modern energy services. A crash programme to overcome this limitation has been identified and is within reasonable costs.

Ulf Moslener (Frankfurt School of Finance and Management, Germany) has shown that investments in climate policies have been growing constantly in the last years. Market instruments are preferred, but market imperfections must be taken into consideration. The concept of energy poverty has also been discussed by Massimo Tavoni from FEEM, showing that the investments necessary to overcome the barriers to universal energy access are relatively modest but would involve an increase in overall energy demand, especially as a consequence of greater economic activities. Roberto Vigotti (formerly coordinating IEA activities on renewable energy) has shown how this effort would involve with similar emphasis isolated production (20%), mini-grids (35%) and strengthening of large-scale grids (45%).

Barbara Buchner, Director of the Climate Policy Initiative Europe (an international institution), has shown how to access information on financial flows (public and private) available for climate protection (often not an easy task). These capitals are of the order of 100 billion dollars per year, they address investments rather than incentives, and for 95% concern mitigation rather than adaptation. The majority of these funds come from private sources and are channelled through intermediaries, mostly bilateral or multilateral institutions.

For Felice Egidi from Enel (Ente Nazionale per l'Energia Electrica) Green Power, Italy, financing the transition towards more sustainable energy systems with a strong contribution from RES requires increased understanding of the market and innovative instruments. Renewables often do not participate in a market competition with other sources as it would be desirable. There is still potential for important cost reductions as the recent experience with solar photovoltaic has shown. New strategies for the diffusion of solar systems have been illustrated also by Massimo Orlandi from Sorgenia (a European private utility). The presence of a very many non-programmable distributed generating systems involves new types of problems.

Domenico De Luca, from Axpo Trading (a major European energy trading company headquartered in Switzerland), has highlighted the main problems that today have to be faced by utilities and, in part, by trading companies. Some problems stem from market imperfections, others by the regulating process itself. European companies in particular have to deal with shrinking electricity demand, the increasing (and often excessive) reserve margins, the increasing role of the spot market, especially for natural gas, no longer closely linked to petroleum prices, and the mechanisms to promote renewable energies often outside the market.

Jean-Michel Glachant, Director of the Florence School of Regulation, Italy, has shown the difficulties that are to be dealt with, when trying to establish a functioning market system to exchange natural gas in the European Union by creating entrance and exit zones, and promoting market liquidity in each zone. Key issues concern the allocation of gas transport capacities, tariffs and investments. Details are often essential.

Tatiana Mitrova, the Energy Research Institute of the Russian Academy of Sciences, presented a rather detailed picture of how Russia sees the evolution of the energy system at the world and regional level, and for Russia in particular. There is no major discrepancy from the predictions of international institutions (such as the IEA) or of other countries. We are experiencing, as Mitrova says, a period of turbulence in energy markets. The price of petroleum will continue to be high but altogether accessible (its upper limit being the production cost of biofuels). Demand will shift more and more towards non-OECD countries and, as destination, to transport. Non-conventional hydrocarbon resources will have increasing importance, especially for gas (USA getting the highest benefits). At the world level, only one half of oil and gas is exchanged at market prices, the rest is subject to regulated prices. One third of the gas consumed in Europe in 2035 will be imported as LNG. Nuclear energy will have an important role only for emerging countries (BRICS). What concerns Russia in particular, at the horizon of 2035 the population will remain stable at about 150 million, but GDP will increase by a factor of three, partly compensated in energy demand by a 2.5 increase in energy efficiency. Production of oil and coal will remain roughly constant, while gas production should increase by about 50%. Hydrocarbon exports will be mostly re-directed towards the Far East.

This report on the Venice Conference so far has been based mostly on the invited papers presented at the plenary sessions. A full presentation of the novelties emerged in the Conference would require an analysis of the 300+ contributed papers, which, unfortunately, we cannot include here, but which do provide more food for thought. Presentation of all papers (for both plenary and concurrent sessions 9) is accessible on the conference website: www.iaeeu2012.it. For abstracts and texts of the papers please send your requests to AIEE: assaiee@aiee.it.

Ugo Farinelli, Secretary-General of Italian Association of Energy Economists

The 5th International Conference on Fundamentals & Developments of Fuel Cells (FDFC 2013)

Karlsruhe, Germany
16-18 April, 2013

The European Institute for Energy Research will organize the 5th edition of the Fundamentals and Development Fuel Cells Conference, on 16-18 July, 2013 in Karlsruhe, Germany, on fuel cells, fuel cell systems and fuel cell applications.

This conference is in continuation of the previous "France-Deutschland Fuel Cells" Conferences held in Forbach (2002), in Belfort (2004), Fundamentals and Developments of Fuel Cells Conference in Nancy (2008) and the Fundamentals and Developments of Fuel Cells Conference in Grenoble (2011), however, with extension beyond the two countries. This last edition, chaired by Pr. Bultel has generated a special issue in the Fuel Cells Journal named the Fourth edition of the Fundamentals & Developments of Fuel Cells (FDFC 2011).

The conference will explore general topics of fuel cells (fuel cells electrochemistry, fuel cell catalysts, catalyst supports, proton transfer and water transport in ionomer membranes, MEA, GDL and bipolar plates development) and also recent issues that hold the same importance (fuel cell diagnosis, power processing and control, characterization of MEA upon operation/ageing).

On a broader scale, the conference will also address the advancement on hydrogen production and storage for different application areas as well as the impact, the role and place of fuel cells and hydrogen at a grid/city level.

The three-day technical conference will consist of invited lecturers, contributed papers and posters.

See details at: http://fdfc2013.eifer.uni-karlsruhe.de/

The 21st European Biomass Conference and Exhibition (21st EU BC&E)

Copenhagen, Denmark
03-07 June, 2013

For over 30 years now, the European Biomass Conference and Exhibition (EU BC&E) has combined a very renowned international Scientific Conference with an Industry Exhibition. The EU BC&E is held at different venues throughout Europe and ranks on top of the world's leading events in the Biomass sector.

The Conference will discuss major issues for the biomass markets, in technical and business areas, from resource assessment to market and policy developments, drawing on leading experiences from all over Europe and worldwide. The event aims to encourage an international exchange of experience on policy, research and development, manufacturing and installation, and to be a showcase for the latest technologies.

The conference is expanding, its coverage on the growing issue of bioeconomy, a sector that has strong links to bioenergy where Denmark became a leading country.

This EU BC&E is supported by European and international organizations such as the European Commission, UNESCO - United Nations Educational, Scientific and Cultural Organization, Natural Sciences Sector, WCRE - the World Council for Renewable Energy, EUBIA - the European Biomass Industry Association, and other organizations.

See details at: http://www.conference-biomass.com

The 4th International Conference on Energy and Sustainability (Energy and Sustainability 2013)

Bucharest, Romania
19-21 June, 2013

Energy and Sustainability 2013 is the fourth International Conference in this series, following the success of the first meeting, held at the Wessex Institute of Technology in the New Forest, UK (2007), the second in Bologna, Italy (2009) and the third in Alicante, Spain (2011).

The world's economic system is driven by energy. Few of the advances made in the past two centuries would have been possible without the large-scale exploitation of fossil fuels. Resources depletion and predictions of severe environmental effects deriving from continued use of fossil fuels are spurring renewed interest in sustainable energy. The effort that will be required to shift from a fossil fuel-based economy to one hinged on sustainability is massive, requiring advances in the basic sciences (materials, electrochemistry and heat transfer to name a few) through to systems engineering (buildings, electric grids, transportation) and all the way to international policymaking.

The evolution of new energy technologies and systems cannot follow the compartmentalized model that has worked so well in the past because of the time constraints imposed by oil depletion and climate change. All parts of the new energy economy are strongly interlinked and researchers in the field must be aware of the entire enterprise to maximize their own contribution. This conference offers an opportunity for scientists, professionals, policymakers and other parties to review recent developments in this rapidly changing environment.

See details at: http://www.wessex.ac.uk/13-conferences/energy-and-sustainability-2013.html

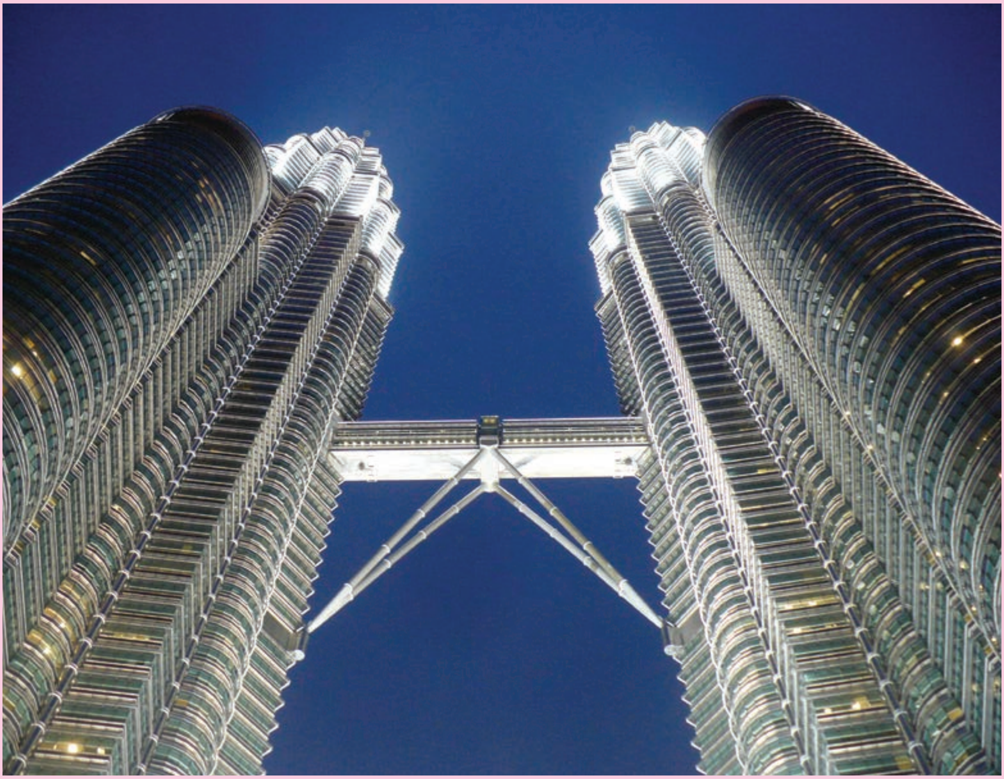
The 2nd International Renewable Energy and Environment Conference (IREEC-2013)

Kuala Lumpur, Malaysia
04-06 July, 2013

The 2nd International Renewable Energy and Environment Conference (IREEC-2013) is the forum of World's Science and Engineering Community for the presentation of new advances and research results in the fields of Energy and Environment. The conference will bring together leading researchers, engineers, scientists and experts from industries in the domain of interest from around the world.

IREEC-2013 is sponsored by WARP, World Academy of Research and Publications. The main objective of IREEC-2013 is to provide a platform for researchers, engineers, academicians, as well as industrial professionals from all over the world to present their research results and development activities in Chemical and Environmental Engineering. This conference provides opportunities for the delegates to exchange new ideas and application experiences face to face, to establish business or research relations and to find global partners for future collaboration.

See details at: http://www.warponline.org



ECOS 2013

Guilin, China
16-19 July, 2013

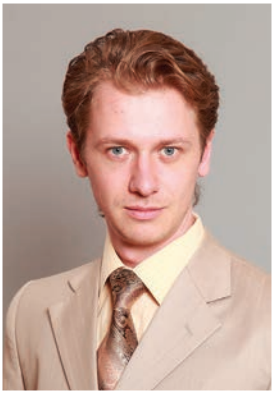
The 26th International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems (ECOS 2013) will be held at Guilin, China, 16-19 July 2013. The Organizing Committee of ECOS 2013 invites all scientists, researchers and engineers in the fields of energy systems to participate in this important event to contribute and share their ideas and research results with other colleagues.

The conference features 18 tracks on various aspects of energy systems: abstracts on these tracks are welcome.

- Basic and applied thermodynamics
- Heat and mass transfer
- Combustion and chemical reactions
- System integration, simulation and optimization
- Renewable energy utilization and energy storage
- Carbon capture and storage
- Coal, oil and gas: mining, drilling and hydrofracturing
- Nuclear power
- Electricity generation and transmission, the smart grid
- System operation, control, diagnosis and prognosis
- Energy and water interactions, water desalination and use of water resources
- Energy systems: social, environmental and sustainability issues
- Building, urban and distributed energy systems
- Transport energy and emissions
- Energy policy, economics and planning
- Energy and manufacturing: new routes to sustainability
- Internal combustion engines
- Poster session

See details at: http://www.ciccst.org.cn/ecos2013

The ISEDC and UNESCO raise the scientific and educational potential for sustainable energy



Alexander Antonov,
Head of the education activities sector
Department of strategic planning and partnership
International Sustainable Energy Development Centre under the auspices of UNESCO

The crucial changes that took place in the modern world in the recent decades, the rapid development of scientific knowledge and information and communication technologies pose absolutely new problems for the world community. Under these conditions, the role of education grows enormously. Education and science come to the foreground as the most important national and global priorities and act as the most important components of the cultural, social and economic development.

The training of specialists implies the creation of a system of education, which will help not only to provide the required human resources for scientific institutions and production enterprises as well as for all other areas of human activities, but also to assure their continuous development and improvement.

The international cooperation aimed at the capacity building at the international, regional and national levels and within the framework of individual local communities, in different areas of knowledge, in the socio-economic and cultural life contributes to the more efficient organization of the retraining of specialists and the so-called «long-life education» system. As a rule, this cooperation contributes to the more rapid solution of global and other problems. An example of real actions in this area is the implementation of the UNESCO renewable energy educational programme (Global Renewable Energy Education and Training (GREET) Programme), which has been successfully implemented for a number of years in developing countries.

One of the international initiatives oriented to the professional improvement in the efficient use of energy resources is the joint programme of the International Sustainable Energy Development Centre (ISEDC) and UNESCO «UNESCO/ISEDC Co-sponsored Fellowships Programme» for specialists from developing countries and countries, which is being implemented as a part of the agreement between the Government of the Russian Federation and UNESCO.

The ISDEC is the only category 2 centre under the auspices of UNESCO in the Russian Federation that implements a fellowship programme in the field of energy resources management. Annual training courses for the above specialists are the main component of the programme.

The objective of this programme is to create an international platform for the development of international cooperation (an intensive dialogue

in a wide range of problems) in the energy industry, to ensure the world energy and energy efficiency as a guarantee of sustainable development in the world and the corresponding strengthening of the institutional and human resource potentials in this particular field of countries of Asia, Africa, Latin America and Europe.

Every year the programme is implemented in several stages: first, the wide advertising of the force coming next session of the programme is ensured in research and educational institutions, industrial organisations and governmental agencies of UNESCO member-states that belong to the above regions via UNESCO and ISEDC information channels; at the same time the contents of the training course that is to be carried out in this session is elaborated in detail. A leading Russian university responsible for conducting the training course, representatives of various research, educational and industrial organisations, as well as specialists from UNESCO Secretariat and ISEDC, are involved in this very important part of the project implementation; then applications for this session of the programme are received and the list of the potential fellowship holders in sections of the UNESCO fellowship programmes is drawn up; further the ISEDC education activities sector performs the final selection of fellowship holders; the last and most important stage of the programme is the training course, which is based, as a rule, in the leading university mentioned above.

The obligatory requirements imposed on the fellowship applicants and, consequently, the potential programme participants are as follows: the presence of a higher education diploma in energy, ecology or economics; fluency in the Russian language (the presence of a Russian Language Proficiency Certificate), and the age limit of 45 years.

In these courses, the fellowship holders study the state of modern energy-efficient and energy-saving technologies, the prospects of using renewable energy sources. They evaluate the latters' economic efficiency and possibilities for their large-scale utilisation, make forecasts for the solution of problems of the global climate change, and assess the environmental and economic risks of energy facilities.

By now, over 80 specialists from 35 countries of the world have participated in this training programme. They came to the courses from Belarus, Bolivia, Burundi, Hungary, Vietnam, Gambia, Ghana, Egypt, Zimbabwe, Jordan, Iran,

Colombia, Congo, China, Costa Rica, Cuba, Kyrgyzstan, Latvia, Madagascar, Mali, Moldova, Mongolia, Peru, Poland, Senegal, Tajikistan, Thailand, Sri Lanka, Uzbekistan, Ukraine, Estonia and other countries, and thus became fellowship holders under the UNESCO/ISEDC joint educational programme. As a rule, energy specialists, engineers, ecologists, university teachers, post-graduate students of research centres and universities, company executives, and representatives of regional authorities become fellowship holders under the programme.

The first four educational sessions under this programme were conducted in 2008-2010 at the Moscow Power Engineering Institute (Technical University). The training was based on an 80-hour programme that included such topics as energy and sustainable development, renewable energy sources, cogeneration technologies, the basics of technology and quality management in the energy industry, automated information systems, production management, project management, etc.

In 2011 and 2012 the educational section of the programme was held at the Faculty of Ecology of the Peoples' Friendship University of Russia. The programme of courses was considerably larger than the training load of the previous sessions and consisted of lectures, practical training and self-training. The 2011 educational course was devoted to "the environmental management of energy resources" and included a series of lectures on the world energy resources, environmental and economic problems and risks of the modern energy industry, state-of-the-art technologies of using alternative energy sources, energy resources management, etc.

The main topic of the sixth training session of the UNESCO/ISEDC joint programme conducted in the autumn of 2012 was "international energy resources management". Within this course, modern concepts of natural resources management in the energy sector, innovative directions in the electric energy development, international aspects of cooperation in energy efficiency, energy security were considered, and the Russian experience of natural resources management was analysed by the example of specific companies operations.

The curricula were developed and implemented by leading lecturers and experts who had a significant experience of research and project work in the energy sector, the study, use and conservation of natural resources, and en-

vironmental management. The faculty members participated many times in international research and educational projects jointly with colleagues from Germany, China, the USA, Mongolia, Norway and Slovakia.

The familiarisation with power facilities and research institutions is an important component of the practical training within the courses. The course participants usually have an opportunity to visit experimental laboratories, research centres and energy facilities.

For example, during the 2011 course the participants visited the All-Russian Research Institute for Electrification of Agriculture (VIESKh), where D.S. Strebkov, Director of the Institute and Holder of UNESCO Chair "Renewable Energy and Electrification of Agriculture", presented some new energy technologies developed in the Institute and the innovative VIESKh projects to the trainees.

The participants also visited the Zagorsk hydroelectric pumped energy storage station, the Research Institute of Power Structures, the Sapsan-Wind Energy company, which specialises in designing stand-alone solar and wind energy complexes, the Insolar-Invest company, which demonstrated technologies of using low-grade thermal energy of the Earth's surface layers in geothermal heat pump systems of heat and cold supply, the Kuryanovo aeration station, the Laboratory of Renewable Energy Sources of the M.V. Lomonosov Moscow State University, where they became familiar with the process of production of third-generation bio-fuel from microalgae.

At the end of the course, the fellowship holders receive a Certificate of passing training under the UNESCO/ISEDC joint education programme.

The seventh session of the education programme is planned for the autumn of 2013. The innovations will concern the language of the course. The point is that the next stage of the education programme will be conducted in English, which will allow ISEDC to considerably expand the geography of the course and to invite foreign experts for lecturing.

Modern Lighting in Schools

Galina Fedyukina,
Lead Researcher,
Russian Lighting Research Institute (VNISI)

The Russian Lighting Research Institute named after S.I.Vavilov (VNISI) is Russia's leading lighting research centre dealing with theoretical issues, methods, technology and standardisation of lighting, as well as specialising in the development of high performance lighting and irradiation equipment/systems for the agriculture, defence and space industries.

Introduction

Experience shows that there is a correlation between pupil performance on the one hand, and the physical environment in schools, on the other. That is why improving the learning environment in schools means investment in the future. Artificial lighting of school buildings is essential for successfully implementing educational programmes, providing adequate visibility for pupils solving complex visual tasks, as well as for improving the energy efficiency of lighting. One of the main issues here is eyesight health, because children and young people in Russia are increasingly suffering from eyesight problems. According to statistics, 22-25 per cent of young people who leave school have impaired vision, the number of vision defects increasing 2.4-2.5 times during school years. It is primarily the development of nearsightedness (or myopia). Among the causes of myopia are poor natural light and the lack of artificial lighting. This is proved by the fact that the overall rate of myopia in pupils depends on the area of residence. For instance, research studies conducted in our country from 1978 to 1982 reported the rate of myopia to be 11-39% in the north and 5-8% in the south. Researchers attribute the prevalence of myopia in pupils living in the northern regions to a number of reasons, chief among them being specific light conditions and poor lighting in schools. Inadequate or poor-quality lighting is known to trigger the development of myopia due to incorrect posture caused by bringing objects too close to eyes to see, which results in eye strain when reading, writing and drawing. This sets particularly high requirements for lighting in schools, since not only do school children actively develop their visual skills, but their eyes continue to grow and the eye's refraction continues to change until the age of 18-24 years, depending on climatic conditions and ethnic background.

Lighting surveys of schools regularly carried out in Russia's urban and rural areas in the early 1980s and in the 2000s reveal that not even half of lighting requirements have been complied with since the surveys began. What is worse is that, in general, lighting conditions in schools are constantly deteriorating. Even in Moscow schools the average illuminance on the whiteboard/blackboard surfaces is 130-140 lux, with the required level being 500 lux. The average illuminance in classrooms varies from 50-100 lux to 250-260 lux on the working plane, though it is required that this illuminance should not fall below 400 lux. Most school buildings are lit with outdated fluorescent lamps, and as a result the luminance flicker frequency is 2.5-3 times higher than the maximum allowed. Despite the fact that a number of regulations adopted in 2003 prohibit the use of incandescent light bulbs to light classrooms, they are still used in many schools equipped with outdated and inefficient lamps, which means that 35% to 40% of excess energy consumption can be saved, thus offering great potential for cost reduction.

Hence there is an urgent need to provide adequate lighting in schools, which requires compliance with relevant requirements for lighting when using new technologies.

Basic lighting requirements

Lighting requirements include health, environmental and energy aspects. In addition, lighting conditions should be comfortable. The health aspect includes standardising lighting parameters that ensure best practice visual performance and prevent fatigue. The environmental and energy aspects are related to the use of energy efficient light sources and lighting control systems for reduced energy consumption. This, in turn, reduces harmful emissions into the atmosphere, thus preventing pollution of the environment. It should be noted that environmental education has already been integrated into the school curriculum, so it is necessary to raise awareness amongst school children about some practical issues of lighting and energy saving (e.g. the need to turn off unused lights), which may have a positive impact on the future of mankind. How comfortable lightning is has practical importance, because this exerts a background influence on standardised parameters for lighting and provides the correct lighting environment.

The values of recommended lighting parameters depend on many factors: the purpose and physical characteristics of rooms; the type, complexity and duration of visual tasks to be carried out in a room.

In accordance with the modern concept of the general education system, all schools are supposed to act as centres for meeting the educational needs of communities, so, ideally, schools are viewed as full day educational institutions providing pupils with the opportunity to acquire knowledge and learn new skills, do homework, practise sports, join special interest clubs, have fun and eat out. To manage, organise, facilitate and control the educational process, various teaching aids and equipment are expected to be widely used.

In this context, architectural and planning solutions, the design of buildings and technological equipment are to meet the requirements of the educational process. In addition, professionals involved in designing lighting schemes for school buildings should have extensive knowledge of lighting equipment.

In Russia, primary documents used in engineering design are health and construction regulations based on international standards.

It is worth noting that the new health standards for educational institutions, which came into force on 1 September 2011, include up-to-date requirements for lighting.

Lighting indicators

An important characteristic of light is illuminance on the working plane and, according to Russian regulations, it is understood to be the minimum illuminance. Normalised values of illuminance are set depending on the type and complexity of visual tasks to be performed, and on the levels of fatigue to be assessed by the amount of time spent entirely on visual work when the eye's line-of-sight is directed to the working surface. Reading and writing require an illuminance of 400 lux on the working plane (desks). As for sketching and drawing, there must be a maintained illuminance on the working plane (whiteboard/blackboard) of not less than 500 lux. Illuminance can be horizontal, vertical or spatial (cylindrical).

Depreciation factor. Normalised values are the values below which the average illuminance should not fall during the use of equipment. Therefore, it is required that a depreciation factor of 1.4 should be applied for school buildings used under normal conditions, and that normalised values should be multiplied by the depreciation factor.

Non-uniformity of illuminance. An illuminance level is determined for a particular work area. And in order to avoid brightness fluctuations within the field of view, it is necessary to standardise illuminance conditions in immediate surroundings, with the illuminance in this case having a lower value.

Limitation of glare. One of the undesirable effects of illumination is direct and reflected glare, which hinders vision and is the result of excessive contrast between bright and dark areas in the field of view. It can also be caused by directly viewing a light source. According to the latest edition of national standards and regulations, the psychological direct glare is evaluated and limited using the UGR method (Unified Glare Rating), which is well-established as an international index. This method calculates the glare of the entire lighting installation at a defined observer position. Normalised UGR values for school buildings intended for different purposes are 14-25.

Shadow formation. To enhance the visual perception of three-dimensional objects it is necessary to strike the right balance between light and shade which is achieved by maintaining a certain ratio between horizontal and cylindrical illuminance. The optimum ratio of Eh to Ec is 1.6-3.0.

Spectral composition of light sources. To create a physically and psychologically comfortable environment in premises, it is necessary to select light sources, taking account of their colour characteristics: colour temperature (Tc) and colour rendering index (Ra). Classrooms and facilities where children interact with each other (canteens, playrooms, gyms) and where it is necessary to maintain adequate visibility of faces and hands should be fitted with light sources with a colour temperature (Tc) of 3000_4500 K (neutral white and warm white) and with a colour rendering index Ra > 80. Painting rooms require light sources with a colour temperature of at least 5000 K.

Limitation of luminance flicker frequency. The luminous flux of light sources supplied with a power current produce flicker with a frequency of 100 Hz. Despite not being perceived visually, such flicker has a negative effect on the biological activity of the brain. It can cause eye strain, fatigue and headache. Flicker characteristics can be defined using a flicker coefficient which should not exceed 10% for the majority of school buildings. As for computer laboratories, the flicker coefficient should be 5%. The main measure to prevent flicker involves converting the current supplied to lamps into a high-frequency current, i.e., it means using electronic devices. Standardised lighting parameters for particular types of school buildings are set out in the normative documents [1_5].

Energy consumption indicators

When designing school buildings, particular attention should be paid to the energy efficiency of lighting. The main parameters used to monitor the energy efficiency of artificial lighting are power density required to provide an illuminance of 100 lux (W/m2/100 lux) and the luminous efficacy of light sources used (lm/W). Depending on the required level of illuminance and room indices, maximum permissible values for the majority of school buildings are 25-35 according to national standards, which is more than is required by international standards (17-25 W/m^2).

The luminous efficacy of light sources used for internal lighting should be not less than 70 lm/W. The optimum energy performance of lighting and, therefore, the energy efficiency of lighting systems in schools along with environmental improvement can be achieved by using modern light sources, luminaires and lighting control systems.

Light sources

Lighting systems in the majority of school buildings should be fitted with triphosphor fluorescent lamps with a high luminous efficacy (75-100 lm/W), good colour rendering (Ra = 80-90) and long service life (16-20 thousand hours). The most effective are T5 triphosphor fluorescent lamps with a tube diameter of 16 mm and with associated electronic control gear, which completely eliminates flicker. In the case of utility rooms it is advisable to use compact fluorescent lamps with a relatively high luminous efficacy (55-75 lm/W), good colour rendering (Ra = 80-90) and long service life (8-12 thousand hours). Innovative LED technology is being increasingly used as a very effective lighting solution. Due to their high environmental performance (free of mercury), long service life (up to 50 thousand hours), good impact resistance and the absence of UV or IR radiation, LEDs are likely to have promising applications in the near future, especially for accent lighting, and for the lighting of conference halls, stages, utility rooms and hard to reach areas. It is also possible to use other innovative light sources.

Lighting control systems

Lighting control systems provide additional opportunities to save energy. They make lighting installations more efficient and economical so that lamps and luminaires can be optimally controlled and maintained in order to create the most comfortable lighting levels possible. Automatic lighting controls with presence detectors monitor occupancy or movement of people and automatically switch off lighting when the area is unoccupied. Daylight detectors with associated dimming controllers monitor daylight availability, and automatically dim artificial lighting by reducing its power consumption to the level needed to sufficiently illuminate the area. These systems combined with Venetian blinds, which can be used to let daylight into the interior space, create energy saving potential for schools and other educational establishments. The use of presence detectors and daylight detectors, which adjust lighting levels according to the level of daylight the room is receiving, provide energy savings of up to 65%.

Lighting recommendations for different areas of school buildings

Classrooms. In Russia, classroom desks are normally placed in a standard arrangement. The line-of-sight is directed mainly towards the blackboard/whiteboard, with desks arranged in a line along windows. Since teachers and students interact with each other, it is required to provide adequate horizontal and vertical illuminance, as well as a favourable light environment (basic lighting requirements are set out in the normative documents [1_5]). The general lighting system (400 lux) is most commonly used. For general lighting, it is recommended to use light sources and predominantly direct light sources with fluorescent lamps (Fig. 1, a_b).

Special attention should be paid to the lighting of whiteboards/blackboards (500 lux). It is recommended to use luminaires for fluorescent lamps which produce an asymmetric light distribution in the lateral plane. They should be installed in a line parallel to the plane of the blackboard/whiteboard. Other lighting options are also possible: luminaires with direct light output, which are installed at an angle. In any case, to provide uniform illumination it is necessary to relate the height at which the luminaire will be installed to its distance from the plane of the board (Fig. 1, c). Interactive whiteboards, which are increasingly used in schools, do not require special lighting.

Normally, classrooms receive good levels of daylight. To reduce energy consumption, it is required to use lighting control systems, namely luminaires fitted with daylight detectors, which switch on lights and adjust lighting levels, taking into account the natural light contribution from the windows during daylight hours. To provide lighting for wall-mounted visual aids, it is necessary to use luminaires for display and accent lighting because they help highlight display areas and achieve the required level of light intensity in a room.

Computer laboratories. The rapid computerisation of Russian schools has led to the provision of computer laboratories, which require special lighting design, the requirements for which are distinctly different from those for the lighting of general purpose classrooms. Health requirements specified in the relevant regulations [1_4] not only determine standard specifications, but also set maximum permissible levels of luminance of light sources emitting light which can be reflected in the computer screen (Table 1).

Great attention should be given to the elimination of direct and reflected glare, which is achieved by adhering to the following guiding principles: a luminaire with direct light output should be sited on one side of a computer workstation; alternatively, it is possible to use reflected light luminaires to be mounted above workstations (Figure 2). Combined lighting installations are another option. In this case, to ensure adequate lighting over a desk it is necessary to use luminaires with opaque reflectors with a shielding angle of at least 40 degrees.

Table 1. Maximum permissible luminance of light sources when using different types of displays

Display types (as defined by ISO)	I	II	III
Display quality	Good	Average	Bad
Maximum permissible average luminance of light sources	<1000 cd/m²		<200 cd/m²

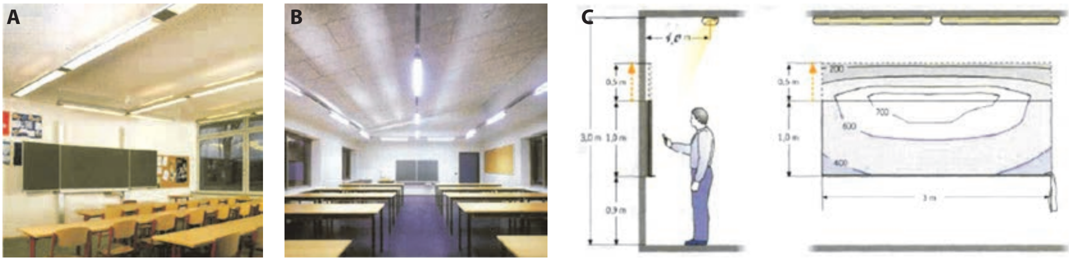


Figure 1. Suspended fluorescent luminaires used for classroom lighting:
a – fluorescent luminaires installed in a line, b – luminaires mounted on fixturing system ceiling bus bar;
c – blackboard lighting using fluorescent luminaires with asymmetric reflectors
(producing an asymmetric light distribution in the lateral plane)

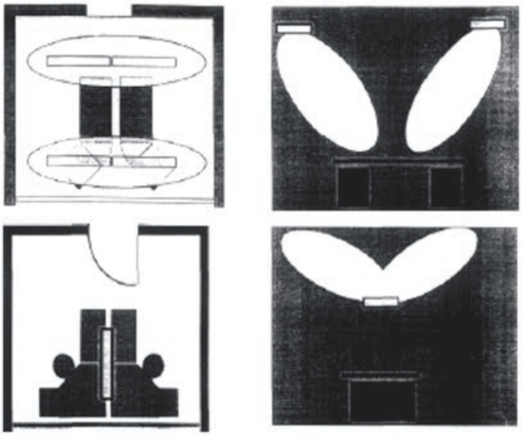


Figure 2. Illustration of luminaire layout:
Top – luminaires with reflectors 1 ´ 58 W and direct light output, with two luminaires mounted on either side of the desk; bottom – reflected light luminaires 2 ´ 55 W mounted above the workstation.

Technical drawing and painting classrooms. More demanding visual tasks result in much higher requirements for lighting – 500 lux. Particular attention should be paid to correct colour rendering, so it is only necessary to use light sources with a colour temperature (Tc) of 5000–6000 K and with a colour rendering index (Ra) of not less than 80. The general lighting system is normally employed, with luminaires being the same as for classrooms.

Metalwork- and woodwork- rooms. There should be adequate lighting in the work area, which is achieved by maintaining high levels of illuminance through combined lighting installations. It is essential to avoid glare and ensure adequate contrast, sharp shadows being totally unacceptable, especially where dangerous tools and equipment are used. When working with rotating parts, it is required to use luminaires with electronic control gear in order to avoid stroboscopic effect.

All the recommended specifications are given in [5].

Conference halls may be used for various purposes, which is why it is crucial to provide for the installation of lighting control systems and stage lighting systems. High levels of vertical illuminance on stage allow a better view of the speaker. The general lighting system (200 lux) is normally comprised of rows of fluorescent lights. It is also possible to use compact fluorescent lamps, halogen ceiling lights (Fig. 4), and reflected light sources.

In addition, if a conference room can accommodate up to 100 students, it is required that illuminated exit signs be provided above all exit doors and connected to an evacuation lighting system.

Gyms. The main purpose of lighting in gyms is to provide a safe and well-lit environment with an adequate level of vertical illuminance and with minimum glare. It is advisable to use fluorescent luminaires mounted on the ceiling along the side walls or at an angle on the side walls. Each luminaire should be fitted with a protective grille which can withstand the effect of ball impact during games. The minimum illuminance should be 200 lux at floor level.

In the case of indoor swimming pools, the most commonly used are luminaires with direct light output. As a general rule, they are mounted on the ceiling or walls above side aisles for ease of maintenance. Reflected light sources (reflect-

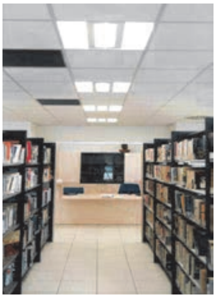


Figure 3. Example of lighting in the books storage area of a library

Figure 4. Conference hall lighting example

Figure 5. Lighting of staffroom

ing light from walls onto the ceiling) are also useful for swimming pools and gyms.

Staffrooms. Teachers' common rooms, head-teacher's rooms and secretary's offices are designed for multiple purposes and require a maintained illuminance level of 300 lux. In these rooms the lighting has the following role: to light teachers' desks and workstations, which is why it is important to prevent glare on screens. In meeting spaces it is necessary to use luminaires capable of providing sufficient levels of cylindrical illuminance (Fig. 5).

Recreation areas, staircases. Well-lit corridors and staircases prevent injuries and create a feeling of confidence and security. Light-coloured walls and ceilings are most preferable. Modern LED signs in stairs, together with luminaires installed in walls to light stairs, can increase safety. Naked lights should not be seen when looking up and down. It is necessary to provide for an evacuation lighting system. Lighting in recreation areas is exemplified in Figure 6.

Exterior lighting of schools. To prevent accidents, areas around schools should be well lit, and all the luminaires should be architecturally compatible with school buildings and the surrounding landscape. To save energy when employing outdoor lighting systems, it is advisable to use dimming technology as well as selective switching (switching off selected lights) at night-time. Facade lighting can help to protect school buildings from being hit by burglars or vandals.

Conclusion

Currently, there are favourable conditions for the design of lighting systems for school buildings in Russia in line with the latest technological developments. Relevant health and construction regulations have been developed and brought into effect to set requirements for lighting that will provide healthy environment for children and teenagers.

Modern types of lamps and luminaires contribute to energy saving, whilst improving the quality of lighting. The use of electronic control gear reduces power loss and eliminates flicker. Modern reflective materials used in lighting equipment improve luminaire efficiency and the shielding of light sources.

Daylight detectors with associated dimming controllers monitor daylight availability and automatically dim lighting to the level needed. Presence detectors automatically switch off lights in unoccupied areas. All this reduces power consumption, thus improving the environment.

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Alternative energy technologies as a cultural endeavor: a case study of hydrogen and fuel cell development in Germany

Ante Galich
Faculty of Language and Literature, Humanities, Arts and Education, University of Luxembourg

Lutz Marz
Social Science Research Center, Berlin, Germany

The University of Luxembourg is the only university in Luxembourg, founded in 2003. Prior to that, there were several higher educational institutions such as the cours universitaire or the IST that offered one or two years of academic studies. Luxembourgish students had to go abroad in order to complete their university studies (usually to Belgium, France, Germany, Austria, and the United Kingdom). The new university makes it possible for these students to complete their studies in their own country, as well as to attract foreign academic interest to Luxembourg.
The Social Science Research Center Berlin (Wissenschaftszentrum Berlin für Sozialforschung), also known by its German initials WZB, is an internationally renowned research institute for social sciences, the largest such institution in Europe not affiliated with a university. It was founded in 1969 through an all-party initiative of the German Bundestag. Around 140 German and foreign sociologists, political scientists, economists, historians, statisticians, computer scientists and legal scholars work in the WZB conducting basic research on selected social and political issues, concentrating on the industrialized societies of Japan and the West, as well as on the transformations of Central and Eastern Europe and China.

Abstract

The wider background to this article is the shift in the energy paradigm from fossil energy sources to renewable sources which should occur in the twenty-first century. This transformation requires the development of alternative energy technologies that enable the deployment of renewable energy sources in transportation, heating, and electricity. Among others, hydrogen and fuel cell technologies have the potential to fulfill this requirement and to contribute to a sustainable and emission-free transport and energy system. However, whether they will ever reach, broad societal acceptance will not only depend on technical issues alone. The aim of our study is to reveal the importance of non-technical issues. Therefore, this article presents a case study of hydrogen and fuel cells in Germany and aims at highlighting the cultural context that affects their development.

Background

Shift in the energy-technology paradigm: from fossil to renewable energies

The contemporary energy system will be radically transformed in the twenty-first century, and these expected changes are often labeled as the 'new industrial revolution' [1]. At the core of this revolution there is a shift in the energy-technology paradigm away from fossil energy technologies to renewable ones [2]. This paradigm shift is enforced through two pivotal global processes:

– Firstly, in the future, there will not be enough cheap crude oil for worldwide economic growth [3].
– Secondly, it has become almost indisputable that greenhouse gas emissions will lead to considerable changes in the global climate.

This growing awareness of climate change has strengthened environmental policies and supported the development of renewable energy technologies [4].

Until recently, there has been a huge schism between scientists in their predictions of the future oil production. While some of them assumed that oil production has already reached its peak and will soon decline, others argued that there are large undiscovered oil reserves that will be exploited in the future. However, voices supporting the latter position have become scarce, and most scientists now believe that oil production has either already reached its peak and will not increase further [3] or will reach it at the latest by 2035 [5]. Forecasts on the worldwide oil demand are even more consistent. Despite the current demand collapse due to the economic crisis, it is widely believed that the demand for oil will increase again. Both decreasing oil production and growing oil demand will inevitably lead to a rise in oil prices. Hence, economic growth needs to be decoupled from oil, and alternative energy technologies that do not rely on fossil energy sources must be developed.

The second process that promotes this development is climate change. A rise in the global surface temperature has been observed since 1850, when instrumental recording first started [6]. Simultaneously, the concentration of greenhouse gases in the atmosphere has increased since 1750 as a result of human activities, in particular the beginning of the industrialization at the end of the eighteenth century [6]. Though it has long been contested, whether these two processes are related to each other, with some uncertainty still remaining, it is very likely that the global warming is caused by humans [6]. Both the concentration of greenhouse gases and the resulting rise in temperature have been characterized by exponential growth since the beginning of the twentieth century. This development has had consequences; scientists have observed several phenomena that are caused by global warming. There is a strong conviction that the rise in temperature resulting from greenhouse gas emissions will lead to considerable changes in the global climate [6,7].

Alternative energy technologies

For all the reasons outlined above, it is necessary to decouple economic growth from fossil energies and to develop alternative energy technologies that rely on renewable energy sources. Hence, the decreasing availability and rising prices of fossil fuels, as well as climate change and its consequences, resulting from their mass usage, not merely cause the change in the energy technological paradigm, but also determine its direction. It is not only a transformation from fossil to non-fossil renewable energy sources, but also a change to those renewable energy sources whose production and consumption allows a CO_2-free energy cycle. Therefore, energy technologies need to be developed, which in combination with renewable energy sources provide a CO_2-free energy cycle from generation to the end use. While this at first glance may seem to be a technical endeavor, the transformation from fossil to renewable energy sources cannot be achieved by engineers alone, as diverse research strands such as, for instance, economic history perspectives (e.g., [8,9]) or micro-sociological studies (e.g., [10] or [11]) have highlighted the significance of culture in technology development. In fact, interdisciplinary collaboration is required in order to tackle this shift in the energy paradigm.

An important area of application of alternative energy technologies is the transportation sector that heavily relies on the combustion of fossil fuels and thus accounts for a large share of overall emissions. Within the range of this quest for new energy sources, various fuels such as, for example, natural gas, synthetic fuels, or fuels from biomass have been developed and tested in combination with several different propulsion systems in the automotive industry [12]. Hydrogen and fuel cells are among the technologies that open up the chance to deploy renewable energy sources in transportation and electric power, as well as in heat generation, in

CO_2-free energy cycles. Thus, they target an area which is currently responsible for half of the European Union's [EU] total greenhouse gas emissions [13].

However, for two reasons, this is not necessarily the case. Firstly, the term 'hydrogen and fuel cell technology' suggests a combination of the two technologies, which is possible, but not mandatory. Hydrogen can be used without fuel cells, for instance, as fuel for internal combustion engines in vehicles. Likewise, fuel cells can be powered by fuels other than hydrogen, such as methanol. Furthermore, there is a substantial difference between the two technologies: hydrogen is an energy carrier, while fuel cells are energy converters. Hydrogen and fuel cells are, therefore, the combination of an energy carrier and an energy converter technology. This combination is a broad application area of both technologies, but not the sole one.

Secondly, it should be noted that both technologies are not ecological per se. As hydrogen rarely exists in its pure gaseous form in nature, it has to be obtained from hydrogenous compositions. There are a variety of possible production processes, and hydrogen can be generated from coal, natural gas, biomass, and water. Each production process results in a different energy cycle. Fuel cells present a similar picture. They can be powered by methanol or hydrogen, which can be produced from several different raw materials and in a variety of ways, so that both result in completely different energy cycles.

Therefore, the supporters of hydrogen and fuel cell technologies do not promote them in general, but with regard to their ecological potential. They envisage 'green' hydrogen and fuel cell technologies that rely on renewable energies and contribute to a CO_2-free energy cycle instead of 'black' technologies that are based on fossil energy sources. In order to speak of a CO_2-free energy cycle, the entire fuel process chain has to be considered. This concerns the fuel pathway from 'fuel processing from the primary energy source' to its use 'by the propulsion technology that converts fuel to motion on board the vehicle' [14]. In the case of hydrogen, only hydrogen production from renewable energies can contribute to a CO_2-free energy cycle [14]. This green potential of hydrogen and fuel cell technologies and their wide variety of applications are what attract the interest of many diverse actors. Hydrogen and fuel cells can, for instance, be used to generate power and electricity, as well as to run small-scale heating devices for private households and large-scale devices for industry. They can not only provide power for small, portable applications such as mobile phones and notebooks, but can also serve as a propulsion system in large vehicles.

The history of hydrogen and fuel cells

The basic inventions of hydrogen and fuel cell technologies (hydrogen combustion engine and fuel cell) were made at the beginning of the nineteenth century and are today closer to societal usage than ever before. However, the history of hydrogen and fuel cell technologies presents by no means a linear process. Their development for the transport sector is illustrated in detail on the website 'H2Mobility' of TÜV-SÜD [15], the technical inspectorship for vehicles in southern Germany, and is briefly summarized in the following paragraphs.

The first hydrogen-driven combustion engine was constructed by Issac de Rivaz in 1806. The invention did not receive much attention in the societal discourse for the next 50 years, and it was not until 1863 that the next vehicle driven by a hydrogen-powered combustion engine was constructed by Étienne Lenoir. Nevertheless, the technology had disappeared once again from the scene until the late 1920s when Rudolf Erren constructed a hydrogen-powered two-stroke engine. This development was followed by single concept studies during the following decades, but none of them passed beyond the laboratory stage.

The history of fuel cells is characterized by a similar trajectory. The mechanisms of fuel cell technologies were discovered in 1838 by the German-Swiss chemist Christian Friedrich Schönbein and the British lawyer and natural scientist Sir William Grove, who did research independently of one another. The fuel cell gained its actual name in 1889 from Ludwig Mond and Charles Langer who conducted thorough investigations into this technology. Still, it was not until 1932 that the first model of an alkali electrolyte fuel cell was constructed by Francis Thomas Bacon. This development was followed by the construction of the first vehicle with fuel cell propulsion in 1959.

The development of hydrogen-powered combustion engines and fuel cell propulsion systems exhibited a similar picture until the late 1960s. Both began with basic inventions by a single person, followed by single inventions and wide temporal intervals during which the technologies did not gain societal attention. However, by the end of the 1960s, the initiatives aiming at the societal acceptance of hydrogen and fuel cell technologies started to increase all over the world. This rise in interest was the result of two separate developments: first, hydrogen and fuel technologies were successfully applied in spacecrafts in the 1960s and 1970s where they not only demonstrated their technical functionality, but also gained a high value as key technologies that enabled travel to the moon; second, the 1973 oil crisis fostered the development of alternative technologies for the transport sector that should decouple modern mobility from crude oil.

Various indicators could clarify the dynamics in the development of hydrogen and fuel cells from the 1970s to the present. One could, for example, take media attention (cf. [16-18]) or the number of constructed prototypes and optimistic statements by the industry (cf. [19]) as a standard for the upgrading or downgrading of these technologies. However, we decided to focus on the statistics of the German Federal Republic regarding the funding of hydrogen and fuel cells developments as these illustrate very well the societal and, in particular, the political valuation of these technologies.

Public funding increased continuously from 1974 and reached a temporary peak in 1994 [20]. However, from 1994 onwards, funding decreased and reached its lowest point in 1999 when it fell back to the 1988 level. The end of the lighthouse projects 'HYSOLAR' and 'NECAR' accompanied this development. HYSOLAR, an abbreviation for 'Hydrogen from Solar Energy', was a German-Saudi-Arabian research, development, and demonstration program to assess the chances of CO_2-free hydrogen production from solar energy in Saudi Arabia that then should be transported to Germany [21]. The program ran from 1985 to 1995 without a follow-up project [21]. NECAR, an abbreviation for 'New Electric Car' and 'No Emission Car', was initiated and accomplished by the German car manufacturer Daimler. The objective of this project was to develop a fuel cell propulsion system for vehicles. For this purpose, five fuel cell-powered vehicle prototypes were constructed between 1994 and 2000, when the project had finished.

The end of these projects and the decrease in funding made clear that hydrogen and fuel cell technologies at the turn of the millennium reached the bottom of their history in Germany, but then, a short period from 1999 to 2005 followed in which funding again began to rise and was stabilized at a comparably high level of above €20 million/annum. Thereafter, funding increased vastly, and hydrogen and fuel cell technologies should attract funding of at least €100 million/annum from 2008 to 2016 [22], which would exceed the average annual funding from 1974 to 2004 by more than a factor of 10 [20]. This development raises the question: What factors led to this rapid increase in funding a technology field that appeared to have lost its attraction?

Methods

We chose to conduct a single case study as it allowed the data to be gathered from six different sources: documents, archival records, interviews, direct observation, participant observation, and physical artifacts [23]. Our information comes from a rich pool of data generated in various research projects on the development of alternative energy technologies. We conducted more than 30 in-depth interviews with experts in this area, attended conferences, analyzed protocols from the meetings of relevant networks, and examined the formation of specific agencies launched to promote the development of hydrogen and fuel cell technologies. Hence, the results presented in this article are drawn from a rich pool of data from multiple sources of evidence in order to increase their validity and reliability [24].

As is usual in case studies, we performed the data collection and analysis simultaneously. After data gathering and analysis, theoretical frameworks, which explain the examined phenomenon, had to be developed by abstracting the collected information from the case in question [25]. By focusing on principles that regularly occur under certain circumstances, while ignoring aspects that are specific to the case in question [26], we generalized our results into a generic framework that explains how to grasp the cultural influence in technology development.

Results and discussion: hydrogen and fuel cells in Germany from 2000 to 2010

To capture the cultural influences in technology development, Banse and Hauser recommend focusing on the overall context characterized by history, language, and institutions in which the technology is embedded [27]. While the historical dimension has been outlined above, with regard to the language part, it should be noted that in Germany, most attention is paid to transport applications due to the importance of the automotive industry. The transformation of the contemporary CO_2-emitting energy system into a CO_2-free one that is based on hydrogen and fuel cell technologies is strongly associated with the development of a sustainable transport system. The guiding vision is the image of hydrogen that is produced from renewable energy sources and then used as a transport fuel to power fuel cell-driven vehicles.

Institutions, however, do not merely constitute the explainers in this case but are simultaneously part of the explanation as well. The launch and development of the National Organization for Hydrogen and Fuel Cell Technology [NOW], for instance, characterizes a milestone in the history of hydrogen and fuel cells in Germany. On one hand, the launch of NOW is accompanied by a huge increase in funding and thus constitutes an event that needs to be explained. On the other hand, NOW influences the further development significantly due to its generous budget. Hence, the launch of NOW has to be explained in order to understand the important role of this institution in the further proceeding. For this purpose, the relevant individual and collective actors as well as their practices will be portrayed in the following paragraphs as recommended by Banse and Hauser [27].

Individual and collective actors

The trajectory of hydrogen and fuel cell development described above was no coincidence, but rather a result of the work of diverse individual and collective actors. On the basis of our analysis of hydrogen and fuel cell technologies in Germany from 2000 to 2010, we can distinguish at least three types of individual and collective actors: experts, alliances, and agencies.

Experts are individuals who observe the environment for the organizations they belong to. Their objective is to detect relevant changes in good times so that their organizations can adapt to them. Two relevant experts are, for example, Klaus Scheuerer from the German car manufacturer Bayerische Motoren Werke AG [BMW] and Patrick Schnell from the French mineral oil company Total. Scheuerer represents BMW in the agencies 'Transport Energy Strategy' and 'Clean Energy Partnership' [28]. He is the link between BMW and these agencies as he presents the company's efforts in promoting hydrogen and fuel cell technologies to other experts while keeping the company up-to-date on the efforts of other actors. The same can be said for Schnell who not only represents Total in the Clean Energy Partnership [29], but also represents the Clean Energy Partnership in relation to other agencies such as the National Organization for Hydrogen and Fuel Cell Technology [30].

In order to detect relevant changes at an early stage, experts from diverse organizations work together and exchange their views on the development of certain inventions. This enables the emergence of alliances that stabilize the cooperation. Alliances are 'inter-organizational networks' [31] which are composed of experts from diverse organizations. Individuals such as Schnell and Scheuerer compose the hard core of an alliance that initiated several agencies. It consists of 14 persons: 5 from large-scale enterprises, 3 from Federal Ministries, 3 scientists, 2 from associations, and 1 self-employed member. In addition, there exists a group of 25 to 30 associated persons representing the members of the hard core in case of illness or holiday [32]. They cooperate not only in exchange of views, but also to influence the development of certain technologies. As this work is quite intense and the individual members of an alliance still have to carry out the daily work for their organizations, they create agencies whose sole objective is to influence the development of specific technologies. Agencies can adopt various organizational forms such as departments, task forces, working groups, partnerships, networks, and so on. In the following paragraphs, the three most influential agencies in Germany should be briefly presented.

The Federal Government, represented by the Federal Ministry of Transport, Building and Urban Affairs, and the private enterprises Aral, BMW, Daimler, MAN, RWE, Shell, and Volkswagen (TES, unpublished work) launched the Transport Energy Strategy [TES] in May 1998. Ford, General Motors [GM]/Opel, Total, and Vattenfall joined it at a later date [33]. The objective of TES was to develop a strategy that should secure an internationally leading position for Germany in the field of energy production from alternative sources and its application in the transport sector during the next 10 years (TES, unpublished work). Out of ten potential alternative fuels and more than 70 different ways to produce them, the involved actors finally identified CO_2-free hydrogen produced through means of renewable energy as the most promising future fuel (TES, unpublished work) [33].

The Clean Energy Partnership [CEP] is the largest demonstration project for hydrogen and fuel cell technologies in the EU. It was set up in October 2003 [34] and is composed of car manufacturers BMW, Daimler, Ford, GM/Opel, Honda, and Volkswagen; energy supplying companies Aral, Linde, Shell, StatoilHydro, Total, and Vattenfall; and transport companies BVG and Hamburger Hochbahn [35]. Furthermore, the Federal Government is involved in CEP represented by the Federal Ministry of Transport, Building and Urban Affairs [34]. It funds the project with up to €5 million in order to support the construction of a hydrogen infrastructure [34]. The shared ambition of the involved actors is to work towards a silent and clean transport system with hydrogen and fuel cell technologies at the core [36]. Therefore, they construct hydrogen filling stations and test hydrogen-powered vehicles in order to foster technology development [36].

NOW was launched in 2008. It is composed of a supervisory board, an advisory board, and a management committee [37]. The supervisory board is composed of representatives from the above-mentioned four Federal Ministries [38]. These ministries are also involved in the advisory board that also consists of representatives from energy suppliers, car manufacturers, and scientific institutions [39]. The main task of the management committee of the NOW is to coordinate and steer all demonstration projects in order to push hydrogen and fuel cell technologies towards market entry [40]. For this reason, NOW funds more than 35 hydrogen and fuel cell demonstration projects [41]. The most important of these projects is CEP. From 2008 to 2011, NOW provided 48% of CEP's complete budget of €25.8 million [22].

Supportive practices

The actors described above have deployed various practices in order to promote the development of hydrogen and fuel cell technologies. Based on our analysis, we distinguish five practices of (1) networking, (2) agency creation, (3) agenda setting, (4) problem/solution framing, and (5) vision building which will be explained in more detail in the following paragraphs.

Networking refers to the cooperation of the diverse members of an alliance and their efforts to attract new members. This can be done at conferences, workshops, or at other official meetings where alliance members attempt to convince other actors of the value of hydrogen and fuel cell technologies. Very significant events are the so-called parliamentary evenings which are held on a regular basis. These provide diverse actors with the opportunity to meet decision makers from politics, science, and industry and to inform them about the latest developments in hydrogen and fuel cell technologies [42].

Successful networking in alliances is the prerequisite for agency creation. Alliance members create agencies whose sole objective is to enhance the societal usage of certain inventions. Thus, the creation of agencies aims at accelerating the development of specific technologies. A prime example for the creation of an agency is the emergence of NOW which was implemented on the initiative of other agencies such as TES and CEP in order to set up a superordinate authority that would eventually merge all of them into one central organization. The main task of NOW is to coordinate and steer all demonstration projects in order to push hydrogen and fuel cell technologies towards market entry [40]. Hence, the launch of NOW reveals the efforts of diverse actors to make the process of technology development more efficient.

The practice of agency creation can not only result in agenda setting, but can also result from it. Agenda setting focuses on the development, promotion, and implementation of strategies, programs, or plans for the societal usage of a specific invention. TES is the actor who deployed agenda settings most successfully. It suggested, for instance, the launch of CEP in June 2001 [43], and CEP was set up in October 2003 [34]. TES has also lobbied towards the establishment of a common European platform for the promotion of hydrogen and fuel cell technologies and has apparently succeeded as the launch of the Fuel Cell and Hydrogen Joint Undertaking by the Council of the European Union indicates [44]. Finally, TES had been successfully lobbying towards the development of a national innovation program for hydrogen and fuel cell technologies and had also succeeded as such a program was initiated by three Federal Ministries in 2006 [20].

Problem/solution framing and vision building are two further practices. Problem/solution framing aims at clarifying that the societal value of hydrogen and fuel cell technologies is based on their capacity to solve serious problems of modern societies. The practice always starts with the presentation of a certain problem that can be of economic, political, or ecological nature. Typical examples of such problems are climate change, rising oil prices, transport sector emissions, or the dependency of Western economies on the import of crude oil. All these issues are portrayed as urgent problems that endanger our standard of living. Hydrogen and fuel cell technologies are then presented as an ideal solution to these problems as they enable an emission-free energy and transport sectors on the basis of renewable energy sources (cf. [36,45,46]).

Vision building also refers to the future potential of hydrogen and fuel cell technologies; however, in contrast to problem/solution framing, it does not focus on current problems but rather highlights the advantages of hydrogen and fuel cell technologies by future visions. Vision building is embedding hydrogen and fuel cell technologies in a future world that reflects the current desires for a sustainable and secure energy system. These future visions can bring together diverse actors and coordinate their further actions as they all pursue the same target of realizing the vision. In this way, vision building contributed to successful networking and agency creation, in particular, in the USA, the EU, and partly also in Germany [47].

Arenas of meaning

Actors and their practices do not exhaust the cultural influence in the development of alternative energy technologies. Moreover, the cultural context, in which technologies are applied, is of great importance as it provides meaning for the use of the technologies [48]. Cultural context does not only provide meaning for technologies, but can also provide a space in which the meaning of a technology is renegotiated and redefined [48]. Hence, diverse individual and collective actors adjust their practices to the cultural context in which they attempt to establish a certain meaning for a specific technology. Considering the development of hydrogen and fuel cell technologies, we identified five dominant arenas of meaning: (1) an economic arena, (2) a political arena, (3) a regional arena, (4) a European arena, and (5) an ecological arena. These five arenas of meaning will be outlined further in the following paragraphs.

The economic arena is characterized by demonstration projects as these shall exemplify the capability and functionality of the technologies and move them closer towards an entry in the market place. Agencies such as NOW promote the hydrogen and fuel cell technologies as climate-friendly and economically sustainable solutions for the maintenance of modern mobility requirements [22]. Hence, NOW funds demonstration projects as well as CEP in order to convince producers and users that 'even today hydrogen-powered cars and busses can be developed as an alternative to conventional road traffic' [22]. Furthermore, it identifies market niches in which fuel cells are already close to market readiness and supports their commercialization with the intention that these niches shall function as stepping stones for the breakthrough into mass markets [22].

The emphasis of the national importance of the technologies depends on the specific implications from the political arena. Here, it is argued that Germany is about to lose its international leadership in hydrogen and fuel technologies if the country does not react immediately [20]. A catchy and often-mentioned slogan is fuel cells are coming either from Germany or to it [49]. This slogan illustrates that Germany could lose about 250,000 jobs if, for example, 20% of all vehicles have to be imported because there is no domestic production of fuel cell cars [20]. Therefore, the development of hydrogen and fuel cell technologies is of national interest and cannot be ignored by politics.

Apart from this political arena, which primarily matters on the national level, we could also identify a regional arena. Here, the ambition is to convince the diverse actors in a specific territorial area of the value of hydrogen and fuel cell technologies by highlighting the special importance of these technologies for the region in question. The agency 'hySOLUTIONS,' for example, focuses on the promotion of hydrogen and fuel cell technologies in the city of Hamburg. Its objective is to turn Hamburg into a hydrogen metropolis and to move the city into a pioneering role in setting international environmental standards [50]. Its regional strategy has apparently been quite successful so far as the 'ZEMSHIPS' project indicates in which diverse industry actors cooperate in order to develop fuel cell ships that enable emission-free trips on Hamburg's rivers [51].

Agencies are also present in the European arena where they promote hydrogen and fuel cells as the key technologies of the future for the EU. The Fuel Cell and Hydrogen Joint Undertaking [52] provides an example of a European agency, which is working towards the implementation of the European hydrogen vision [53]. It promotes the hydrogen and fuel cell technologies on the basis of their potential to reduce emissions and to contribute to economic growth. Since its members come from the European Commission, the European industry, and the research community [52], the agency succeeded in involving some of the most influential stakeholders in the EU.

Almost all individuals and collective actors do refer to the ecological potential of hydrogen and fuel cell technologies and support their development in the ecological arena. Diverse studies emphasize the emission reduction potential of the technologies in combination with renewable energies (cf. [54,55]). Hydrogen and fuel cells are presented as the key technologies for the transformation of an emission-producing energy system relying on fossil energy sources towards a sustainable emission-free energy system based on renewable energy sources in Germany [20] as well as in Europe [53].

As the illustrations above indicate, these five types of arenas of meaning do not exclude each other but rather overlap and support each other. Diverse actors adjust their practices to the arenas in which they intend to promote the technologies.

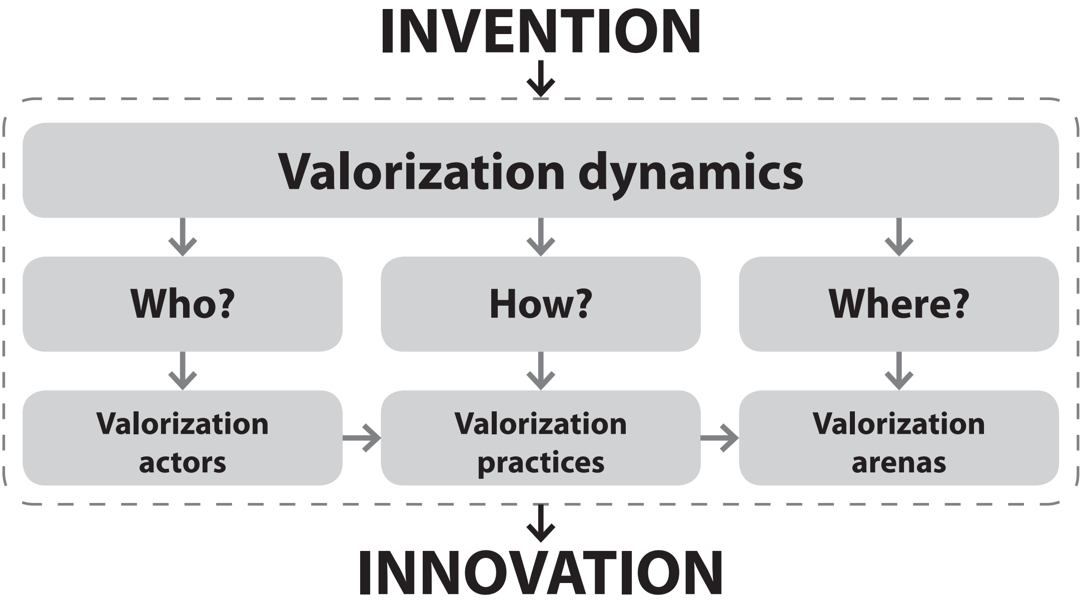
Conclusions

The analysis above has revealed how the development of hydrogen and fuel cell technologies is culturally embedded. Individual and collective actors from economy, science, and politics have succeeded in establishing an overall institution for the development of these technologies and in allocating a generous budget for it. Based on these findings, we deducted a general model for the analysis of cultural influences in technological innovations. It focuses on the history of a certain technology and on the actors who promote it with specific practices in specific contexts. The model should be employed for the analysis of the cultural influence in the development of alternative energy technologies in order to contribute to the interdisciplinary collaboration required to tackle the challenges in the energy sector of the twenty-first century.

Our model centers on the process during which diverse actors attempt to portray novel inventions as societally valuable in order to lead them to societal acceptance. It is challenging to find a specific term for the process of 'making something valuable' which is so important for the transformation of inventions into innovations. In German, one could speak of Wertgebung or Inwertsetzung, but these terms are difficult to translate into other languages and also sound dated. Boris Groys defines “valorization” in a generic sense as “reassessment” [56] that can mean both upgrading and downgrading. Unfortunately, this term is neither easy to comprehend nor was Groys the first one to use it. In projects of the European Union, valorization plays a role in applications and evaluations [57]. However, in spite of these ambiguities, valorization still appears to be the most precise term to describe what we intend to analyze. With reference to the work of Boris Groys [56], we define valorization as a reassessment process that transforms inventions into societally valuable innovations.

Analogous to commercialization as the economic transformation of an invention into an in-

Рис. 1. Модель валоризации.



novation, we speak of valorization as the cultural transformation. However, as cultural contexts are only temporary agreements, every valorization process is unique, determined by the invention, the era, and the place. However, despite this uniqueness, a comprehensive framework is recognizable as every valorization process is characterized by certain dynamics that are driven by specific actors who develop special practices in diverse arenas. Therefore, our suggestion is to focus on such dynamics, actors, practices, and arenas that constitute the valorization model outlined in Figure 1.

First, the dynamics of valorization have to be recognized. All valorization processes start with the detection of a value in a specific artifact. We speak of detection in order to emphasize that this value is an inherent aspect of the artifact in question. Hence, value detection is not an ascription process because the value of a certain artifact is present at all times, therefore making it feasible for usage. This feasibility for usage is a necessary but not sufficient condition for the transformation of an invention into an innovation. Archives of technology such as museums, libraries, textbooks, journals, scientific laboratories, movies, patent offices, and so forth are revealing inventions which never became innovations, and innovations which were replaced by other ones. They clarify that the detection of a specific value in an artifact does not necessarily lead to its societal usage [58]. Valorization can be successful in the short term but fail in the long term, or it can be interrupted and later successfully resumed; it can occur continuously, discontinuously, or not at all. The dynamics of valorization can be recognized by focusing on factors such as the number of published articles on a specific topic, the amount of funding, or the number of performed demonstration projects. The development of these factors over time indicates whether an invention moves towards societal usage or becomes less relevant.

Actors play a crucial role in the valorization dynamics as they assess whether an invention is only feasible or if it is also worthy of usage. For a successful valorization, there has to be a specific group of actors who believe in the worthiness of an invention and lobby for its societal usage. These valorization actors can be individuals, networks, or organizations. Some of them are working exclusively on the valorization of a specific technology, while others only dedicate a certain part of their daily work to it. What all these diverse types of valorization actors have in common, however, is that they promote the value of a certain invention in order to make other actors aware of it. A successful value promotion results in the upgrading of the invention and can finally lead to its societal usage. The upgrading of an invention, however, also means the downgrading of something else, i.e., the artifact intended to be replaced by the invention or other competing inventions. Hence, valorization actors who promote diverse technologies can be in competition with each other. However, whether they are in competition depends on whether they regard the inventions as competing or complementary.

In order to promote certain inventions, the actors have to develop diverse valorization practices. They can, for example, cooperate with each other and launch new organizations where their sole objective is to work on the valorization of a specific artifact. In addition, they can lobby for a certain technology on the political or public level. A specific technology can be portrayed as valuable by embedding it in wider societal contexts. It can be illustrated as the ideal solution to certain societal problems or as a desirable goal that could benefit society as a whole. Valorization actors attempt to set the political agenda by such lines of argumentation. Another strategy would be to include the end users in the valorization process. This can be done by public demonstration projects that bring the users in contact with the technology and give them a chance to express their opinion on it. However, the end users can also become the main valorization actors if the artifact in question is made available to them (cf. [59]). This occurs, for example, in the case of open source software engineering.

These illustrations have already indicated that valorization practices differ because they are applied in diverse arenas. Valorization arenas denote the topical focus that frames valorization practices. An economic valorization requires other lines of argumentation than a political one. While technologies have to be efficient and low-cost to become attractive for industry, political actors may be more interested in environmentally friendly or societal consequences. Furthermore, it is important whether an invention shall be valorized regionally, nationally, or Europe-wide as these arenas provide different conditions for new technologies. Due to the differences in culture, end user preference, or technical conditions, it may be comparably easy to promote the value of a specific invention in one European country, while it is almost impossible in another. Hence, valorization actors adapt their practices to the arenas which they intend to address.

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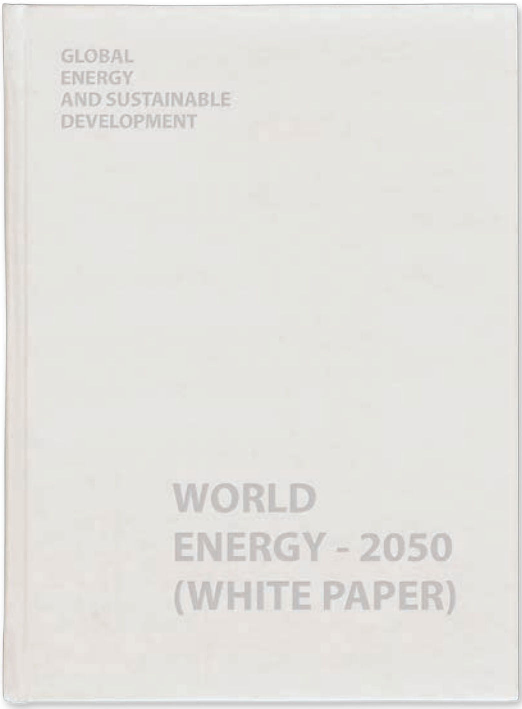
«World Energy – 2050 (White Paper)»



In Moscow, the Russian Federation, a group of Russian experts in almost all areas of the fuel and power sector, which is perhaps the most complex and extensive segment of the economy, has published a book entitled "World Energy – 2050 (White Paper)." This publication is the result of in-depth research carried out as part of a joint project initiated by the International Sustainable Energy Development Centre under the auspices of UNESCO (ISEDC) and the research centre "Globalisation and Sustainable Development – the Institute for Energy Strategy" several years ago, which in 2009 resulted in the book "White Paper: Global Energy and Sustainable Development." Both editions reflect views expressed by teams of contributors with regard to the role of the energy industry and its future potential in the context of the sustainable development of our society at national, regional and global levels. These two books published as two volumes of the White Paper are quite distinct though in terms of content they complement each other. The recently published "World Energy – 2050 (White Paper)" is entirely focused on forecasting the energy development as a complex and diverse system on a global scale under alternative scenarios for the world economy evolution. Therefore, it is of particular interest not only to energy specialists, but also to professionals in various fields of economy, science, education and culture.

It is for this very reason that this project initiated by ISEDC has always enjoyed the full support of UNESCO, which back in the late 1970s and early 1980s was actively involved in scientific and technological assessments of promising energy technologies and exploring their practical applications in the medium and long term perspectives. UNESCO's projections were primarily based on an interdisciplinary approach, which fully reflects the essence of this international organisation responsible for promoting intellectual cooperation within the United Nations system. It should be noted that some of these estimates have failed to keep pace with reality; however, many of them have further encouraged the development and introduction of new energy technologies. During that difficult period for our society in terms of world energy situation, some other international and regional organisations were also involved in forecasting the world economy and energy developments. They produced several forecasts which were extrapolative by nature and did not take into account the complexity of these systems and boundary conditions set for these systems by society in the course of its evolution. It is quite clear that these forecasts have proved to be largely incorrect, though they have provided a sound methodological basis for forecasting the development of complex social and economic systems, including the energy industry.

"World Energy – 2050" provides a brief summary of forecasting research performed by authors and groups of experts, which they represent, taking account of knowledge and experience generated through "prognostic experiments." At the same time it analyses in depth relatively recent forecasts carried out over the last 20 years since there has been a significant increase in forecasting activity during this period.

A series of studies, the results of which form the basis of this book, has been conducted to comprehensively analyse the world energy evolution and its trends, as well as to reliably forecast its development up to 2050. These studies are based on the analysis of a long time series of data on the dynamics of the energy sector, as well as on the results of the latest analytical studies of key issues associated with the energy development. Special attention is paid to trends in the renewable energy developments as this is the fastest growing energy segment, as well as to other promising energy technologies used so far to a limited extent.

A distinctive feature of the book is the support given to the concept of the development of the world society as a complex system characterised by trends that are difficult to forecast, and by either positive or negative dynamics over long periods of time. This concept has provided the authors and their colleagues involved in research with a useful methodological tool in their "prognostic experiments."

The significance of the studies presented in this publication is that they have been conducted over a period of time which is of most interest from scientific and forecasting points of view, since both the world energy and the world economy as a whole have been moving from a long stage of hyperbolic growth to a new mode of development. This situation makes our society seek the most efficient "modes" capable of bringing about significant changes to the energy sector. Such changes more often than not result in recessionary conditions adversely affecting the world economy and the community as a whole. Naturally, there is a number of possible scenarios for new "modes," the analysis of which is at the heart of this book, thus increasing its importance and usefulness.

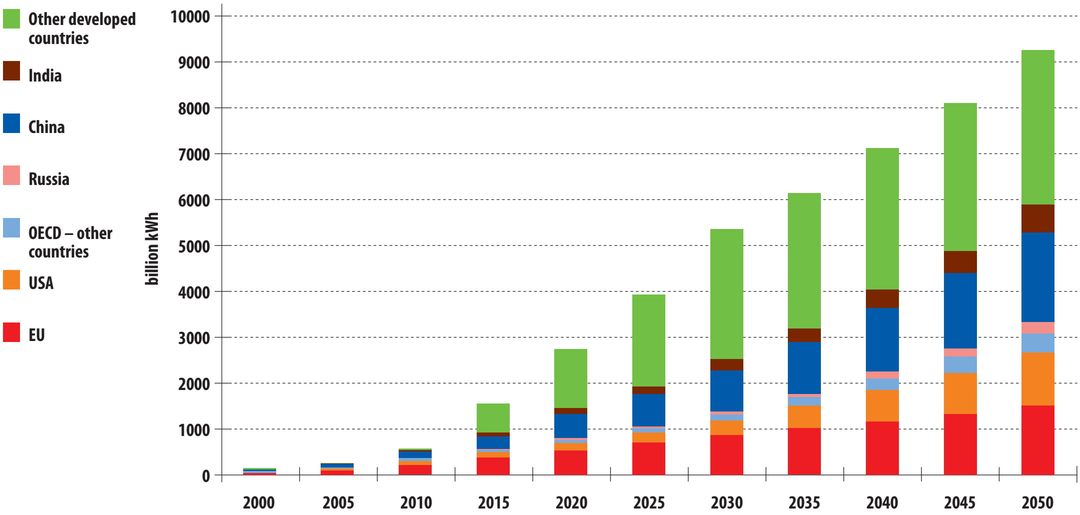
The authors emphasise that, apart from macroeconomic and macrosociological dynamics, the concept of sustainable development creates rather "strict" boundary conditions for the energy development, with the main factors being the availability and effective use of natural resources, environmental constraints, and the availability of efficient green technologies. They have every reason to consider the technological factor to be of overriding importance for the future energy development. This book contains a comprehensive analysis of existing and emerging energy technologies, including the possible scope and consequences of their use. Also analysed are interconnections between different technologies within the overall process of transition to a new type of energy sector. This technological component of the studies undertaken to produce the forecast should be particularly welcomed.

In the book the world energy is considered as a complex, dynamic system of contradictions which reacts to changes in external conditions in a nonlinear way. Based on the current data and recent research findings the authors have identified the key trends in the modern-day energy. In order to explore the full range of factors in the energy development they have considered the following three scenarios: 1) an inertia scenario; 2) a stagnation scenario; 3) an innovation scenario. Each scenario is a set of interrelated trends of different nature and is intended to identify the main challenges facing the world energy development in the future.

Long-range forecasting for the world energy has long been a challenge for researchers. However, recently there have been a number of serious energy problems, and a number of new developments that make this task particularly timely and important. The main part of the book was written in 2010. During the course of its preparation for publication, the situation in the world has changed significantly. Nonetheless, it is unlikely to change the key conclusions from the studies contained in this book. At the same time, the authors believe that recent developments around the world will only result in a slight change of emphasis in their conclusions.

Three major events that made headlines around the world in 2011 (namely growing social and economic turbulence that caused instability in a number of Arab countries exporting fossil fuels, a sharp rise in oil prices, and finally, a serious nuclear accident at the Fukushima 1 plant in Japan hit by an earthquake), and that have undoubtedly had far-reaching consequences for the world energy are not mentioned in this book for the reasons stated above. However, they support a number of conclusions reached by the authors with regard to the following: the possibility of changes in the geopolitical configuration of

Dynamics of electricity production from renewable energy sources from 2000 to 2050 (inertia scenario)



the world energy, the creation of new opportunities for many countries to end the dependence on fuel imports, and the urgent need for innovative energy technologies that are to be put in place across the energy industry.

In their conclusions, the authors rightly argue that three trends, namely a balance between globalisation and regionalisation, the end of the oil age and the development of innovative energy technologies, largely determine the world energy future, which is already undergoing qualitative changes.

As regards the structure of the book, it should be noted that it follows the classic pattern of serious scientific papers with their distinctive characteristics. The book begins with a detailed literature review of studies conducted on the energy future over the past twenty years, including the analysis of specific prognostic studies carried out by such research groups and organizations as the Global Scenario Group, the World Business Council on Sustainable Development, the Millennium Project, Royal Dutch Shell, Greenpeace, the International Energy Agency, and the Intergovernmental Panel on Climate Change (IPCC).

One section of the book is devoted entirely to the methodological issues of forecasting the energy development. Its authors provide a rationale for producing a forecast scenario defined as "a collection point for related demographic, economic, technological, political, social, cultural, environmental, and energy trends." This section suggests the following three scenarios for the energy sector: the inertia, stagnation and innovation scenarios used by the authors in their research. It also outlines the underlying principles of forecasting the world energy development. The authors emphasise that it is not quantitative indicators for the development of the fuel and power sector of economy that should be the aim of forecasting, but rather the analysis of qualitative changes in the way it is organised and interacts with society.

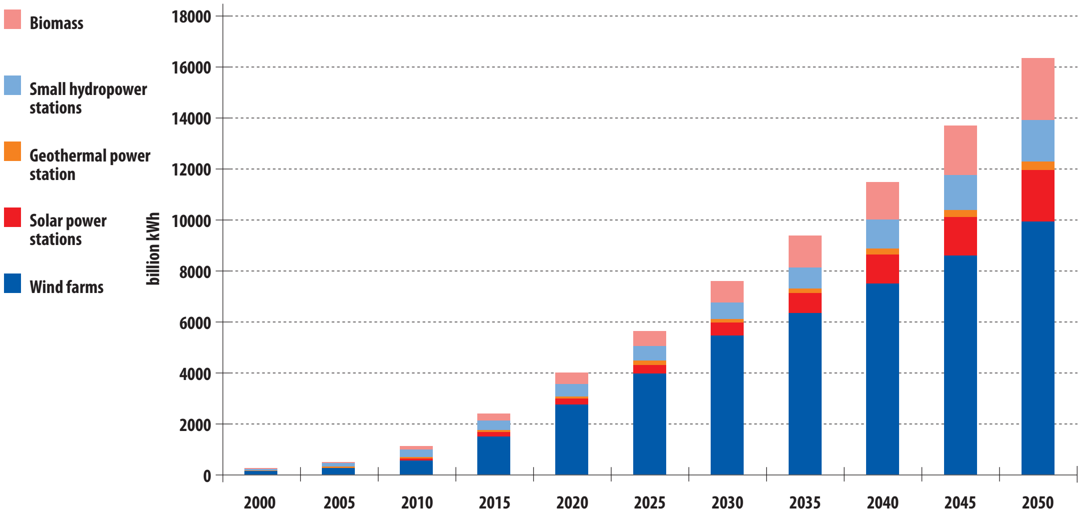
The section "Global Development Trends" provides the analysis of changes in nearly all factors which, according to the authors, are involved in the forecast scenarios.

The authors devote a special section of the book to the analysis of boundary conditions for the three above-mentioned scenarios. In their opinion, these conditions are mainly considered to be resource and environmental constraints.

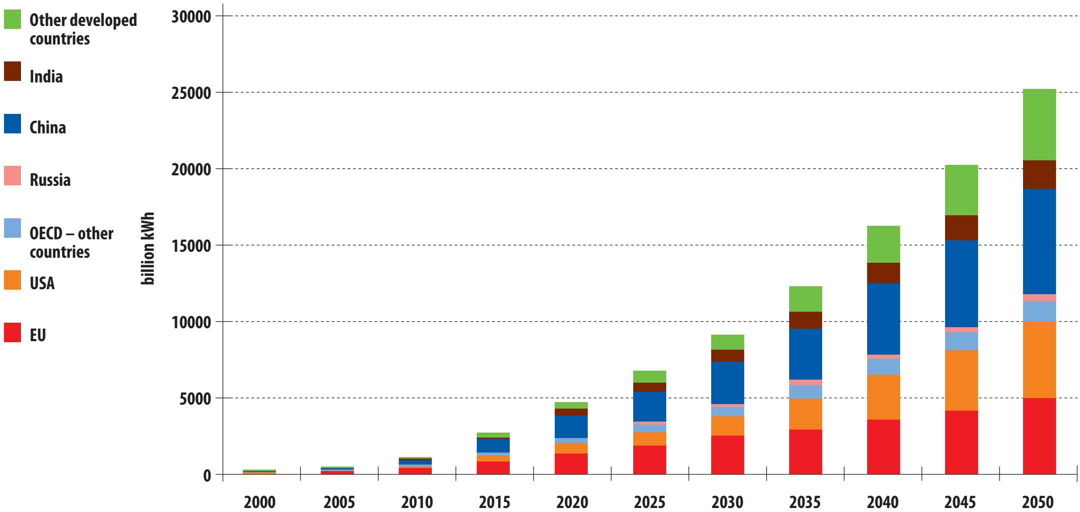
The analysis covers scientific and technological trends in all major energy sectors. What is noteworthy is that the renewable energy is regarded by the authors as a separate energy branch which plays a significant role in analysing and forecasting the energy development, as mentioned above.

Having thoroughly analysed world trends in economic development as a whole, as well

Dynamics of electricity production from renewable energy sources from 2000 to 2050 (stagnation scenario)



Dynamics of electricity production from renewable energy sources from 2000 to 2050 (innovation scenario)



as scientific and technological energy prospects with all its inevitable constraints, the authors have identified trends in the world energy by studying its past and present dynamics and components instead of using conventional extrapolation methods. The analysis of these trends reveals that the world energy is at the beginning of a radical transformation phase due to the transition of many countries from an industrial economy to a post-industrial economy, which causes a significant change in the dynamics and structure of demand for energy. Furthermore, environmental constraints and adherence to the principles of sustainable development require a fundamental energy restructuring to be based on the advancement of society through excellence in science and technology. Industrialisation in developing countries leads to rapid growth in energy demand. The combination of these interrelated but contradictory trends provides the basis for producing an independent forecast.

The final part of the book deals with synthesising the findings of the above analysis and forecasting the world energy development through to 2050 according to the three scenarios suggested by the authors: the inertia scenario which gives priority to the coal energy sector; the stagnation scenario prioritising the renewable energy development; and the innovation scenario, with priority being given to renewable and nuclear energy. It should be borne in mind that the authors have not analysed the situation in the nuclear power after the recent accident at the nuclear power station in Japan for the reasons already explained, and it is quite possible that the vision for the future of this industry will undergo changes, which will in turn influence further forecasting work carried out by this group of experts.

In conclusion, the authors emphasise that "under any scenario there will be a transition to a new type of energy sector though this will occur with varying degrees of intensity (maximum – in the innovation scenario, and minimum – in the inertia scenario). The transition is characterised by intellectualisation, decentralisation, better customer orientation, deep integration into the technosphere, and higher energy requirements. The transition to a new type of energy sector will primarily affect developed countries and the electric power branch, but then it will also influence other regions and industries. There will be a sharp increase in the share of non-fuel energy sources, with there being relative and then absolute decline in carbon sources of energy."

The book in question contains a variety of tables, charts and graphs which illustrate and support the conclusions drawn by the authors with regard to the forecast of development of both the energy as a whole and its branches under the evolutionary scenarios suggested in the book. Below are a number of charts which represent the dynamics of renewable electricity production and which are based on data calculated by the Melentiev Energy Systems Institute, of the Siberian Branch of the Russian Academy of Sciences.

The above projections are not only impressive in themselves, but they also challenge the international community to transform the energy industry into a qualitatively new industry, rather than to simply update it, so that the industry fully complies with the principles of sustainable development.

Finally, a few words about the team of contributors. It consists of Russian experts who specialise in various scientific fields directly linked with the energy industry and related fields, and who represent different research centres, both academic and non-academic independent ones. The backbone of the team is formed by a group of analysts from the Institute for Energy Strategy headed by Professor V.V. Bushuyev, who has managed to adopt successfully an interdisciplinary approach to the series of studies, the results of which are presented in this book.

The book is co-edited by V.V.Bushuyev, Director-General of the Institute for Energy Strategy, and V.V.Kalamanov, Director-General of ISEDC.

Foreword to the book is written by A.V. Yanovskiy, Russian Deputy Minister of Energy, G.Kalonji and H.D'Orville, Assistant Director-Generals of UNESCO.

The book is published in Russian and English by the Energiya publishing house, Moscow, Russian Federation.

The ISEDC took part in the Russian-Chinese economic forum

In the Moscow International Trade Centre, the VII Russian-Chinese Economic Forum was held, which is a regular event within the framework of the National Years of China and Russia jointly established by the governments of the two countries. The Forum programme covered the issues of mutually beneficial cooperation in the electric power industry, the modernisation of electric networks, high technologies, the construction of infrastructure, investment cooperation, the introduction of energy-saving technologies into the industry and the fuel and energy complex.

Leading experts, energy sector leaders, the first representatives and members of the governments, financial organisations, international institutions, companies, centres and agencies from the participant countries took part in the event.

Machine-building, agriculture, transport, infrastructure (the construction of roads, pipelines, airports) and electric power generation were identified as top priority areas. Certain directions in the Far East development are of special interest. A great emphasis is placed on foreign economic activities in the development of renewable energy sources, especially biomass, hydropower and wind power industry. The cooperation in bio energy between Russia and China based on complementarity is a strategic objective. In this connection, the Chinese representatives expressed their hope for the promotion of further cooperation, which would undoubtedly have a tremendous environmental impact.

The cooperation between our countries in the oil and gas sector is very promising. Today agreements are concluded with Russian companies (the agreement with Rosneft: the annual supply of 15 billion t for the period of up to 2020; the agreement with Gazprom: the annual supply of 30 billion m3 of natural gas). Therefore, it is necessary to create a flow of projects to select the most efficient ones.

The cooperation in the power supply from Russia to China is rapidly developing. 2.6 billion kWh was supplied in 2012, and more than 3 billion kWh will be transmittted in 2013. Electric networks that allow the annual transmission of up to 4 billion kWh have already been built within the framework of joint projects. Some promising coal fields, including fields in Trans-Baikal and Kemerovo Oblast are now being developed for these purposes. However, these are only plans based on joint feasibility studies and agreed schemes of project implementation.

The ISEDC took part in a UNIDO business training

The Russian UNIDO office in Moscow conducted a 2-day training in energy management at industrial enterprises, in which the leading expert of the UNESCO-sponsored International Sustainable Energy Development Centre (ISEDC) Mikhail Pavlov took part. The energy management topic is of great interest to Russian business representatives. Despite of the fact that the modern energy efficiency legislation does not provide for meeting the obligatory requirements for the energy management directions, the all-round compliance with energy-saving standards, the current policy of the government, as well as the pronounced trends in the global energy industry often encourage the domestic producers to take critical actions, one of which is the development of an efficient system of power consumption management at an enterprise. And against the background of the GOST R ISO 50001:2012 national standard that is now being developed, the participation in the development of a progressive management model and increasing the efficiency of work and interaction of individual production units, as well as the attitude to the own power supply become a priority and the issue of image for any conscientious industrial technologist, engineer and power engineering specialist.

The Austria and Ireland representatives presented their reports as an invited party. The training was conducted in the form of workshops, interactive sessions and open discussions between the participants. The agenda included key concepts, business cases, the policy and methodology and approaches and modern standards in energy management systems.

The developed system of workshops is the first UNIDO experience in Russia in training energy management specialists. The second stage (planned for the period from January to February of 2013) is an expert, professional level, which makes it possible to become a certified trainer with the opportunity to teach. The further steps in training qualified specialists will increase the commitment of the management and contribute to the participation of Russian top managers in introducing efficient energy management mechanisms into production.

The ISEDC took part in the IEA presentation of the World Energy Outlook 2012

The key moments of the current state of the global energy industry and the trends of its development for the period of up to 2035 were presented by the International Energy Agency (IEA) Executive Director Maria van der Hoeven in the Ministry of Energy of Russia.

The ISEDC representatives took part in the event dedicated to the presentation of the World Energy Outlook 2012, which took place on the 4th of December of 2012 in the Ministry of Energy of the Russian Federation. Representatives of the Russian Ministry of Foreign Affairs, the Institute of Energy Studies of the Russian Academy of Sciences, the Moscow State Institute of International Relations of the Ministry of Foreign Affairs of Russia, INTER RAO-Export, REA, Transneft, the Institute of World Economy and International Relations of the Russian Academy of Sciences, FGC UES, Tatneft, Gazprom Neft, MRSK Holding.

In his opening speech, the Minister of Energy of the Russian Federation Alexander Novak said that "such publications as the World Energy Outlook are of great interest to Russian experts." In addition, the Minister emphasised the importance of cooperation between the International Energy Agency and the Ministry of Energy of the Russian Federation.

In her turn, after her welcome remarks, the IEA Executive Director Maria van der Hoeven proceeded with the presentation of the World Energy Outlook 2012. In her presentation, Mrs. Maria van der Hoeven elucidated the key moments of the current state of the global energy industry and the trends of its development for the period of up to 2035. Mrs. van der Hoeven put emphasis on the following aspects:

- Profound changes occur in the USA energy industry, that is, the revival of oil and gas production.
- Energy efficiency is recognised everywhere as a key element of the energy strategy and can provide a huge benefit for the energy safety, economic growth and the environment.
- The Asian oil and gas markets grow rapidly and continuously.
- Iraq is becoming a major oil supplier.
- The demand for traditional energy sources will remain high.
- The share of renewables in the energy production will reach 1/3 by 2035.
- The ubiquitous access to energy is still in the focus of attention.
- Water becomes increasingly important as a criterion for the assessment of economic expediency of energy-related projects, since the competition for water resources increases due to the growth of population and business activities.

The ISEDC became the operator of the exposition of Russia's Ministry of Energy at the GASTECH-2012 Exhibition in London.

The ISEDC became the operator of the exposition of Russia's Ministry of Energy at the GASTECH-2012 International Exhibition and Conference on Natural Gas, LNG and Oil Gas (London).

The 135.0 sq. m stand of the Ministry of Energy of Russia contained the information about the main activities of the Ministry, including the oil, gas and coal industries, the electric power industry and renewable energy industry. Such companies as TREI Holding, the Pipe Metallurgical Company (TMK), Yamal LNG, the Sakhalin Energy Investment Company, STROYGAZMONTAZH, Pechora LNG and others.

Within the exposition of the Ministry of Energy of Russia, the companies presented a number of innovative projects in the automated oil and gas accounting and the control of the production, treatment, transportation, storage, operational and commercial accounting facilities of an oil and gas producing company. The objectives of the exposition of Russia's Ministry of Energy at GASTECH-2012 were to demonstrate the potential of Russia, to present Russian companies and research institutes, developments and projects in the oil and gas industry, as well as to develop scientific and technological cooperation, to establish contacts with leading experts from around the world, to enlarge investment cooperation.

The Russian Federation was presented at GASTECH-2012 by the Ministry of Energy of Russia headed by the Minister Alexander Novak. Alexander Novak said at the exhibition that the gas industry is one of the most dynamic and high-tech industries in Russia. "We began the implementation of grand projects that have no analogues in the world, such as Yamal LNG. This requires the solving of unique problems, beginning with the technologies of gas production in areas with extreme natural conditions and ending with transportation of produced raw materials, including the necessary design and construction of ice-class methane carriers that do not exist in the world."

The Day of Russia was a major event of the GASTECH-2012 business programme. The main event of this day was the plenary session "The role of Russia in ensuring the energy safety of the world economy", which was held under the chairmanship of the head of Russia's Ministry of Energy Alexander Novak. The fact that the Day of Russia was a major event at GASTECH-2012 is confirmed by the reports made by the heads of the specialised committees of international organisations and the government agencies of Great Britain and other countries.

The chairman of the International Gas Union (IGU) LNG Committee Dirk Van Slooten emphasised the special role of the Russian oil and gas complex in the world energy industry. Vsevolod Cherepanov, a Member of the Board of Gazprom and the Head of the Gazprom Department of gas, gas condensate and oil production told about Gazprom's prospective projects in his report "Gazprom projects in the LNG sector".

The high economic efficiency of the events that were held within the framework of the Day of Russia is confirmed by the signing of an Agreement between the Russian petrochemical holding SIBUR and the Solvay Group (the world's major surfactant producer) to establish a joint venture for producing surfactants in Russia.

In the GASTECH-2012 International Exhibition and Conference Alexander Novak said that Russia intended to increase the annual production of natural gas to five trillion cubic metres.

INVITATION TO COOPERATION ON ENERGY BULLETIN PAGES

Ladies and Gentlemen,

The Editorial Board invites experts, governmental and non-governmental, both public and private, organisations to cooperate on the pages of our periodical.

The objective of the Energy Bulletin is to facilitate development of international scientific discussions on sustainable energy development, utilisation and exchange of clean energy technologies, climate change mitigation as well as to attract attention of energy experts, politicians and representatives of various economy sectors to the most important energy problems facing our society.

It is extremely important today to hold a continuous international dialogue at the experts, politicians and public levels on the issues of strengthening interdependency in the fields of energy, ensuring of energy security, energy efficiency and energy conservation, environmental responsibility during development and use of energy resources, reduction of energy poverty.

We would be pleased to publish materials on the actual energy and related problems in the coming issues of the Bulletin.

For additional information you may contact Alexey Grammatchikov, Editor.

Tel.: +7-495-6410426
Mob.: +7-916-1508172
E-mail: a_gramm@isedc-u.com

Technical requirements to the presented materials

The materials should be in the form of articles, reviews, analysis, assessments (MS Word, Excel). It is also possible to put schedules, diagrams, tables (MS Word, Excel), illustrations, photographic materials (Jpg format, 300 dots resolution) to the Bulletin. The volume of materials should range from 15,000 to 25,000 printed characters in a language chosen by author. It is also necessary to provide the photo of author (Jpg format, 300 dots resolution).

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