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POWERING THE PLANET

Nathan S. Lewis has described and analyzed a number of the existing challenges in relation to modern energy problems and possible solutions. He has paid an additional attention to renewable energy technologies (Lewis, 2009). Solar power is considered to be the only real solution for sustaining the necessary levels of energy use. It is important from both current and future perspectives.

Energy problem may be considered as one of the most significant nowadays. It should be solved as soon as possible as it affects both the ecological and economic situations on the planet. Lewis has analyzed the available fossil fuel reserves and resources according to the recent statistical data. Current global energy consumption consists primarily of oil, gas, and coal consumption. Renewable sources of energy are only a small fraction of the total energy consumption. According to the existing resource base, oil resources may be used for about 150 years, gas resources – for almost 600 years, and coal resources – for more than 2000 years. On the one hand, it seems that the amount of the existing resources is sufficient for the satisfaction of production and other needs. On the other hand, the level of CO_2 tends to increase significantly under

such conditions.

The population of the planet is expected to be about 10-11 billion people in 2050. At the same time, the GDP growth per capita is expected to be about 1.6% a year. Thus, the energy consumption per unit of GDP is supposed to decline at the rate of 1% a year. A greenhouse gas influence on global carbon emissions, together with the expected population growth, is supposed to stimulate the demand for carbon-free power. This demand cannot be satisfied with the current level of development of renewable energy technologies. Moreover, the current supply and demand pricing tradeoffs do not correspond to potential changes in the market needs.

It is estimated that under the existing tendencies, the level of CO2 emissions will reach the highest point in the near future. Thus, the renewable sources are expected to increase their percentage in the total energy consumption, but their rate of growth is not satisfactory. Without efficient policy incentives, it will be impossible to satisfy the global energy demand in 2010. The ecological situation is also expected to become more problematic. There are some greenhouse gas buildup limitations regarding the potential carbon-based power consumption. It may be considered as a significant externality to the potential fossil-fuel consumption. Lewis has evaluated the necessary level and scale of R&D investment that should be implemented in order to produce the desired quantity of carbon-free energy by 2050. The measures needed to satisfy the expected energy demand for this type of power include the rapid development of renewable sources of energy; in particular, it is necessary to efficiently use solar power.

There are three main sources of carbon-free power. They include nuclear power (fusion and fission), carbon sequestration, and renewable sources. Nuclear solution means that a new reactor should be built every day during the next 50 years. Therefore, this option may not be considered as practical and attractive. Carbon sequestration includes the ocean release of CO_2. Thus, it may have some negative ecological consequences in the long run. Thus, the only possible solution is the efficient use of renewable sources of energy. There are six main types of renewable sources. They include biomass, hydroelectric, geothermal, wind, ocean, and solar power. The potential of hydroelectric power is only about 4.6 TW. Thus, it is not enough for the satisfaction of the global needs. Geothermal energy has a larger potential. It is about 11.6 TW. However, the production of this type of energy is highly expensive and problematic. Wind may be considered as a crucial source of energy as it is comparatively inexpensive. However, wind cannot satisfy all the existing demand for energy as it can produce only 2-3 TW. The ocean energy potential may be used in this respect, as well. Biomass is another possible source of energy. Its gross potential is about 7-10 TW. However, the net potential is substantially low; it is only about 1-2 TW. Therefore, biomass cannot play a central role in the overall energy supply. The only real way of solving the global energy problems is solar power. Its practical potential is more than 600 TW. The onshore electricity generation potential is only about 60 TW, and the potential of photosynthesis is about 90 TW.

Lewis has proposed to use the area in the central and southern part of the US for purposes of the solar energy production. It is possible to select six such areas in the world. They may include the zones in the US, South America, Africa, Asia, Russia, and Australia. Each of these zones is

expected to produce about 3.3 TW of energy a year. Thus, it will possible to satisfy the growing demand for energy. It seems reasonable to introduce additional nanostructured networks in order to save higher amounts of energy. New energy conversation strategies should be adopted. They should relate to the conversation of light into fuel and electricity. Some chemical analogy of photosynthesis may be used in this regard. Advanced semiconductors should be produced, as well.

The storage of fuel and electricity is another significant problem. A fuel processor and electrolyzer may be used for these purposes. Then, the fuel may be distributed and stored accordingly. A stationary generation may allow producing higher volumes of energy. Efficient solar water splitting may be developed. Its efficiency in the laboratory is about 10-18%. Thus, the necessity for additional energy sources is present. The energy efficiency includes both the energy and environmental security. A cheap solar fuel seems to be the most effective method of solving the existing energy problems. An additional attention should be paid to modern storage systems and inexpensive conversation technologies. Nanotechnology may be used for the production of new solar cells. In fact, solar power may be considered as a pivotal part of all long-term energy strategies. This market is significant and expanding over time. However, additional and long-term investments seem to be necessary in order to make the technology breakthrough possible. In this way, the potential of solar energy may be used.

The production of solar electricity is currently limited. The rates of growth are significant, but the initial base is considerably small. There are some competitive advantages in the long run. However, a complex solution

(including electricity, heat, and storage) should be implemented. Chemical transformations demonstrate the large potential of solar power. Photoelectrolysis may enable the fuel generation and integrated energy conversion. Renewable energy does not constitute a main fraction of the current total energy supply for a number of reasons. One aspect is a policy issue; not all companies are ready to implement innovations. However, the most critical issue is an economic one. Energy is one of the market commodities. Thus, the use of renewable sources of energy is determined not only by policy, but predominantly by cost. Coal is the cheapest way to produce electricity nowadays. Electricity from natural gas is comparatively not expensive. From all renewable sources of energy, wind is the cheapest (5-7 cents per kW-hr). Solar energy is more expensive. However, it may be efficient in the long run.

From an economic point of view, the least expensive method of storing solar-produced electricity seems to be pumping water uphill. The current energy storage refers not to the conversion of kinetic - into potential energy, but to storing energy in special chemical bonds. The main part of the current energy is received not from making electricity, but from dispatching energy with the help of chemical fuels, which may be considered as the most cost-effective energy method.

The cost efficiency of photovoltaic devices tends to increase, but the industry is searching for new technologies. The costs of materials play a vital role in energy conversion applications as the installed capacity depends linearly on the area of the device. All realistic energy programs should be based on the energy efficiency, as saving energy is less expensive in comparison with producing energy. Energy programs should

be based on a system that combines technology and policy. It seems that a complete agreement regarding the urgency of energy problem and the implemented methods should be achieved. It is necessary to produce as much energy as it is possible. At the same time, the amount of clear energy should be maximized. The energy problem should be addressed in any way. Efficient urgent measures should be implemented in order to change the existing energy tendencies. Modern technologies allow increasing the production of solar energy. The main concern relates to its cost and economic efficiency.

A climate change is another serious problem nowadays. Solar energy may be the solution in this respect. Solar thermal energy is roughly equally used in each of the following sectors: industrial, residential, transportation, and transformation. Storage is required due to the temporal mismatch between the actual source and market demand. High-temperature solar thermal energy is currently the cheapest solar electric source. Its potential is competitive with the fossil sources in the long run. Solar-to-electric efficiency is about 18-20%. An additional research is needed in relation to metals, hydrogen, and synthetic gases. The production of solar energy requires a comparatively large area. However, it is only about 1.7% of the US territory.

The crucial issue is the tradeoff between the cost and efficiency. At the same time, recent researches demonstrate that solar energy is highly efficient, especially in the long run. With the help of photoelectrochemical cells, light may be converted into electrical and chemical energy. Nowadays, the production costs of electricity in relation to solar power are comparatively high (25-50 cents per kW-hr). However, the situation

may be different in the future. An abundant and inexpensive base of fossil sources of energy makes it more difficult for renewable sources of energy to become dominant in the global markets. In order renewable sources of energy to play the dominant global role, significant technological and cost results should be achieved. Unpriced externalities should be analyzed, as well. They are primarily of the ecological nature. The pollution may be considered as environmentally-driven carbon taxes.

The planet needs a substantial amount of carbon-free power. The current price system does not correspond to this challenge. In fact, the price system does not produce enough motivation for the use of renewable sources of energy. Therefore, it is necessary to examine the energy potential of different sources of renewable energy. The technological costs of these renewable sources should be examined, as well. Then, it is possible to select the most appropriate energy solution. Moreover, the impact on the secondary power infrastructure and energy utilization should be taken into account. However, Lewis has demonstrated that solar power has the long-term competitive advantages for a number of reasons. First of all, it has the largest energy potential (more than 600 TW). Secondly, it does not lead to the air pollution and climate change. Finally, it is particularly effective in the long run (2050 and later).