Energy for Sustainable Development

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Abstract - *The review provides a detailed analysis of scientific and technological aspects characterizing implementation of energy for sustainable development. This implementation includes: transition from fossil fuel to renewable energy; complete replacement of gasoline and diesel cars, trucks and buses by hybrid ones and at a later stage by electric or hydrogen cars; increase of energy efficiency for all of the exploited equipment (it is a separate huge and complex program); development and implementation of the "green" economic incentives; "green" trends for the traditional technologies. The analysis and discussion of the newest tendencies, and also conclusions and recommendations are made.*

Keywords: *Green Energy, Energy Efficiency, Renewable Energy, Energy Savings, Sustainable Development*

I. Introduction

Unfortunately, the human civilization stepped on a dangerous way of energy production by incinerating carbonic and hydrogen natural fuel (coal, gas, oil, others). Therefore, first, the natural deposits of accessible hydrocarbons become exhausted; secondly, the environment gets contaminated by toxic combustion gases and dust; thirdly, the negative changes of the climate ("global warming") take place. Now world financial expenses of customers for payment of energy resources are about six trillion dollars per year; it is approximately 1/10 part of the World Gross National Product.

Note. *Now the problem of the "global warming" is loudly being debated (for example, [1]). Indeed, many factors can impact on the "global warming":* ● *Humanity activity by means of emission of the greenhouse gases [2]: first, incineration of fossil fuel and emerging of large forest fires (CO_2), secondly, exploitation of coal mines, farms, and landfills (CH_4);* ● *The World Ocean's deposits of CO_2 and the Permafrost's deposits of CH_4-hydrates [3], [4];* ● *The periodic cycles of "warming-freezing" on Earth: Solar cycle variations and Earth's axis cycles (so-called the "Milánkovich-cycles") [5], [6], North Atlantic Fluctuation [7], others. It is definitely that the average temperature of Earth's and oceans' near-surface air is rising. But what is contribution of a human activity into the total effect of the "global warming" - 20%, 60%, 90%? The clear answer still is not present.*

There are five basic and parallel directing in the Energy for Sustainable Development:

1) Transition from fossil fuel to renewable energy; **2)** Complete replacement of gasoline and diesel cars, trucks and buses by hybrid ones and at a later stage by electric or hydrogen cars; **3)** Increase of energy efficiency for all of the exploited equipment (it is a separate huge and complex program); **4)** Development and implementation of "green" economic incentives; **5)** "Green" trends for the traditional technologies.

II. Transition from Fossil Fuel to Renewable Energy

II.1. Solar Energy, Wind Energy, and Small-Hydro Energy

It is obviously that **solar energy** (concentrating thermal panels or photovoltaic cells) and **wind energy** are the future energy number one [8]. Although the "green" energy has not still occupied the big segment

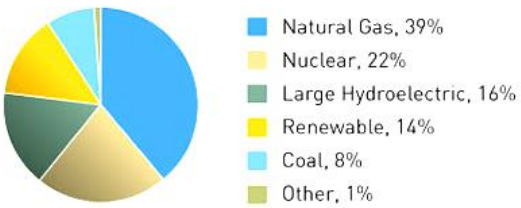

Fig. 1. PG&E's 2008 electric power mix

in the world (not more 3-4 %), some large energy companies show the vast progress, for example, "Pacific Gas & Energy" (USA, California) [9] (see Fig. 1). Indeed, the producing of the "green energy" and especially investments there rises by huge rates. So, it was spent $155 billion for implementation of the "green" energy projects during 2008 ($51,8 billion – wind energy, $33,5 billion – solar energy, and $16,9 billion – bio-fuel), and for the first time it was more than for fossil fuel. Also, the great successes were achieved for the other "green" technologies during the last some years.

So, the efficiency of the wind generators and solar panels was increased at some times (up to 35-40%), and price for 1 kW of the "green" energy was

decreased up to 10-15 cents. For example, the "Semprius"-company (USA) has developed the high-efficient system of solar modules with lenses-concentrators and with micro-solar batteries (less 1 mm) [10]. "Skyline Solar"-company has combined the photo-electric panels with parabolic concentrators. With their help the flux of sunlight falling on silicon panels, is being increased at 10 times [11]. Also, the wind turbines were created (for instance, by Siemens) with a hub height 100-120 m, with a rotor diameter 80-100 m, and with capacity up to 5 MW.

The new ideas are being quickly implemented. One of the biggest solar power stations (on a basis of the parabolic troughs) is being built in Arizona's desert (USA) [12]. Its capacity will be 280 MW, and the area of its solar parabolic panels will be 7.7 km^2 (i.e. its specific capacity will be 280 : 7.7 = 36.4 W/m^2, but the special capacity for traditional electrical power stations is about 200-300 W/m^2). Expected future efficiency are nearly 40%, and the cost of 1 kW-h will be 10-15 cents. One of the biggest offshore wind farms "Gwynt Y Mor" is being built in the North Wales [13]. This power station will produce 576 MW with help the Siemens' wind turbines (total number - 160, total height of each – 154 m, rotor diameter – 107 m). Total farm's area is 79 km^2 (i.e. its specific capacity will be 576**:**79 = 7.3 W/m^2). Expected future efficiency is nearly 36%, and the cost of 1 kW-h will be 10-15 cents. These both projects will be capable to provide by power about 600,000 private houses and to prevent environment from about 2.5 million tons of CO_2 per year. However, inside scientific laboratories are grown up the newest incredible energy projects. For example, "Solaren Corporation" and PG&E (USA) are planning to launch the huge solar panels into space orbit as a satellite and to transfer the solar energy on the Earth in a form of radio waves [14]. This project can cover the complete energy demand of California. The other example: Caltech Institute (USA) has developed a flexible solar array that converts 86% of all sunlight into electricity (it means the efficiency of a solar panel more 80% instead of the present maximum 30-35%) [15]. It is the thin silicon wires in a plastic substrate that scatters the light onto them. Each silicon wire has diameter up to 100 microns.

"Small Hydroelectric" is a term used for electrical power received from rivers' streams (without dams) and oceans' waves and tides [16]. Usually the producing of the small hydro-power station is not more 100-200 MW. Now China is leader for small hydroelectric (47 GW from 75 GW for the all world). The small hydro-power stations don't demand of the big investments and can effectively solve local energy problems, especially for the depressed regions and countries. Tidal power stations are more expensive and complex industry. The first tidal power station La Rance (240 MW) has been constructed in France in 1966. The European company "Minesto" has developed the interesting simple and non-expensive project "Deep Green." In the basis of this tidal power station is the special 12m-wing with a water turbine which swims under the water, fastened to bottom by a long cable [17]. However, the tidal power stations still are not popular now in the world.

Comparison for the world energy sources is in the Table 1 [18] (see Appendix below).

Norway's Statcraft Company has found a way to transform the direct osmotic pressure in an electricity, using a natural difference of the concentrations of mineral salts in river's and sea's waters. By its estimations, world resources of renewed osmotic energy are up to 1.7 тераватт. Unlike a capricious wind, the tidal flows, and the sun, osmosis processes don't stop whole 24 hours a day all year long. This process is completely ecological and renewable. The Company's target is to create power station 25 megawatts - the same as a small wind farm - by 2015.

II.2. "Secondary" Solar Energy

The nature has created the grandiose thermal energy source for mankind: it is heat of the upper layers of oceans, seas, rivers, lakes, soil or Earth's near-surface air (it is so-called "secondary" solar energy). This "secondary" solar energy can be utilized with help of

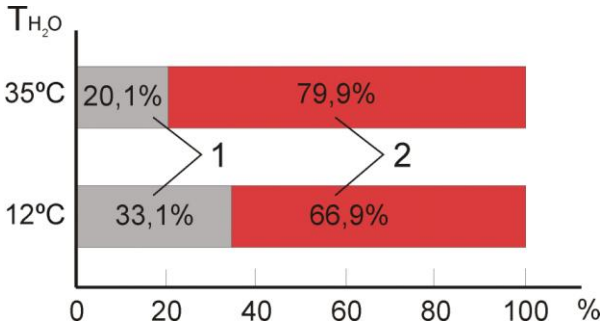

Fig. 2. Heat-pump efficiency:
1 -energy spent for work of the heat-pump;
2 - energy received from work of a NFPS.

the large heat-pumps [20]. For example, millions heat-pumps warm up houses in the North of Europe - in Sweden, Norway, Finland. The heat pumps have a high efficiency - up to 80% (see Fig.2). If to combine in a united cycle the heat-pump, the Stirling-engine (it is engine of external combustion), and heat-exchanger, we shall have so-called "non-fuel power station" (NFPS) (see Fig. 3), where transformation of heat into electrical power will occur. Moreover, the condensation of a water vapor from air takes place during working of the NFPS (if its cooling agent extracts heat from atmosphere). For example, the big NFPS (100 Megawatt) in a warm and wet climate will manufacture about 200,000 tons of the pure (condensed) water per year. However, it should be understood that in this case the question is about the huge heat pumps and huge thermodynamic cycles.

Besides, the using of the giant NFPS is also a unique way for struggle with the "global warming" because it pumps out the superfluous heat from environment.

II.3. Biomass energy

Its world energy potential is about 500 TWh. The liquid biomass fuel can be manufactured by thermal or biochemical conversion (there are tens of the various technologies). Also, so-called fuel's pellets are the solid biomass fuel. The municipal solid waste (including landfill gas which, in fact, is biogas fuel) in

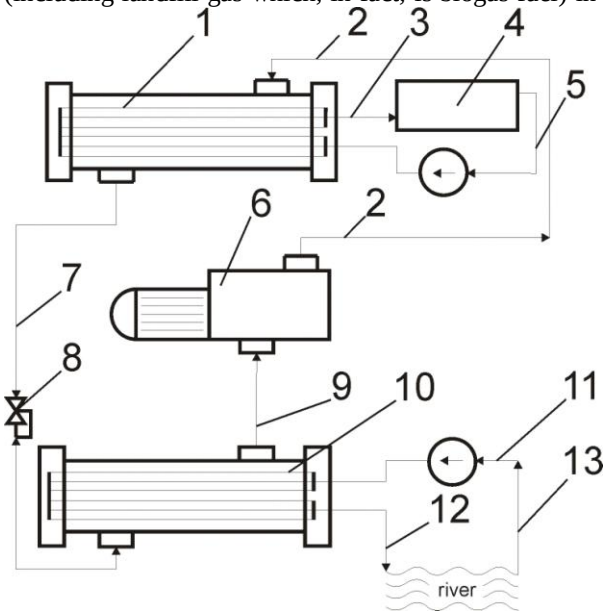

Fig. 3. The scheme of the "non-fuel" power station (NFPS) *(Krasnyansky's project [19])***:**

1 - condenser; 2 - compressing of the more hot gasiform-ammonia (+80 ºC); 3 - more hot water (+70 ºC); 4 - heat-exchanger (it is possible to combine a Stirling-engine and an electrical generator); 5 - less hot water (+30 ºC); 6 - compressor; 7 - compressing of the less hot gasiform -ammonia (+30 ºC); 8 - choke; 9 - fluid-ammonia (- 40 ºC); 10 - evaporator; 11 - less cold water (+ 10 ºC) from river; 12 - more cold water (+ 5 ºC) into river.

urban communities, the worn-out tires, the plastics waste, the harvest waste like straw and the forest wood waste (as the fuel's pellets), the farm animal dung, the slimes of city sewage, and others can be used as the biomass resources [20]. Also, the production of bio-gasoline (on the basis of the cellulose ethanol or seaweeds) and bio-diesel (on the basis of a corn and a colza oil) can be included there. Besides, for example, the LS9 Corp. (USA) announced creation the super-bacteria which enables to produce analog of a pure gasoline with cost about $50 per barrel [21].

It happens often that local residents protest against building of a factory for waste recycling. The idea to convert the marine ships (tanker, large dry-cargo ship, suitable military vessel) into floating factory for thermal recycling of the municipal waste, worn-out automobile tires and others can help to solve this problem [22] (see Fig. 4).

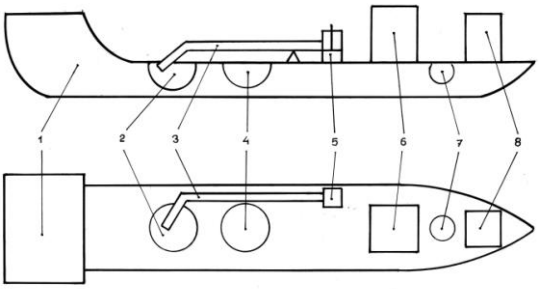

Fig. 4. The floating factory for thermal recycling of the municipal waste and worn-out automobile tires: *(Krasnyansky's project [22])***:**

1 - body of the ship; 2 - holds for warehousing MSW and of worn-out tires; 3 - conveyor-line for sorting MSW and selecting the secondary raw material; 4 - holds for warehousing of slag and secondary raw material; 5 - machine for pressing and briquetting of the sorted secondary raw material; 6 - furnace for high-temperature-incineration of MSW; 7 - hold for produced compost from nutrition-waste; 8 - furnace for low-temperature-pyrolysis of worn-out automobile tires.

Each the recycling floating factory can come into the seaport of any country, and will be able to accept aboard annually 100-150 thousand tons of MSW as well as the worn out automobile tires and other municipal and agricultural waste. It is enough for service of city with the population of 200-300 thousand. Cities-waste and old-tires will be collected in any nearest marine-port in the special terminals. Further the ship can sail to the open waters to carry out the recycling. The energy produced will be used for own necessities of the ship. It is obvious all ecological standards must be carried out rigidly. Realization of this project gives the following advantages: a) It will not demand new land-allotment to build MSW-factory; b) Floating factories in during of MSW-processing will be located afar from the cities with the high density of population; c) Many large military-ships and cargo-ships will find "the second life."

Такие комплексы называются системами конверсии тепловой энергии океана (Ocean Thermal Energy Conversion — OTEC). Описанный выше принцип носит дополнительное название "OTEC с закрытым циклом".

http://www.membrana.ru/articles/technic/2010/12/01/163800.html

II. Complete Replacement of Gasoline and Diesel Cars, Trucks, and Buses by Hybrid

II.1. Vehicles

The **hybrid cars** and **full electric cars** began really to take over the world's car market. For example, Toyota Prius, which has the average gasoline consumption only 4-5 liters
per 100 km, are very popular around of all world. (Usual Toyota Camry consumes 8 liters/100 km, i.e. Prius saves fuel on about 35-45%). Many advanced "green" models of vehicles have recently appeared as a concept (see Tab. 2 – Appendix below) [22] – [25].

Besides, the experimental airplane **"Solar Impulse Airplane"** (SIA) with solar batteries is manufactured [29]. This project fulfills Euro Union. SIA has wingspan of 65 meters and area 200 m^2, but weight of the plane is 1.6 tons only as it is made of carbon composites. On its wings are located more than 10,000 solar cells. The possible speed is 250 km/h.

Notes. 1. *But there is the serious problem: the super-capacious electric batteries (Li-ion or others) of a little weight and a small size are necessary for the future cars, trucks and buses. Nano-technologies might help to increase the capacity of car accumulators at 5-10 times compared with the present lithium-ion batteries. For example, MIT's scientists have created the accumulator in which electrodes are made with use of the carbon nanotubes [26]. Such accumulator can sustain a current at 10 times more in comparison with modern Li-ion batteries, and its special capacity for unit of a mass has increased at 5 times.*

2. *Possibilities for savings of fuel are not exhausted yet also for traditional vehicles' engines. So, EcoMotors company (USA) develops Opoc-engine [27], which consumes fuel at 50 % less and costs at 50 % less than the traditional engines of comparable capacity (and also its emission of toxic gases is at 2-3 less). It is very important that it can with identical success be applied in cars, lorries, aircraft and shipbuilding, others. It is doubtless that «Opoc» will open a new era in designing of cars.*

II.2. Other Alternatives for Gasoline Vehicles

The bushy network of **high-speed electric railways** (speed - 200-300 km/h) covering any country also is effective way to save energy (as partial alternative of personal cars) . For example, the total length of the high-speed (320 km/h) railway in France is now 1700 km with 149 points of destination (and it is planned to extend up to 3500 km by 2020). This railway carries over 40 000 passengers per day [27]. If these passengers used personal cars, they would need 100,000 tons of a gasoline every year.

The **underground logistic centers and the freight pipeline's network** (diameter - 1-2 m) can be a partial alternative of the trucks [28]. The container-capsules (length 1-3 m) with a goods will move (speed 20-30 km/h) inside of these freight pipelines with help of pneumatic power or of linear inductive monorail.

III. Increase of Energy Efficiency for All of the Exploited Equipment

These technologies will give possibility to increase energy-efficiency of the exploited (in-service) equipment without its large-scale replacement. This way is faster and cheaper and thus more preferable.

III.1. Hydrogen Technologies

For example, hydrogen technologies were used for improvement of fuel incineration, and it has much wider prospects. A lot of the research has shown that hydrogen additive to fossil fuel (to any fuel used for industrial boilers – natural gas, black oil and even coal) considerably improves the process of fuel incineration and substantially reduces toxic gas emissions into atmosphere. I.e. the speed and completeness of fuel combustion grows and concentration limits of burning extend when the ratio of H /C in fossil fuel increases over 1.5. It has been explained that according to Hinshelwood-Semenov theory (see [31]), atomic hydrogen [H] is the most active center of the chain reactions of burning (for instance, speed of the [H]-diffusion in a flame is four times higher than the speed of diffusion for particles O and OH, and an activation

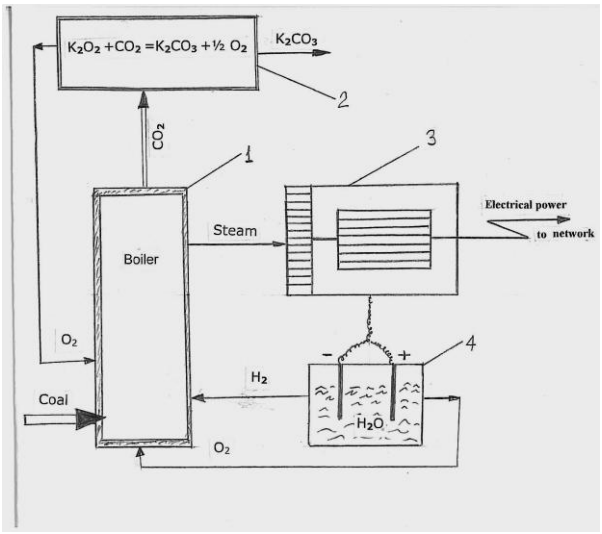

Fig. 5. Scheme of the coal clean incineration
(Krasnyansky's project [31])
1 – boiler at the thermal power station; 2 – absorber of the carbon dioxide stuffed with potassium peroxide *(K_2CO_3 – Can be used for manufacture of glass, especially optical, and also detergent materials)*; 3 – electrical power generator (steam turbine combined with electrical rotor on one axle); 4 – electrolysis vessel *(it spends 3% from generated energy).*

energy for such reactions with [H] participation is at some hundreds or thousands times less. It is known that similar technologies are used for coal gasification by Fischer-Tropsch process (the company "Sasol", the RSA [32]) and for bituminous sand (the company

"Syncrude Canada" [33]). Usually it's enough to have 1-5% of H_2 from the weight of any fuel. There are good prospects for using a similar technology in order to increase incineration efficiency of any fossil fuel in industrial boilers and furnaces which are "in service". For this purpose it is necessary to use a small part of electric power produced by power station (see Fig. 5).

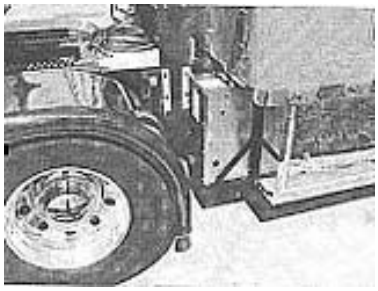

Fig. 6. HFI for a lorry engine
(a small box to the right of a wheel)

The similar technology can be used to increase efficiency and to decrease the fuel consumption for trucks and buses which are already sold. For instance, the Caltech Institute (USA) has developed, and the Canadian Hydrogen Energy Company has manufactured the Hydrogen Fuel Injection (HFI) for diesel truck's engines (see Fig. 6) [34]. A small part of an electric power produced by an electrical network of a truck has been used for water electrolysis. The studying has shown that it is possible to save about 10-20% of fossil fuel (plus to reduce toxic gas emissions at 1.5-2 times, especially of nitrogen oxides).

The Bloom Energy Company (USA) has recently begun the sale of the compact independent power stations (Energy Server-100 kW) based on a solid oxide fuel cells (SOFC) [35]. It can be the source of electrical energy for 100 private houses or one average office-building. The expense of gas on 1 kW is reduced at 8-10 times as compared with traditional electrical power stations.

III.2. Utilization of the Superfluous Kinetic and the Unused Heat [31]

Full utilization of the **"superfluous" kinetic energy** of moving streams of gases and liquids in pipelines is necessary. For instance, use of gas-turbine generators at numerous gas distribution stations which lower pressure of natural gas at the exit from the main pipeline (5-7 MPa) to final consumers (0.1-0.3 MPa). Often superfluous pressure of gas simply falls in on a throttle with the big loss of energy. If gas passes through the turbine (or expander-generator), the decline of its pressure will be carried out by a transmission of the energy of a gas stream to the turbine which rotates the generator of an electric current. Each such gas-turbine generator embedded into pipeline can produce up to 50 MW of additional energy.

So-called **"co-generation"** (it is a combined production by one device of two kinds of energy – electrical and caloric) must be widely used. The efficiency of such systems can be over 80%. Therefore, the low-efficiency steam-boilers must be gradually replaced everywhere by the steam-gas' turbo-generators with additional using of a heat-pump for recycling the residual calories. It is preferable to use the small (up to 25 MW) gas-turbine's devices, for example, Advanced Turbine Systems (USA), Siemens (Germany), or "Permskiy Motors" (Russia).

Also, it is necessary full utilization of the all residues of **unused heat** from the power stations, metallurgical, chemical and other factories, including energy of the tail-gases torches from gas' and oil's extract fields. It can be fulfilled with help of a heat-pump or other devices.

Besides, the **closed coal mines** can be transformed in a source of energy**,** more exactly, in the accumulate hydro-power station (see Fig. 7). The warm water (about 50-60 ºC) from a deep mine's horizon (500-800 m) can lift on a few hundred meters at the expense of a mine's pressure without external energy sources. This water can be additionally calorified (up to 70-75 ºC) and risen above with help of the so-called hydrodynamic pumps (it is simultaneously both a pump and a heater). On the upper mine's horizon, the hot mine water passes through a large heat-pump for heat-exchange. Then chilled water again is directed down into coal mine, where a cascade of hydro-turbines ("water-wheels") is assembled. The water falls consistently on the several hydro-turbines with electrical generators on its axis and rotates them, producing the electric power (due to a huge difference of heights). One such mine is capable to provide hot water and electricity to approximately 300-500 houses of 1-2-floors (plus about 50 new workplaces).

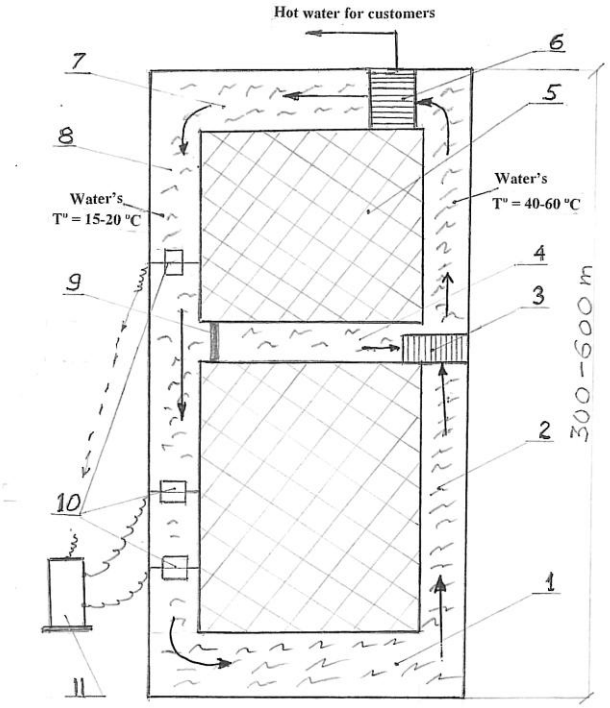

Fig. 7. Scheme of recycling of thermal and kinetic energy for the mine's waters

(Krasnyansky's project [31]):

1 - lowest horizon; 2 - ascending prospect-hole; 3 - hydrodynamic pump; 4 - middle horizon (water rises to it at the expense of mining pressure without external energy sources); 5 - block of the coal and rock; 6 - heat-pump; 7 - upper horizon; 8 - descending prospect-hole; 9 - water dam; 10 - water-turbines with electrical generators; 11 - transformer station.

III.3. Zero Energy Houses

"Zero Energy Houses" (i.e. the houses without or almost without consumption of any energy and resources from the outside) is now a popular trend. So, Chicago's companies "Zoka Zola" and "SOM", Passive House Institute from Darmstadt, Germany, and others are developing it fully or partly (for example, [36]). Also, many firms develop and create low-energy household appliances. The sharp reduction of energy and water consumption of household appliances at 2-3 times takes place. For example, Xeros-company together with Leeds University (UK) has developed a washing machine which consumes on 90 % less water, on 30 % less electric power and twice less detergents [37]. Some companies developed household refrigerators on the basis of magnetocaloric effect. Its system for vapor compression is actually based on a nanotechnology. Such refrigerators will be a cheap and highly efficient (up to 80%) [38]. Also, it will be very preferable to use of the newest energy-savings light-sources instead of the traditional white hot-bulbs, for example, light-emitting diodes (LED) [39]. So, a small 5W LED has luminous efficacy about 20 lm/W vs. usual 100W lightbulb having around 15 lm/W. Cambridge University's scientists have created the solid-state lighting technology (SSL) [40]. The new source of a light will cost about $3 per unit and will keep working capacity within 60 years. Its efficiency at 3 times more than fluorescent lamps, and at 12 times - than the traditional white hot-bulbs. Its important feature is the instant switching on. Besides, Jin Woo Han from South Korea has created Micro-Hydro-Turbine [41]. It is cap on water-tap with water-wheel (mini-turbine) inside. It uses the energy of water pressure in water pipe which rotates the mini-turbine. Produced electrical energy will be stored in the electrical accumulator which can be connected to the any plug (see Fig. 8).

Fig. 8. Micro-hydro-turbine for house's water taps *(by Jin Woo Han)*

The author's project "Zero-energy house" [42] is shown (see Fig. 9 – Appendix below). Many the above energy-saving and resources-saving technologies were used there.

IV. Development and Implementation of the "Green" Economic Incentives [43]

1) Considerably increase the production of high-efficiency wind generators, solar electric panels, large heat-pumps, turbines for small hydroelectric stations and all concomitant equipment, as well as of light-emitting diodes.

2) Creating a big quantity of small and medium-sized companies for production of all kinds of green energy in order to replace fossil fuel by alternative energy sources

3) It also must be (for both producers and consumers of the green energy):

-preferential credits, taxes, bonuses;

-high penalties for exceeding the limits of energy and fuel consumption per unit of production, or per inhabitant, or per 1 driveway mile for vehicles;

-creation of considerable quantity of green jobs (each 1% of the additional green energy will bring to Americans 20,000 workplaces on the average).

4) Wide development of public green initiatives and movements.

V. "Green" Trends for the Traditional Technologies

V.1. Nuclear Power

The newest nuclear stations must use the breeding [44] and transmutation [45] technologies. These technologies can use as a fuel the depleted (non-concentrated) uranium and also nuclear waste from the traditional nuclear power stations. These technologies are not only interesting for power generation, but also due to its capability of consuming the surplus weapons grade plutonium. They also are able to use much safer "thorium-uranium" cycle ($Th^{232} \rightarrow Th^{233} \rightarrow U^{233}$) [46] instead of a dangerous "uranium-plutonium" cycle. As a result, the average depth of burning of the nuclear fuel there will be at some times more, and accumulation of dangerous isotopes of the transuranic elements in its slag will be at some thousands times less. The mini nuclear power reactors using the above technologies have a big perspective for the future. For example, Hyperion Power Generation Company (USA) has elaborated a compact Hyperion Power Module (capacity 25 MW, price $25 million) (see Fig. 10) [47]. Also, TerraPower company (USA) has created nuclear fast traveling-wave reactor "TWR" [48], which uses depleted uranium and is able to operate for up to 100 years without fuel reloading. The similar but ultra-compact reactor "4S" (10 MW) has already developed Toshiba (Japan) [49], work-term of which is 30 years without fuel reloading. Now TerraPower, Toshiba, and Bill Gates as an investor will jointly create the super-modern mini nuclear reactor [50]. Wide using of the large and especially mini nuclear reactors on the base of breeding-transmutation technologies can lead to huge saving of fossil fuel and to big relief of the nuclear waste problems.

Note. *Although the nuclear power stations don't give emission of the greenhouse gases, its radioactive waste are potentially dangerous to the environment and human health. Besides, the nuclear power station in case of a serious accident like the Chernobyl disaster [51] (or of the terrorist action) can be dangerous for mankind. However, the need in the nuclear power stations for additional electric power will inevitably arise during transition to a mass use of electric or hydrogen cars (for constant charging of a big quantity of car electric batteries or for production of a large quantity of hydrogen by water electrolysis or by methane's conversion).*

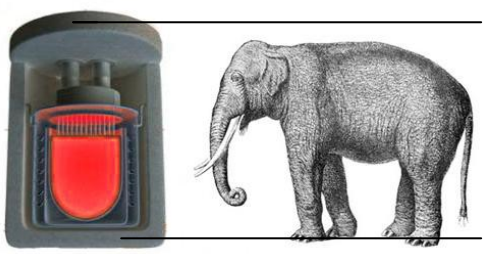

Fig. 10. Hyperion Power Module

V.2. Urban Agriculture

If to imagine a 30-storeyed **"farmskyscraper"** (see for example, [52]) with the area of a basis equal one hectare (100x100 m) and 5 tiers of the hydroponic containers (see Fig. 11) on an each floor, a crop can be reaped from a total area of 30x5=150 hectares. Because inside the "agricultural skyscraper" the temperature and humidity are always constant, you can take the crop 3-4 times per year (even on the North Pole!). With the average yield of wheat being 60 quintals from one hectare, the total annual yield for the "agricultural skyscraper" will be 150x60x3=27,000 quintals/year. Harvesting will be completely automated. First of all, the agricultural skyscrapers isolated from the environment will be protected from vermin and diseases, and this will allow to refuse completely from any chemical herbicides; secondly, we will be able to move agricultural industry directly to cities, where the majority of population lives. As a result, transport expenses will slump. Local governments of many cities from China, South Korea, the United Arab Emirates, and USA have expressed serious interest to vertical farms [53].

Fig. 11. Some tiers of the hydroponic containers on an each of a farm-skyscraper's floor

V.3. Green Energy and Paperless Information for a Person

If to consider food as energy for a person, we must accept some hard decisions. It is necessary to decrease of the production of the **cattle's meat**, and the full stopping of its export. This industry is the low-effective and super-spending foodstuff for energy and water [54], [55]. For example, it is necessary to produce about 7-9 kg of a vegetative protein in the kind of forage for cattle to produce 1 kg of an animal protein in the kind of a beef. In fact, the beef's protein is similar to the "second hand's" protein. Besides, the cattle-breeding demands at 8-10 times more water,

than the vegetable growing. Complete manufacturing of a hamburger (225 grams of a beef) emits into atmosphere the quantity of the greenhouse gases equivalent to journey of a car of 15.6 kilometers (this equivalent for pork is much less - 4.2 km, and it is a tiny for a chicken - 1.1 km). Thus, the vegetative protein (which, by the way, contains the all eight "irreplaceable" amino-acids and is much more useful to health of humanity!) is a source of energy-savings and vastly surpasses cattle's meat for all of the medical and economic indexes. I.e. the cultivation of the cattle, especially for export of meat, is an inefficient spending of natural resources for any country, plus it leads to pollution of the own environment. Therefore, it is expedient to put into law the surtaxes for manufacture of beef and especially its export.

Note. *Netherlands' scientists have raised "green" pork "in vitro" using pig's mioblast cells, which they have placed into a culture medium created on the basis of pig's blood [56]. Under their forecasts, buyers will see the sausages with such meat after five years. This technology in case of mass implementation could prevent the emission of the billions of tons of the greenhouse gases (the meat manufacture gives 18% from the total world quantity).*

Also more high taxes are necessary for manufacturing and sale of the super-sweet food (candy, cakes, rolls, soda). For example, it has recently done in Denmark and some other European countries. The use of such food is frequently the main reason of development of the many diseases which cannot be cured if these products won't be deleted from diet.

Paper manufacture is one of the most ecologically dirty and energy-spending industry in the world. Therefore, the distribution of the paper-information, paper-records and paper advertising should be limited (with help of the high taxes) in order to preserve forests (the average expense of a paper for one person per year can be 200 kg up to 2020; besides, paper's manufacture has huge energy-outlay (40-50% of a paper's cost). It is necessary for all of governments and businesses gradually to switch completely to electronic records and electronic advertising (CDs, DVDs, TV, Internet, e-mails, phone-messages, etc.).

V.4. New Systems of Electricity Transmission

The losses of electricity in the grids, for example, for the USA was in 2007 6.5% on the average (about 250 billion kW per year) [57]. Besides, it is necessary to spend about 50-55 kg of copper per 1 kW of electricity, transmitted by high-voltage lines (from a power station generator to any building). These problems can be solved by using the newest systems of electricity transmission with a high efficiency.

"American Superconductor" company produces the **"cryogenic" superconducting cables** for electric high-voltage and high-amperage networks. Their usage for networks of the large capacities (5 GW and more) on the big distances (1-2 thousand km and more) can bring many benefits [58], [59]. First, the efficiency of transfer of a current on a superconducting cable is nearly 100 %. Secondly, one superconducting cable for capacity 5 GW (which at 10 times is more thin than the similar cupreous cable) can be laid under the earth with "safety zone" of 5-10 m while usual high-voltage line for the same capacity will occupy a strip of the earth in width of 100-200 m and will have height of 30-50 m (see Fig.12).

The **resonant-wave method** of transmitting electricity (so-called "wireless power transmission") was offered for the first time by the famous American physicist Nikola Tesla [60]. In accordance with Maxwell's electrical dynamics [61] a current of polarization does not generate a joule heat because there is no resistance in conductors for that. However, the mono-wire high-frequency system of electricity transmission is more real (see Fig. 13). Thus, first, thermal losses in such networks decrease 8-10 times, secondly, instead of three non-ferrous metal wires there will be only one steel wire with the diameter of 8-10 times less as the density of current in this wire can be at hundreds times higher.

Note. *The mono-wire high-frequency system of electricity transmission (in which the so-called "Tesla's transformers" will be used instead of the traditional ones) will make it possible to send through electrical grids the accompanied managing signal-"router", that will optimize current flows in the electrical grids. This signal can pass without*

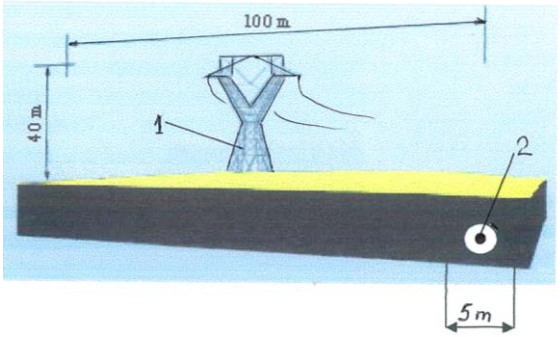

Fig. 12. Comparison of an usual high-voltage line (1) and the superconductor electricity pipeline (2)

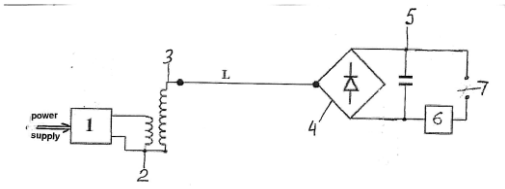

Fig. 13. The scheme of the resonant high-frequency mono-wire electric transmission system
(Krasnyansky's project [31])
1 - frequency converter; 2 - resonance primary Tesla's transformer coil; 3 - resonance secondary Tesla's transformer coil; L - mono-wire line; 4 – "bridge"; 5 – condenser; 6 – corrector of "managing-signal"; 7– load.

distortions inside of a mono-wire high-voltage line provided it is corrected at some points of a line and also at intermediate transformers. Such managing signal will eliminate forever the danger of a huge-scale collapse of power supply systems.

V.5. "Green" Metallurgy and Metal-Processing

Nanotechnologies in the future inevitably partially or completely liquidate many of the traditional energy outlaying and ecologically dirty kinds of the heavy industry, such as metallurgy and also stages of metal-processing (rolling, pressing, milling, welding etc.). So, the Israeli company "ApNano" has already created new materials which are many times more strong, light and heat-stable than a steel [62]. New materials are named "inorganic fullerene like nanostructures – IF-LN). It is special sulphides of the titan, tungsten and vanadium. These materials are synthesized as the nanotubes with a diameter about tens of atoms. These nano-materials show extraordinary high strength and excellent ability to absorb impact, keeping after impacting the initial form. So, samples "IF-LN" on the basis of tungsten had stopped the projectiles flying with speed of 1.5 km/s (thus, pressure 250 tons on sm2 was created in a impact-point). "IF-LN" materials can use for constructing bodies of rockets, airplanes, sea ships and sea submarines, skyscrapers, cars, armor-machines and for other purposes.

VI. Conclusion

The implementation of the grandiose "Green Energy Program" will change up to 2025 the energy-balance in any country, especially in such large countries as USA, China, the Euro Union, <u>namely:</u>
- Decrease of power consumption by means of energy-savings – 25-35%;
- Consumption of gasoline and diesel by vehicles will be reduced at 2-3 times (by means of usage the hybrid and full-electric cars, trucks, buses, and also bushy networks of high-speed railways).

<u>The rest energy consumption will be covered:</u>
- Solar energy and wind energy – 20-25%;
- Energy of rivers, oceans and seas – 25-35% (Large Hydroelectric plus Small Hydroelectric);
- Safe nuclear energy – 25-30%;
- Biomass energy – 10-15%;
- Traditional fossil fuel energy – 10-20%.

Note. *A few percents of energy can be additionally received by using the geo-thermal water sources.*

<u>Besides, it will be:</u>
- Reducing the greenhouse gases emission at several times;
- Creation of about 15-20 million new "green" workplaces.

I would like to express a hope that we together understand the necessity to solve the global energy problems and will not wait till all of the fossil fuel resources will be burnt and natural environment will be fully destroyed.

Let's recollect: the Stone Age was ended not due to a lack of stones on the Earth!

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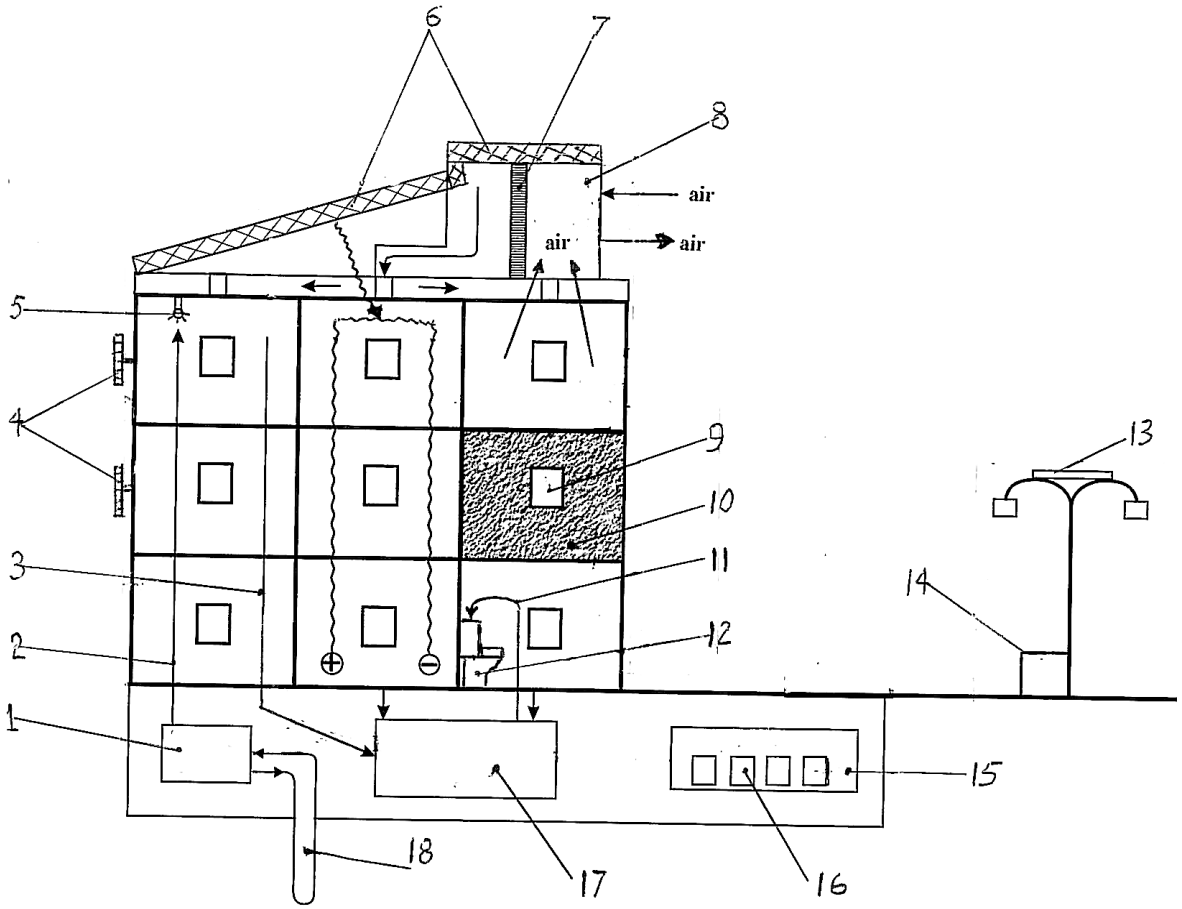

Fig. 9. Zero-energy house *(Krasnyansky's project [42])*:
1 – heat-pump; 2 – warm water; 3 –cool water; 4 – micro-wind--turbines; 5 – light-emitting diode; 6 – solar panel; 7 – air filter; 8 – air-exchanger; 9 – double-triple pane; 10 – super-insulation; 11 – water after cleaning ; 12 – toilet; 13 – solar panel; 14 – electrical accumulator; *(13 and 14 - it is a street lamppost with independent manufacture of the electric power*); 15 – laundry; 16 – "dry" washing-machines *(without using of water and any soaps)*; 17 – bio-chemical cleaning of the sewage; 18 – coil with liquid ammonia.

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