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ENERGY SELF-SUFFICIENT HOUSES (a.k.a. ZERO-ENERGY HOUSES)

with own water intake and electricity and hot water obtained from renewable sources of energy

energy and persistence conquers all things

(-) Benjamin Franklin

In this article, published in D&E bulletin, prospective homeowners are going to find a concise guide for building an energy efficient home on a piece of land located in Central Europe with its specific weather and, besides - „close to the blue sky and far away from the people". The place I mean has not yet been reached by greedy monopolists from the energy sector (both local and foreign) who produce energy both from chemical and natural sources. However, even in the latter case, for unknown reasons, energy is still produced on large wind and solar energy farms rather than by the isolated stand-alone systems.

The greatest problem of the present-day civilisation and this problem has been growing for over 150 years is our dependency on electricity in almost every aspect of our activity, complicated by the fact that it cannot be stored in the form of alternating current. Supplied at 50 Hz frequency to be finally converted to heat or light, as appropriate, it has to pass through different conductive or resistive wires. The high global consumption of energy, high failure rate, as well as outbreaks of fires are the inevitable consequences, accompanied with the lowest energy efficiency when the energy is used for heating.

Yet another step in the wrong direction, this time driven by the greed for money, is the trend to build large energy-producing facilities, an example of which are wind farms. Leaving aside issues such as mechanical energy efficiency of popular turbines and the site sensitivity let us focus on the transmission of energy via high-voltage and distribution lines from the wind farms to the homes and industrial facilities located hundreds of kilometres away because it is where the greatest losses occur. These transmission losses can be as high as 30%. Simultaneously, electricity generated in coal-fired and nuclear power plants (happily enough the latter are not yet present in Poland) is delivered to the same grid. Lack of synchronisation is an intrinsic feature of this system (how can you stop the wind from blowing?) and if it occurs at peak time, during the night or the weekend it results in ineffective burning of coal during shut-down and start-up cycles which is the second leading cause of energy losses, as proven by our western neighbours. For this reason the residential developments and industrial sites should be provided with their **own dedicated turbines** to serve their needs. The losses are not that high in the case of solar farms which operate at the same time as the rest of the industry, in particularly in the countries to the west and south of Poland while in Poland itself the demand from the industry is dropping.

The solution proposed by ROTAL are graphite radiant heating film supplied with direct or alternating current at 12, 24, 48, or 230 Volts, as required. They feature simple design and low production cost. With our technology any excess of electricity can be converted to thermal energy and then stored in the building enclosure, from where it can be emitted to heat the inside space. In hot weather periods the excess heat, namely hot air is used to heat up water by the air/water heat pump, and the obtained heat is stored in the thermal buffer – a water tank as big as possible, located preferably in the attic space.

This said, effective thermal and, even more important, reflective insulation remain prerequisite to low energy construction and the most important in this respect are the horizontal components of the building fabric, while the vertical components should include 1 cm gap at the side, top and bottom of each wall to enable movement of air and evacuation of any moisture which could have penetrated inside (see our guidance to flood victims in issue No. 6 of this bulletin and the following websites:

www.lps-gmbh.com
and www.onduline.pl

Our objective is to obtain a house where drinking and hot water, electricity, thermal comfort and fresh air are ensured at all times.

Whatever the place, access to fresh water is a primary consideration. This is because one just cannot live without having sufficient amount of water to drink and wash. For this reason, the first visitor invited to our dream plot of land is a water finder and/ or an experienced well digger, and even better two independent water finders and two well diggers. When finally some location has been chosen by at least two of them we can start digging or boring, as appropriate. With the wide range of robust and highly effective water filters available in the present market soil water drawn from a dug well may be a reasonable choice. In this way we can have our water without having to apply to the authorities, which would be required if water was to be abstracted from a deep well.

Fig. 1. Windmill-driven pump operating in Lędzin near the Polish seaside.

So here is the water but how to get it where we actually need it?

As the first step one must find a cheap and reliable way to convey water up to the house, as far as practicable without the need for electricity. Then it remains to distribute the water throughout the premises for drinking and, in cold weather, also for sanitary purposes. Both cold and domestic hot water are in consideration. Pressure boosting systems require electrical power and, as such, they are not the preferred option. A conventional elevated water tank (a.k.a. water tower) would do the job and it is a most recommended solution for flood risk areas (combined with a sealed bored well). A system based on a traditional concrete-encased dug well should include a discharge pipe through which a suction pipe is lowered to abstract water. This can be done with a windmill driven pump and we have two in operation at the moment - one in the village of Babigoszcz near Goleniów and the other in the village of Lędzin at the Polish seaside. In Europe pumps of this type are manufactured for example by BORNEY - a Spanish family company which has been in this business for three generations and which I have the pleasure to know personally. A similar result may be obtained with a shallow tubewell equipped with an electrical connecting rod and piston assembly supplied with electricity by diesel generator, wind turbine or a solar panel. The second option is to use an electrical submersible water pump, and this can be supplied with electricity also from the local sources (see Fig. 1). With supply of 230 V A.C electricity sufficient to satisfy the demand of 1.1 to 1.5 kW water pump the problem can be solved cheaply giving us complete independence from external supplies.

However, a generator set should be on standby just in case the regular sources of energy are not available. As an alternative to conventional gas, oil or petrol fired set HHO hydrogen generator may be used (see issue No. 8 of D&E). These auxiliary sources of electricity will be indispensable also during construction (to supply concrete mixer, power tools, etc.). Still the cheapest solution can be found in mountainous areas. The prerequisite is to obtain a sufficient difference of elevation between the home and the source of fresh water (stream or pond) which should be at least twice the building height. Then a single buried pipe in combination with a Pelton wheel will provide us with a reliable source of electricity of a few hundred watts and clean water for all household needs.

Having secured the supply of electricity and water we need to think of waste disposal and for this we propose a biological septic tank system integrated with a **heat exchanger to recover heat from grey water** (see **schematic No. 1** or D&E issue No. 5).

Now it is time to find a way to use of the solar energy which accumulates during hot months in soil and in the roof space.

If we have a choice the preferred location for our home would be the top of the south facing slope. For air supply a 180 mm dia. polypropylene pipe (an ordinary non-perforated drain pipe would be fine) should be buried in soil at min. 1.5 m depth. It should have a min. length of 0.5 m per square metre of the heated space. The air passing through the soil may be additionally heated by solar air collectors (see Photo No. 2). The pipe is laid at a rising gradient of 5° up to the air inlet under the sealed fireplace

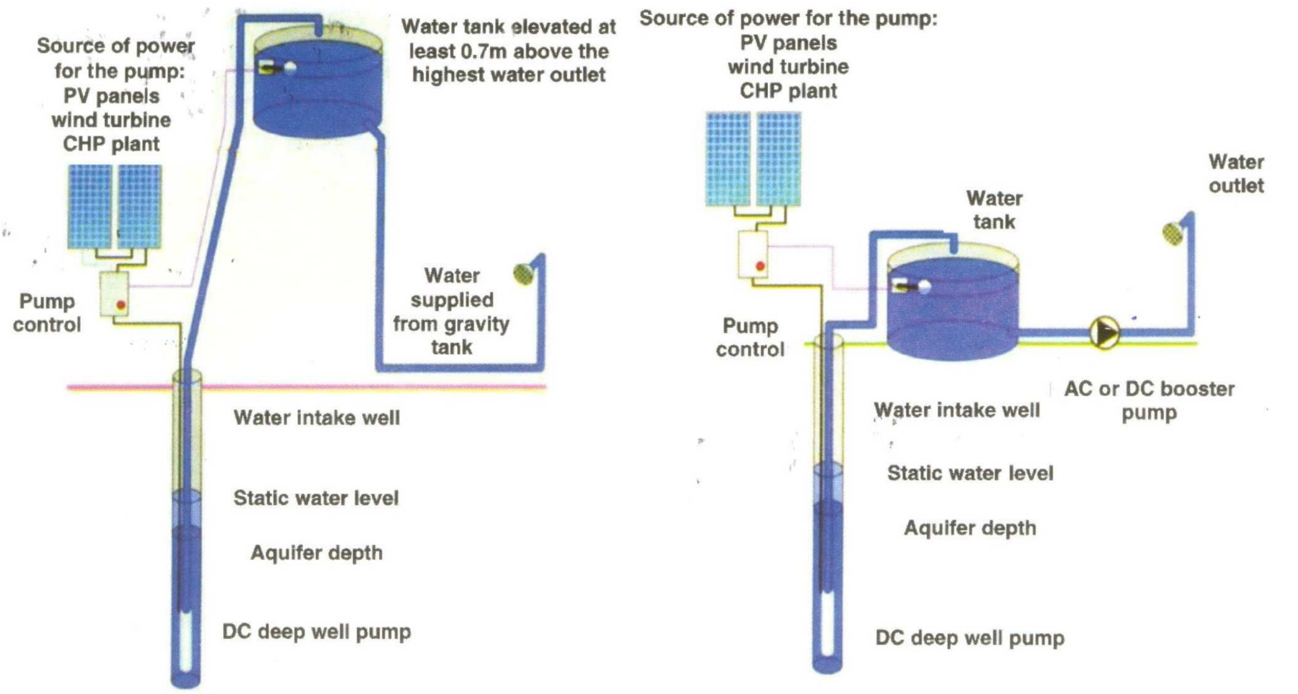


Fig. 2. Methods to supply water abstracted from a deep well by DC borehole pump supplied with electricity from own sources distributed from a gravity tank or forced by a booster pump.

insert. This stream of air will be used for ventilation and for transfer of heat from the fireplace, as well as by the air/ water heat pump. For supply of combustion air to the fireplace a separate pipe should be laid between the air intake installed right outside the foundations and the firebox air connection located under the ash tray – this is of primary importance for passive homes. After passing through the heat exchanger the stream of fresh air passes over the sealed firebox and the flue pipe in traditional chimney reaching the level above the collar ties. This flue pipe installed in the chimney flue (external concrete elements will be sufficient in Shiedel system) is extended to ca. 0.5 m above the roof ridge. In the part penetrating above the roof the flue pipe is surrounded in mineral wool and sealed with crown mortar and air drawn through the ground-air heat exchanger, whether heated up or not flows naturally or is forced by a blower fan to reach all the rooms in the building.

During a sunny day in March the temperature of soil surface at the solar air collector (Photo No. 2) was -1.5 Deg. C, the temperature of intake air was +3 deg. C and the temperature of air supply at an outlet in the north facing room on the first floor was +14 deg. C (for the previous two days fireplace was not used). Preferably the house should have internal non-bearing knee walls. In this way a void will be provided along the walls, which may be used for routing all the electrical wiring, water pipes and warm air ducts with vertical droppers leading to the respective rooms.

Three years ago one of our clients persuaded us to implement his concept based on the hot air distribution system used in the Teutonic Knights' castle of Marienburg. At first sight it appeared to be the design of Legalet, a German company, having its representative office in the Polish Tricity. Unfortunately they refused to give him advice or consultation or sell the components according to the amended and simplified design proposed by us. In this system fresh air is drawn from outside and, after passing through the ground-air heat exchanger and chimney flue, it is released in the attic space and from there forced by a blower fan through one vertical 120 mm pipe to 100 mm piping (uninsulated) to finally reach a system of smaller pipes

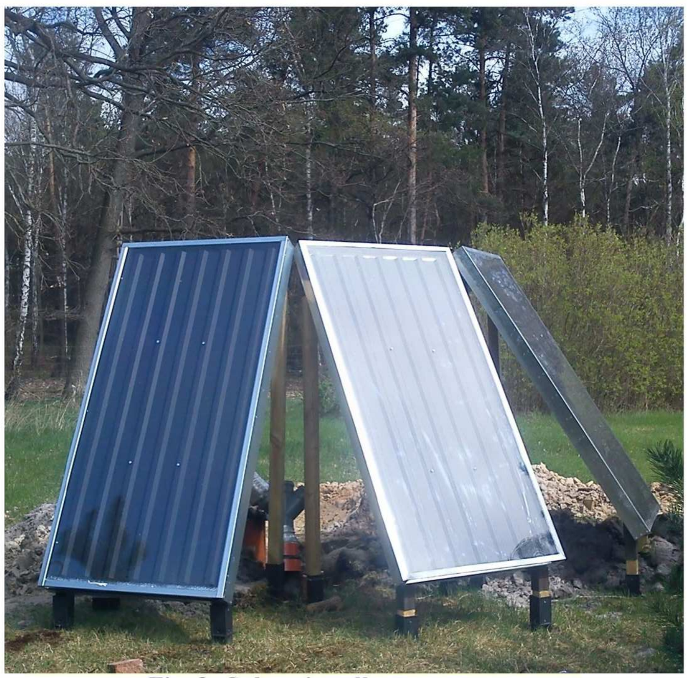


Fig. 3. Solar air collector operating in Cisewo.

installed under the ceramic ground slab heating up the groundfloor rooms. These smaller pipes are laid on some thermal insulation, for example EPS boards or a layer of expanded clay aggregate. The layer of hot air distribution pipes is separated from ground with horticultural grade polythene sheeting and aluminium foil as reflective insulation. These pipes terminate under the firebox where the stream of cooled air is mixed with the stream of fresh air conveyed through the heat exchanger from outside the building and the air from the spaces on the ground floor. The combined stream passes over the firebox and flue pipe and then, after passing through the heat pump, it is forced by a blower fan down under the ground slab (see the schematic in issue No. 3 of D&E).
This intensifies convection of warm air from the ground floor upwards since it is heated up by the ceramic ground slab. Warmed air leaves the spaces through the exhaust ducts and through the staircase to finally reach the roof space through the opening in the uppermost ceiling (on our diagram air passes through the triangular duct installed under the ridge beam).

At this point recovery of heat takes place with the use of air/ water heat pump. During operation the pump creates vacuum which spreads throughout the whole building. In this way the part of the attic space around the heat pump becomes the heat source. When the pump is not working the used air is discharged outside the building through the vents installed in the top part of gable wall or through dedicated roof terminals. The heat obtained in the heat pump should be stored in a thermal buffer (gravity tank), as big as possible, for example 500-700 litre - heat exchanger filled with water, glycol or other suitable medium. The thermal buffer, if possible, should be installed in the attic space, next to the heat pump. Of course, these two devices may as well be located on the ground floor, in the basement or even in the garage, if location in the attic is not practicable due to excessive load or if the Architect has denied acceptance. Then the warm exhaust air will be brought down from the attic space through an air duct and the available heat energy will be discharged by the lower coil and stored in the thermal buffer. The heat will be received by the second coil in the upper part of the tank. Why not use a plate-type heat exchanger? - somebody could ask. Let us first look at the issue of heat storage: a big **thermal buffer** is what we need in all cases. Then it will be capable to accommodate also the heat generated by cogeneration plant and all other sources of electricity. The heat recovered from combustion gasses in the fireplace coil or, if the homeowner decides to have them, also generated by the solar water panels is **delivered by gravity to the thermal buffer** located in the attic taking into account cheap and reliable gravity-fed system. If the thermal buffer has to be located on the ground floor, hot water from the upper coil should be delivered to a small 200-300 litre heat exchanger incorporating two coils and **located in the attic space**. The top coil will serve the forced air heating system combined with fireplace heating system and in winter it may be used for swimming pool heating. The second, lower coil is supplied with fresh water from our upper storage tank installed under the ridge beam, from the water tower elevated above the house or from the mains or own water supply system. In order to maximise the overall amount of recovered heat this water should be passed through the **wastewater heat recovery system**, where it can be heated by grey water from 6-8 deg. C up to 27 Deg. C. In

Fig. 4. Image of the designed Tuscan style home, currently under construction on a site near Warsaw incorporating saw-tooth skylight allowing natural light to all the floors.

this way waste heat may be recovered from grey water (black water is excluded). We must not forget that the liquid in the lower thermal buffer (if it is a gravity tank) is not changed (coolant fluid diluted with distilled water, pure coolant fluid or any other medium featuring high thermal capacity). On the other hand it is perfectly clean and cut off from air with a paraffin oil membrane to prevent growth of algae. Its function is to **store the heat obtained from all the available sources**.

The above-described system has been implemented by one of our Clients, and specifically it comprised of a large, over 700 litre capacity gravity water tank installed in the attic, incorporating two coils in the upper part supplying forced air heating (upper coil) and DHW systems (lower coil). Solar heat and glycol heated up by the fireplace (it has an integral heat exchange system unfortunately) are supplied at the bottom of the tank. With this system in place it is enough to run the fireplace five times a fortnight to have warm air and water at all times and without various pieces of equipment fitted on the fireplace (except that it has an integral heat exchanger, which we do not recommend). This might be quite a novelty for readers of the most popular Polish magazine on the subject.

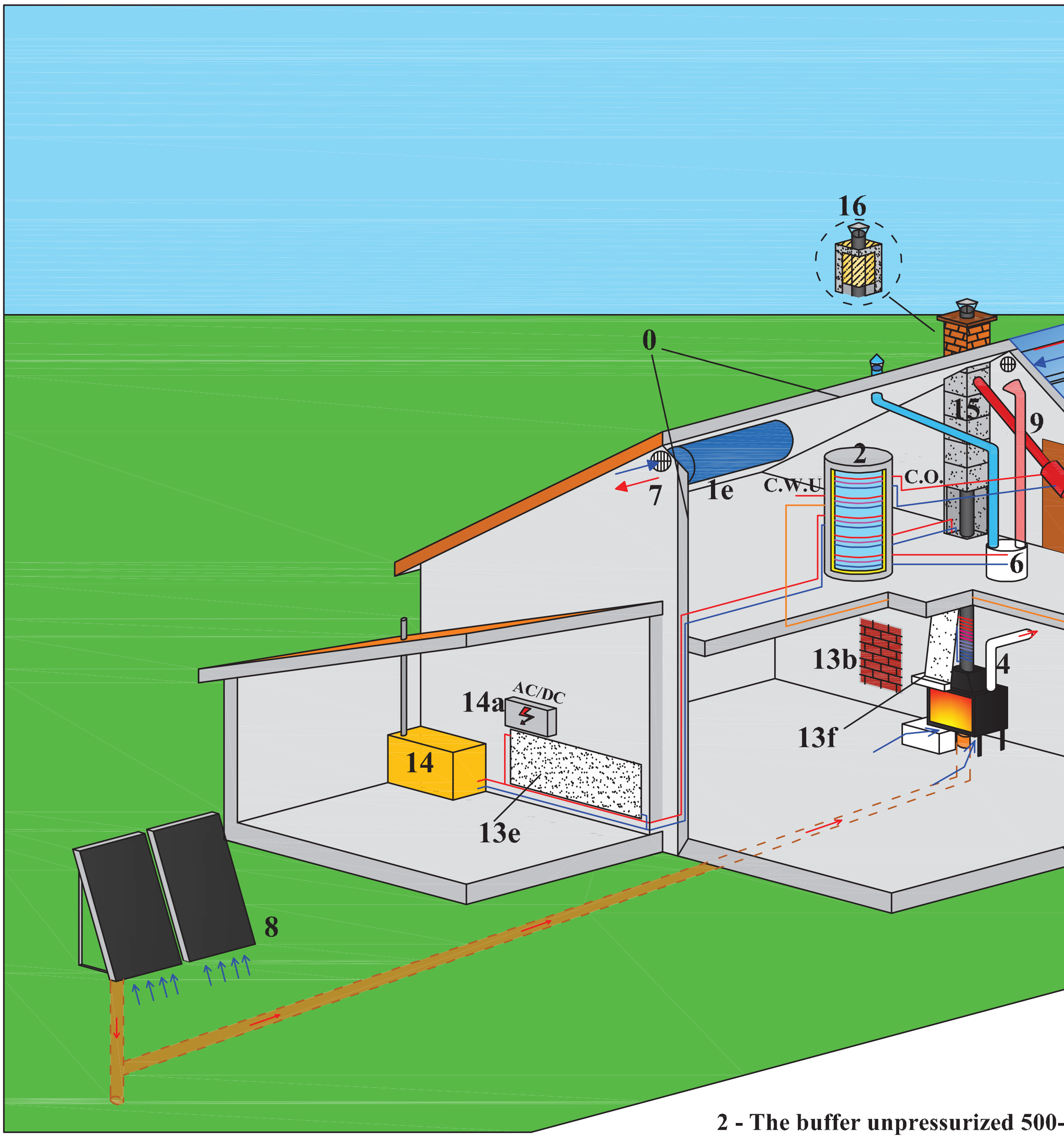
What we mean by **Tuscan style home** is a residential building with glass roofing over the staircase or with a light shaft extending from the roof space to the ground floor. Moreover, it should have open sides or at least removed the top parts of walls at each floor. The inspiration for me were the homes I saw in Tuscany in 2010 and, interestingly enough, also in Pompei. In our solution (which you can see in detail on the computer simulation) which is being implemented near Warsaw the staircase coincides in space with the light shaft leading from the roof to the groundfloor level. This design accompanied with two solar air panels, one as a stand-alone unit upstream of the ground-air heat exchanger and the other installed on the south facing roof slope and the air/ water heat pump in the attic, should altogether **let us do without the solar water panels**, so popular in Poland, as probably the only country in Europe owing to strong support from our "so called experts" in renewable energy. With a simple and cheap air/ water heat pump or air/ air heat pump as less advisable solution (so-called air-condition) we are able to collect solar heat round-the-clock and year-round **with higher efficiency and store it**, together with the heat recovered from used air for use when it is actually needed. The south slope of the roof, specifically the space between the roof covering (be it sheet metal or tiles) and the vapour barrier, reaching up to the ridge cap (foam sealed in this case) is a perfect and cheap heat collector. The air present in the downspout where it is heated up by the sun is delivered to the attic where, upon mixing with the used air, it supplies the heat source of our heat pump, the so-called wet heat exchanger. The system is complete with a thermal buffer, which should be as big as practicable. A parallel and reliable supplement to our heat pump will be solar energy heating up the used air accumulating under the glass roofing on the top of the staircase.

Remember that we do have some 500-1000 litres storage capacity in the gravity tank installed in the attic or in the water tower outside the building. This tank is always equipped with a return pipe to discharge water to the well or borehole, as appropriate. On the other hand, precipitation water drained from this storage system will **always** be warmed up on the heat exchanger. The second line is routed to the cold water outlets.

Forced air heating is based on water/ air heat exchanger, similar to the device we have in our cars (cooling radiator) working parallel with the fan-assisted fireplace heating system. Warmed air will finally be discharged through air valves to the respective rooms. Circulation of water from the heat exchanger to the cooling radiator is effected by a small DC pump (such as commonly used in aquariums) supplied with electricity from renewable sources, a diesel generator or from the mains. In certain systems when there is only one high-capacity (for example 300 litres) forced-flow heat exchanger for DHW and the temperatures are too high it is our

Fig. 5. Horizontal axis wind turbine, 3.5 kW nominal capacity.

Energy self-sufficient house with own independent water intake, e



LEGEND

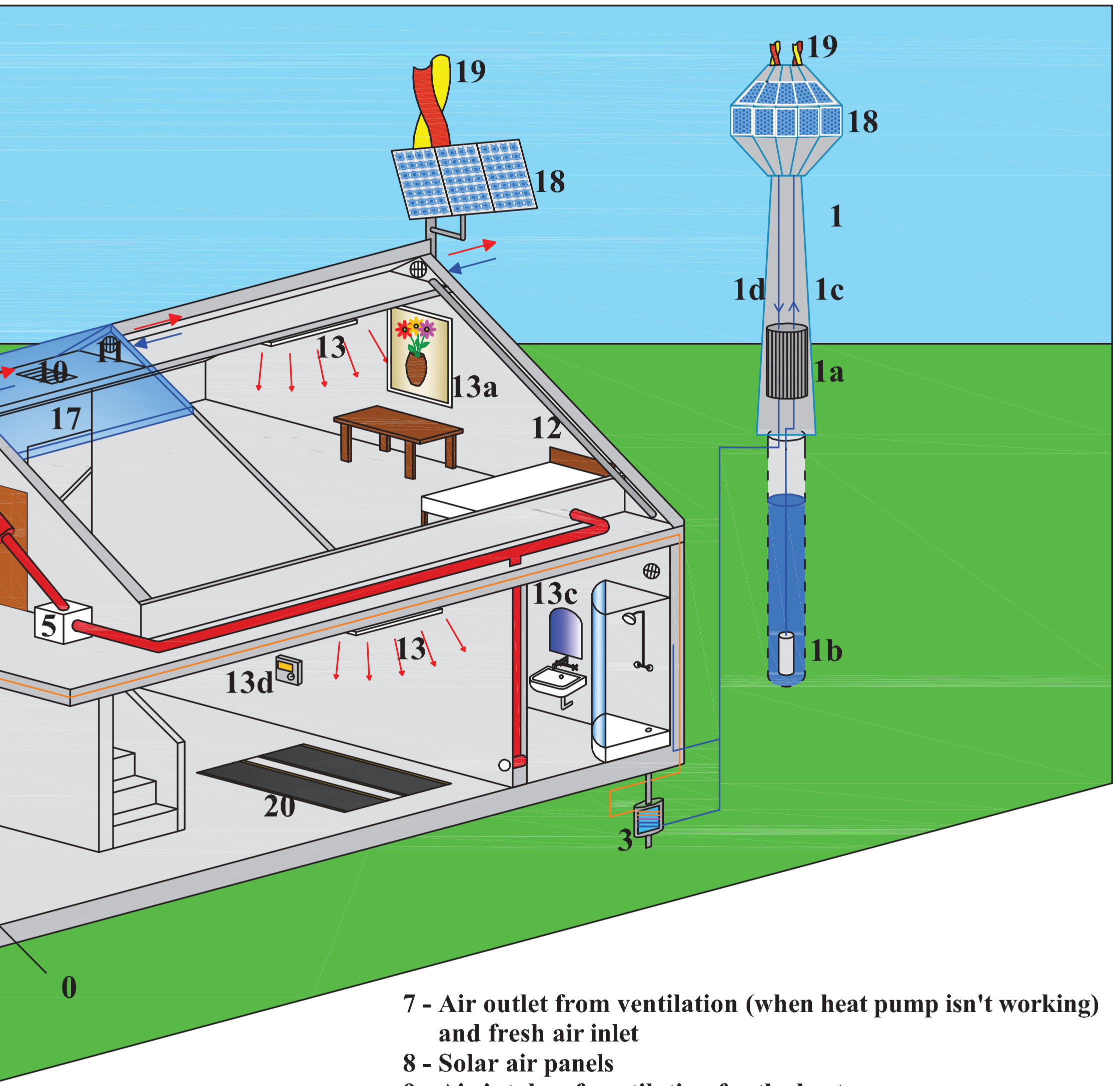
0 - Thermal - heat insulation from the inside
1 - Water tower with a capacity of 15-20 m³ with the well of ground water or subcutaneous and supply it to 20-30 houses by using the energy from wind, solar or cogeneration
1a - Water treatment station (filters)
1b - Submersible pump powered by electricity or wind motor
1c - Water inlet pipe to the tower through the filters
1d - Water inlet pipe from the water tower by gravity to individual customers
1e - Unpressurized gravitational tank flooded with water individually (unnecessary in case of power from the water tower)

More informations www.rotal.pl

2 - The buffer unpressurized 500-
hot water from:
- **fireplace and solar panels**
- **heat pump**
- **cogeneration**
- **surpluses of own electrici**

In the upper part are the spira (water or air) and hot water
3 - Sewer recuperator (more reco water panels)
4 - Fireplace cassette with jacket the flue pipe
5 - Air turbine: distribution of ho to the premises through the he and the solar air panels (8)
6 - Heat pump - "wet recuperation from ventilation

electricity and hot water from many different renewable sources.



-1000 liters, the supply of

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air and water coil on

ot and cold air from outside
at ground exchanger

n" from fresh air and air used

7 - Air outlet from ventilation (when heat pump isn't working)
and fresh air inlet
8 - Solar air panels
9 - Air intake of ventilation for the heat pump
10 - Inlet probe the used air from the heat of house on the staircase
11 - Rasters for ventilation air flow heated by sunshine through
the skylight roof (17)
12 - Ventilation duct in the roof ceiling
13 - Electric radiant heaters
13a - Radiant heater - painting
13b - Two-sided accumulative radiant heater from bricks
(for two rooms at once)
13c - Radiant heater - mirror
13d -Temperature control of radiant heaters and floor heating
13e - Water radiant heaters
13f - Air - combustion radiant heaters
14 - Generator to produce electricity and hot water
from gas, oil and HHO
14a - Distributive from many differents sources
15 - Flue metal pipe in a ceramic housing from the ceiling above
the fireplace to 0.5 meters above top of the roof
16 - The space between the pipe and the chimney thermal insulated tightly
17 - Skylight roof
18 - Photovoltaic cells on the track
19 - Vertical wind generators
20 - Graphite foil for electric floor heating

practice to incorporate an auxiliary heat exchanger on the by-pass between the main heat exchanger to supplement the stream of warm air.

In a simplified form this solution is nothing else than the air conditioning systems based on the air/ air heat pump, offered in USA for a few dozen years. The difference is that it does not allow for storage of heat to be used when it is actually needed. This can be obtained with our system. The American system copes with the cold weather periods (which in our local climate must be taken into consideration) by heating the air by electric, oil or gas-fired air heater. They are reach, they can afford it, but is it worth the cost? In 1992 I asked that question during my visit to one of their heating research centres in Albuquerque. I heard that they have own oil and gas from Alaska, they can afford it and the business goes on for everyone. At this point in time we the Poles have to import these fuels from other countries. On the other hand, as I already mentioned in the previous issue of D&E solar water panels were invented around 1880 in USA. During several trips across California and during my presence at two conferences devoted to renewable energy sources which took place in Palm Springs in 1990s I looked for solar water panels and there were hardly any in sight.

I found this type of solar panels only on one roof in San Mateo and in San Bernardino swimming pool complex. Quite interesting, isn't it? - Especially when you compare solar radiation maps of Poland and California. I have already answered that question.

Electrical heating as the cheapest option? How on Earth?

Now we have arrived at a point where we have already secured supply of potable water, cold and hot domestic water, electricity generated by wind, water or gas, oil or petrol fuelled genset or by cutting-edge HHO generator. However, the most reliable source of energy is always our dearest sun and photovoltaic panels to convert it to electricity. Therefore, our house will be provided with photovoltaic panels installed on the roof or on the south facing elevation. Their energy performance may be increased if a network of thin PE or copper pipes is installed at their underside to carry away waste heat by water circulating in a closed circuit. Mounting the array on a sun tracking system driven by a step engine will yet increase their performance by up to 40%. However, it is not absolutely necessary to transform the 12 V or 24V DC current to 230 V AC.

The hybrid system we propose would be complete with a robust wind generator based on neodymium magnet (see: http://www.rotal.pl/index.php?g=produkty&ps=produkty_turbina). Monitoring of the above-described system will be implemented soon. Both wind speed and power yield will be checked continuously. The wind generator has already been installed in Cisewo in Poland, near the seaside.

One of the inspirations to write this article was the heating solution used by the Pueblo Indians living in the desert areas of Arizona of which I heard from the ASTEC engineers in Albuquerque (New Mexico). They told me how NASA solved the problem of space heating in most challenging conditions ever, that is in the spaceships with the outside temperature of -100 Deg. C, lack of gravity and sun being the only readily available source of energy (except for fuel cells of course). The visit resulted in the transfer of ECONSUN radiant heating technology. There are two threshold temperatures which are critical to maximise the energy performance. The first threshold is in the range 100-110 deg. C and the other in the range 270-300 deg. C. Therefore, the device should incorporate a sheet resistor yielding ca. 0.1 W per 1 sq. cm to control the first threshold and a conventional ca. 40 W resistor to control the second threshold. Interestingly enough, the principle was copied from the solution used in the desert homes (see Photo 5 and the articles published in issues No. 1 and No. 3 of D&E). Just as a matter of interest, one of the rooms of Home&Power magazine office block in Aschland (Oregon) is heated by a 500 W radiant heating panel supplied by ROTAL, which in this case is disguised as the portrait of Mr.

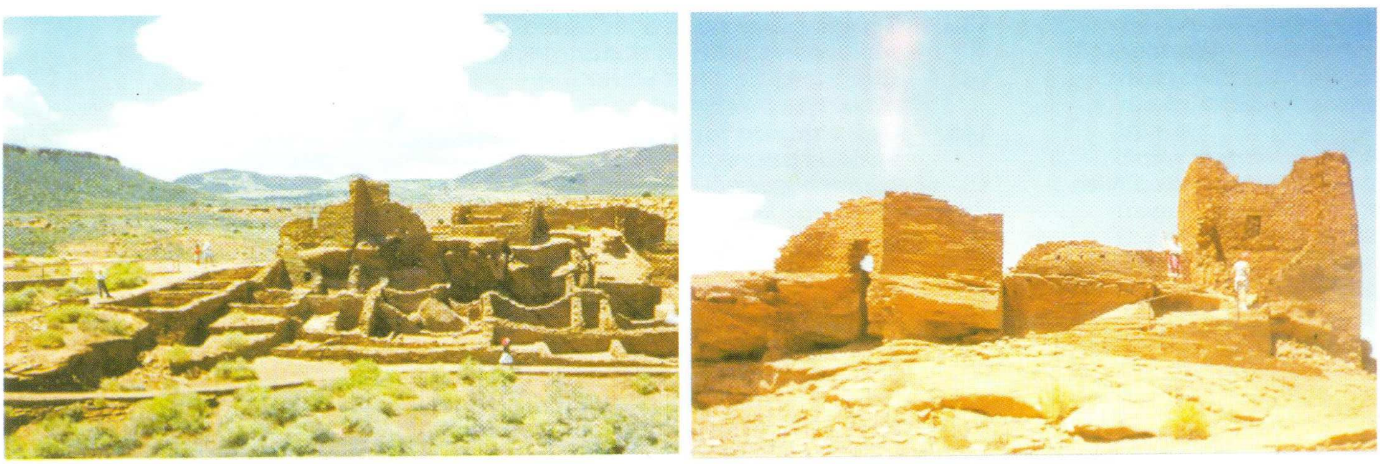


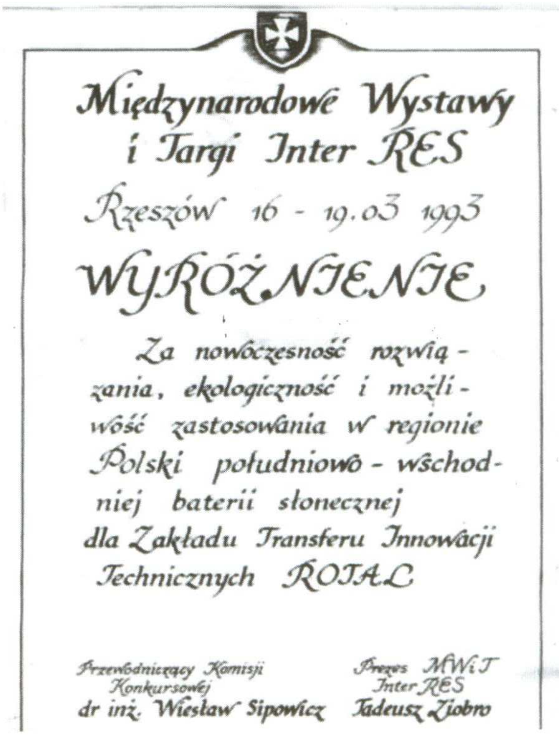
Fig. 6. Buildings of Pueblo Indians in a desert location in Arizona built of quartz bricks.

Richard Perez, the editor. Electricity is generated entirely by photovoltaic panels.

The next inspiration to look for heating solutions for the most challenging conditions was a meeting with two inhabitants of a village located in a depressed area of a Mexican desert with very hot days with ambient temperatures reaching 40 deg. followed by ice cold nights. They inspired the design of our heat storage radiant heating panels utilising **brickwork partitions**, similar to those built by Indians living in the deserts of Arizona. The walls incorporate the above-mentioned radiant heating film, **preferably made of graphite** in order to simultaneously supply heat to two neighbouring spaces. This allows us to store electricity generated by all the available renewable sources and drawn from the mains (preferrable during the lower rate period), although for this purpose it must be first converted to heat. **This allows us to conclude that both heat and light can be obtained without access to 50 Hz power.** In our most recent fair displays we present a 35-100 W LED reflector which may be supplied both with AC and DC power.

This allows for accumulation and use of the energy when it is needed. It is more effective than the most popular method using water as the heat storage medium since transfer of heat from water to space requires more costly equipment and distribution systems which in any case will generate some energy losses and in our solution the whole system comprises of a **wire and a simple cheap resistor**. For this reason the solar water panels will never „beat" the PV systems and our south-eastern neighbours know about it. Another advantage is a better thermal comfort provided by electrical radiant heating panels. In the analysed case heat is accumulated in brickwork, which can be easily replaced with a thick quartz glass panel, marble plate, etc. (see the photos of the monitored piece of brickwork incorporated in the partition wall in a building located in Szczecin and in a brick factory in Kraśnik in issue No. 6 of D&E) During hot weather excess heat from electrical energy is accumulated by covering the wall with a sheet of coloured aluminium fabric and then hot air is conveyed through narrow channels to the attic space and used as the heat source by the heat pump to heat up domestic water stored in the thermal buffer installed in the attic or on the ground floor.

The idea of our direct radiant heating system is based on the two fundamental laws of physics, to which A. Einstein referred when already in the 1950s he pointed to **radiant heating as the heating system of the future**. The first law states that heat is the internal energy of any object and the other states that warmer air, gas or liquid is **pushed upwards** by gravity. Hence, the primary building component in terms of storage of hot water and air is the attic with the space above the collar ties being the most convenient place for our thermal buffer and heat pump installation. This system makes our home independent of any external sources of energy and a minimum


Międzynarodowe Wystawy i Targi Inter RES
Rzeszów 16 - 19.03 1993
WYRÓŻNIENIE
Za nowoczesność rozwiązania, ekologiczność i możliwość zastosowania w regionie Polski południowo - wschodniej baterii słonecznej
dla Zakładu Transferu Innowacji Technicznych ROTAL

Przewodniczący Komisji Konkursowej
dr inż. Wiesław Sipowicz

Prezes MWiT Inter RES
Tadeusz Ziobro

Fig. 7. Model of the author's home in Szczecin which in 1993 was equipped with gas-fired CHP plant, hot water and electric radiant heating, solar panels, 900 litre thermal buffer coupled to the heat pump, fireplace with an air jacket and hot air distribution to three rooms.

consumption of electricity. This would not be attainable in any passive home (is there a passive house which may do without electricity and in particular 50 Hz current?)

The attic is right place for installation of all the devices related to distribution of hot air in forced-air heating system power with electricity (preferably obtained from own sources). In our system electricity may not be even necessary since air will be moved downwards due to difference in the density of fresh air which have been passed through the air-ground heat exchanger and the chimney flue. Moreover, with the gravity tank in place, we will not need electricity to bring down water to the lower levels.

Electrical heating is always one of the main options considered by homeowners. However, according to a common belief electrical heating is expensive, no matter where from it is obtained. Those who follow this common belief are invited to read the report from the research carried out at the Kaiserslautern Technical University by the team headed by Peter Kossack, D.Sc. and ordered by the Austrian company Redwell.

The report covered the period between autumn 2008 and spring 2009 (see http://www- user.rhrk.unikl.de/~kosack/forschung/index.php?Home and http:// www.rotal.pl/artykul_pliki/kossack-pl.pdf). Contrary to the common opinion prevailing among our partners in the Czech Republic, USA and Scandinavia and contrary to what we heard in the 19 years of our activity in the business the article proves that a heating system based on radiant heating panels uses **2.5 times** less energy than conventional hot water heating system based on gas or oil-fired appliance, no matter if it is Germany, Austria or Switzerland. We have arrived at the same conclusion much earlier. However, the report is not complete as it leaves out the investment cost of the two compared system (see issues No. 1-3 of D&E). I pointed this out during my phone conversation with Mr. Peter Kossack. Besides, the report, which now is referred to by all the manufacturers of low-temperature radiant heating panels in the world ignores the savings related to the whole process of energy production and starting up of outdated hot water heating systems, which can cut the energy consumption almost by half. And this includes energy produced from renewable sources, as advocated throughout Europe and Poland, much underdeveloped in this field, in particular if these are not cogeneration plants focused on production of electricity. Much greater ventilation losses should also be taken into account.

Let us summarise what we have said up to this point. In order to be considered energy efficient a home should be provided with efficient thermal and reflective insulation, high thermal storage capacity (heat banks, heat accumulating partitions and water tanks), air/ water heat pump and waste heat exchanger for heat recovery and finally low temperature radiant heating panels such as our ECOSUN panels used only in colder period when the temperature drops a few degrees below the limit of thermal comfort.

The brand name ECOSUN is given for reference only. In fact any other radiant heater would to the job as well, as it has been demonstrated by Mr. Peter Kossack. The above requirements apply irrespective of the climatic zone, elevation above sea level and thermal performance of the building fabric.

However, for the prediction of Albert Einstein to come true and **for the over 300 years ruling of conventional stoves and heating systems to come to an end** we still need to wait patiently, mainly because of the resistance from the academic circles, architects, builders and publishers. It is high time to accept that the highest savings can be made by phasing out outdated, expensive and inefficient indirect heating systems, whether convection or forced flow type and based on boilers or air-heaters, especially that 160 years have passed from the moment when electricity was discovered. A reliable and cheap heating system is the aim for any homeowner. There are a number of ways heat can be provided to the space (distributed through some kind of central heating system) and it can be produced with energy obtained from various sources, including the most recent renewable sources (modern – yes they are, and more and more expensive besides).It is important to realise that before the heat reaches its final destination, i.e. room in the building it must travel a long way, the same for the last 290 years and more and more expensive (and thus inefficient).

This problem has inspired scientists, academics and politicians to look for a solution based on nuclear energy. They just could not be more wrong! Why? The answer has been provided in the previous issues of D&E. In the next issues we will calculate the total investment cost of nuclear power plant per 1 kW of produced electricity and set it against the cost of obtaining such amount of energy in other simple and safe ways resulting in thousands of created job places.

Production of graphen in Poland, the idea of which was hinted to our Prime Minister is the last of trivia in our field. This could work, as long as production of graphite film heating elements was launched simultaneously. This would multiply the energy benefits both for us and the next generations alike. I am familiar with the issue from 1985 in my business. However, from 1993 I use simple, safe and reliable graphite heating film imported from Britain.

The model of my home of 1993 was used as the basis of discussion at that time and now I can add a lot more information to it. Those who are interested in maximising the energy obtained from wood burnt in a fireplace might be interested to hear that it was me who patented the first fireplace insert in Poland, which was in 1985, followed by its presentation in the 1988 fair in Poznań. It was a cast-iron insert with air jacket and forced air flow with so high efficiency that the temperature of warmed air was sufficient to ignite a piece of newspaper inserted in the warm air outlet pipe at a point located 2 m downstream of the air jacket. I personally use fourteen fireplaces, iron stoves and kitchen ranges maximising recovery of heat inside the chimney flues (see the schematics published in the previous D&E issues). Having this experience I can give advice how to choose the best fireplace insert and design optimum chimney.

The above described solutions could or even should be used by residential developers and housing associations (such as the Polish TBS) also in multi-storey apartment buildings (covered with pitched roofs). This concerns in particular provision for common recovery of heat from exhaust air and used grey water. Both forms of energy (electricity and hot water) should be supplied by cogeneration plant, gas or oil fired, accompanied with PV panels and electric heating and cooking appliances. A small air/water heat pump would provide a solution for recovery of heat from exhaust air and assist in recovery of heat from grey water. However, it would not be compatible with a hot water central heating system. Currently we are in the process of designing such solution for an apartment building in Lublin, Poland designed for 4-6 families.

Global economy aspects following from the above article

Anybody who has experience in energy production and at least basic understanding of the principles of economy applied in any cost and benefit analysis, be it a residential or industrial building in any country throughout the world is aware that some running costs just cannot be avoided and they include the cost of electricity, heating and domestic water. Based on my experience in implementation of the above-described systems in various buildings I have arrived at certain conclusions as to the reasons of the present energy situation of Poland. These conclusions are given in the following points:

- We should **not** apply the principles of **free market economy to the energy sector**. This applies in particular to production of energy based on imported source materials to be subsequently used in public buildings and governmental offices, where the running costs are paid by the state.
- Privatisation of the power sector lead to lack of synchronisation between the suppliers of source materials, producers of electrical and thermal energy (power station and CHP plants), utility companies and the end users of energy.
- **Lack of public debate in the form of confrontations, publications and presentations of effective use of electricity for production of energy** and, on the other hand, focusing on gas and oil fired CHP plants in order to demonstrate insufficient supply of electricity and thus justify investing money in nuclear power projects. This is not true as we have more than enough electricity and phasing out conventional light bulbs is not the only way to reduce its consumption as it has been demonstrated by Peter Kossack from the Kaiserslautern Technical University and pointed out in issues No. 1 and No. 3 of D&E.
- Architects are the most difficult to accept the energy saving attitude and, as such, they should not be given full control over the building plans. Their role should be limited to drawing a sketch to be later worked on by an experienced energy efficiency specialist (a mechanical engineer would not perform at this point).
- Decisions should not be taken solely by politicians advised by academic scientists. It is the practicing engineers to be asked for advice.
- Decapitalisation of power generating facilities and equipment, as well as the associated transmission systems (both electrical and heating) is an argument for building local, stand-alone systems.
- The requirements contained in the 1300 pages of the regulations issued by the Polish Energy Regulatory Office should be eased with respect to use of energy obtained from all sources, including in particular renewable sources.
- PV panels should be promoted, yet these should be local stand-alone systems, used to satisfy own needs in the first place.
- General support, financial assistance, VAT incentives should be given to the manufacturers of small wind turbines, PV panels and any other equipment using renewable sources.

This would create thousands of work places throughout the country. This is the way to create work places in any municipality with small investment cost needed (see issue No. 5 of D&E). Then the debt clock placed in Warsaw by Prof. Balcerowicz would at last slow down its pace.

Below is the list of equipment mentioned in the article, which is not and yet could be easily manufactured in Poland:

* Micro-CHP systems up to ca. kW_{el} - both asynchronous and synchronous (water cooled), for the production of which small water-cooled spark-ignition car engines could be used
* Wastewater heat exchangers - these could be more efficient that solar water panels and yet they are not produced in Europe
* Heat exchangers - gravity tanks with 500-1.000 litre storage capacity
* DC deep well pumps
* Mini water towers, most useful in flood risk areas
* Low speed, low power wind turbines
* Low speed generators incorporating neodymium magnets for small water turbines
* Simple screw type rotors (Savonius design) for surface and submerged small and medium hydropower plants and wind generators
* PV panels c/w auxiliary equipment
* Graphite heating elements
* Solar air panels

* Rotary combustion engines (based on Wankel principle) as an aternative to the Otto cycle engines which have become dominant since 1882. We could start this production with no inferiority complex towards our closest and more distant neighbours. Why not use the machine designed long time ago by one of our engineers? An example of such machine is presented at our website: http://www.rotal.pl/index.php?g=produkty&ps=produkty_rotacyjna.

It is a rotary machine which upon installation generated 20 bar and now after 10 years of continuous operation it supplies 50 bar pressure.

We have blueprints and prototypes have been in operation for years.

Following the above recommendations we would not be afraid of any financial crisis. As a rule-of-thumb the financial crises are invoked by the energy crises (and not the other way round). The situation in Poland is additionally complicated by the lack of easily available and sufficient subsidies, accompanied with a dominant role of power and automotive monopolies which do not allow (possibly due to their ignorance) for implementation of hundreds of inventions. Therefore it is high time to demonstrate in public discussions, confrontations, fairs the technologies enabling efficient use of the energy obtained from electricity and fuel gas and only then consider the use of new sources of energy, including the so-called renewable sources. This is because in the energy sector, a major component of the economy, any analysis should start from the end-user, namely a man - in his home, work, public facilities. In all these places it is needed to ensure thermal comfort at a minimum cost. The photo on this page shows the largest and the oldest wind farm located near Palm Springs (California) – the effect of the oil crisis in 1970s.

The imminent or even already happening developments of the situation in Africa and Asia Minor made Americans build on their territory wind generators located in a line stretching from the east to the west. And one should ask why in a line rather than in groups? This question should be addressed at our local specialist on the subject who should know the answer. Moreover, they do not invest in nuclear power, for reasons which should now be obvious to most of us. Instead, they bring to life all the inventions in the power sector which up to now waited in a secure location for their turn. Bill Gates could be behind it. I remember his speech at the Business Centre in Warsaw when he said to the gathered scientists and businessman:

If all the tax revenue was invested in production of power production equipment we would no longer have unemployment or poverty.

All the solutions described in the first part of this article have been used in real life applications in which they have performed as expected. Moreover, the investment cost was confirmed by the later research carried out by the team headed by Mr. Kossack at the Kaiserslauter Technical University. And this is only one yet fundamental technology of ours, namely electrical radiant heating. Besides 2.5 times lower running cost, as compared to gas-fired systems we have 10-year savings on the investment cost, which could be used to cover the cost of other solutions which we propose to obtain additional savings.

Having received the building plans we will be able to modify it in order to lower the investment cost related to the building structure, propose energy-saving modifications and lower the running costs, including in particular the cost of energy. Our modifications will concern all the off-the-shelf solutions applied by architects for years and years and often accepted even by their mechanical engineers (note that piping and energy are actually two different fields of expertise). However, it is you, the homeowner who will have to pay for years for poorly designed solutions. On the other hand, following the above guidelines will benefit future generations and improve the financial standing of the whole country. Enough talking, let's get to work!

Photo 7. Wind farm in Palm Springs in California (USA), built in 1970s after the first oil crisis.

I remain at your service.
Best Regards.
Józef Jaszczerski, Eng.