

9.5 About energy vision in the 21st century and the role of ecological resources.

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Abstract.

It is now frequently recommended, that only ecological resources can save us and keep for the mankind more or less contemporary way of living for future. During such consideration it is obviously forgotten that ecological wind and sun have occasional character and that still we do not know how to store great amount of energy. It is also not easy to estimate, what is the maximal capacity of such resources, supposing that we want all such energy use. Work estimate one special case in which all ecological resources are fully correlated – the same wind or sun on all places of local power stations – typically one state or economy.

Why we, nuclear engineers, are opening such distant problem, like role of ecological resources in the energetic mix? I think there are several reasons:

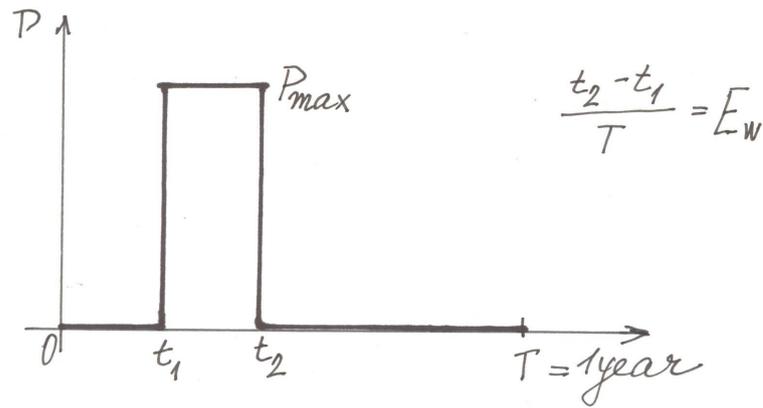
At least now a good piece of Europe is antinuclear and they are stating that they are ready to ensure energy fully by ecological resources, without CO₂ production and even in the collective of IAEA specialists, preparing energetic (nuclear) vision of 21st century, there are boys declaring that sun panels will be so cheap, that there will be no needs for nuclear energy.

Everybody must take into account public views and moreover public views are decisive for science and technology support. Industry and agricultural production are making our welfare and nobody will have any prospects if they would stop. Immediate consequence of available energy deficiency is practically stop of some part of production and if it is long time lasting we must modify technologies and production to the new lower available energy consumption – this mean we shall go “roughly speaking” tenths of year back, maybe not into the times of thirty years war, but surely into the last century - unimaginable consequences.

Such considerations are leading us to have real engineering answer, if in future ecological sources of energy can help us or not.

I hope that from the supported renewable resources (law public notice 475/2005 and 364/2009) water power, biomass, biogas, wind power, geothermal energy and sun energy only wind power and sun energy could be used in greater amount – other sources seems to be limited and hardly can reach decisive amount at least in the European conditions.

How they are functioning? Let us at first speak about wind separately. Special maps are prepared, based on the solution of wind flowing and long time measurement of wind power to estimate velocity of wind at different places and based on it, how effectively will work wind propeller at the given place in our space. Such calculations are done (for example) in the Institute of Atmospheric Physics of the Czech Academy of Sciences. It is helping us to decide whether on given place and height will be effective to produce wind electricity. Obviously we are using year mean values giving us, which relative part of year will work wind machine on maximal projected capacity. Let us denote it e_w . Real form of produced wind energy will have occasional character from zero to maximum, depending on actual meteorological situation. So that e_w denotes mean relative integral value at the given place and height. It is not characteristic of technology it is mixed meteorological and surface profile characteristic and by people activity it is not influenced. Can we estimate maximal wind power usable for national economy? Answer is yes, if all wind power stations will work on maximal capacity it will be needed electricity power, which will be completely used for our national economy P_{max} . Relative effectiveness will be mean integral of all e_w , over the space of installed wind machines - E_w on the space of our national economy (of course) it is purely geographical and meteorological characteristics. In such surely very simplified example we have to suppose that the rest of time energy supply will be supplement by another source, which will be ready to go if there is no wind in order the national economy would not be stopped. Technically the most convenient are gas power stations.



Simplified wind graph.

There are United Kingdom studies for their local wind situations with wind efficiency about 40% (surrounding of La Manche) that price of energy from the wind machines must be multiplied by twice.

Remark.

Based on existing experience our geographical space enable us to speak about the E_w around 10%. To find such full (price and effectiveness) characteristics supported by measurements is practically impossible and producers or Energy regulation body are refusing such question because that it is denoted as secure information. Several years ago we have occasionally catch investment data for one wind power station (Jetricovice pod Smrkem) and that was for one installed kilowatt with the precise of about 4% the same as old Temelin blocks. But it must be noted that nuclear power-station is working about 90% of year and wind power-station about 10%. Moreover we can hardly fully forecast wind energy supply. There is also big difference in the life-time of power-station – nuclear is supposed to be in operation for 60 years and wind ones about 20 years. There are further arguments – composition of electricity supply has great tradition and preferable is stable base load. If standard fossil power station are analyzed, effectiveness of constant supply is about 5% to 10% higher than supply with variations – with 10% effectiveness supply even the CO₂ production is higher for the combination of wind and gas. It is hard to combine coal and nuclear with wind, because you cannot so quickly change their power. Contemporary situation has for wind slightly different machines. Full power is limited sooner and if the wind has corresponding force and more propeller is turned to keep the same force and electricity production. Such machine is taking from give space point less energy than full amount but has greater so called capacity factor. New public notice should demand 22% - equivalent time in which propeller works with maximal capacity. It is clear that I will have to have more poles to reach maximal aloud capacity. The task how to compose optimal system is more complicated, but not principally different. Up to now there are no such considerations for sun. It is clear that both sources will be anyway occasional, so that following considerations are the same..

We must admit that there is an exception – if we have accumulator of wind energy, we can save the energy and put it in the operation, when needed. But we dot know any other accumulator than pump storage hydro plan and this is very costly

investment with very rare possibilities to be realized. To speak about it in the demanded amount is nonsense.

Let us look – if we put into the operation sun we shall be in better situation. We shall try to apply the same model of absolutely correlated sources, which can be represented by the same graph.

Sun will be represented by the same curve, with the same height, only t_1 and t_2 will be different and instead of E_w there will be E_s . Even if we cannot fully represent occasional character of the curves, we hope that integral values will be kept, only sun will have smaller space $T - (t_2 - t_1)$, because we have to switch off sun source if wind source is working. Overall effectiveness of the system will be

$$E_w + E_s(1 - E_w) = E_s + E_w(1 - E_s)$$

Both cases are symmetric; result is the same irrespective which type is switch off, if the net capacity P is reached. We understand that maybe it is not complete mathematical proof. Also the preposition that all machines are fully correlated is idealistic and complete capacity should be probably higher if we want to reach maximum, but at least we are able to star somehow. We can conclude this considerations by the conclusion that in our Czech conditions we can reach based on special regulations up to 10% + maybe another 5 or 10%. To reach it we need spent investment of the order of two complete energetic demands. All other ecological resources are practically already to the given date exhausted or are at the beginning of technological start and without clear expectations. Taking into account that there should be basic supply of about $\frac{1}{2}$ of the used capacity, which is ensured from stable fossil or nuclear resource our space is divided twice – 10% of supply and full volume of investment.

I have naturally tried to bring some considerations concerning money – support from the regulation body etc concerning different sources and basic level obvious prices. To find it without giving it special effort and do not try to be specialist was out of my possibilities and I have not find corresponding survey material, even if I have used all possible ways. Specially looking for Google information I have recognized, that economic information were canceled, which was there explicitly written. My nowadays conclusion is that it is too dark and very probably need special effort to go through this ecological lobby. It should be remarked, that Czech capacities are negligible – less than 1%, but bad estimated and too profitable value of sun electricity support brought sharp increase of demands for licenses over the full Czech electricity needs and giving of permissions were stopped. Future destiny of it is open including some expected court negotiations.

Concerning money support for these technologies, it could be said, that it is too hard to find some global mean data and it is evident that it is in favor of businessmen in that particular ecological activities and basic philosophy declares that the more we shall have the cheaper it will be and conditions are changed to cover investment expenses during 15 years and supposed lifetime is expected 20 years. Even if basic investment is decreasing it seems that it is still at least on the level of another resources, but they are working about 90% or at given time and not occasionally. Coefficients of mean effective time as for wind so for the sun are much smaller and in our conditions about 10% and this is evidently too small together with practically not existing capacities for accumulation. Maybe there will be progress in

technologies how to accumulate energy but up to now their readiness is not yet on the table.

International ecological lobby is trying to open question that we must use ecological accumulators in Norway and pump there additional electricity and use it for the pumped water power stations. Special transmitting net should be realized for it. The greatest deal of wind is now in operation in Germany and it is still less of 8% of overall installed capacities.

Group of mathematicians from Czech technical university in Prague expressed interest to perform complete analyzes and cooperate with specialists and students in all the branches, which are needed to have complete and competent picture. I am wishing the success and I am ready to cooperate.

Remark.

There is a set of possibilities how find approximative estimation how much subsidy will be paid for so called ecological energy or electricity. Basic algorithm was prepared supposed that investment should be compensated during 15 years and from this and mean effectiveness was derived yearly payment for electricity. Mean lifetime was estimated 20 years, so that the rest 5 years should be profit (maybe longer, if you can prolong lifetime. It is clear that there is great space for manipulation and local and differences.

Specially the price for photovoltaic electricity was overestimated and during the last two years technical development lead to the cheaper investment and principle of 15 years for investment was not included. Such a way it has become extremely advantageous business. We do not know how it is exactly legally formulated, newspaper's information estimate full payment about

$$500\ 000\ 000\ 000\ \text{CZK} = 500 \times 10^9\ \text{CZK}$$

And this is something comparable with the state debit. Contemporary price for photovoltaic electricity is about 12 CZK, more than ten times more of standard – about 1 CZK per 1 kWh. We pay in the institute 3.70 CZK per 1 kWh. Difference is due to place – payment in the input to the net and payment in the output from the net.

It is true that amount of applications for permission reached more that 6 500 MWe, which is more than minimal amount during the year. Full net in Czech Republic is about 17 000 MWe.

If we go back into history of such subsidies – there was false believe that 20% profit will be enough to support start of such technologies and that electricity companies are obliged to pay for all produced electricity and use it. At the beginning there were small amount of wind and sun power stations and money was within the national economies negligible and for such situation laws were voted. Technical progress made these facilities much cheaper and measure of profit grew up – there was suddenly industry – not cheaper than classical power stations, but giving in the sum for users remarkable greater prices of electricity and bad view into future, if laws and the whole situation are not be somehow managed.

Conclusion.

Based on the discussion and analyses we are concluding that occasional source is available only and only if we have capacity to accumulate energy. Even if such sources would be cheap and maybe free of charge we need for all their capacity sufficiently quick compensation and this is nowadays only gas power-station. To suppose that gas will be cheaply available and that we shall be able to enlarge foreign supply seems not to be supported by any analyses. Moreover gas is expected to be decreasing in the second half of century and it is without any doubt that regulation source is more expensive than the source with constant supply.

Literature, which is mentioned here, could be found if some additional effort will be made. Just now I am only ready to help to collect it.