

SUSTAINABLE DEVELOPMENT PROBLEMS

Mircea Dimitrie CAZACU¹

Abstract. *One presents the methods to combat the negative effects of any natural and renewable energy sources, which by their inexhaustibility are one self-capable to assure the sustainable development of the humanity.*

In this aim one considers for the fortuitous energies: solar with waste and axial rotor twisted blades, wave with wind and river energies the possibilities to satisfy the consume requirements by their combine exploitation, as well as the river Dorin Pavel's complex uses solutions to take away against the floods and also the drought, like the Black Sea deep-water naturalization with energy recoveries.

Keywords: Sustainable development, Renewable energy sources, Combined and complex uses of renewable energies

1. The characteristics of any renewable energy sources

It is better known the inexhaustibility quality of the natural energy sources, which are able to assure the sustainable development of the human society [1-3], but any of these sources present two disadvantages, as to be fortuitous and worse to have sometimes catastrophic intensities.

For this reason the solar, wind, wave and river energy must be considered as energy alternative sources, requiring other auxiliary energy sources in absence of a national electric network to balancing the energy requirements with its production, to assume the energy peaks being proper the hydraulic power stations with bigger accumulation lakes and also with two lakes for accumulation by pumping units.

Against the floods and also against the drought [4] we shall present the best environmental friendly solutions.

The best method to solve both these problems is so called the **complex uses method** of our famous professor and renowned hydropower master Dorin Pavel [5-7], formerly among the firsts members of the Romanian Scientists Academy in 1934, after which we must have in view not only the energy production, but also the water for drinking and irrigations, as well as the environment friendly works as tourism, sport, recreation, etc.

¹Prof., PhD, Eng., University *Politehnica* of Bucharest, Power Engineering Faculty, Chair of Hydraulics and Hydraulic Machines; Honorary Researcher of Romanian Academy (e-mail: cazacumircea@yahoo.com).

2. Solutions to optimise the operation of fortuitous renewable sources

In this paragraph we shall study the followings two specific problems.

2.1. Combined use [8, 9] of the solar thermal energy with waste incineration

To combined use of solar thermal energy broad daylight, with that of the waste incineration overnight, lead as to a better thermal efficiency, eliminating the heat loses of equipment cooling and heating, by its continuous working at optimal parameters, as in installation scheme of figure 1.

Also, to ensure the machines and equipment working at their best conditions, even in the day periods in which the solar radiation is diminished by the clouds or by the sun lower azimuth positions, one can supplement the installation power, raising the final temperature by addendum of the waste energy, how is presented in the lower scheme.

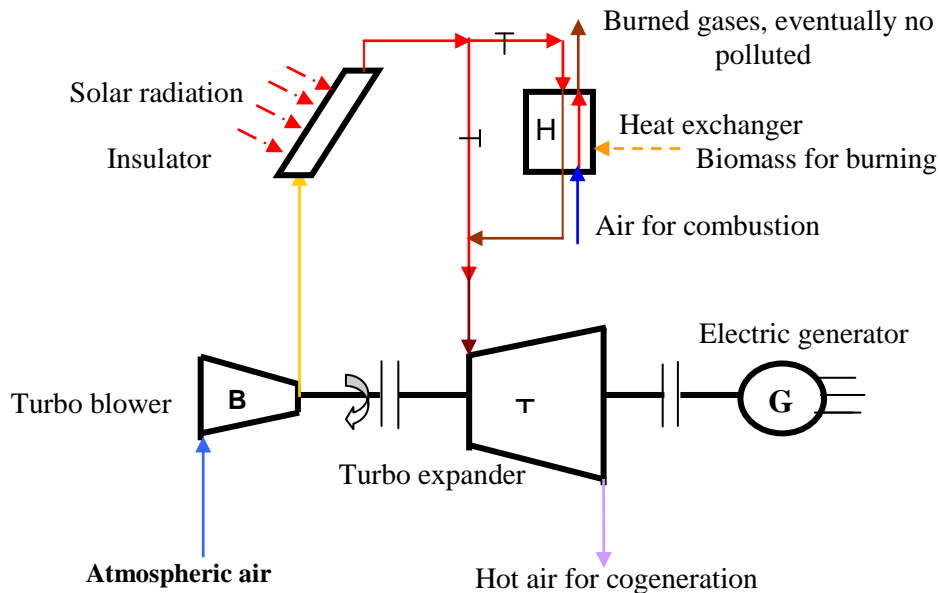


Fig. 1. Scheme for the combined use of the solar thermal and waste incineration energy.

From the thermodynamic cycles in $P-V$ and $T-S$ coordinates, which are represented in fig.2, one can see that the best thermodynamic performances can be obtained using an isothermal compression and expansion, in which aim we used a turbo blower with lateral channel having a partial peripheral admission, on its rest time of compression the air being submitted at a peripheral cooling process.

As thermodynamic agent we chose the atmospheric air, in the aim to eliminate the low temperature heat exchanger by the exhaust of the warmer air direct in atmosphere, or to utilize him for the cogeneration in the houses heating in cool seasons.

2.2. Extraction of maximum power of the kinetic wind or water energy

By applying our original method to determine the optimal relative angle β (fig.3) of the profile settlement for any blade radius [10-15]

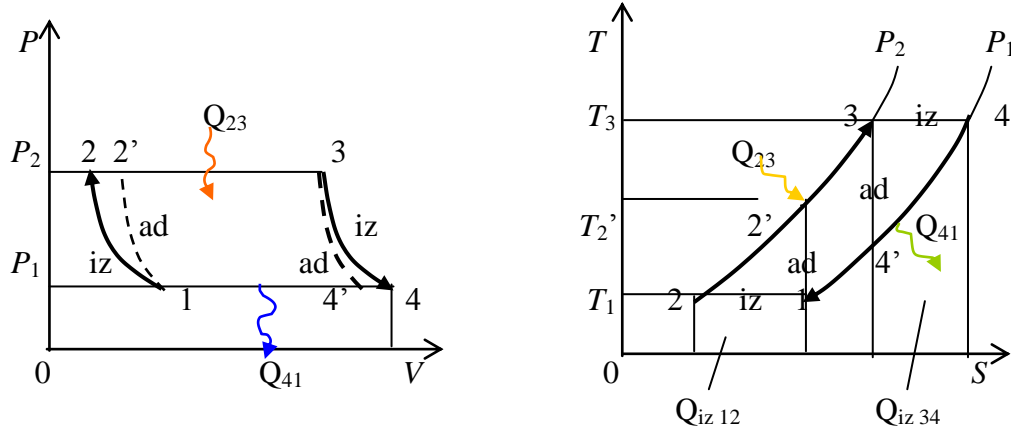


Fig. 2. Thermodynamic cycles in $P - V$ and $T - S$ coordinates

Projecting the two components of hydrodynamic resultant on the rotational peripheral direction, we shall obtain the mechanical power expression

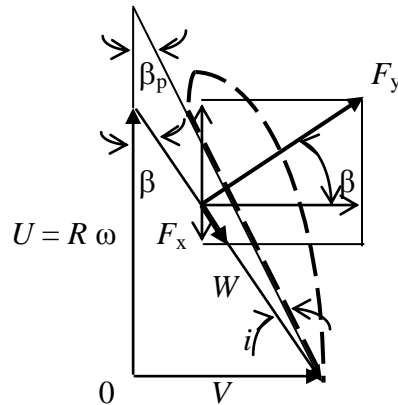


Fig. 3. Velocity triangle and the components of hydrodynamic resultant

$$P = UF_u = U(F_y \sin \beta - F_x \cos \beta) = \frac{\rho}{2} V^3 b l \left[c_y(i) \frac{\cos \beta}{\sin^2 \beta} - c_x(i) \frac{\cos^2 \beta}{\sin^3 \beta} \right], \quad (1)$$

and cancelling the partial derivative

$$\frac{\partial P}{\partial \beta} = -c_y(i) \frac{1 + \cos^2 \beta}{\sin^3 \beta} + c_x(i) \frac{\cos \beta (2 + \cos^2 \beta)}{\sin^4 \beta} = 0, \quad (2)$$

introducing the notation $\sin^2 \beta = x$, we must solve the algebraic equation

$$P(x) = [f^2(i) + 1] x^3 - [4f^2(i) + 7] x^2 + [4f^2(i) + 15] x - 9 = 0, \quad (3)$$

from which the sub-unit solution maximizes really the power, for any chosen profile-shape.

Once more, introducing these values i and β in the power expression (1), the maximal power value will indicate the best profile to use [10], which in this case is Gö 450 (see the Table 1), having also a greater ratio U/V to realize an submerged electric generator with smaller sizes.

Table 1. Determination of the best incidence and relative angle and ratio U/V for Gö 450 profile

i (degree)	$C_y(i)$	$C_x(i)$	$f = C_y/C_x$	β (degree)	Power	U/V
-3	0.2	0.023	8.7	9.84	2.28	5.77
0	0.41	0.02	20.5	4.19	25.59	13.65
3	0.63	0.032	19.69	4.36	36.28	13.11
4	0.705	0.039	18.08	4.75	36.3	12.0
6	0.85	0.055	15.45	5.56	30.22	10.29
9	1.05	0.081	12.96	6.62	26.31	8.62
12	1.15	0.112	10.27	8.34	18.15	6.82
15	1.21	0.147	8.23	10.39	12.35	5.46

For other radii, applying the relation $V = U_p \operatorname{tg} \beta_p = R_j \omega \operatorname{tg} \beta_j$ at the outskirts, we obtain the optimal angular velocity, which being the same for all the blade, determines the rotation velocity at any other radius R_j and because the relative angle will be done, the power maximization will be obtained only by the variation of the incident angle in case of same considered profile.

For other fluid flow of the blade channel, placed at radius $R_j \neq R_p$ – peripheral radius, we can obtain the maximization of the extracted power from the fluid by cancelling its partial derivative with respect to the incidence angle i [10].

$$P_j = \frac{V}{\operatorname{tg} \beta_j} \frac{\rho}{2} V^2 b l_j(R_j) \left[c_y(i) \frac{1}{\sin \beta_j} - c_x(i) \frac{\cos \beta_j}{\sin^2 \beta_j} \right] =$$

$$= \frac{\rho}{2} V^3 b l \left[A(R_j) c_y(i) - B(R_j) c_x(i) \right]. \quad (4)$$

$$\frac{\partial [A(R) c_y(i) - B(R) c_x(i)]}{\partial i} = 0 = \left[A(c_{y1} - 4i^3 c_{y4}) - B(c_{x1} + 2i c_{x2}) \right], \quad (5)$$

in which we considered the usual expressions of variation with the incidence angle of the lift and drag coefficients, supposed of the form:

$$c_y(i) = c_{y0} + i c_{y1} - i^4 c_{y4} \quad \text{and} \quad c_x(i) = c_{x0} + i c_{x1} + i^2 c_{x2},$$

finally obtaining the calculation formula of the best incidence angle for any radius

$$i^3 + i \frac{\omega_{\text{opt}} c_{x2}}{2V c_{y4}} R + \frac{\omega_{\text{opt}} c_{x1}}{4V c_{y4}} R - \frac{c_{y1}}{4 c_{y4}} = 0, \quad (6)$$

with the interesting remark that the optimum incidence angle rises at the same time with the radius decreasing, to obtain a greater velocity around the profile [14]. The good performance of power coefficient $C_p = 0,42$ obtained for a three blade rotor [12] and $C_p = 0,56$ for a four blade rotor [13] have put into the evidence the validity of this maximization method.

Finally, although the renewable energies are gratuitous, to obtain the maximum production of energy from an axial turbine rotor, diminishing the period of investment amortization, it is very important to preserve the maximum power coefficient, which can be realised by conservation of the same report between the peripheral component velocity $U = R \omega$ and the wind or water velocity V .

3. Hydraulic energy arrangements against the floods and drought

We shall present the historical stages known from the very ancient times to solve these important two problems.

3.1. The method known from the very ancient times

From very ancient time the human establishments were affected of the nature caprices bonded of the torrential rain intensity and of the river big discharges, because the peoples placed their households in the proximity of the springs or rivers, to benefit easily of the water beneficent actions, used for drink, garden holdings, domestic animal breeding, corporal and clothes hygiene, as well as indispensable element of any trades.

In the oldest technical book *De Architectura* [16], preserved after the Alexandria library burning by the caliph Omar, written in the 1st century before Jesus Christ by the renowned roman architect Lucius Pollio Vitruvius and dedicated to the emperor Octave August of marble Rome, in whose then chapters he present all the science and technique of house and fortress building, as well as of known machines and apparatus, one describes also the used methods to hunt out the healthy water springs, necessary to any human establishments, because even the halting places from the deserts must benefit of the presence of any oasis.

But the vicinity of water springs or rivers can become dangerous in the case of abundant rains, when the torrents carry away at valley not only the earth, stones and trees, but even the people house holdings, and can even produce massive landslides due to the pressure exerted by the infiltration in earth of the incompressible and very weight water, while the speed torrents and the river growth of water flooded the agriculture terrains and plain soils without sufficient slope to facilitate the water rapid flowing, as well as even the people house holdings with all their assets and living being.

In the human struggle against the floods and drought, the rudimentary solutions of the peoples was to built their households on the hills, in which case to ensure the blessed water one necessitates almost daily the water transport in the big casks by means the carts pulled by animal traction, or the water raise with the help of the water wheels from rivers or of pails from fountains, bored till the ground-water surface, which descends much in the case of long droughts.

In the same aim on used little dams of wood tightened with earth and supported by unflinching tree pickets on the smaller water valleys, accumulations from which on supply the hydraulic mill wheels for the cereal grinding, or eventually on used the floating mills [17], which being anchored on the river used the kinetic energy of watercourses by utilization of the wheels with paddles, which have used from the antiquity also for the water lifting for agriculture terrain irrigation [16].

3.2. The best present solution to prevent the catastrophic floods and drought

In this aim we have Dorin Pavel's method of **complex uses** of the hydropower arrangements, which take into consideration all the aspects bound of watercourses by realization of accumulation lakes in multiple aims:

- creation of water storages in view to assure the drinking water in drought time and to realize the technical economic advantageous irrigations, the water descending from up to down and being not obtained by pumping with energy consumption from the inferior levels,

- the optimum energetic exploitation of the water from the accumulation lakes by maintaining of its maximal level in lake,

- realization at least of a single dam with an accumulation volume more important on each river, for the attenuation of the high water wave of so called catastrophic discharge, with the assurance of one thousand years, but which can come tomorrow, obtained on the statistic calculus on the basis of the measurements effectuated on a longer row of years for each river,

- these dams constitute too and beautiful natural places for rest and agreement, as well as to practice the nautical sports, over these weir coping being possibly to realize a road to traverse the watercourse.

3.3. Means of environment protection and biodiversity conservation

Of course, the ecologists become worried when they think of the impact over the environment of any like buildings, but alike how a highway with intense traffic no more constitutes a „no crossing barrier”, if one practices on its below a row of under crossings traversing for the free circulation of the animals, ever thus so do and these dams must be foreseen with a row of adjacent buildings [5][6], which in the last time are not realized from the bad understand economical reasons and no ecologic, as:

- locks for different boats passing, even of the large steamers,

- Rankine's funnels for water transport of woods, problem very important in future to economize the fossil fuels in continuous diminishing,

- fish scales constituted from a row of overfull basins, taking into consideration of the multiyear migration of a fish species on the circuit Danube-Black Sea- Mediterranean Sea - Atlantic Ocean and the coming back of their young's through European rivers towards the Danube springs,

- wire nets or wind turbines against the birds, to protect the fishes which traverse scales or overfull basins,

- special installations for the stagnant water aeration from these hydraulic dams, against their eutrofization with plants, which by consuming the oxygen cause the death of fishes, which can not abandon the lack.

Hence it is necessary to insist on the annexe buildings and special equipments to hinder their negative impact on the environment and to protect the adjacent flora and fauna.

Very important is to realize many storage lakes on whole watercourses [6] to obtain the drinking water and water for corporal and garments hygiene, animal breeding and indispensable element of some trades, in the droughty periods and to technical-economic advantageous irrigations, from up to down, with a few pumping energy consume, to realize at least a great dam on every river to

diminish the flood-water wave discharge and to utilize the performant hydro-mechanic equipment, which is our present problem, the dams constituting at the same time beautiful places of rest and amusement, as well as to practice the nautical sports; over the weir coping being possible to realize a crossing road.

The taken measures to protect the environment and to conserve the biodiversity, like the practice of the under crossings for the animals in the case of the highways with intense traffic, in the case of the dams, these must foreseen with locks for the ships, Rankine's funnel for water transport of woods, fish ladders and artificial aeration against the stagnant water eutrofization.

4. Wave energy and their complex uses

I proposed a special sea highway (fig.4) as hydro energetic building, placed in the front of the Black Sea shore at the isobaths between 5 and 10 meters, which realize the following utilities [18] with large advantages:

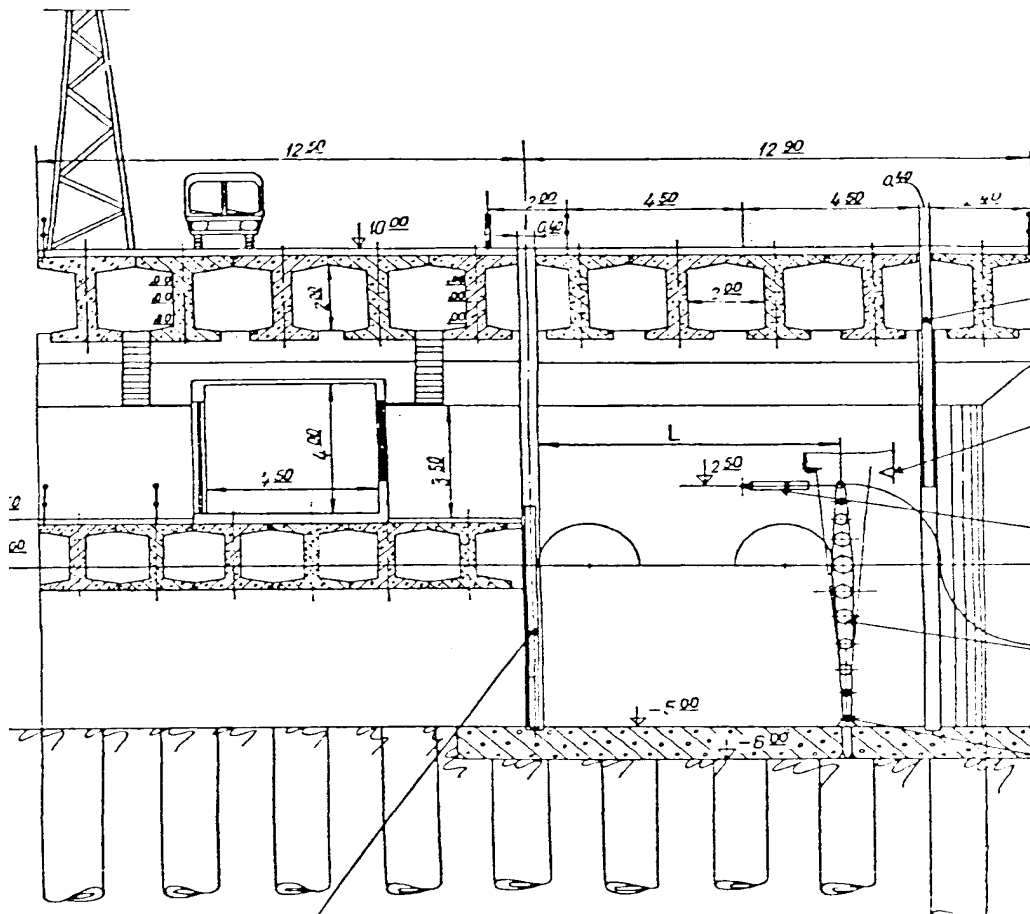


Fig. 4. Cross section through the sea highway with multiple utilities

- the catching of no polluted and inexhaustible wave energy, which on the little Romanian littoral of about 200 km has the same size order of that of interior river potential energy [19],
- the shore protection against the wave destructive action [20] in the conditions of diminishing of Danube alluvia transport, as fact of the hydro-energetic built dams and of the general dispositions to struggle the soil erosions,
- the catching of no polluted and inexhaustible energy of wind, by laying a row of wind turbine along the sea highway,
- the high speed sea link by means of the slider ships on air cushion in this zone without waves, between the littoral and the energy collectors of the catching devices,
- the terrestrial high speed transport on this sea highway parallel to the littoral,
- finally, the transport of containers, gaseous or liquid hydrocarbons by the pipe-lines mounted on the highway construction.

For a such project there are many beneficiaries in Romania as: Ministries of Industry and Trade, of Transport and Environmental Protection, of Health, Turism and Sports and in the foreign countries as: Ukraina, Moldova Republic, Bulgaria, Greece, Turkey and other West European countries.

5. Black Sea deep-water naturalization

One presents some advantageous techniques to restore the quality of the Black Sea depth waters, which in the present situation becomes a dead sea in two or maximum three decades [21-23].

The water layers, that contain a dangerous concentration of hydrogen sulfide in the Black Sea increase with around 2 m yearly, affecting finally, even the life in the biosphere reservation Danube Delta, in the last few years, these layers were raised from 180 to 150 m depth (fig.5).

One presents two proceedings for the advantageous elimination of hydrogen sulfide from the Black Sea depth waters, the first with energy production by partial burning of hydrogen sulfide and the second by pneumatic expansion of eliminating gases from the ascendant extracted waters, with which we wish to make these long-term plans profitable through the many advantages obtained in the same time with restoration of the Black Sea, such as: the extraction of hydrogen and sulfur, the production of pure sulfuric acid and of heavy water for the present atomic power stations, as well as the obtaining of deuterium, needful for the future nuclear fusion reaction and in addition the production of future clean energy [22-24].



Fig. 5. The aspect of isobathic lines in the Black Sea, the 180 m isobath marking the deep zone contaminated with hydrogen sulphide

Conclusions

- (1) The presented methods, to correct the fortuitous characters of the renewable energy sources, are proved very important from technical and economical point of view and may be extended in many other fields of inexhaustible energy sources.
- (2) These clarifications are very interesting for the sustainable development of human society and require an urgent advantageous solving in the case of Black Sea deep-water naturalization and Romanian shore protection against the wave erosion.

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