WIND AND SOLAR ENERGY MULTIPLIER OPERATED BY WATER RESOURCES WITHOUT VIOLATING AN ENERGY CONSERVATION PRINCIPLE, AND ENERGY CONVERTER WITH CHANGING MARK HYDRAULIC UNIT

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The essence of the innovative project - Wind and Solar Energy Multiplier that does not violate the concept of the energy conservation is the use of water resources having lower mark than the existing HPPs and the use of the reservoir itself; pumping of water from the pond created by us to the accumulation pond - reservoir - with wind and solar energy, water resource, pumping unit. This provides practical realization of a new idea.

The same circumstances occur in case of changing-mark hydro units of the energy multipliers since at the first stage of converting the hydro energy the electric power is generated by specifically changing-mark hydro units and at the second stage it is generated by the hydro units of the existing HPP.

In implementing the new idea, the water pipelines of the existing HPP, electric-technical equipment, etc. are used to supply water to its hydro units which obviously increases the technical and economic indicators of the new energy converter.

Key words*: Wind equipment, solar photoelectric transformer, hydro unit, reservoir, pond, mark*

Introduction

By the year 2010 an important, in fact, revolutionary progress was achieved both in wind and solar energy engineering. In particular, the cost of the flat solar photovoltaic panel per watt made 0.7-0.8 USD i.e. less than 1 USD (see http://www.ecobusinesslinks.com/surveys/free-solar-panel-price-survey), and the prime cost of the wind energy equipment (1.6 MW) dropped significantly as well making 780 USD/Kw (see The Economics of Wind Energy. www.awea.org).

The main problems relating to wind and solar energy development are: (1) generation of unregulated electric power due to significant change of the wind and solar energy value in time; (2) restricted operation time of the wind and solar equipment within a year. This factor significantly affects the efficiency of any type of the power plat.

It is easy to technically resolve the problems relating to the generation of the unregulated electric power by means of hydro-accumulation. Such layouts are well known enough however their implementation in most cases is less profitable because the efficiency factor ofthe traditional layouts of accumulation and re-accumulation do not exceed 70-80%, therefore it is obvious, that the generation of such new and effective ideas that providefurther progress in the field of the wind and solar energy engineering has been put into the agenda.

1. **New Technology – Power Plant Multiplier of the Electric Power Generated by Wind and Solar Energy**

It is possible to effectively resolve the above problems by means of the innovative idea elaborated by us and the respective technology under which it is possible to implement such an energy multiplierwhich with wind, solar and hydropower does not violate the energy conservation concept and at the same time provides thetransformation of the wind and solar energy with the coefficient more than one. This is achieved when the height of the water upload of the additional water resource by the water pumping unit in the upstream-reservoir H_{ac} of the regulating Hydropower Plant (HPP) is less than the re-accumulation height H_R in the same HPP.

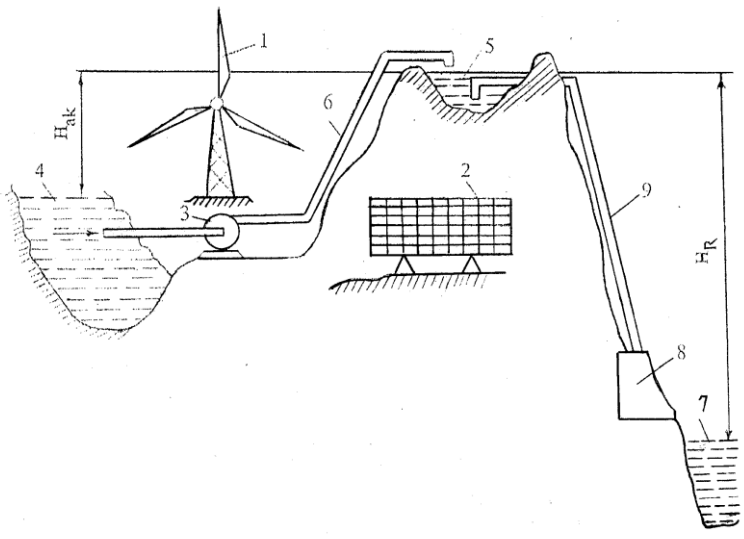
Given this, in certain ratio (H_R /H_{AK}), we may get more electric power than consumed for creating the charge (sparkle) by pumping unit.

In case of the energy multiplier compatible with the regulating HPP, it is enough to arrange just non-accumulation downstream on the hydro resource located in the vicinity of the HPP and an opportunity to construct the pumping station and accumulation pipeline since the HPP hydro units, head pipelines, electro-mechanic systems and reservoir are used as an upstream for the energy multiplier.

Multiplication of the wind and solar energy will occur under accompanying environment, when the current ratio (H_R /H_{AC}) is more than its marginal value (H_R/H_{AC}) >(H_R/H_{AC})$_{RN}$the value of which is defined by unrecoverable hydrauliclosses in the accumulation and re-accumulation pipelines and the efficiency coefficients of the pumping unit and hydro unit.

Under the evaluation calculations, the real multiplication value of the energy at Georgian units may achieve 2.5-3 equivalent sequence value.

Principal layout of the wind and solar energy multiplier is presented on the below drawing.



The wind and solar multiplier operates in a following manner: water from the river or the non-accumulation downstream (4) arranged on it is pumped to the accumulation upstream at H_{ac} height (5) via the pumping unit (3) which is supplied power from the wind (1) and solar (2) energy units by means of the pipelines (6) and thus the wind and sun energy unequal in time is accumulated-

transformed into the regulated hydraulic energy. The accumulated water from the upstream (5) is supplied to the HPPT hydraulic units (8) located at the re-accumulation downstream (7) through the head pipeline (9) bya downfall at $H_R$height.

Georgia is mountainous country quite rich with water resources. Its geographic environment together with ravines and lakes containing hydro resources and the presence of the dry water ravines allow to implement number of such units that satisfy the condition (H_R/H_{AC})> 1. At this stage four areas and respectively the HPP's compatible with them having additional water resources have been chosen as the research facilities for the wind and solar energy multiplier in various regions of Georgia. Such facilities are: Enguri HPP, Khrami HPP, the so called Ertso lake and Anistskali river. In the project they will be used as examples of high efficiency of the innovative idea including the prime cost of the generated electric power.

Regardless of the expected high efficiency of the innovative idea, the biggest fault of the wind and solar energy engineering is that it stops functioning in the concurrent absence of the wind and radiation. It is possible to avoid such destruction by working out and implementing new options-layouts of the wind and solar multiplier, in particular:

1.1. Multiplier of the Electric Power Generated by Wind, Solar and External Source

When there is the deficit of the electric power in a pumping station feeding, we consider it reasonable to supply the electric power to the pumping station from the external source, for instance, in form of purchasing or "borrowing" electric power from the power system which will be returned to the power system in a same quantity when the wind and solar energy equipment are back to operation.

1.2. Multiplier of the Electric Power Generated by Wind, Solar and External Hydropower

Generation of certain quantity electric power by means of an external water power will be possible and acceptable in case the parameters of the river feeding the multiplier allow to locate thehydro system with the hydro units on its pond. Other optional solutions, in particular the implementation of only hydropower multiplier and/or use of only wind or solar energyare subject to discussions as well.

1.3. Energy Multiplier for the Diversion Hydropower Plants Being Under Design

Practical experience shows that the energetic potential of the river inflows is not completely utilized during designing the HPPs since when reviewing particular river layouts, in determining their potential, the potential of the inflow flown below each stage of the series is not taken into the consideration. In this case, it is reasonable to use energy multiplication method at HPP's operating under the diversion layout. Under the evaluation calculations, it is feasible to achieve the generation of extra 10-15% electric power.

One of the important issues of the presented project is the selection-identification of the location for the wind and solar equipment. In number of cases their "forced" location – installation in the optimal areas rather than in the vicinity of the energy multipliersis not excluded either.

1.4. Purpose of the article

Determine basic technical and economic indicators of the energy multiplier matched with certain HPPs that satisfy the requirements set for the energy multiplier identified in Georgia;

Define quantitative increase of energy potential of HPPs existing on the account of use of the wind and solar energy;

Determine the efficiency of the options elaborated for the energy multipliers

Determine basic technical and economic indicators of the energy multiplier that is subject to implementation based on the HPPs being under design. Besides, the implementation of this idea is predominantly reasonable at the HPPs operating under the diversion layout and on their series where the head is mainly established in the water transferring systems.

2. Energy Converter with Changing-Mark (CM) Hydro Units

Introduction

The feature characteristic to mountain hydropower engineering is an unequal generation of the electric power within a year. From one hand, this is caused by a natural phenomenon – drop of the water

discharge values in the rivers feedingHPPs in Autumn-Winter-Spring period and on the other hand, by drop of the water head value at the HPP hydro units during the same period, when treating reservoirs i.e. when discharging and charging the reservoirs at the regulating HPPs with the reservoirs. As a result, the drop of the generation of the additional electric power occurs.

Regardless of the above, until now the specialists of this field assume that the regulating HPPs virtually provide the full development of the hydropower potential of the utilized river section (area). This point is incorrect and does not describe a real picture because during charging and discharging of the reservoirs, HPPs' hydraulic units are provided with the working body / waterflows at the respective pressure of the current reservoir mark (H_j) and not at the mark of the upstream i.e. at the maximum reservoir level H_1in a constant value of the tail water mark H_0.

2.1. Innovative Technology - Energy Converter with the Changing-Mark Hydro Units

The marks ($H_1$and H_0) of the hydraulic unit(s) located at the tail waters of the conventional HPPs and the head waters (of the so called normal flooding) are constant. Besides, the value of the normal flooding either equals or is slightly greater than the value of the maximum water level (H_{max}) in the reservoir. Only the working water level in the reservoir and respectively its mark (H_j) vary. The conventional regulating HPP is functioning atits maximum specific power only when there is the maximum water level (H_{max}) in the reservoir, and it is functioning at its minimum power when there is minimum water level (H_{min}) in the reservoir.

Specific power of HPP when the current water level (H_J)< H_{MAX} in the reservoir during its discharging and charging periods also drops downfrom (H_{MAX} - H_O) to (H_J - H_O) due to the decrease of the head (pressure) value of the water flows supplied to the hydraulic units of HPP. At this moment irreversible loss of the potential hydropower of the river flowing into the reservoir occurs and its value is proportional to the difference (H_{MAX}- H_J) between maximum, normal flooding

horizon (H_{max}) of the reservoir and its current level (H_j); its maximum theoretical value is defined by the water discharge value.

The issues relating to the irreversible hydropower losses are easily resolved by the innovative technology, in particular, by installing the hydraulic units in a bilge of the circular shape floating facility, on the facilities floating on HPP reservoir surface and by two stage conversion of the hydropower into the electric power. At the first stage, the electric power is generated during discharging and charging of the reservoir, by the derivative supply of the water flow from the head water of HPP reservoir at (H_1H_{MAX}) mark respectively during charging and discharging of the reservoir when (H_{MIN})< (H_J)< (H_{MAX}). The hydraulic units in changing of the current reservoir level mark (H_J)value will work with the changing value pressure [(H_1– H_J) -∑Δh] and consequently with the changing value power.

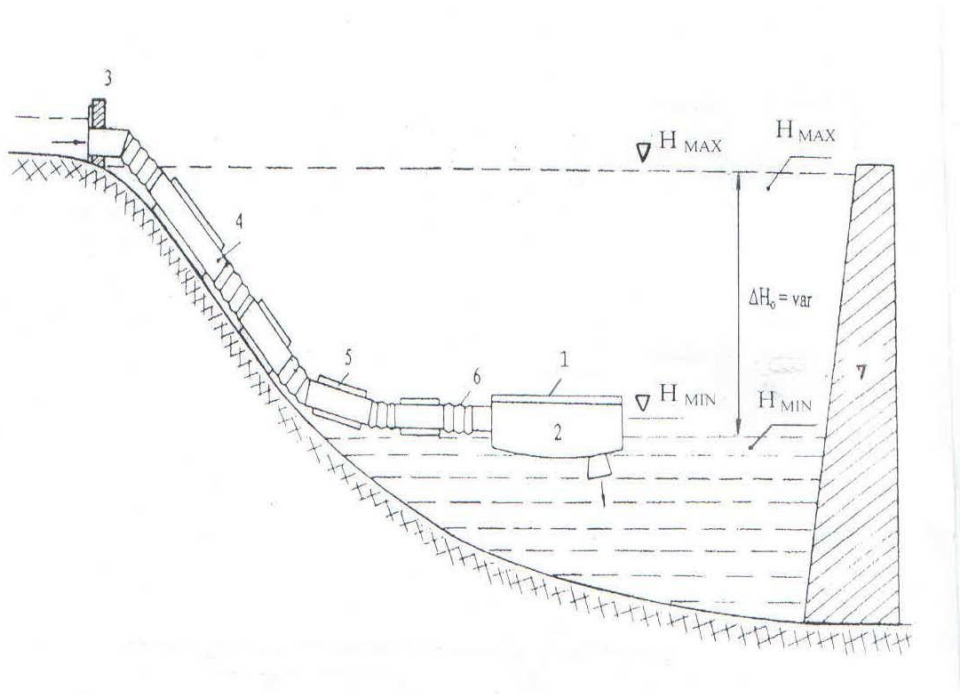
At the second stage, the conversion of the energy occurs according to the traditional layout - with the hydraulic units of the existing HPP which are connected to the reservoir.

As a statement of facts it should be specifically noted that according to the innovative technology the electric power is generated on the account of the water potential that is to-date lost at all the power plants of the world. At the same time, we should note, that for practical realization of the power converter with changing mark hydro units it is necessary to resolve the problem relating to the diversion water supply.

Optional solution of the principal layout of the implementation of the energy convertor with the CM hydro units is presented on the below drawing.

The CM HPP operates in a following manner:

after reducing the water level mark to the certain value, to H_{J1} in the existing HPP reservoir, (H_{J1}<H_{max}), the river water flows into the overhead tank via the diversion pipeline (via tunnel or an open channel)from the headwork located at the maximum mark of the reservoir - the water intake (3) and then is supplied to the hydraulic units (2) located in the hold of the floating platform through the water supplier (4-6) from where it flows back to the reservoir. Thus, the CM HPP should not anyhow affect the operation modes of the existing regulating HPPs.



The structure of the water supplier provides a non-stop water supply to the units (2) with the rotating bellows (6) hence its ensures the generation of the electric power in the reservoir (1) within the entire range of the water level mark change specifically, when changing the water level to the minimum value, to H_{min}, in the reservoir and afterwards, when charging the reservoir during the period of changing the water level from the minimum level H_{min} to H_{J1}. Respectively, the potential hydropower loss of the river flowing down to the regulating HPP reservoir is theoretically completely (and in fact, partially) eliminated in the hydraulic units (2) by supplying the derivation flow of the river from maximum reservoir level mark when ($H_{min} \leq H_J < H_{max}$), and principal novelty – the idea of HPP with CM hydraulic units is realized. Its description definitely indicates that the elaborated flexible structure of the water supplier which isbased on the use of the bellows (6) provides rational solution of the problem relating to the practical implementation of a new idea. It should be noted, that Danish company BELMAN manufactures the high pressure 6 m diameter bellows. It should also be noted, that even the plastic pipes including the corrugated ones are flexible enough. Transverse stabilization of the HPP with CM hydraulic units in their vertical and longitudinal shifting is important too, although there are several options to fix this issue. For instance, one option is to rig up electrically driven pressure screws on the opposite sides of the body of the floating facility.

The electric power generated by the HPP with CM hydraulic units is the additional energy usually lost at the conventional HPPs. In addition, based on the use of the transformation sub-station of the basic HPP and high-voltage network, capital investment and exploitation costs are significantly low at the HPP with CM hydraulic units.

During the shallow waters the electric power generated by the HPPs with CM hydraulic units will be more selling than the one generated by the conventional mining HPPs since, in fact, they are "winter HPPs".

The field of using new technology is the regulating HPP with reservoirs. For example, such HPPs in Georgia are Zhinvali HPP, Enguri HPP, Sioni HPP, Lajanuri HPP, Tkibuli HPP; and Khudoni and Namakhvani HPPs and Nenskra HPP in future) and hydro-accumulating power plants.

2.2. Wind and Solar Energy Multiplier with Changing-Mark Hydro Units

For the purposes of increasing the value of the energy multiplication sequence by the energy multiplier, it is reasonable to concurrently use both innovative technologies presented in the project which involves the installation of two changing mark operated energy converters on the facility floating on the HPP reservoir surface. In two stage conversion of the hydropower into the electric power, it is possible to generate additional electric power using the energy converter. Besides, water to the second, additional, CM energy converter hydro unit installed on the reservoir for the energy multiplier is directly supplied from the pumping unit of the energy multiplier at the maximum pressure within the entire range of annual change of H_1m reservoir level. Therefore, the generation of the electric power will be conducted from two various sources – from the river feeding the regulating HPP and based on the use of the water resources supplied from the pumping unit.

2.3. Purpose of the article

The article is aimed at justifying the effectiveness of implementation of the innovative idea of arranging HPPs with CM hydraulic units on the reservoirs of number of the existing HPPs of Georgia by elaborating the relevant business plans.

The efficiency of the concurrent use of both innovative technologies presented in the project will be determined. The values of the multiplication sequences of the wind and solar energy will be estimated for the facilities to be reviewed.

The issue of installing the CM hydro units on number of regulating HPP reservoirs of Europe with identifying the average annual volumes of the generated electric power will be reviewed and considered as well.