IMPACT OF NEW MODEL FOR PREFERENTIAL PRICES FOR SHPP IN REPUBLIC OF MACEDONIA

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Abstract
Paper gives complete overview of proposed new preferential tariff structure in Republic of Macedonia, for purchasing electricity produced from Small Hydro Power Plants .Proposed new methodology for tariff structure will have very small influence of overall price of electricity for tariff consumers but in the same time will attract investors in less attractive location for construction of Small Hydro Power Plants since feed in tariffs for less attractive location will be increased on account of larger and more attractive locations. Analysis is extended with correction coefficients due to variable flow leading to improvement of potential of less attractive location for construction of small hydro power plants.

Keywords: tariff structure, preferential prices, SHPP, install power, correction coefficient

1 INTRODUCTION

In first quarter Q1 of 2014 year, Macedonian Government published new tendering procedure for 80 location for concession for designing, building, and operation of Small Hydro Power Plants (SHPP). Prior to this procedure feasibility study was made in order to be checked attraction of possible location, and 80 locations were analyzed by*"GIM Institute"* in Skopje. Results of the study show that not all of analysed locations have expected return of investment. Main factors which influenced attraction of location are Block (Feed in) Tariff and projected investment. In addition, quantity of water depending from year to year in wet or dry year has substantial influence as well.

Variations in these factors significantly affect financial ratios of analyzed SHPP or changes in some of these parameters make the analysis of SHPP attractive to potential concessionaires.

In order to increase the attractiveness of the less attractive SHPP, for SHPP primarily with small installed capacity, new concept was proposed for changing the Feed in tariffs.

2 CALCULATION OF NEW ELECTRICITY TARIFFS (FEED IN TARIFFS) BASED ON THE SIZE OF THE INSTALLED CAPACITY OF SHPP

The existing Regulation for feed-in tariffs in Republic of Macedonia for fee of electricity, generated and delivered by SHPP is calculated on the basis of preferential tariffs for individual blocks according to the amount of delivered electricity.

The new tariff concept proposed the fee for electricity generated and delivered by SHPP to be calculated on the base of the size of the installed power of the SHPP. This concept was developed on the basis of analyzed five representative samples from eighty SHPP included in the 6th package for granting concessions for electricity generation – SHPP.

The input parameters, on which this concept is based, are:

- Number of operation hours: 4000/year (according ESHA - European Small Hydro Association)
- Duration of concession: 20+3years
- Return of investment: 7years

According to the installed capacity, the feed-in tariffs will be grouped in five groups:

- Group 1: PI ≤ 0,2 [MW]
- Group 2: 0,2 [MW] < PI ≤ 0,5 [MW]
- Group 3: 0,5 [MW] < PI ≤ 1[MW]
- Group 4: 1[MW] < PI ≤2[MW]
- Group 5: PI ≥ 2[MW]

Based on above defined groups, feed in tariffs will be as follows:

- Group 1: 12,7 [€c/kWh]
- Group2: 10,9 [€c/kWh]
- Group 3: 9,1 [€c/kWh]
- Group 4: 6,7 [€c/kWh]
- Group 5: 5,6 [€c/kWh]

The "investment activity" for the construction of SHPP as a "turnkey" project based on calculations and simulations will be as follows:

- Group 1: 3500[€/kW]
- Group2: from 3000 to 3500[€/kW]
- Group 3: from 2500 to 2750[€/kW]
- Group 4: from 1750 to 2000[€/kW]
- Group 5: 1500 to 1750[€/kW]

3 METHODOLOGY

The total power generation which is expected after construction and commissioning of SHPP is calculated according to the following methodology [1]:

-The installed capacity of SHP is calculated according to equation:

$$P_i = k \cdot Q_i \cdot H_n \quad (1)$$

Where:

k is coefficient of efficiency

The coefficient of efficiency is calculated according to equation:

$$k = g \cdot \eta_t \cdot \eta_g \cdot \eta_{tr} \quad (2)$$

Where $\eta_t \eta_g \eta_{tr}$ are coefficients of efficiency for turbine, generator and transformer.

or:

$$k = 9.81 \cdot 0.9 \cdot 0.94 \cdot 0.97 \approx 8 \quad (3)$$

Q_i–Installed water flow

H_n– net height of water

Net height of water is calculated according to the equation:

$$H_n = H_b - h - 0.1 \cdot h \quad (4)$$

H_b – bruto height of water

h - height

-Based on the average monthly flow profile intake, amount of water was calculated, affected by months. Calculation was done according to the equations:

$$\text{If } Q_d \geq Q_i + Q_{b,\min} \text{ then } Q_z = Q_i \quad (5)$$

$$\text{if } Q_d \prec Q_i + Q_{b,\min} \text{ then } Q_z = Q_d - Q_{b,\min} \quad (6)$$

$$V_z = Q_z \cdot 3600 \cdot 24 \cdot t_d \cdot 0.94 \quad (7)$$

The total production of electricity which is expected after construction and commissioning of SHPP is calculated according to the following equation:

$$E = \frac{V_z \cdot H_n}{367} \cdot \eta_t \cdot \eta_g \cdot \eta_{tr} \quad (8)$$

The number of effective working hours per year is determined by the following equation:

$$t_e = \frac{V_z}{Q_i \cdot 60 \cdot 60} \quad (9)$$

4 INDIVIDAL CALCULATION

Below are listed the individual calculations for each SHPP representative of the five groups of newly proposed SHPP, from eighty SHPP subject of sixth tender.

4.1. SHPP 361 (group 1)

(flow: river Mala, River basin: Kochanska)

Q_i=0.204[m^3/s]
H_n=86.16 [m]
P_i=111 [kW]

Produced amount of electricity: Q≈444 [MWh]

Investment activity for building SHPP 361 on a "turnkey" basis is: 388.500 [€], or 388.500 [€] / 0.98 = 396.428 [€] - (correction of 2%-concession of water).

Tab. 1 Tarifs for Group 1 SHPP

	Current tariffs	Proposed tariffs
Average cost of purchased el energy (per year)	12.0 [€c/kWh]	12.7 [€c/kWh]
Total annual income	54.830 [€]	56.388 [€]
Change	↑ 5.8 %	

4.2. SHPP 15 (group 2)

(flow: river Zelezna; basin: Lakavica)

Q_i=1.561 [m^3/s]
H_n=158 [m]
P_i=338 [kW]

Produced amount of electricity Q≈1352 [MWh]
Investment activity for building SHPP 15 on a "turnkey" basis is: 1.014.000 [€], or 1.014.000 [€] / 0.98 = 1.034.964 [€] - (correction of 2%-concession of water).

Tab. 2 Tarifs for Group 2 SHPP

	Current tariffs	Proposed tariffs
Average cost of purchased el. energy (per year)	10.41 [€c/kWh]	10.9 [€c/kWh]
Total annual income	140.813 [€]	147.368 [€]
Change	↑ 4.65 %	

4.3. SHPP 82 (group 3)

(flow: river Pena; basin: Vardar)

Q_i=0.418 [m3/s]
H_n=215.12[m]
P_i=719 [kW]

Produced amount of electricity Q≈2876 [MWh].
Investment activity for building SHPP82 on a"turnkey" basis : 1.797.500 [€], or 1.797.500 [€] / 0.98 = 1.834.183 [€] - (correction of 2%-concession of water).

Tab. 3 Tarifs for Group 3 SHPP

	Current tariffs	Proposed tariffs
Average cost of purchased el. energy (per year)	8.7 [€c/kWh]	9.1 [€c/kWh]
Total annual in come	250.247 [€]	261.716 [€]
Change	↑ 4.5 %	

4.4. SHPP 352 (group 4)

(flow: river Zrnovka; basin: Bregalnica)

Q_i=1.559 [m^3/s]
H_n=133.3 [m]
P_i=1663 [kW]

Produced amount of electricity Q≈6652 [MWh]

Investment activity for building SHPP 352 on a "turnkey" basis: 2.910.250 [€], or 2.910.250 [€] / 0.98 = 2.969.642 [€] - (correction of 2%-concession of water)

Tab. 4 Tarifs for Group 4 SHPP

	Current tariffs	Proposed tariffs
Average cost of purchased el. energy (per year)	6.786 [€c/kWh]	6.93 [€c/kWh]
Total annual income	451.454 [€]	460.982 [€]
Change	↑ **2.11 %**	

4.5. SHPP 315 (group 5)

(flow: river Topolka; basin: Vardar)

Q_i=1.561 [m^3/s]
H_n=212 [m]
P_i=2649 [kW]

Produced amount of electricity Q≈10596 [MWh]
Investment activity for building SHPP 82 on a "turnkey" basis : 3.973.500 [€], or 3.973.500 [€] / 0.98 = 4.054.591 [€] - (correction of 2%-concession of water)

Tab. 5 Tarifs for Group 5 SHPP

	Current tariffs	Proposed tariffs
Average cost of purchased el. energy (per year)	5.94 [€c/kWh]	5.66 [€c/kWh]
Total annual income	629.490 [€]	599.733 [€]
Change	4.72 % ↓	

5 BENEFITS

Feasibility study has proved that there are numerious benifits with respect to usage and utilization of small hydro plants in different regions of R. Macedonia. Some of them are:

- Increasing the attractiveness of investing in smaller relatively speaking-attractive locations for construction of SHPP.
- Increased amount of Foreign Direct so called, "Greenfield" investments in total amount of 167 million euros.
- Increasing the production portfolio of renewable energy in R. Macedonia of about 225,66 [GWh] which means increase of nearly 4 % of total electricity production in the country.
-Reduction of import of electricity for captive customers of nearly 50 % compared with imports ofelectricity in calendar year 2012 made by companies A.D. ELEM and EVN Macedonia (Annual Report for 2012, the Regulatory Commission Energy Office).
- Increased employment in the construction sector. Application of previous experiences in R Macedonia in construction of SHPP leds to the conclusion that directly are involved at least 25 to 30 construction workers and highly qualified staff, which means additional two thousend jobs during the construction of eighty new proposed SHPP, subject to tender number six.
- Knowledge transfer and acquisition of applicable "know-how". Construction of eighty new proposed SHPP , will involve one houndred and fifty highly qualified specialists (engineers) who will be directly involved in control, managing and maintaining them.
- Involvment of a domestic production capacities (producers of polyethylene, polyester and steel pipes and fittings as well as electrical and construction materials and fasteners) needed for the construction of 80 new proposed SHPP.
- Development of rural municipalites through improvement of the local infrastructure (new roads, power lines and substations), and the opportunity for tourism development in rural areas.

6 WEAKNESSES

From the analysis it can be concluded that the construction and operation of the proposed new 80 SHPP and application of the proposed new "feed-in" tariff system would result a slight increase in the price of electricity for consumers. The analysis showed that the increase of "feed-in" tariffs in smaller and less relatively speaking - attractive locations (taken from previous experiences from five public announcements) at the account of larger and more attractive locations, compared with net electricity distributed in the previous period (2009-2012) will lead to an increase in the price of electricity for tariff customers in the net amount of 0.0034 denars /kWh or 0.1 % compared to the current price of that same year, whose tariff is valid from 01.08.2013

7 COEFITIENT FOR CORRECTION OF FEED-IN TARIFFS IN ORDER TO BUFFER RISK FACTORS – OSCILLATORY FLOW CHANGE IN RIVERS

Having on mind the importance of the project of construction and operation of SHPP and the need for maximum utilization of hydro power potential of rivers in the country, by attracting investments in the energy sector the ability to offset additional risk by factor targeting oscillatory changes in flow of rivers was analyzed.
The analysis included the introduction of a correction coefficient for preferential tariffs visa oscillatory change of flows in river beds in positive and negative gradation. The correction coefficients will be calculated by the following equation:

a). In a case when production is less than 4,000 hours following formula will be applied to determine the coefficient of correction:

$$K = \left[\frac{\frac{4000}{Nr} - 1}{2} \right] \cdot 100\% \qquad (10)$$

Where N_r is realized number of the working hours

b). In case when production is more than 4,000 hours the following formula will be applied to determine the coefficient of correction:

$$K = \left[\frac{1 - \frac{4000}{Nr}}{2} \right] \cdot 100\% \qquad (11)$$

7.1. Observations from the analysis of the proposed solution by applying the so-called coefficient for correction of feed-in tariffs

If the proposed model for the correction coefficient of preferential tariffs is correct, in order to buffer the oscillations of flows on annual average of 4000 hours and if this is applied to the already constructed SHPP result will be:

a. Out of 23 locations, only two locations are with average of over 4000 hours per year and the average is 5197 hours. Total annual production of this SHPPs is 5,245,779 kWh. In these locations the average ratio reduction will be 11.52%. Both locations are locations on water systems.
b. Out of 23 locations, 21 locations are with average of under 4,000 hoursper year and are with average of 3050 hours. Total annual production of these SHPPs is 27,298,444 kWh. In these locations the average ratio of the increase will be 15.57%. For 9 locations there is no complete data (production for all months).

From analysis of newly proposed eighty sites for construction and application of SHPP and proposed solution of the so-called coefficient for correction of feed-in tariffs following can be concluded:

- Out of the eighty sites, twenty two sites are with an average of over 4000 working hours annually more precisely with average of 4252 hours and a total annual production of 70.171.836 kWh. In these locations the average ratio **reduction** will be 2.96 %.
- Out of eighty sites, fifty eight sites are with an average less than 4000 working hours per year and the average is 3425 hours and a total annual production is 155.487.084 kWh. In these locations the average ratio of increase will be 8.39 %.

8 COMPARATIVEE CONOMIC ANALYSIS

As the basis of the analysis were used data of five SHPP contained in the feasibility study under the name "Feasibility of granting concessions for the use of water for power generation by building small HPPs - Book 1", funded by the Ministry of Environment and Physical planning of the Republic of Macedonia, part B - Technical documentation Annex 4 - Financial - economic analysis. The individual display of the most important technical and financial parameters of the analyzed five SHPP is contained in section 4.2. A comparative analysis is made between existing and new tariffs including and excluding the correction coefficient. Used and recommended methodology adopted by the European Association of SHPP (ESHA - European Small Hydro Association), founder of the European Renewable Energy Council [1] (EREC - European Renewable Energy Council) document "Guide on How to Develop a Small Hydropower Plant" 2004 year (pp. 236-254). The results of the conducted comparative economic analysis of five SHPP, are presented in Tab. 6:

Tab.6 Comparative economic analysis

	361	15	82	352	315
According to the existing tariffs					
IRR	0,83	6,74	10,07	4,98	17,9
NPV	-136.904	35.366	300.309	-162.619	1.698.095
According to the new tariff and with correction coefficient					
IRR	3,96	8,25	14,49	6,7	15,66
NPV	-55.625	110.452	642.034	109.989	1.361.624
According to the new tariff and without correction coefficient					
IRR	2	8,55	13,18	4,95	16,38
NPV	-106.889	125.062	539.829	-167.694	1.469.683

9 CONCLUSIONS

Proposed new methodology has changed the approach to preferential prices completely. There are a lot of benefits of implementing the proposed new methodology for tariff structure. Having on mind weakness, which are minor and will affect almost insignificantly the price of electricity for final customers, proposed methodology should increase location atractivity. Analyses are showing that economic parameters are improved for most of the non-attractive locations and in accordance with implementation of correction factor too, expectation are that investor's interest will be increased.

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11 REFERENCES

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