

## ECONOMIC EFFECT ASSESSMENT OF THE FUEL CYCLE IMPLEMENTATION BASED ON THE TVS-2M AT THE BUSHEHR NUCLEAR POWER PLANT UNIT 1

The main position in the comparison of three fuel cycles: the current, the three-year-long cycle based on the AFA, and a new four-year (4x1) or five-year-long fuel cycle (5x1) based on the TVS-2M are the comparable conditions of electricity generation.

The Table below presents the analysis of the economic effect of introduction of the advanced nuclear fuel cycle based on the TVS-2M, the new generation nuclear fuel (four 4x1 or five-year 5x1).

Columns 3-8 list the main parameters of the fuel cycles. The data on the average enrichment of the feed fuel assemblies, the campaign duration and the number of fuel assemblies in the feed are given for the AFA based on the design data on the neutronic features, and for the TVS-2M - based on the data from the feasibility study report on TVS-2M implementation at the Bushehr Nuclear Power Plant, 446-Pr-176 (Feasibility Study, FS).

Column 9 lists the calculated average cost of the fuel recharging operation. For the purposes of calculating the economic effect, the costs of reloading the AFA and TVS-2M (column 9) are calculated based on the prices and conditions of the year 2016. Column 10 gives the fuel component calculation for each fuel cycle (Column 9/Column 7).

Column 11 shows the economic benefit (the difference between the cost of refueling for the 3x1 cycle based on the AFA and the 4x1 and 5x1 cycles based on the TVS-2M).

Table - Calculation of the economic benefit of the TVS-2M implementation

| Cycle | Type of fuel assembly | Average feed enrichment, % | Fuel mass, kg | U mass, kg | Campaign duration, effective days | Generation of electric power, bln kWh | The number of fuel assemblies in the feed | Cost of refueling, mln USD | Fuel component, cents/ kWh | Annual economic effect of fuel use, mln USD |
|-------|-----------------------|----------------------------|---------------|------------|-----------------------------------|---------------------------------------|---|----------------------------|----------------------------|---|
| 1     | 2                     | 3                          | 4             | 5          | 6                                 | 7                                     | 8   | 9                          | 10                         | 11  |
| 3x1   | AFA                   | 3,92                       | 489,8         | 430,0      | 297,0                             | 7,13                                  | 48  | 35,7                       | 0,501                      |   |
| 4x1   | TVS-2M                | 4,25                       | 527,0         | 463,2      | 324,0                             | 7,78                                  | 42  | 36,5                       | 0,470                      | 2,30  |
| 5x1   | TVS-2M                | 4,85                       | 527,0         | 463,2      | 324,0                             | 7,78                                  | 36  | 34,7                       | 0,446                      | 4,10  |

From the results listed in the Table, it follows that the economic effect of introduction of the advanced nuclear fuel cycle based on the TVS-2M at Unit 1 of the Bushehr NPP will amount to:

- 2,30 million US dollars a year in the 4x1 fuel cycle;
- 4,10 million US dollars a year in the 5x1 fuel cycle.

Based on the information presented above and the data laid out in the Feasibility Study 446-Pr-176, it can be concluded that at the introduction of the TVS-2M, and given a fuel mass increase in the assembly, the energy potential of the fuel load, i.e., the energy output of the campaign will increase. At the same time, this also increases the costs of fresh fuel acquisition. However, at that, the energy production growth exceeds (overcompensates) the price increase, and therefore the fuel component of the cost goes down. The operational component of the cost will also decrease (as a result of increased energy production during the campaign), as well as the cost of electricity generated itself.

JSC «TVEL» recommends a transition of the Bushehr NPP Unit 1 from the operation of AFA to the TVS-2M new generation nuclear fuel in the 4x1 cycle fuel for the following fundamental reasons:

- The use of proven reference solutions;
- Optimization of the volumes, timing and cost of works on this project.