

Total replacement cost comparison between mineral oil and Cargill's FR3[®] fluid transformers.

The transformer life extension enabled by Cargill's FR3[®] fluid reduces total expenses for replacing transformers in the grid.

Every time a transformer fails or it needs to be replaced by any reason, the utility takes a new unit from its inventory and mobilizes a crew of technicians to perform the replacement. By extending the transformers' average lifespan, the total expenses for replacing the transformers will be reduced, including the investment in purchasing new units.

The calculation of the total ownership cost, considering one lifetime of the longer lasting one, the depreciation of the investment and scrap value of the units, at present value, lead to effective savings even when initial cost of the transformer is higher.

This is the essence of this Net Present Value calculation: to reduce the number of times a transformer is replaced leads to economic savings.

Basic assumptions

For same operating temperatures, paper degradation rate is 7.4x lower for thermally upgraded kraft paper (TUK or TUP) and 5.3x lower for neutral kraft paper. This will lead to an extension of average transformer life, which can be estimated in the range of 1.33x to 2x for a fleet of transformers. The value depends on most common failure modes of each utility¹.

Based on the IEEE unit of life, the calculation considers a minimum life for the mineral oil transformers of 20 years (180,000h).

The initial cost of a transformer immersed in FR3 fluid, designed to same temperature rise limits, is expected to be slightly higher than a conventional mineral oil one. The price different is affected by many parameters, such as the materials cost, number of units purchased and the market strategy of each company. Practical experience in different places around the globe shows a typical range between +3% to +15% of cost increment in comparison to conventional mineral oil transformers. In order to be conservative, the worst case scenario was used in this calculation, assuming the purchase price of the FR3 filled unit will be 15% higher.

The scrap value of the transformers was assumed to be 15% of initial purchasing price.

Transformers' replacement cost

The costs for replacing a transformer installed in the grid exceeds the transformer's cost by a few times. It requires the mobilization of a crew of at least 2 or 3 technicians, a truck equipped with crane / man basket for a couple of hours. The cost is the same for conventional mineral oil and FR3 immersed units.

Based on average costs of US based utilities, the following numbers were assumed for the calculations:

Replacement costs	
Single-phase overhead (pole mounted transformer)	\$ 8,000 USD
Three-phase pad mounted transformer	\$ 15,500 USD
Three-phase subsurface (underground transformer)	\$ 18,000 USD

Financial parameters

All calculations consider USD currency. For the Net Present Value calculation it is necessary to assume some financial parameters:

	Value
Nominal discount rate (not reduced for inflation)	8%
Inflation rate	1.50%
Effective tax rate	35%
Tax depreciation horizon for asset class	20

Calculation results

The estimated savings resultant from the calculation are a total cost considering not only the transformer price, but also the replacement costs. Due to this, the estimated savings may, mathematically surpass the transformer price.

Cargill's team has excel spreadsheets for reproducing the webtool calculation and tailoring all calculation parameters to any specific utility, currency and assumptions.

Take the challenge and start saving money!

REFERENCES AND FOOTNOTES

¹ Vaidya, C. V; Karady, G. G., Sbravati, A., Vamus, J. Dyer, M.; Evaluation of High Temperature Operation of Natural Ester Filled Distribution Transformers, 50th NAPS - North American Power Symposium, North Dakota State University, September 2018.

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