Total Cost of Ownership method
Basics of transformer TCO calculation
Total Cost of Ownership
How much does a transformer cost?

- The real cost of a transformer for the owner is the sum of the initial purchase price (first cost) plus the cost of running it for its useful life 30 - 40 years
  - Purchase price
  - Cost of Losses
    - No Load Loss
    - Load Loss
  - Commissioning cost
  - Maintenance cost
  - Emissions cost (depending on regulations)
  - Cost of out-time (reliability)

Purchasing decisions requires the right balance between the initial purchase cost and the cost of future losses

Reduction of energy losses and related cost normally leads to a higher initial cost
Total Cost of Ownership
Total Cost of Ownership (TCO or aka. TOC)

- Provided that the MEPS (Minimum Efficiency Performance Standard) is fulfilled, use of proper loss capitalization for purchasing transformers is essential to select a transformer with the optimal economically justified level of efficiency. The way to consider it is by using TCO (Total Cost of Ownership) method.

- The cost of losses comes into effect during transformer life time; losses costs are therefore converted to the moment of purchase (Net Present Value), by assigning their capitalized values A, B.

- Factors A, B (€/kW) depend on transformer loading conditions, as well as cost of capital, energy market forecasts, expected transformer life.

\[
TCO = IC + A \times (P_0 + P_{c0}) + B \times (P_k + P_{cs} - P_{c0})
\]

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<tr>
<td>Po</td>
<td>No Load Losses (NLL)</td>
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<td>Initial Cost</td>
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\[
A = t \times C_n \times \frac{1 - \left(\frac{1}{1+i}\right)^n}{i}
\]

\[
B = \mu \times C_n \times t \times \frac{1 - \left(\frac{1}{1+i}\right)^n}{i}
\]
Total Cost of Ownership
Inputs needed for determination of A- and B-factors

\[ A = t \times C_n \times \frac{1 - \left( \frac{1}{1+i} \right)^n}{i} \quad B = \mu \times C_n \times t \times \frac{1 - \left( \frac{1}{1+i} \right)^n}{i} \]

\[ C_n = \frac{C + (C \times (1+j)^n)}{2} \quad \mu = k^2 \]

- \( t \) is the operating hours per year (hours)
- \( i \) is the discount rate for the investment ("cost of money", "WACC", in percentage)
- \( n \) is the expected lifetime of the transformer (years)
- \( C_n \) is the cost of energy at the mid-life of the transformer

Note: if annual increase of energy price is assumed to be constant, \( C_n \) can be calculated using \( C, j & n \)

- \( C \) is the initial cost of energy (in currency)
- \( j \) is the annual increase of energy price (in percentage)
- \( k \) is the average loading of the transformer during it’s lifetime
The task is to design a transformer that minimizes the Total Ownership Cost.

Using more materials reduces the losses and the running costs, but on the other hand can increase the manufacturing costs.

An optimizing software is used to find the lowest Total Ownership Cost.

To enable the manufacturer to find the lowest Total Owning Cost for him, the customer must provide the capitalized loss values; A and B.
Total Cost of Ownership
Principle – aiming at lowest total cost

Initial Cost (price) (1:1)

Lowest Ownership Cost

Optimal Design & Initial Cost

Cost of Losses vs. Initial Cost

Total Ownership Cost vs. Initial Cost
Total Cost of Ownership
Example - No Load Loss capitalization

- Price: 0.06 €/kW
- Interest rate: 5%
- 40 years of life time
- No increase in el. price, No CO₂ tax
- 2% increase in el. price per year
- No tax

- Cost of no-load loss (€): 9,000 €/kW
- PV of cost of losses (€): 14,400 €/kW

Years:
1 5 9 13 17 21 25 29 33 37

Cost of no-load loss (€)
PV of cost of losses (€)
The purchase decision of a transformer should be based on the optimum design and purchase price that results in the lowest lifecycle cost.

The use of TCO method allows the manufacturers to tailor the design to the unique situation of each customer, and allows the customer to evaluate multiple designs in order to find out the optimal solution for his need.

With the TCO method the sum of the cost of purchase and the lifetime cost of operation due to the lost energy can be evaluated.
Total Cost of Ownership
ABB Transformer TCO tool available for You

www.abb.com/transformers-tco-calculator