

Transformer Capacity Calculation with Load Growth

Engineering Formula Guide

This document provides a clear, engineering-oriented methodology for transformer capacity planning considering long-term load growth. All formulas follow common IEC / IEEE planning logic and are suitable for engineering evaluation, project design, and procurement reference.

1. Variable Definitions

Symbol	Definition	Unit
P ₀	Initial connected load	kW
g	Annual load growth rate	%
n	Planning horizon	Years
DF	Demand factor	—
PF	Power factor	—
SM	Safety margin	%
P _n	Projected active load after n years	kW
S	Apparent power requirement	kVA
S _{req}	Required transformer capacity	kVA

2. Step-by-Step Capacity Calculation

Step 1: Load Growth Projection

$$P_n = P_0 \times (1 + g)^n$$

This step projects future active power demand based on the annual growth rate.

Step 2: Demand Factor Adjustment

$$P_d = P_n \times DF$$

Accounts for non-simultaneous operation of connected loads.

Step 3: Conversion to Apparent Power

$$S = P_d \div PF$$

Transformer ratings are based on apparent power (kVA), not active power (kW).

Step 4: Safety Margin Application

$$S_{req} = S \times (1 + SM)$$

Provides reserve capacity for temperature rise, aging, and short-term expansion.

3. Unified Engineering Formula

$$S_{\text{req}} \geq [P \times (1 + g) \times \text{DF} \div \text{PF}] \times (1 + \text{SM})$$

Engineering rule: always select the nearest higher standard transformer rating above S_{req} .