Paris Session 2022

cigre
For power system expertise

Concept to reduce no-load losses in PV parks

A2

PS1, Question 1.2: What design and operation considerations should be included to optimize the selection of transformers for photovoltaic plant applications?

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MR

***Question 1.2**: What design and operation considerations should be included to optimize the selection of transformers for photovoltaic plant applications?*

Status quo

- No electricity is generated at all between sunset and sunrise.
- During the night the live transformers and lines cause no-load losses.
- Option to reduce levelized energy costs are getting more important.

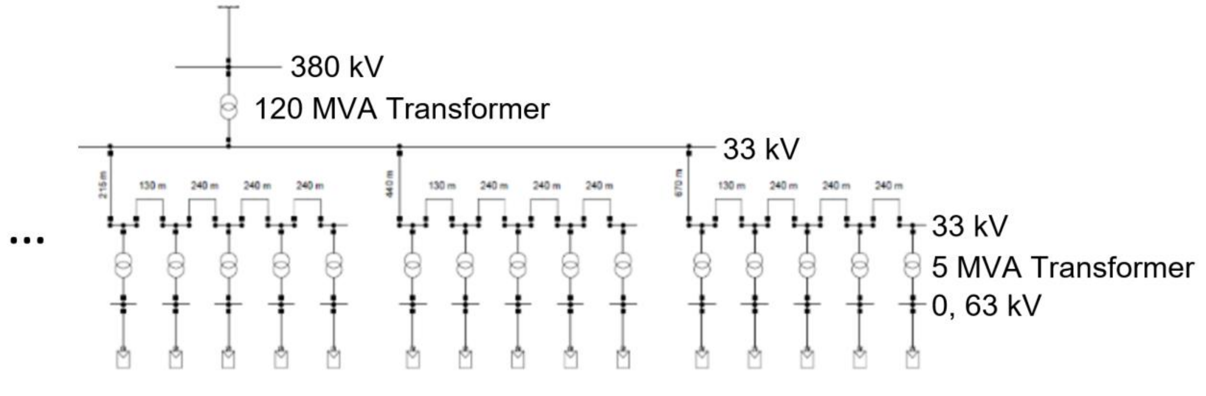


Figure: generic sketch of a PV park with approx. 120 MVA installed capacity, devided into 25 groups of each 5 MVA

Options

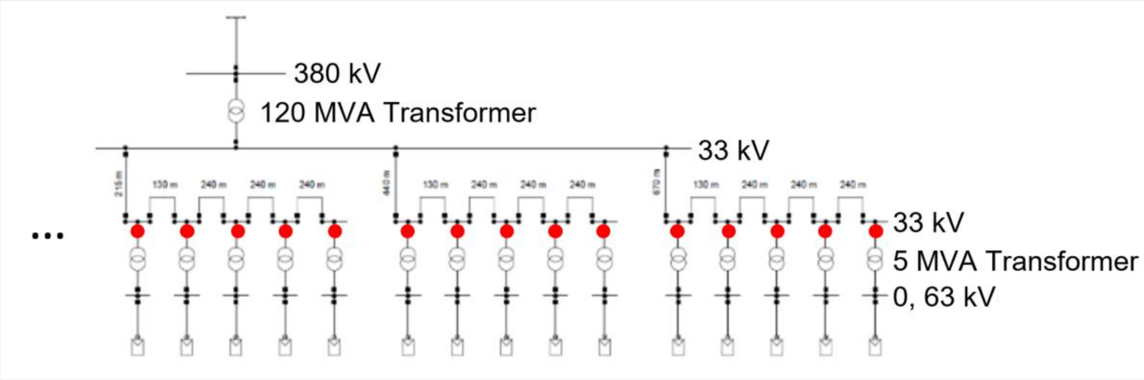
There are different options to reduce the levelized costs by avoiding costs to cover losses:

1. option: switching of the transformer during nighttime

2. option: reduce the voltage at the PV park during nighttime

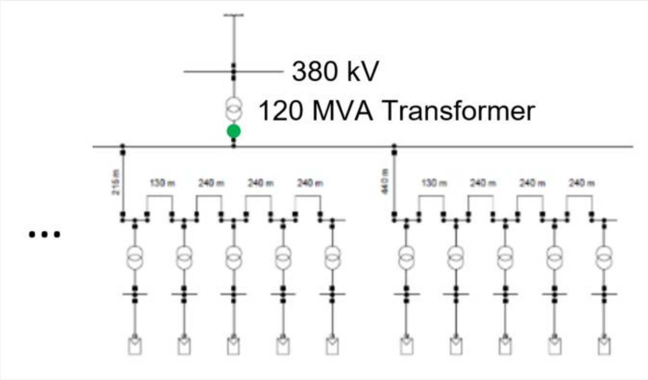
1. Option: using circuit breaker

- Use of circuit breakers to switch off the 5 MVA transformers (red dots)
- Larger number of additional operating devices (OPEX, CAPEX) with only approx. 10,000 switching cycles
- High inrush currents with heavy load on the transformer insulation

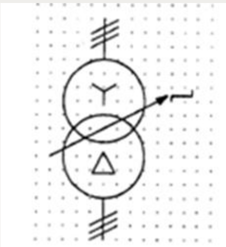


2. Option: using an OLTC

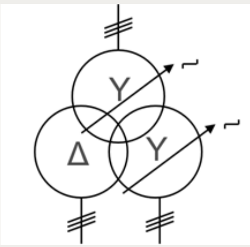
- Use on-load tap-changer to reduce the voltage on the secondary side near to 0 V over night.
- Use of a tertiary winding to supply auxiliary equipment
- Only one additional operating device
- No high inrush currents and no stress on the transformer insulation.



Todays concept



Possible futur concept



Estimation of costs for no-load losses

- Assumption: 0.07 % no-load losses for 5 MVA transformers.
- With 25 transformers, there are 25 · 5 MW · 0.07 % = 87,5 kW no-load losses.
- Sum of annual hours between sunset and sunrise between 4.209 h (e.g. Oslo) and 4.323 h (e.g. at the equator)
- Night-time electricity purchase to cover idle losses:

  87,5 kW · 4.300 h/a = 376.250 kWh/a

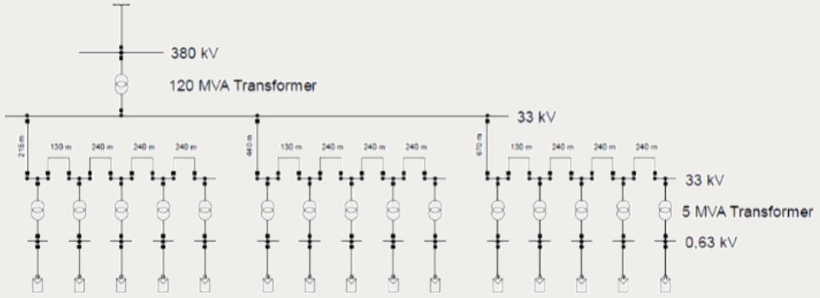


Figure: generic sketch of a PV park with approx. 120 MVA installed capacity, devided into 25 groups of each 5 MVA

Power purchase costs:	5 Cent/kWh	10 Cent/kWh	15 Cent/kWh	20 Cent/kWh
Total costs for no-load loss compensation	18.812,5 €/a	37.625 €/a	56.437,5 €/a	75.250 €/a

→ savings are in reality even higher, if the cable no-load losses are taken into account.