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Research Article

Analysis of Auxiliary Energy consumption in Utility scale Solar PV Power plant

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Abstract

The main concern of this paper is to investigate average daily auxiliary consumption of PV plants of various capacity & to obtain an inter-relation between them. Further to investigate percentage contribution of each component in order to get consumption of transformers and inverters separately. In addition, inverters & transformers used in various plants are not of same capacity and same manufacturer. Hence the study will figure out an inverter & transformer which has least per unit consumption & a PV plant designer can have an idea while selection of inverters & transformers for a given size of plant. Overall this study helps us to maximize the export energy & minimize the aux consumption within plant by right selection of equipment's for PV plant during design stage.

Keywords: *Solar PV Plant, Auxiliary, Consumption, Generation.*

1. Introduction

A power plant has to supply not only grid but also its auxiliaries that keep plant up for a certain period of time. For a PV plant these auxiliaries are inverter control circuitry, transformer magnetizing circuitry, cooling fan, air conditioner, lights, computers & night time auxiliaries like street light, server etc. Total plant auxiliary consumption is divided into two broad categories i.e. plant generated auxiliary (day time consumption) & total import (Night time consumption). This paper presents the result based on two-year data analysis of 19 no. of different PV plants of different capacity (1MW-20MW) located all over India & the total auxiliary (Aux) consumption, total import & no load losses have been presented as percentage of total energy exported by the plant.

Further plant generated auxiliary & total imports are divided into sub-components. Plant generated aux is composed of inverter aux consumption & other loads like fans, AC, local server etc. Similarly, total import is divided into night time consumption & no load loss i.e. power consumed by magnetizing circuitry of transformer. All the sub-components are defined as percentage of total auxiliary power consumption of the plant.

2. Curves & calculations

2.1 Breakup of total Aux as % of total energy exported

Following curve shows total aux, total import & no load losses as percentage of total energy exported by the PV plant. The %Auxiliary consumption of smaller capacity plant is large and it goes on decreasing for larger plants. However, some PV plants may deviate from described pattern since the aux is taken from external sources like grid sub-station etc. by that plants. In the curve shown below plants using thin film & polycrystalline technology for PV modules were considered separately.

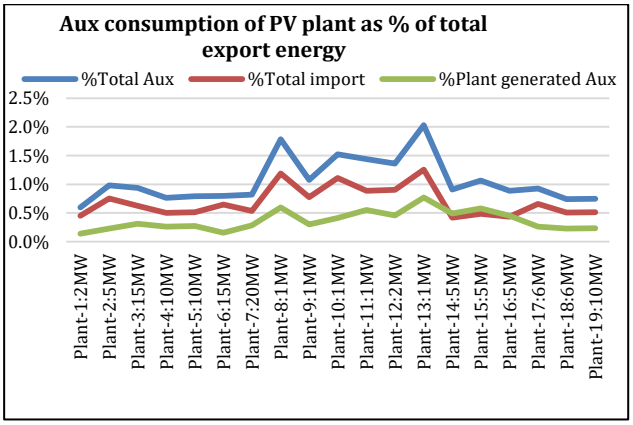

Fig 1. Aux consumption of plant in broad view ranging from 1MW to 20MW

2.2 Breakup of total aux in minor sub-components

Plant generated aux & total imports are divided in four sub components & each component is represented as %of total auxiliary consumption. The calculation was carried out on basis of total energy exported by all the

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plants throughout the two years & sum of all sub components for each plant. And the data is represented in following pie chart. It can be seen that transformer no load loss contributes highest of auxiliary consumption i.e. 44.08% & inverter aux consumption [T] is second highest i.e. 23.41%. Other loads consume least of total aux as shown in chart below.

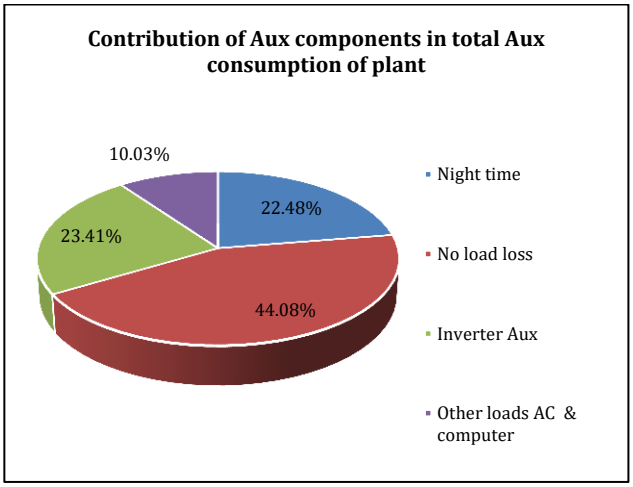

Fig 2. Contribution of aux components in total aux

The calculation of inverter aux & other loads is based on assumption that in 70% plant generated auxiliary is consumed by inverter since there is no mean to measure inverter output after filter side. So it is quite difficult to get exact auxiliary consumption of inverter.

3. Inverter & transformer contribution in total aux

Based on calculations executed in step-1 & step-2, inverter auxiliary[T] consumption and transformer no load losses are separated from the plant generated aux & total import and all the results obtained for various capacity of plants are normalized for unit capacity of plant to get realization of inverter & transformer contribution in total aux according to its manufacturer. The results obtained are shown below.

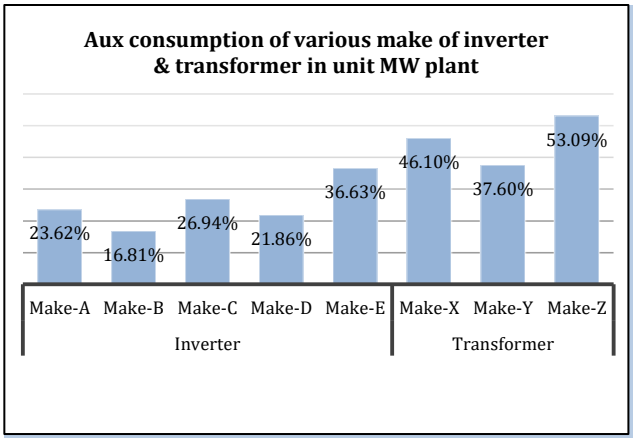

Fig 3. Aux consumption of Inverter & No load loss in transformers

4. Results

The paper shows that in compare to lower size of plant, larger capacity plants have less % auxiliary consumption which is based on real time data. The results can be summarized from Fig 1 as below: -

Table 1 Aux consumption of PV plant of various capacity

Plant capacity (MW)	0-5	5-10	10-20	>20
%Aux consumption	1.54%	0.90%	0.85%	0.82%

From table-1 it can be seen clearly that up to 20MW plant size there is considerable difference in %Aux consumption of Solar PV plants.

Conclusion

The paper suggests an idea to a new beginner to install AC capacity of PV plant of known capacity. For example, if anyone wants to install a 10 MWac plant then he should install 10.109 MWac, since the plant would have 1.09% of total auxiliary consumption. Also the paper suggest the auxiliary consumption of plant can be reduced by selecting inverter & transformers wisely. Fig 3 suggests that auxiliary consumption of Make-B & Make-D inverters is least however other inverters are also in same range. Study of performance of inverters is also necessary for proper selection of inverters. Similarly, Make-Y transformers possess least "no load loss" and Make-X & Make-Z have no load loss in same range but higher than Make-Y. While selection of transformer efficiency should also be considered. The transformer with highest efficiency but least no load loss should be preferred.

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