



7th International Conference on Sustainability in Energy and Buildings

Performance analysis of roof-mounted photovoltaic systems – The case of a Norwegian residential building

Habtamu B. Madessa,

*Oslo and Akershus University College of Applied Science, Department of Civil Engineering and Energy Technology, Postboks 4, St. Olavs plass
0130 Oslo, Norway*

Abstract

Currently, the application of solar Photovoltaic (PV) systems on energy efficient buildings such as passive house, zero energy building (ZEB) and net-positive energy building (NPEB) is becoming increasingly attractive, particularly in Europe and North America. The rooftops of residential and commercial buildings are ideal places for the installation of PV systems. The work presented in this article aims at parametric analysis of PV systems applied to a 100 m² flat rooftop of a Norwegian residential building in Oslo. The study shows the effect of PV module types, the modules' row spacing, and installation tilt angle on the electrical energy yield. The study also includes the economic and environmental aspects of a selected PV system.

© 2015 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Peer-review under responsibility of KES International

Keywords: Solar energy; Photovoltaic(PV); roof-mounted; NPV; greenhouse gases

1. Introduction

Buildings use a significant amount of energy for heating, ventilation, cooling, and lighting systems. Currently, nearly 40% of the total primary energy in Norway is used in the buildings sector [1]. A strong interest in the reduction of buildings' energy consumption and the improvement of their environmental performance drives researchers to look for new systems and technologies. Thus, the passive house, zero-energy building (ZEB), and net-positive-energy building (NPEB) concepts have emerged and become increasingly attractive, particularly in Europe and North America. In Europe, for example, the Energy Performance of Buildings Directives (EPBD) require that all new buildings be 'nearly zero-energy buildings' by 2020 [2].

These concepts have encouraged buildings to produce their own energy on site from renewable energy sources, such as solar energy. One interesting area of solar energy utilization for buildings is the application or integration of solar photovoltaic (PV) systems onto a building's rooftop and facade. The basic component of a photovoltaic (PV)

system is PV cells, which convert sunlight directly into electricity with an efficiency ranging from 10-23 % [3]. The most commonly known technologies for PV cells are mono-crystalline silicon (m-si), polycrystalline silicon (P-si), cadmium-telluride (CdTe), copper-indium-diselenide (CIS), and amorphous silicon (a-Si). The PV cells are interconnected to create PV modules, which absorb direct solar radiation, diffused solar radiation, and reflected sunrays from the ground (albedo). The assembly of the PV modules called PV array.

It has become common to observe grid-connected PV systems mounted on buildings. Buildings' rooftops, particularly flat surfaces, provide a number of possibilities for the integration of PV modules [4, 5], both in the design phase of a new building or in the retrofitting stage of an existing building. As pointed out by Ceron et al [6], nearly 50% of building-integrated PV systems are based on roof installations and their performance could be affected by a number of factors, including the solar radiation availability, the tilt angle of the PV modules, the distance between the module rows, the surface temperature of the module, etc. In this study, the impacts of certain parameters that could affect the performance of PV systems mounted on the rooftop of a residential building were investigated. Moreover, economic and environmental analyses of a selected PV system were also conducted. However, since this work is a preliminary study, the entire work depends on weather data available in the PVsyst simulation tool. Moreover, the impacts of PV modules' azimuth angles, shading loss due to the surrounding elements were not investigated.

2. Methodology

In this paper, a basic parameter analysis was conducted for PV systems integrated into a Norwegian residential building's rooftop. This will help to discover how to achieve optimal energy production using the given system. For this purpose, simulations of roof-mounted PV systems were conducted using PVsyst V5.52 software [7]. The software was developed at the University of Geneva and is one of the most widely used simulation tools for analyzing the performance of PV systems. The software offers an opportunity for the preliminary or detailed design of a complete PV system, either grid-connected, stand-alone, pumping, or DC-grid. The software also has databases of weather files (global and horizontal solar radiation, ambient temperature) for various geographical locations and basic PV system components. In addition, the program provides 3D representations of buildings, PV fields and surrounding shading elements.

Table 1. Physical and electrical characteristics of the PV module types.

	m-si	p-si	CdTe	CIS	a-si
Manufacturer	Canadian Solar Inc.	REC Scanmodule	First Solar	Wurth Solar	T-Solar
Model	CS6P - 220M	REC 220PE	FS-385	WSG 0036 E080	TS90
Maximum power output @ STC	220Wp	220 Wp	85.0 Wp	80.0 Wp	85.0 Wp
Voltage at Pmax	29.90 V	29.0 V	47.70 V	34.9 V	71.1 V
Current at Pmax	7.37 A	7.63 A	1.79 A	2.31 A	1.2 A
Temperature coefficient of max power	-0.45 %/ °C	-0.43 %/ °C	-0.25 %/ °C	-0.2 %/ °C	-0.24 %/ °C
Module efficiency	13.68%	13.41 %	11.88 %	11.04 %	10.92 %
Open circuit voltage	36.9 V	35.9 V	61.0 V	44.0 V	93.5 V
Short circuit current	7.97 A	8.3 A	1.980	2.5 A	1.4 A
Module dimensions , Length (m) X width(m)	1.638X 0.982	1.665 X 0.991	1.2 X 0.6	1.205 X 0.605	1.3 X 1.6

The study focused in Oslo, Norway (latitude: 59.5° N and longitude: 10.4° E) whose local solar irradiation is shown in Figure 1. For the simulation, a flat rooftop with a total available surface area of 100 m² was selected for detailed design of PV systems. It was assumed that the PV modules faces towards south (zero azimuths). The type of PV modules and their specifications is summarized in Table 1.

متن کامل مقاله

دریافت فوری ←

ISIArticles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات