J&P Lougheed Performing Arts Centre

IEA PVPS

Introduction

Jeanne & Peter Lougheed Performing Arts Centre is a unique performing arts venue located on the historic University of Alberta's Augustana Campus in the heart of the province. Concluded in 2014, it presents a BIPV system covering the whole flytower. Clark Builders was the prime contractor, Howell Mayhew Engineering (HME) was subcontracted to prepare and submit documents for development and building permits, and to provide project planning, administration, and procurement of equipment and installation labour. SolNorth Engineering delivered the structural design of the BIPV system while HME was responsible for the electrical design. Great Canadian Solar was responsible for obtaining the electrical permit and delivering the electrical installation of the BIPV system. HME obtained grid-connection approvals, commissioned the BIPV system and performed post analysis on the electricity bills.

Source: [Successful Building Integration of Photovoltaics – A Collection of International Projects]

Aesthetic integration

The BIPV system was design to fit with the 20-metre flytower shape and size. It characterizes all four façades (South, West, East and North). Despite the lower solar energy generation potential on the north face, it was decided to install the dark PV modules in order to provide a uniform appearance.

Energy integration

The project was a logical step toward meeting the University of Alberta greenhouse GHG emissions reduction plan objectives. As an added benefit, it allowed saving on operational costs. The BIPV system is grid-connected and supplies approximately 20% of the building's energy requirements. Almost all of the solar electricity generated is consumed instantaneously by the building. In 2017, the system generated 75 MWh, reducing the annual electricity costs of the university by approximately 6,900 € and emissions by more than 57 tons of CO_2 equivalent per year (Gordon Howell, Howell-Mayhew Engineering and Michael Versteege, Manager, Energy Management & Sustainable Operations, University of Alberta). The building also has a number of other important energy efficiency measures, including LED lighting for all the stage lighting and throughout the building, upgraded insulation in the building envelope, high-efficiency chiller and boiler, exploitation of underfloor air distribution to deliver the conditioned air at the floor level.

Technology integration

The BIPV system, made of 488 standard modules, replaces the otherwise required rainscreen cladding. Vertical Z-girts and standard 3-metre Unistrut-type P1000T galvanized steel struts with aluminium clamps were used. Standard mill-finished racking clamps were powder coated black so that they blend in with the color of the modules. The DC cables run down the wall and into a gutter at the bottom, then over to the south side and into a conduit to the inverters located on the second floor roof. Flashing was installed between the modules to prevent intrusion by insects and birds. The BIPV system had to meet the Canadian National Building Code as per all structures on buildings. Thus, all the necessary steps were taken (e.g. calculations for dead and environmental loads) to ensure that the installation met or surpassed the minimum code requirements.

Decision making

The decision to include BIPV was made while the building was already under construction. It was mainly driven by the GHG Emission Reduction Plan of the University of Alberta, aimed to reduce GHG emissions, but also represented an opportunity to educate the university students and create awareness on solar PV technologies. A building-intgrated system was chosen over a conventional building?applied system mainly to reduce the capital cost of the building envelope. The BIPV system displaced the costs for the flytower cladding and therefore, resulted in only slightly higher capital costs, which is offset by electricity bill savings.

Lessons learnt

The idea of integrating the PV system was initiated in May 2013 while the building was already under construction. Just two months were available to design the PV system. First, the DC part of the system was designed so that the array construction could start as soon as possible. Then, they proceeded with the AC part of the system. As a result, the construction schedule was pushing the design process, which is not the preferable way for any project since so many key elements of a BIPV system are interrelated. During the design process, time should be allocated to simulate the hygro-thermal performance of the BIPV envelope. However, for this project there was no time for such analysis and the design decisions taken were simply based on experience.

Integrating 488 standard off-the-shelf PV modules to seemingly fit the building and form its rainscreen had its challenges. The flashing between the modules was tailor-made. The purpose of the flashing was to prevent insects and birds from building nests in the insulation or between the modules and the insulation.

Initially, the installation contractor did not completely follow the string connections to the inverters as per the drawings. The inverters were single?phased whereas the building was on three phases. The incorrect wiring could have led to voltage imbalance in the building. At the end, the wiring was corrected.

Also, the Canadian Electrical Code changed in the middle of the BIPV system construction. The new code required arc-fault protection for the inverters. The inverters initially selected did not have arc-fault protection. Knowing that the manufacturer would eventually discontinue the inverter model with no arc-fault protection, a new one was chosen. The new inverters were of smaller capacity than originally planned, so the BIPV system ended up having a larger number of inverters. (Gordon Howell, Howell-Mayhew Engineering and Michael Versteege, Manager, Energy Management & Sustainable Operations, University of Alberta)

Designing a PV system with sub-arrays facing different directions was challenging because the sub-arrays are exposed to different irradiance levels throughout the day. As a result, the methods used to size the BIPV system's breakers and panel boards had to be adapted from standard electrical design practices. Another lesson learned from this project is that when designing a BIPV system, appropriate ventilation at the back of the PV array should be provided to reduce its operating temperature and improve the array efficiency. Allowing for ventilation should not compromise the building aesthetics, however, and care should be taken to ensure that the layers under the array remain invisible to the outside.

PROJECT DATA

Project type	new construction
Building use	cultural
Building address	4501 50 St, Camrose (Alberta), Canada

BIPV systems

BIPV SYSTEM DATA

Architectural system	rainscreen
Integration year	2014
Active material	monocrystalline silicon
Module transparency	opaque
Module technology	glass-backsheet, hidden PV, standard modules
System power [kWp]	242
System area [m²]	882
Module dimensions [mm]	1,652 x 994
Modules orientation	South, West, North, East
Modules tilt [°]	90
Annual FV production [kWh]	75000

BIPV SYSTEM COSTS

Total cost [€]	250000
€/m²	248
€/kWp	2050

Stakeholders

Main building designer

Derek Sampson (BR2 Architecture)

BIPV system designer

Howell Mayhew Engineering (HME), SolNorth Engineering

BIPV system installer

Great Canadian Solar
14576 116th Avenue NW Edmonton, AB T5M 3E9, Canada
info@greatcanadiansolar.com (780) 455-7277
https://www.greatcanadiansolar.com/

BIPV components producer

blueleaf energy
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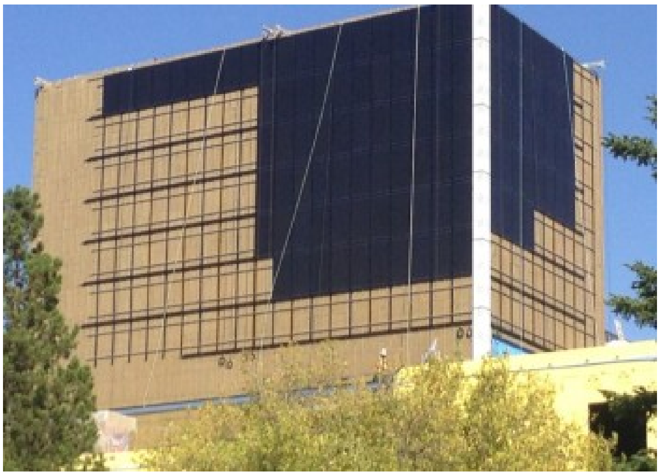
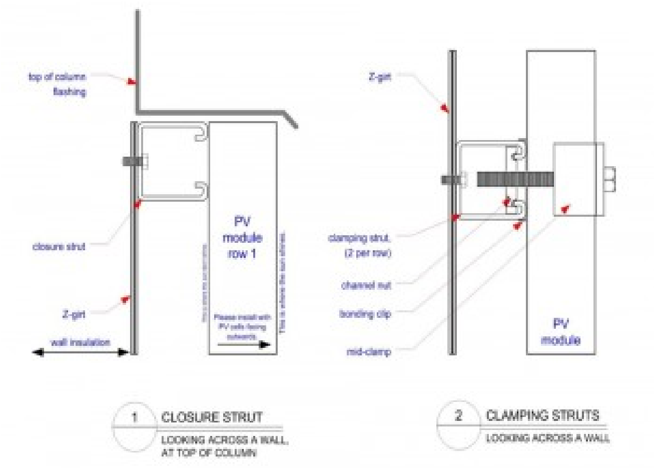
Collaborators

Clark Builders


West and south façades © Gordon Howell (HME)


PV modules installation © Gordon Howell (HME)


Mounting detail showing vertical Z-girts © Gordon Howell (HME)



PV module attachments to racking and building © HME drawing PV08


BIPV strings cables (DC) running into a gutter © Gordon Howell (HME)


North and west façades © Gordon Howell (HME)

Case study author:

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