



Réseau Énergie et Bâtiments, May 24, 2023

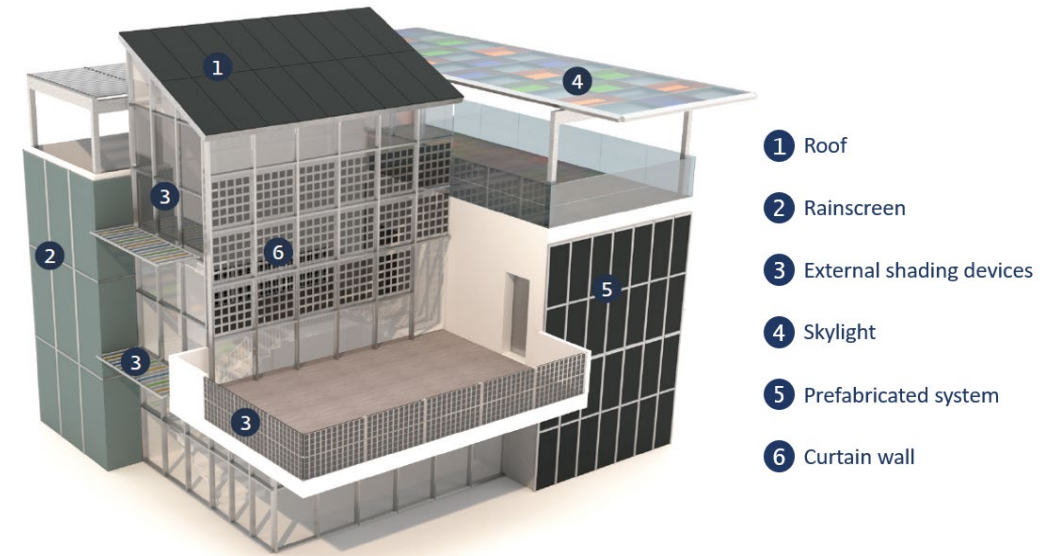
Integrated Design for Solar Building Envelopes

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Supervisor: Andreas Athienitis

Building Integrated PV

BIPV

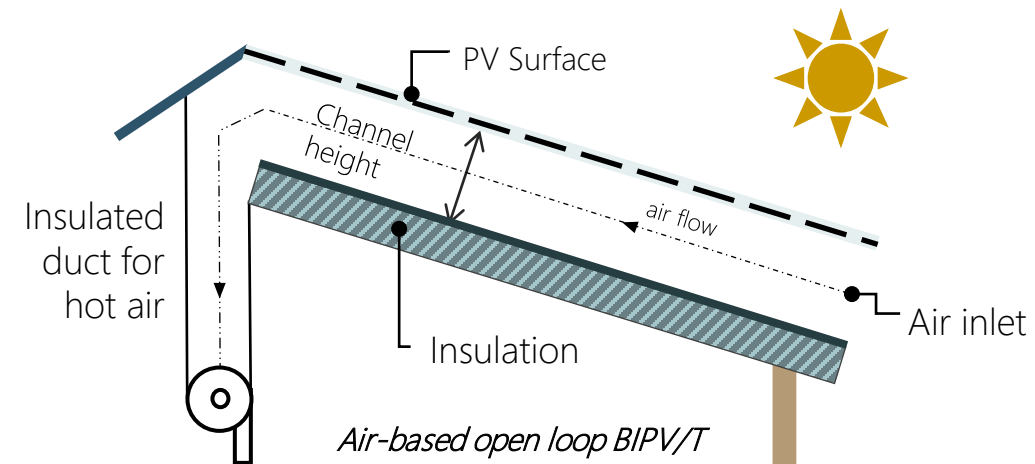
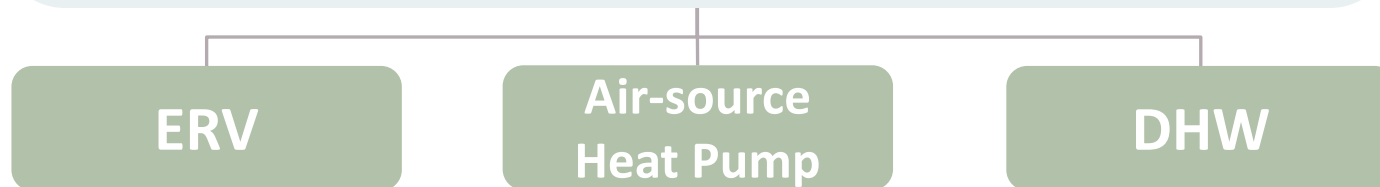
- Local electricity generation centers (distributed energy network)
- Status of "net-zero energy" or even "net-positive"
- Higher architectural and aesthetic integration
- Lower material cost (replace conventional building elements)



Paolo Corti et al. "Building Integrated Photovoltaics: A practical handbook for solar buildings' stakeholders," 2020.

Building Integrated Photovoltaic/ Thermal (BIPV/T) systems:

Combine the BIPV and solar thermal collector concepts generating both **electricity and heat**.

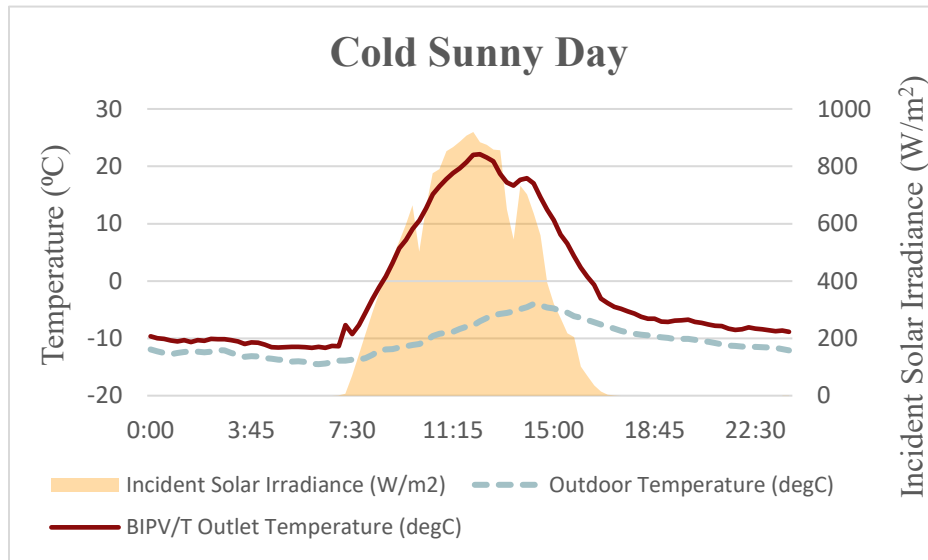
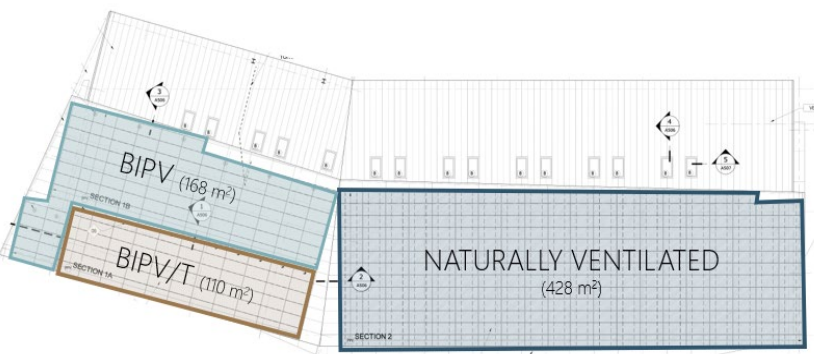


Bibliothèque de Varennes

The Varennes library is the first institutional Net-Zero Energy building in Canada.

One of the key technologies facilitating the net-zero energy goal is the use of **BIPV & BIPV/T** on the south-facing roof (700m², 37°)

- On-site PV, nominal capacity (kWp): 110.5 kW
- BIPV/T air is used as preheated ventilation air
- net EUI: 14.5 kWh/m²y (95% reduction over the national institutional average)



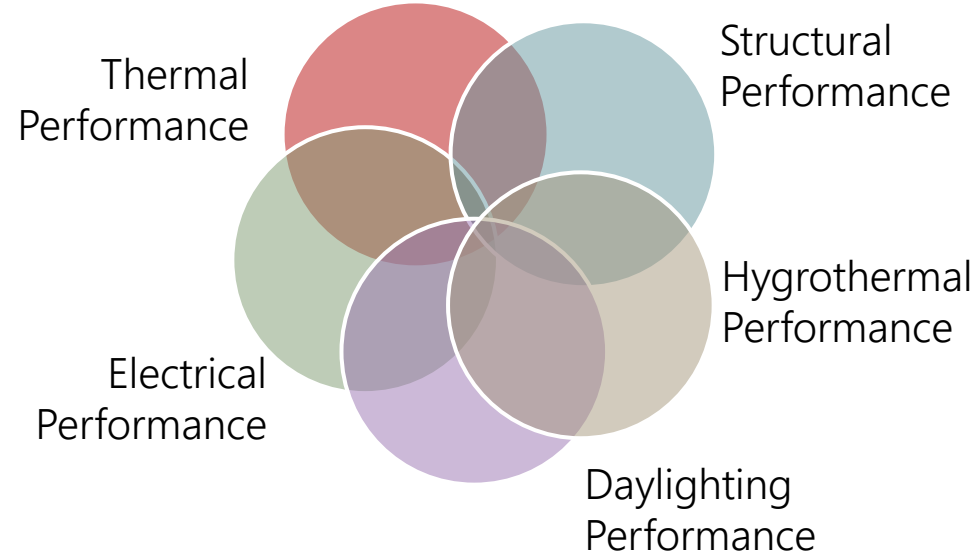
520 kWh of electricity

210 kWh of heat

Max ΔT : 29 °C



BIPVs are multifunctional building elements




BIPV applications are still confined to exemplary projects.

WHY?

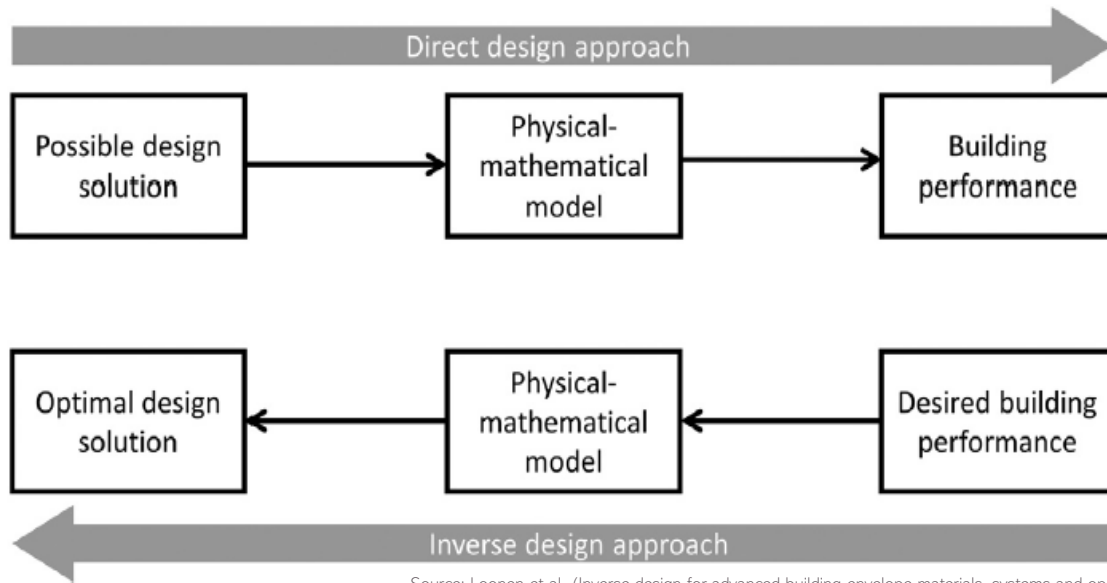
Integration with the building structure

Integration with the building energy system

 Simulation tools that incorporate holistic assessment capabilities through Building Information Modelling (BIM)

BIPV Integrated Design

Multidisciplinary semantic modelling can support decision-making during the design stage and enable integrated design for BIPV and solar building envelopes



Source: Loonen et al. (Inverse design for advanced building envelope materials, systems and operation)

Identify an optimum solution range for a given set of objectives, where **energy efficiency** and/or **energy flexibility** are prioritized

Simple + Accurate modelling approach **targeted** especially for **BIPV**

The screenshot shows a journal article page from 'Solar Energy' (Volume 232, 2022, pages 328-343). The article title is 'A novel approach for the modelling of convective phenomena for building integrated photovoltaic thermal (BIPV/T) systems'. The authors listed are Efstratios Dimitrios Rounis, Zisis Ioannidis, Anna-Maria Sigounis, Andreas Athienitis, and Theodore Stathopoulos. The page includes the Elsevier logo, a ScienceDirect link, and a 'Check for updates' button.

BIPV Experimental Testing

- Real weather conditions & Controllable lab conditions
- Full scale systems
- Different colors & patterns
- Different envelope functions
- Different framing options
- HVAC integration
- Smart control studies

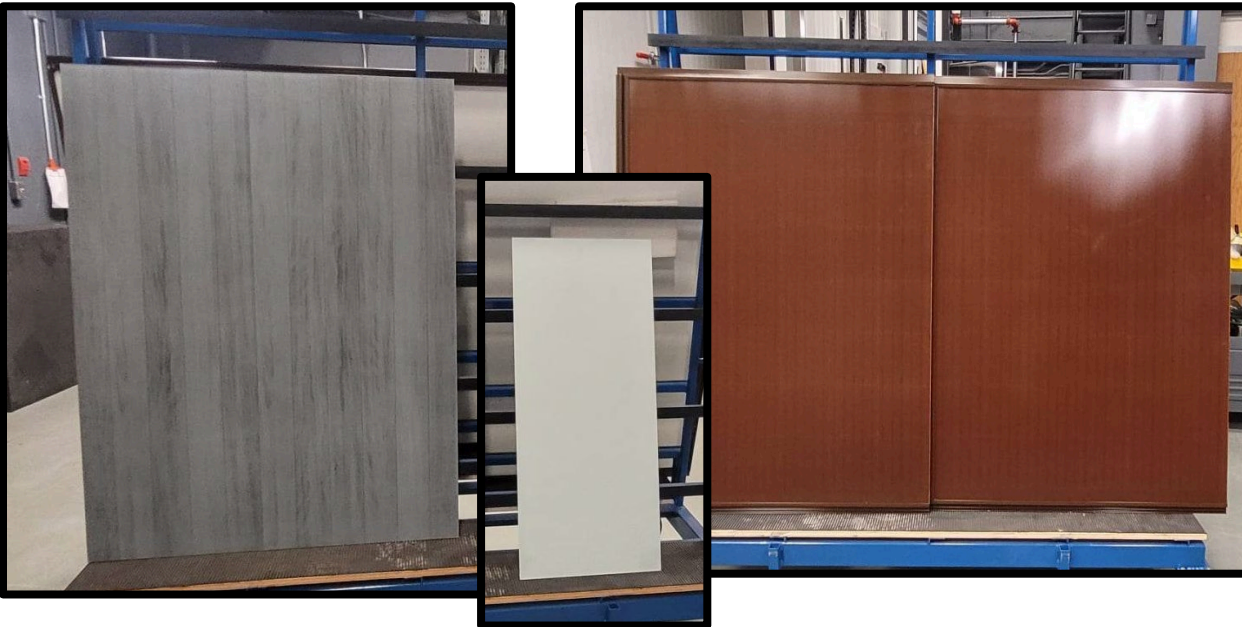
Enable an inverse, multidisciplinary approach for BIPV design



**Solar Simulator &
Environmental Chamber**



Future Buildings Laboratory



Thank you!

Questions?



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