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Experimental Analysis Of The Performances Of Ventilated Photovoltaic Façades

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Photovoltaic plants integrated in buildings (BiPV) contribute to increase the building **energy autonomy** and to reduce **greenhouse gas emissions**. To avoid the reduction of efficiency due to the rise of the **cell temperature,** the proposed BIPV system is installed in configuration **naturally ventilated**.

Material and Methods

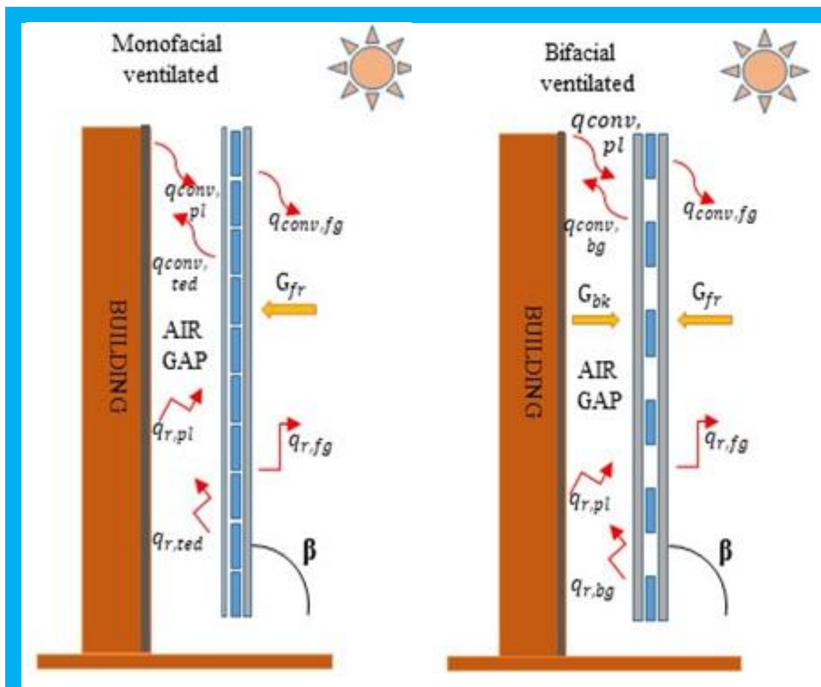

Fig.1: Heat Fluxes between the PV façades to the environment

The **thermal behaviour** of the ventilated façade is mainly determined by the airflow within the ventilated gap and the forcing environmental variables. These interactions determines the heat flows and the temperatures on the different layers of the facades.

Figure 1 shows the heat fluxes acting on the PV facades, that are:

- conduction between multilayer elements
- convection/radiation between the external surface of the system and the surrounding environment ($q_{conv,fg}/q_{r,fg}$)
- convection due to the air flow on the two sides of the ventilated cavity ($q_{conv,bg}/q_{conv,pl}$)
- solar radiation on the outermost surface of the model (G_{fr})
- radiative exchange between the two sides of the ventilated cavity ($q_{r,bg}/q_{r,fpl}$)

Description of the experimental PV façade

Figure 2 shows the two prototypes of ventilated facades, with monofacial (on the left) and with bifacial modules (on the right), with an azimuth of 19°. The bifacial bPV module is **semi-transparent** with Hetero Junction Technology (HJT). The modules are spaced 14 cm from the wall, thus creating a gap to allow the **air flow** on the back of the PV modules. BIPV façades are continuously monitored by the sensors installed, weather data and operative conditions are recorded in a data logger. The solar irradiance reflected by the building wall, which hits the backside of the bifacial modules, is measured through the pyranometer placed in the strip of structure between the bifacial modules.

Figure 2: BiPV (Rain Screen) Ventilated Facade

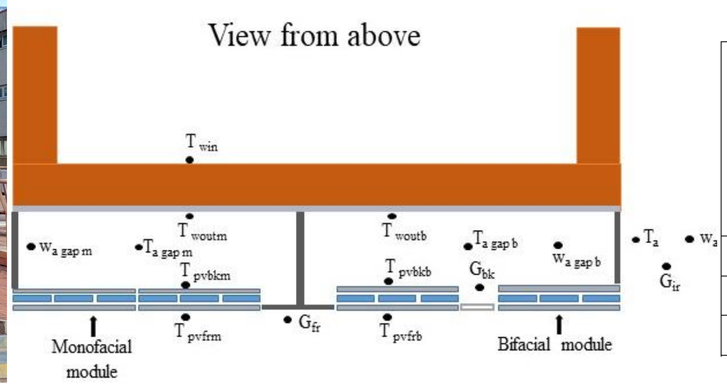

Figure 3: Installed Sensors

	Pyranometer	Rotary Band Heliometer	Tacogonium anemometer	Air Temperature Sensor	Humidity and Air Temperature	Surface Temperature	Pyranometer
							
Measuring Range	0-4000W/m^2	0-1500W/m^2	0-75 m/s	-50 +70°C	-50 +100°C	-50 +70°C	0-1800 W/m^2
Accuracy	5%	15%	1% direction 2-3% velocity	0.15 °C	0.1 °C temp 1% hum.	0.1	5%
Response Time	20 s		0.9 s	30 s	10 s	30 s	

Table 1: Characteristics of the Installed Sensors

Results

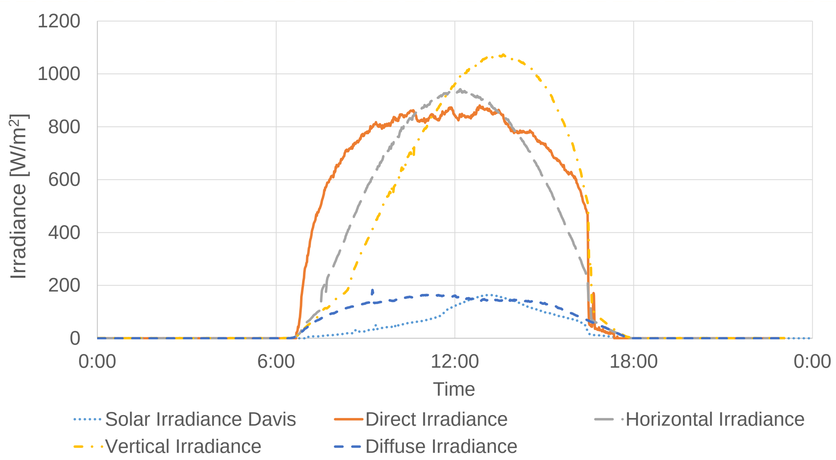

Figure 4: Measured Components of the Solar Radiation

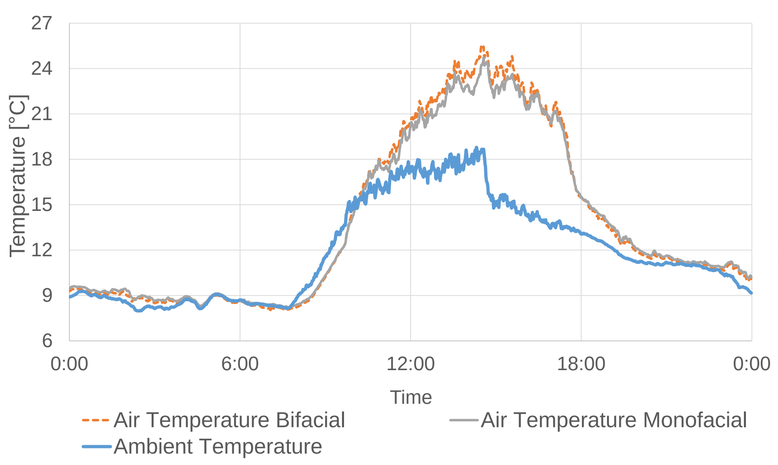

Figure 5: Measured Air Temperatures at the Exit of the Cavity

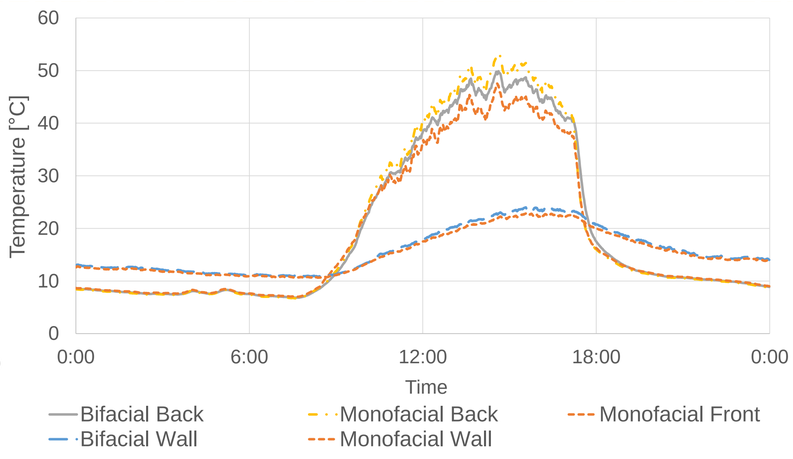

Figure 6: Superficial Temperatures Measured

Conclusions

Main **Advantages:**

Reduction of the temperature of photovoltaic modules that allows to achieve an increase of the electrical production; decrease of the temperature gradient on the building envelope, reducing both thermal losses and solar gains; improvement of the acoustic performance and protection of the exterior envelope against atmospheric agents and pollutants.

Main **disadvantages**:

Extra costs and space required for the construction of the structure; increased vulnerability to the fire of the building due to the chimney effect

Further development will be devoted to present the fluid dynamic simulation, as well as the electrical performance of these PV ventilated façades