



**POLITECNICO**  
MILANO 1863

DIPARTIMENTO  
DI ENERGIA

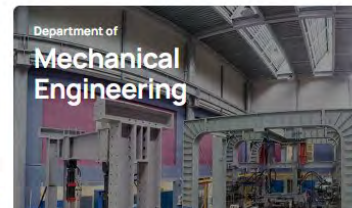
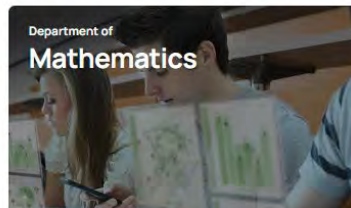
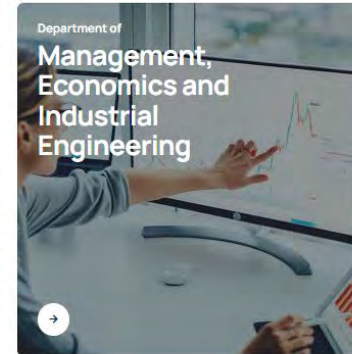
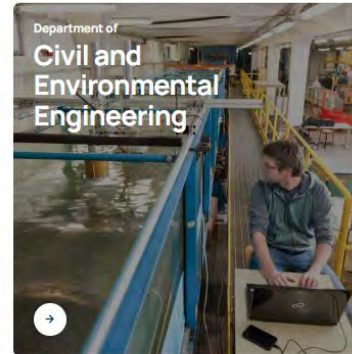
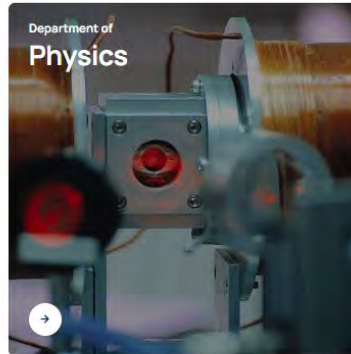
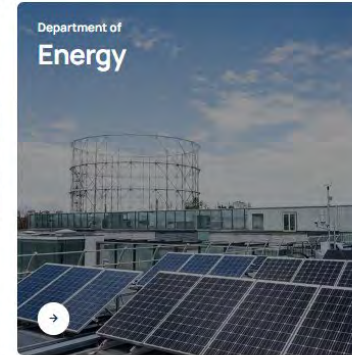
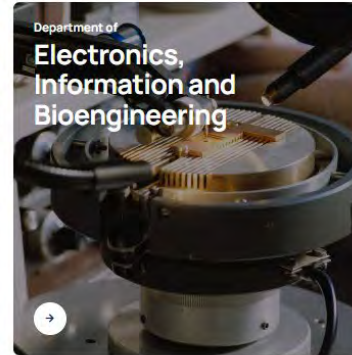
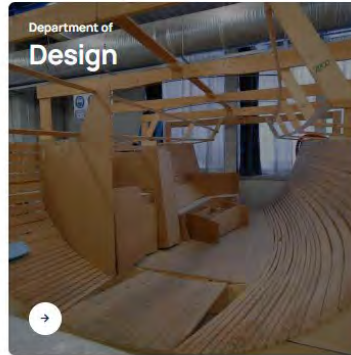
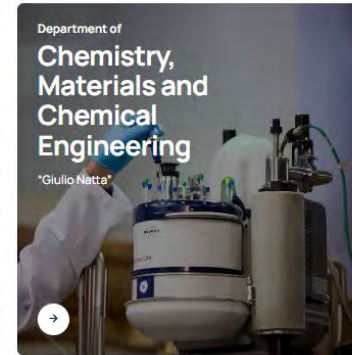
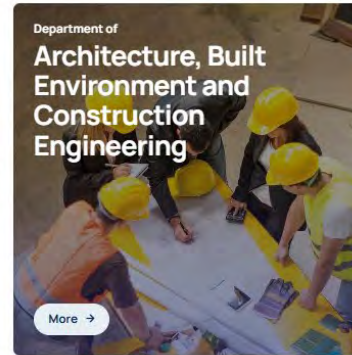
**A Laboratory for Energy and  
Sustainability**

**EN:lab**

*the New flagship building of the  
Department of Energy*

08.10.2025 | Rossano Scoccia – [rossano.scoccia@polimi.it](mailto:rossano.scoccia@polimi.it) - Department of Energy

# The 12 Departments of Politecnico di Milano



# EN:lab – the new living lab of the Department of Energy

## EN:lab combines in a single building:

- a “**laboratory**” for efficient and integrated energy management

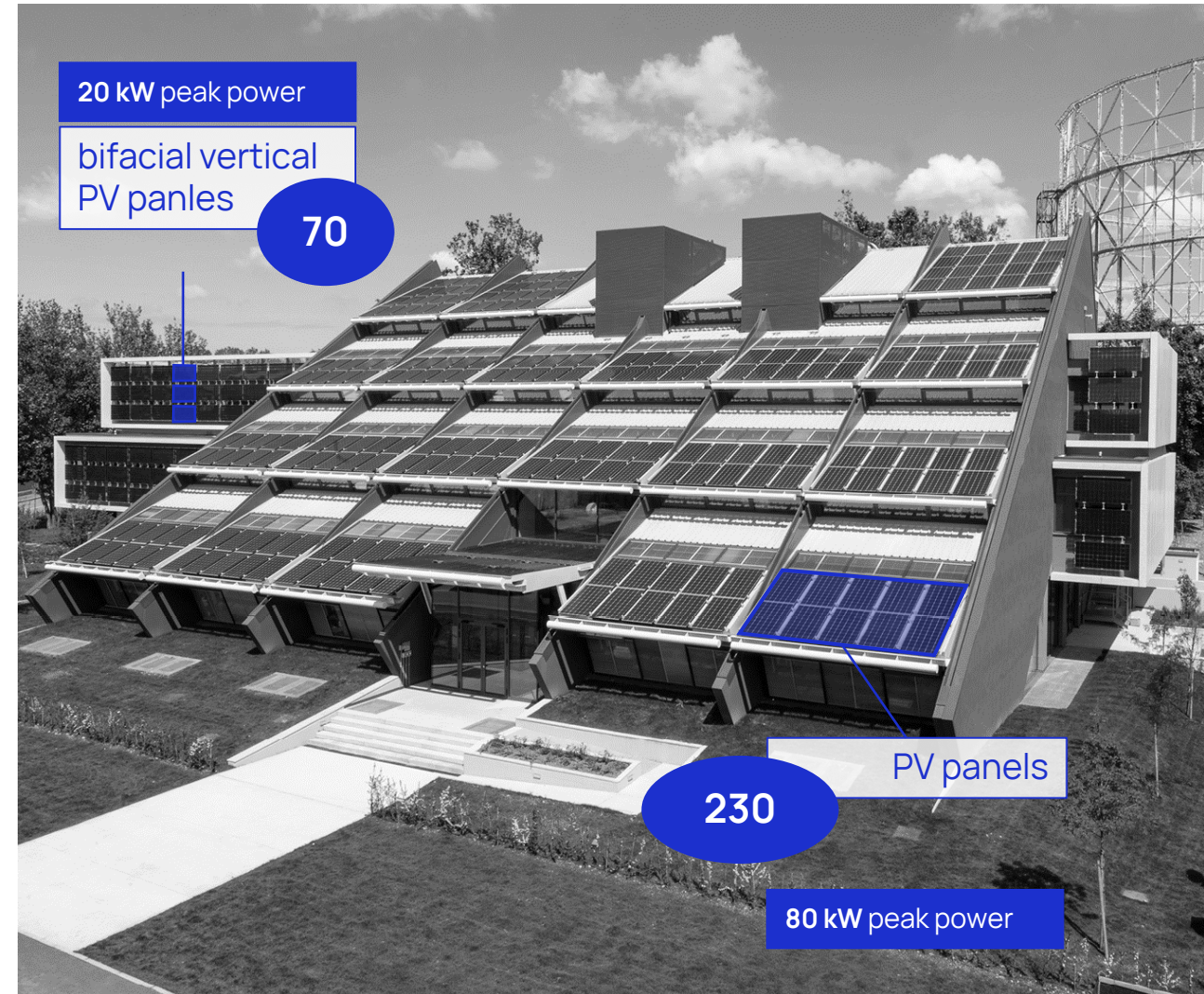
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- **experimental laboratories** on cutting-edge topics that expand our research context

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- **spaces for knowledge sharing and dissemination**, intended for events open to the public, meetings among researchers, and advanced and innovative teaching



# Sustainable energy generation/conversion systems on-site

- On the south facade, 300 monocrystalline silicon **PV** modules are installed, with a peak power of over **100 kW**.
- Thermal and cooling energy for air conditioning is provided by:
  - two reversible **air to water heat pumps** with a nominal cooling and thermal capacity of **500 kW** and **390 kW** each, using low GWP refrigerant
  - Ready to be connected to the **future District Heating Network of the Bovisa Campus**, which will be built together with the Gasometers Park using groundwater heat pumps
- No combustion systems are present on site  
(zero direct emissions)



# «Smart» building envelope: Elisya by Focchi spa

Glazed surfaces are "**active and responsive facades**," provided by Focchi Group, designed for **energy efficiency** and for the **comfort and well-being of people**.

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**70 sensor kits** have been installed, each logging **16 variables**:

- Master unit with sensor for irradiation and surface temperature of the glass
  - Slave 1 unit: sensors for **presence, temperature, internal CO2, brightness, internal humidity, air quality, internal noise**
  - Slave 2 unit: sensor for **external temperature, noise, air quality, brightness, external humidity, pressure, solar irradiation**
- 

The data collected by the sensors are processed through algorithms that activate the integrated technologies (**automatic windows opening, blinds, and air conditioning set-point temperature**).

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Users can provide feedback regarding comfort.

Feedbacks are crucials to "train" the controller algorithm according to each user's comfort.



<https://www.focchi.it/it/elisya>

# EN:lab @PoliMi

ELISPA

Progetto EN:LAB, Milano



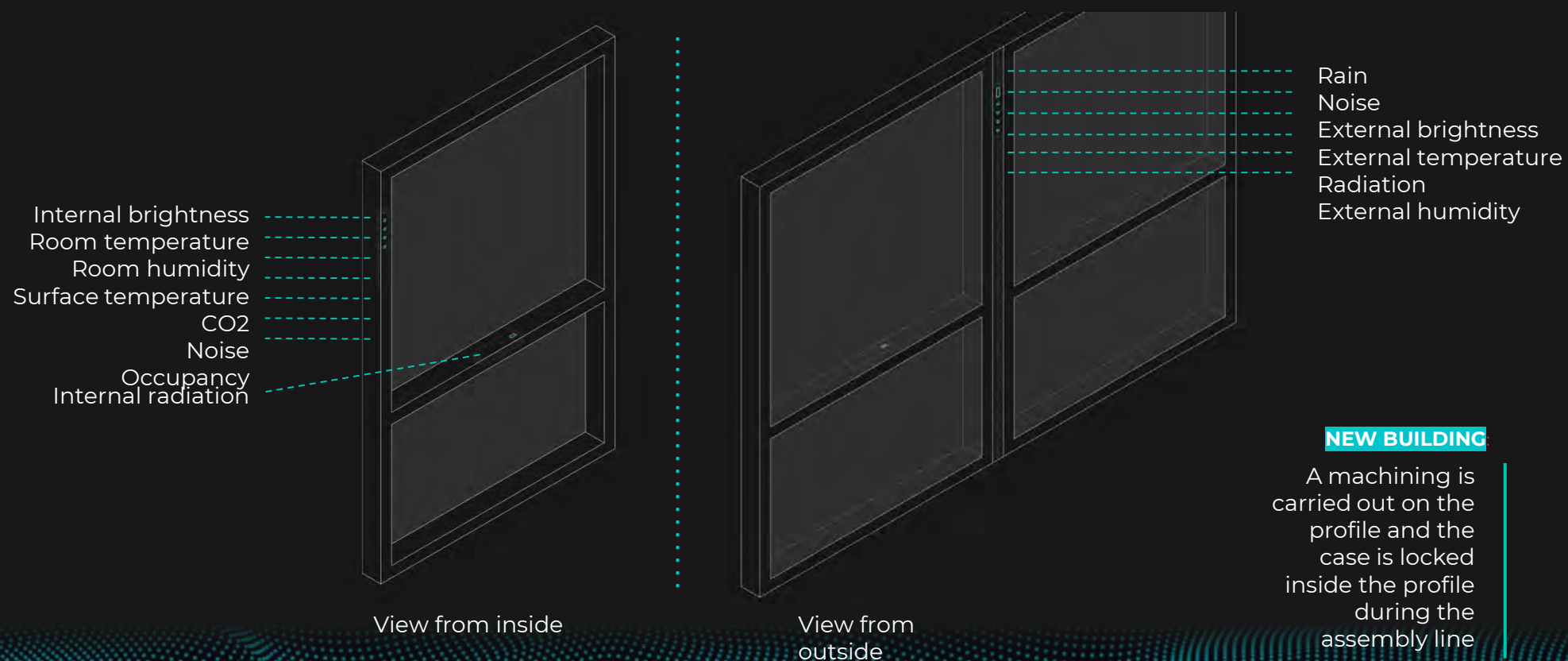
# EN:LAB @Polimi

ELISPA

Progetto EN:LAB, Milano



# SENSORS FOR FACADE



# SENSORS FOR FACADE

## Plug&Play

low intrusiveness in new and existing facade

## Flexibility

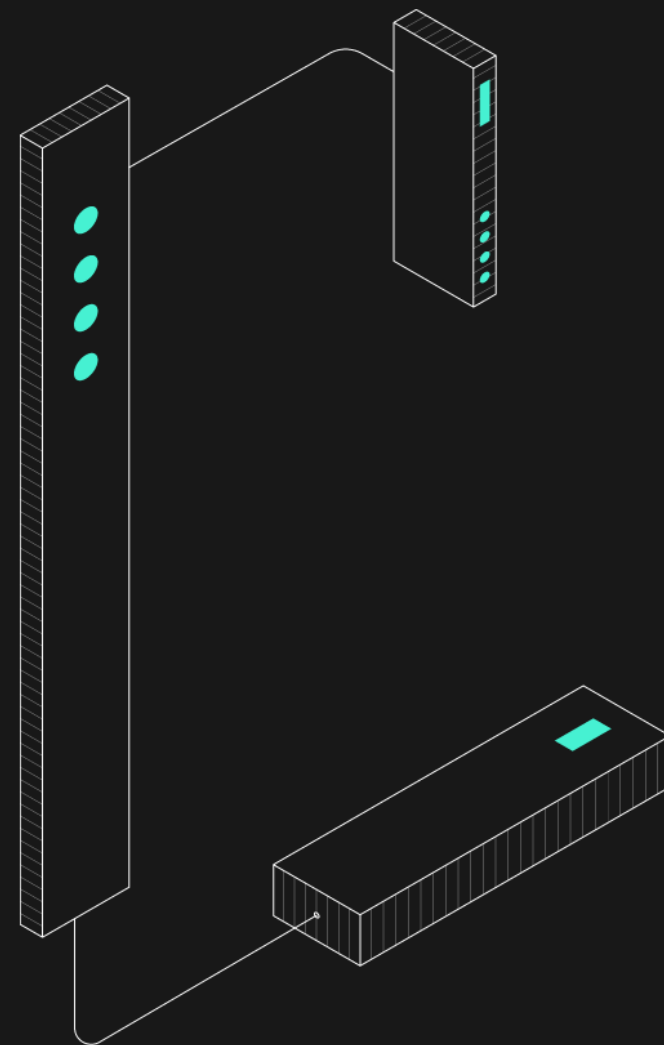
sensors when and where needed

## Small dimension

low impact for aesthetic

## Low consumption

Powered supply by low energy (Next step lifetime battery)



# «Smart» building envelope: Elisya by Focchi spa

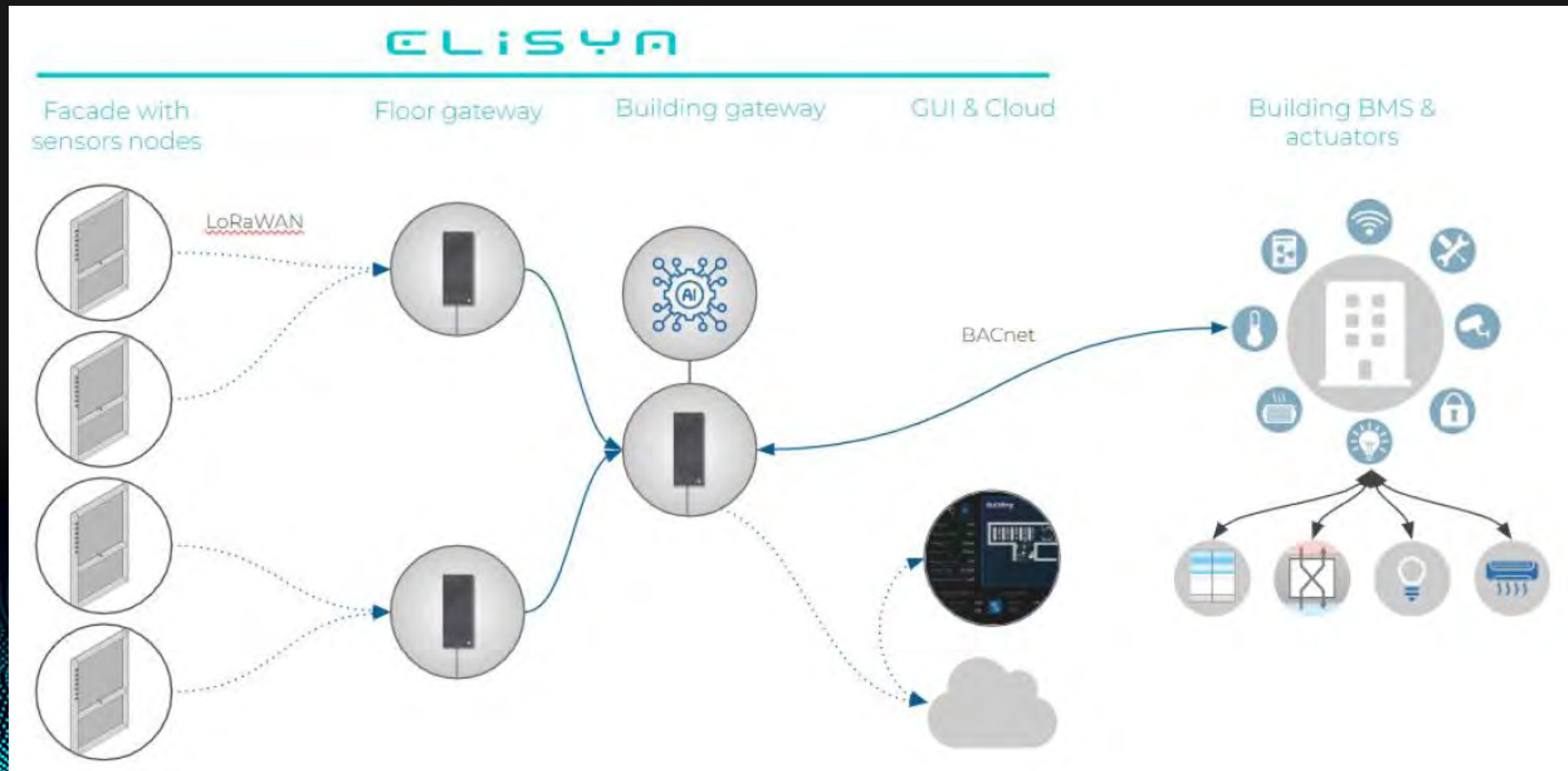
Integration through **IoT** among the needs of:

1. Active and automated management of windows openings
2. Indoor air quality control
3. Comfort: thermal, visual

Integration with the building's **BMS**:

1. Maximization of energy efficiency
2. Monitoring and control
3. Reporting and data publication



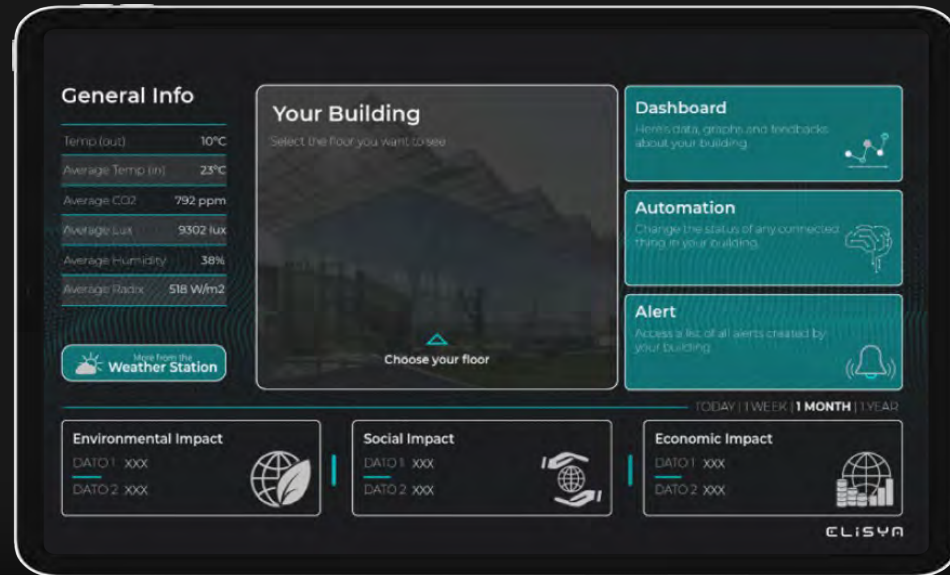


# Requirement for user feedback



# Periodic automatic reporting

## *Under construction/definition*



## Under construction

Monthly  
Report

month, YYYY

## WELLBEING

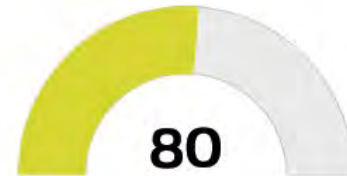
## General comfort (per type)

An average of the general comfort, split by "alert type".

|             |    |
|-------------|----|
| TEMPERATURE | 78 |
| VISUAL      | 70 |
| AIR QUALITY | 80 |
| ACOUSTIC    | 85 |

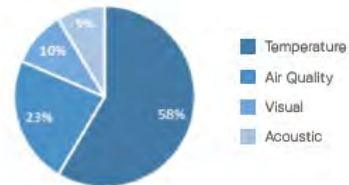
## General comfort (avg)

A weighted average of the general comfort, based on the four "alert type".



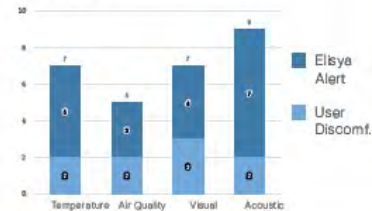
## Discomfort alert (by type)

An average of the general comfort, split by "alert type".



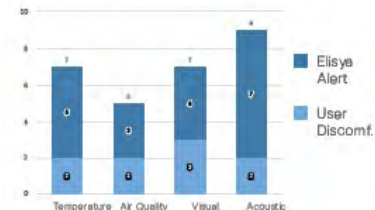
## Discomfort alert (by type)

Elisya vs User



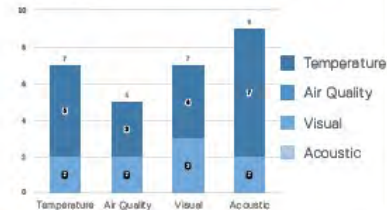
## Discomfort alert by location

Elisya vs User



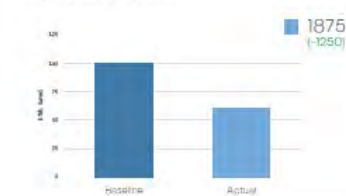
## Discomfort alert by location and type

Elisya vs User

ENERGY &  
ENVIRONMENTAL

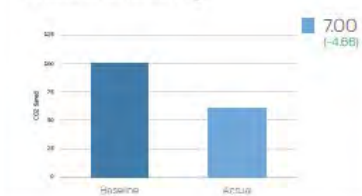
## Energy Savings

Baseline vs Actual kWh



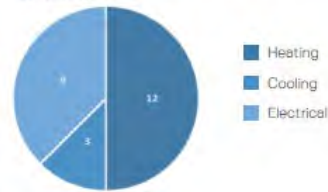
## CO2 Savings

Baseline vs Actual CO2 kg

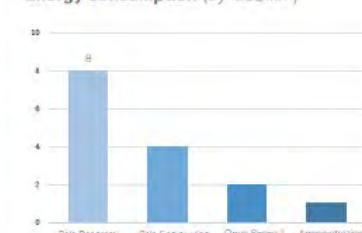


## Energy consumption (by type)

An average of the general comfort, split by "alert type".



## Energy consumption (by location)



## FINANCIAL

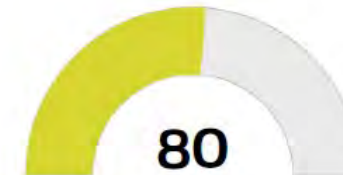
## Energy Savings

Baseline vs Actual €



## Productivity

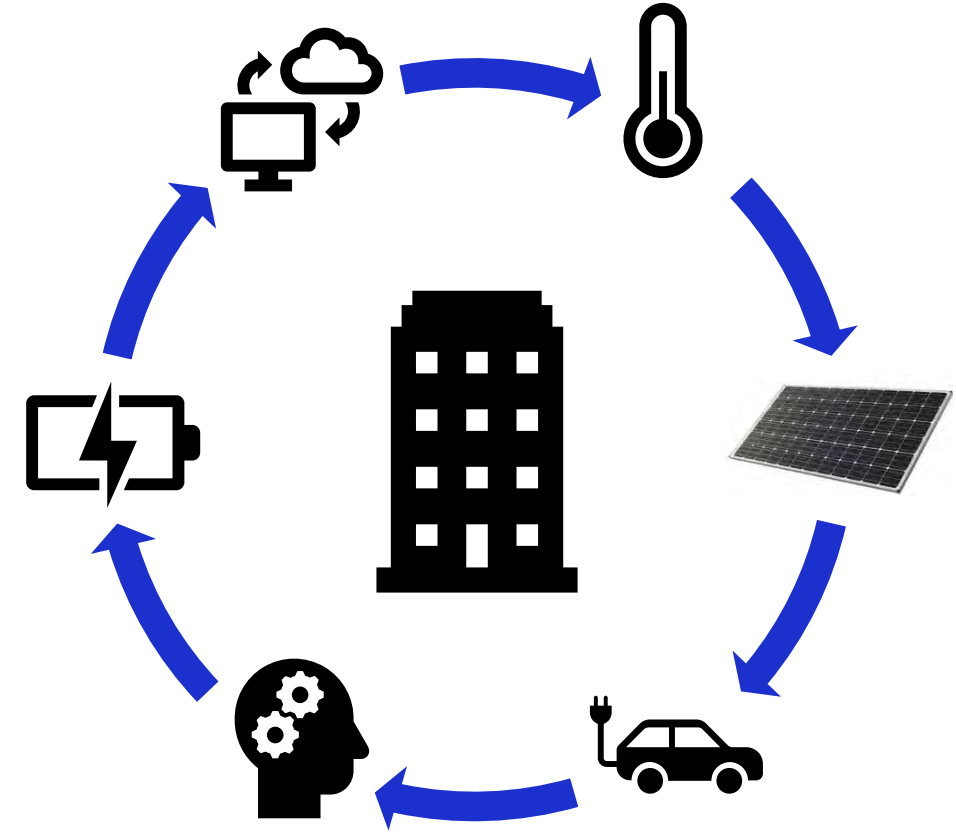
Productivity calculations are based on PMV-Productivity relation (Jensen, Toftum &amp; Friis-Hansen, 2009)

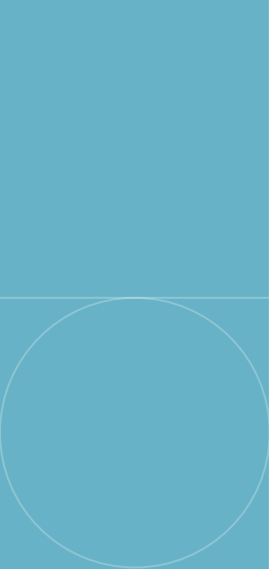


ELISYA

## Further developments

- The building will be integrated into a **microgrid** managed in a smart mode through a control and monitoring system.
- The microgrid will be **connected with the existing one at the BL25 Building**.
- The **installation** of batteries for **electrical energy storage** is planned, managed by the control system to maximize the production and use of photovoltaic energy.
- **Charging stations for electric vehicles** will be provided, contributing to the intelligent management of the microgrid in V2G mode (vehicle-to-grid active system).





## **Actual Research Laboratories in the Building**

02

# Actual laboratories in EN:lab

The building is largely dedicated to highly significant experimental laboratories.

- Some of them incorporate and enhance the laboratories of CeSNEF (Enrico Fermi Nuclear Studies Center)
  - **NanoLab - Micro and nanostructured materials**
- Some of them incorporate and enhance the laboratories of the Electrical Section:
  - **R-SET LAB - Research for a Sustainable Energy Transition**
  - **PEEMS - Power Electronics, Electric Mobility and Safety**
  - **M2EPS - Measurement lab for electrical systems**
- Others develop new technologies ("Department of Excellence" program):
  - **Battery Materials Engineering Laboratory**
  - **MRT Fuel Cell & Battery Lab**
  - **Pro-eStorage Lab**

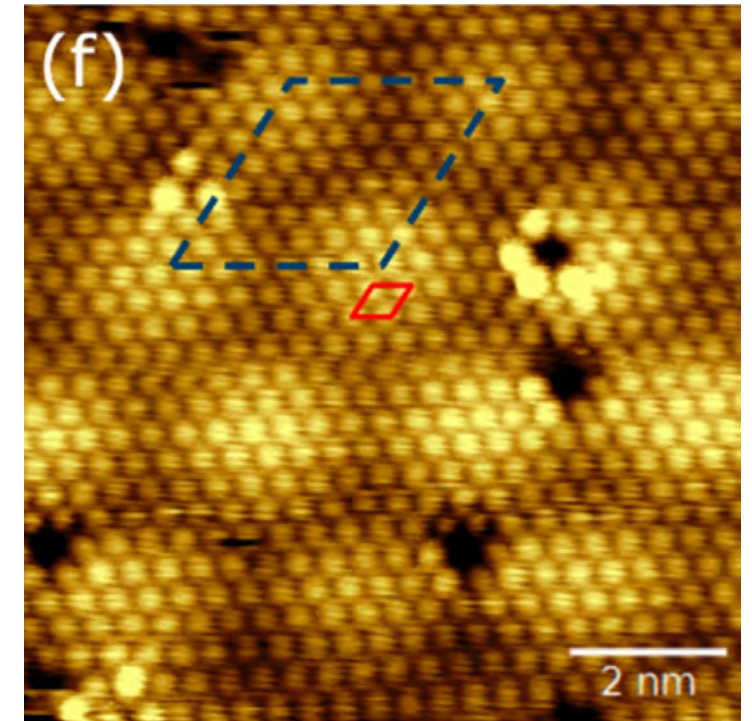


# NanoLab - Micro and nanostructured materials

The laboratories are in the basement floor (**~750 m<sup>2</sup>**) housing the equipment of the NanoLab (Section of Technologies and Chemical Processes and Nanotechnologies), currently located in Building 19 of the Leonardo Campus, dedicated to research in the fields of condensed matter physics and nanotechnologies:



- Systems for the production of nanostructured materials, films, and surfaces;
- Electron and scanning probe microscopes;
- Characterization of structural, vibrational, electronic, and optical properties;
- Systems for the study of radiation-matter interaction.



# Laboratori della Sezione Elettrica

## **R-SET LAB - Research for a Sustainable Energy Transition:**

Dedicato allo studio sperimentale e allo sviluppo di sistemi di Power Electronics per Generazione, Accumulo elettrochimico, Power Quality, Custom Power e Load Management, sia per applicazioni industriali specifiche che per l'utilizzo in reti di distribuzione in BT come Smart e Micro Grid.

**M2EPS - Measurement lab for electrical systems** per la caratterizzazione dei materiali, la diagnostica non invasiva e il monitoraggio di componenti e sistemi elettrici di potenza. Verranno studiati e sviluppati:

Sistemi per il monitoraggio della distribuzione elettrica nelle aree urbane e negli edifici

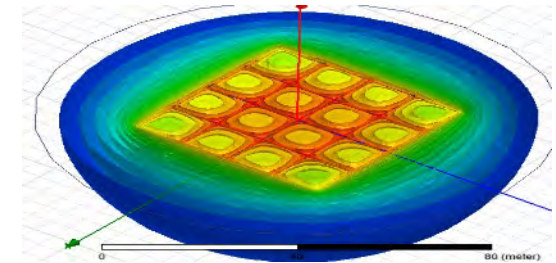
Sistemi per la caratterizzazione di materiali e componenti elettrici

Sistemi di prospezione elettrica per la diagnostica non invasiva

## **PEEMS - Power Electronics, Electric Mobility and Safety**

con carattere multidisciplinare, avrà l'obiettivo di svolgere attività di ricerca nell'ambito dei sistemi elettrici di potenza con particolare riguardo a:

- Sistemi Elettrici per la Mobilità
- Sistemi di accumulo dell'energia elettrica
- Convertitori elettronici di potenza
- Sicurezza elettrica



# Battery Materials Engineering Laboratory

Il laboratorio Battery Materials Engineering Laboratory collocato al primo piano (388 m<sup>2</sup>), ospiterà attrezzature per: fabbricazione di materiali ed elettrodi per batterie, loro caratterizzazione e studio elettrochimico e spettro-elettrochimico, assemblaggio e prova di celle. Il laboratorio, che ha iniziato le proprie attività nel Gennaio 2020, è attualmente operativo presso B18.



- Sistemi per la produzione di materiali per anodi, catodi ed elettroliti per tecnologie litio e post-litio
- Attrezzatura per la fabbricazione di elettrodi
- Dispositivi per l'assemblaggio di singole celle (coin cell, split cell strumentate, pouch cell, batterie metallo-aria)
- Misure elettrochimiche statiche, dinamiche e fluidodinamiche
- Caratterizzazioni *in operando* di proprietà strutturali, vibrazionali, ed elettroniche di elettrodi

# Pro-e- Storage Lab

Un nuovo laboratorio interdipartimentale, sito al piano terra dell'edificio ( $\sim 150 \text{ m}^2$ ), per **lo sviluppo e la prototipazione di soluzioni innovative** per

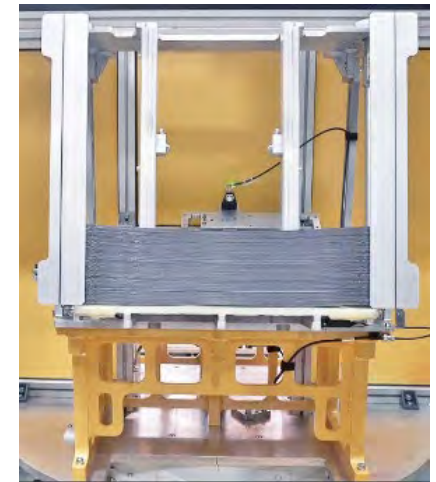
- Celle a combustibile polimeriche
- Batterie agli ioni-litio
- Batterie a flusso

**Le soluzioni innovative comprenderanno**

- Materiali e catalizzatori
- Architetture e geometrie di celle
- Alimentazione dei reagenti
- Controllo temperatura
- Balance of Plant
- Sensori e diagnostica



*Deposizione ultrasonica di film sottili e catalyst layer*



*Cella di assemblaggio flessibile per stack e moduli*



*Sistema di testing per dispositivi fino a 15 kW*

5 Dipartimenti coinvolti: Energia, Meccanica, Chimica e Materiali, Elettronica e Informazione, Scienze e Tecnologie Aerospaziali

# MRT Fuel Cell and Battery Lab

Il laboratorio è situato al primo piano dell'edificio (~ 250 m<sup>2</sup>) ed è dedicato allo sviluppo di dispositivi elettrochimici per la conversione dell'energia. In particolare sono svolte analisi sperimentali e modellistiche di fenomeni di trasporto al fine di:

Ampliare la comprensione di fenomeni critici

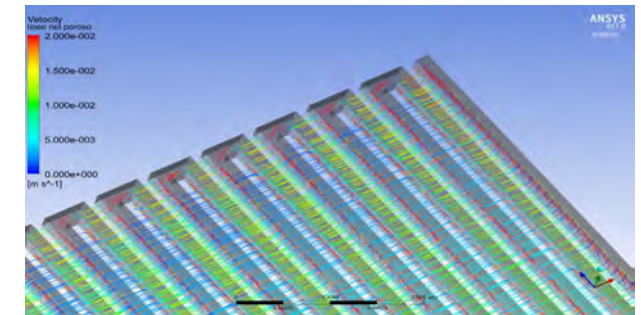
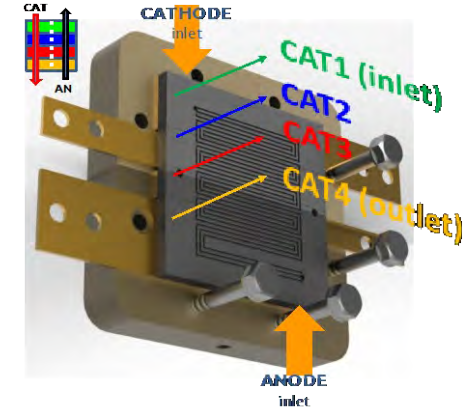
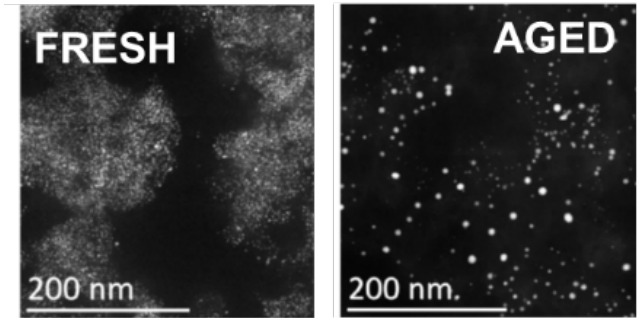
Sviluppare tecniche sperimentali innovative

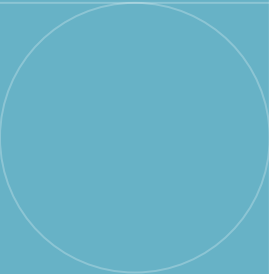
Ideare e progettare componenti innovativi

Sviluppare strategie di funzionamento per l'ottimizzazione delle prestazioni e la mitigazione della degradazione

Il laboratorio è dotato di sistemi di misura allo stato dell'arte per la caratterizzazione della prestazione e della degradazione di dispositivi elettrochimici, comprensivi delle più avanzate tecniche elettrochimiche di diagnosi, applicate anche a livello locale (CV, EIS, segmented cell) e in ambiente controllato (camere climatiche).

Le tecnologie maggiormente investigate sono le celle a combustibile polimeriche, le batterie agli ioni di litio e le batterie a flusso.





**Thank you**



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## Contatti

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