Energy System Application & Integration Lab (ESAIL)

Integrating CHP and PV-Thermal technologies into the built environment

The Oakland University, Clean Energy Research Center (CERC) is building an "Energy System Application & Integration Lab" (ESAIL) for the explicit purpose of conducting micro-CHP and combined solar PV-Thermal applied research and development.

The goal is to investigate, test and demonstrate multiple thermally activated cooling technologies driven by a micro scale, natural gas combined heat and power (CHP) unit(s) as well as hybrid solar PV-thermal systems. Work in this area is needed to allow for net zero energy (NZE) buildings, or near NZE buildings for all climate zones.

There is a need to further develop cost effective HVAC applications that take maximum advantage of low cost and low carbon natural gas CHP as well as abundant solar energy. While space heating is rather uncomplicated, utilizing CHP or PV-T to drive space cooling loads is less known and more complex.

Testing and demonstrating the use of both the thermal output to drive adsorption cooling, desiccant dehumidification, or other emerging cooling technologies will be the focus of this project. Commercially available solutions are available, and new technologies will be investigated both for technical feasibility and cost effectiveness.

Funding is being sought from commercial partners, foundations, and other interested parties to support this important work. Visit www.oakland.edu/ESAIL for updates.

SCOPE OF WORK

Phase 1

1. Set up the "Energy System Application & Integration Lab" with a modular HVAC testing system with:
    a. Install a micro-CHP unit
    b. Indirect evaporative cooler(s)
    c. Adsorption water chiller
    d. Desiccant wheel dehumidifier
2. Install flow & energy metering, sensors, controls, and commission systems.
3. Operate and test under various operating conditions.
4. Write report on findings and present to partners

Phase 2

1. Review of interconnection issues with Mid-west U.S. electrical utilities
2. Install demonstration sites for field installations of CHP / cooling applications
    - both residential and small commercial (subject to funding availability)
3. Write report on findings and present to partners

INNOVATIONS

Several innovations will be investigated as well that will create new product for commercialization:

- An innovative, simplified air side, low cost desiccant dehumidifier prototype
- Test and validate water condensation & reclamation for a desiccant indirect evaporative cooling unit. This system could provide low cost thermally activated solar or CHP cooling anywhere in the world in any climate without consuming water.

INTEGRATED ENERGY SYSTEM DESIGN

The CERC will create a lab-scale HVAC system to utilize natural gas CHP thermal output for space cooling. Although an ongoing review of available commercial products and technologies will continue throughout the project, several products have been identified for testing and demonstration. One is a how water driven desiccant dehumidification unit.

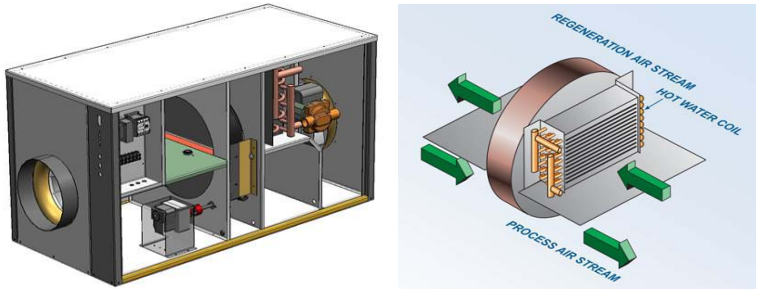


Figure 1. NovelAire ComfortDry desiccant based dehumidifier.

Also, a direct expansion refrigeration dehumidifier, with heat pipe assist will also be tested. This is schematically illustrated in below.

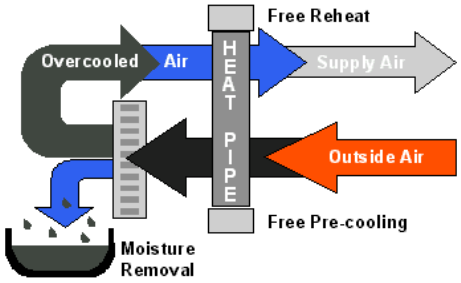


Figure 2. Heat Pipe Assisted Dehumidifier

The dehumidified air will then be cooled with either direct humidification, or via indirect humidification as seen in an innovative unit by Coolerado Inc. This is a patented M-Cycle dew point indirect evaporative cooling product that is a significant improvement over the direct spray evaporative cooling approach that we would otherwise implement downstream of the desiccant unit. The M-Cycle does not impart humidity or any moisture into the conditioned air stream.

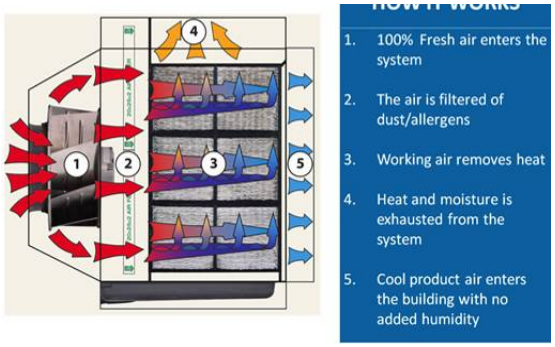


Figure 3. Coolerado M-Cycle cooling schematic.

Lastly, an adsorption chilled water unit could be tested, such as the units manufactured by Mitsubishi Plastics, subject to the available budget.

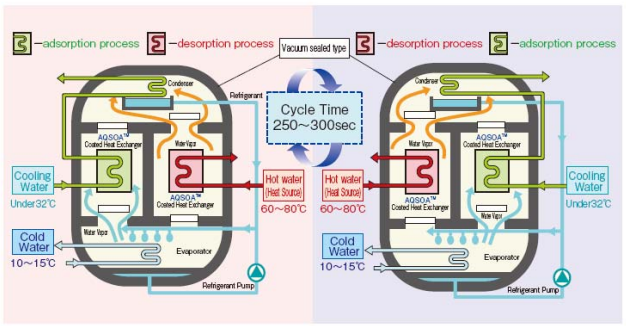


Figure 4. Zeolite based adsorption unit from Mitsubishi

Both residential and commercial field demonstrations of all technologies follow lab testing and validation of systems, such as in Figure 5, below.

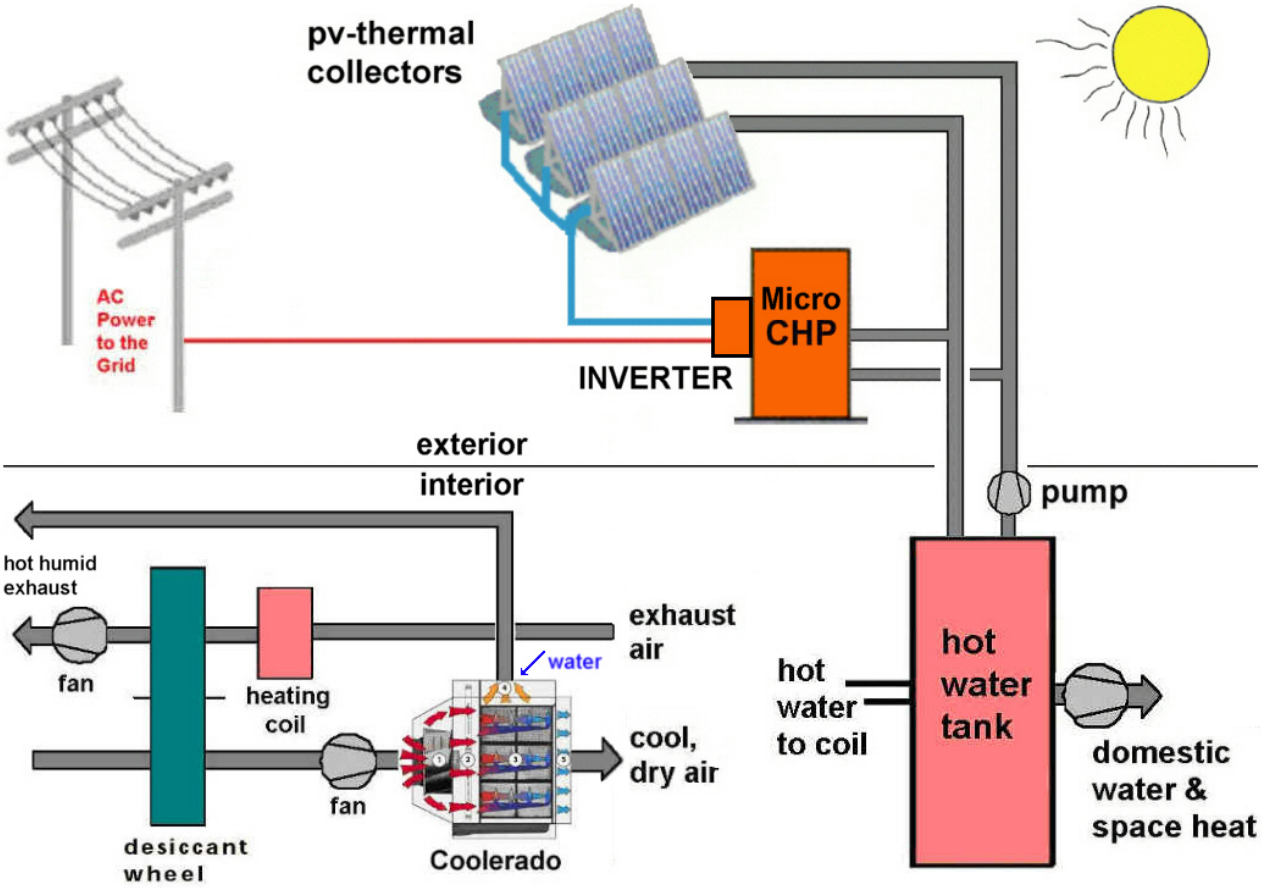
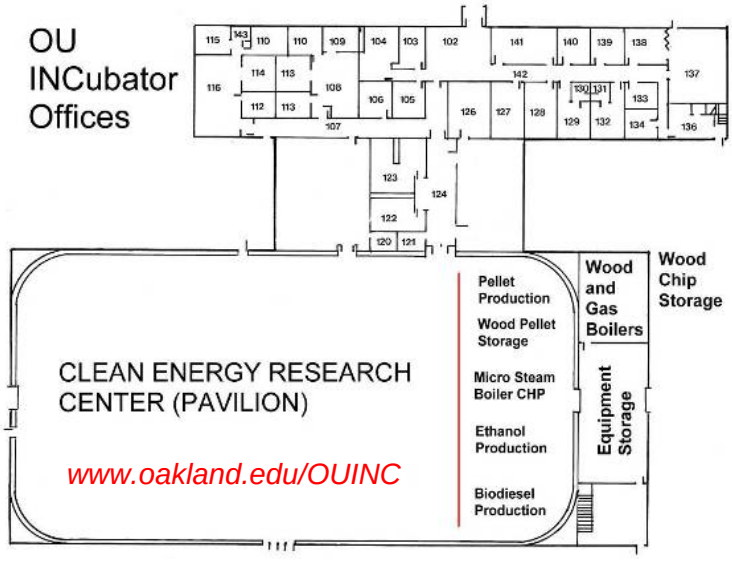


Figure 5. System schematic of a natural gas fired CHP unit backing up a solar PVT array. The hot water storage tank serves space heat, domestic water, and a desiccant dehumidification dew point cooling system for NZE, or near NZE buildings.

Oakland University – OU INCubator and Clean Energy Research Center

This lab will be located at the OU INC / CERC. The project team will have access to computer workstations, copying/ scanning/printing, lab benches, tools, and a custom large format solar simulator. Conference space is available in the Integrated Resource Center as well as the main conference room.



OU INCubator and CERC (37,000 sq feet)