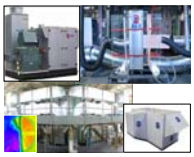
EXPLORE AND COLLABORATE
AMERICAN INDUSTRY AND AMERICA'S NATIONAL LABS
MATERIALS FOR ENERGY APPLICATIONS

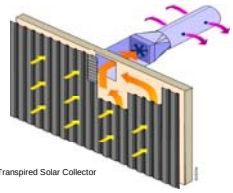
Passive and Active Building Energy Systems

Components

Polymer Solar Water Heaters

Compressorless Cooling





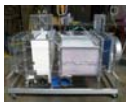
Transpired Solar Collector

BIPV Products & PV-T Array

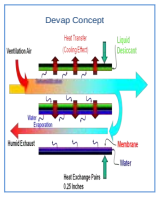
NREL

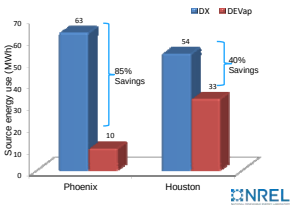
DEVAP: Lab Data Validated the Model

- DEVAP: Desiccant Enhanced Evaporative Cooling
- 40-85% source energy savings, 80% peak electric savings
- Benign working fluids (water and CaCl)
- Independent control of temperature and humidity
- Works in any cooling climate
- More savings possible using solar thermal or waste heat



Devap Prototype



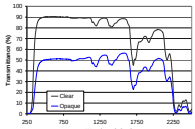


NREL

Application of Thermotropic Materials in Polymer Solar Thermal Collectors for Overheat Protection
Sandia National Laboratories

Problem: While polymer-based solar thermal collectors can reduce hardware cost by a factor of five, these materials are subject to degradation from solar overheating

U.S. Department of Energy Energy Efficiency and Renewable Energy



Tranmission of thermotropic film indicating ~50% reduction in transmittance across the specified spectrum (Source: Sandia National Laboratories)

- **Install a thermo-chromatic layer**

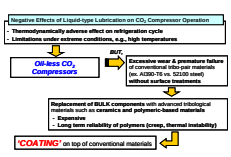
Transition of thermotropic film from clear to opaque at a transition temperature of 80ºC. The film is 0.5 mm thick and it is sandwiched between pieces of Lexan (Source: Sandia National Laboratories)

Solution: Develop cost-effective thermotropic materials that transition from clear to opaque at a specified temperature during heating and reverse the transition during cooling. Once developed, these materials could be integrated into the polymer collector structure as a simple, passive overheat protection mechanism.

Sandia National Laboratories

Tribology Related to Building Energy Efficiency

- Researchers have been investigating alternative refrigerants with minimal global warming potential (GWP)
  - CO_2 is a strong candidate (GWP=1)
  - First generation CO_2 system, under identical operating conditions had equal capacity and reached equal coefficient of performance (COP) with R410a.
- There is room for improvement in cooling systems
  - The compressor is a critical component in the refrigeration cycle
    - Tribological effects of refrigerants on materials define the performance and life of a compressor
    - The sliding components of a compressor suffer the most during operation
  - Solution : coatings
    - We have collaborated with compressor manufacturers and they agree



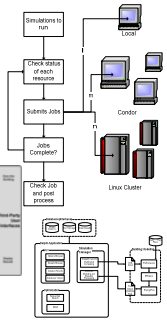
- The Tribology Group has been developing coatings that can:
  - Protect compressor components susceptible to failure during surface interactions
  - Operate under CO_2 environment
  - Transition to oil-less compressors
  - Provide high energy efficiency
  - Provide environmental benefits

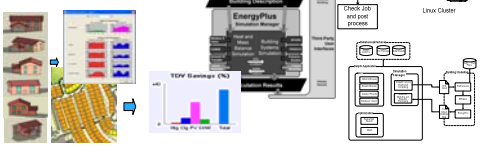
Argonne NATIONAL LABORATORY

Analysis

Building Energy Software Tools

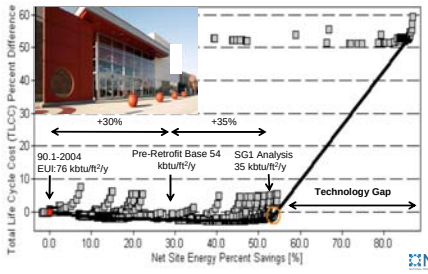
- OptEPlus: Com Optimization
- EnergyPlus: Simulation
- Open Studio: 3-D Interface
- BEOpt: Res Optimization
- SEAT: Community Layout





NREL

180,000 ft2 Big Box, Cold Climate: Retrofit OptEplus Retrofit Package Optimization



NREL

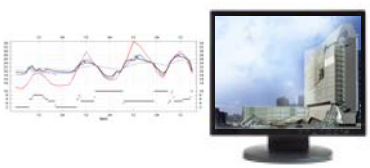
Environmental Assessment of Materials for Green Building Designs and Policies

Schematic of the Berkeley Lab Materials Pathways (B-PATH) Model

Materials modeling advances:

- **Technology resolution** across the building life cycle to better reflect real-world systems possibilities for:
  - Regionalization of materials analyses
  - Exploration of opportunities for materials impact minimization
- **Comprehensiveness** of metrics and issues
  - All feasible environmental and human health impacts
  - Water and fuels
  - Leverage of related science in materials performance: albedo, carbonation
- **Methodological flexibility and assessment**. In particular, the use can control:
  - Functional unit and system boundaries
  - Multi-criterion versus limited criteria approaches (e.g., energy and carbon)
  - Allocation procedures
  - Data aggregation (e.g., use of national averages vs. regional)
- **Transparency** and fully citable public data resource
- Robust treatment of **uncertainties** for improved decision making

Performance Monitoring: Measured vs Predicted

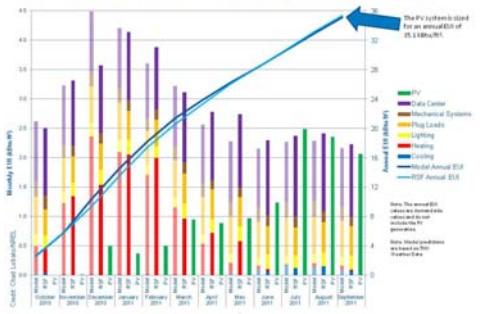


- Real world
- Real time
- Meters, control sensors and special instrumentation
- Measure comfort conditions and energy use

- Simulated using design model
- Real time EnergyPlus
- Driven by control sensors and special instrumentation
- Compare predicted and measured comfort conditions and energy use

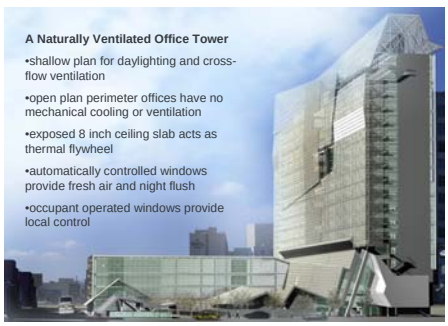
Putting It All Together

Measured Versus Modeled Monthly and Cumulative EUI



NREL

New San Francisco Federal Building



Work supported by the California Energy Commission, the General Services Administration and the Federal Energy Management Program. Images courtesy of mOrphosis and Arup

U.S. DEPARTMENT OF ENERGY
Office of Science

BERKELEY LAB
Lawrence Berkeley National Laboratory