Relevant LBNL Work on Solar Heating and Cooling

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presentation at
First Task Definition Workshop
New IEA Task on New Generation Solar Cooling Systems
Paris, 21 Mar 2013
Berkeley Lab

Managed by the University of California for the United States Department of Energy

- 80 ha next to U.C. Berkeley campus, ≈4500 employees, ≈half technical
- broad research areas, & typically ≈600 foreign visitors at any time
  - National Energy Research Scientific Computing Center (NERSC)
  - Joint Genome Institute (JGI), Joint BioEnergy Institute (JBEI)
  - Energy Biosciences Institute (Helios), world’s biggest public partnership, etc.
- Environmental Energy Technologies Division
  - broad interdisciplinary research agenda, but with a buildings focus
- Grid Integration Group focused on microgrids, demand response, & storage
  within Energy Storage and Distributed Resources Dept.
  with batteries, fuel cells, combustion, etc.
**DER-CAM Data Flow**

**Inputs:**
- Building energy service data
- Electricity & gas tariff data
- DER technology data
- Site weather data

**Outputs:**
- Optimal DER capacities
- Optimal DER operations schedule

**Objectives:**
- Minimize total cost
- Minimize CO₂ emissions

**Investment & Planning:**
Determines optimal equipment combination and operation based on historic load data, weather, and tariffs

**Operations:**
Determines optimal week-ahead scheduling for installed equipment and forecasted loads, weather and tariffs
DER-CAM Users

http://microgrid.lbl.gov/der-cam/how-access-der-cam
XingYe HQ Building, Zhuhai
introduction to Berkeley Lab

interest in new task

inputs from A, other technology performance, building loads, tariffs, etc.

produce optimal equipment fleets and operating schedules

B2: control strategy analysis & optimisation (also B1 & B5, C & D)

ongoing R&D

control of UNM Mech. Eng. Building, and others in Albuquerque (Prof. Andrea Mammoli partner)
collaboration with Chinese researchers on solar applications
optimisation of microgrids generally

input and responsibilities to task

optimisation of complex mixed systems
analysis of single buildings, or market assessment
actual closed-loop building control demonstration
analysis in support of dissemination
Thank you!

http://microgrid.lbl.gov

http://www.youtube.com/watchv=3XuCJBvq6Sk
Lawrence Introduces Big Team Science
LBNL: The First DOE National Laboratory
13 Nobel Prizes

Luis W. Alvarez
Melvin Calvin
Owen Chamberlain
Steven Chu
Donald A. Glaser
Ernest Orlando Lawrence

Yuan T. Lee
Edwin M. McMillan
Saul Perlmutter
Glenn T. Seaborg
Emilio G. Segrè
George F. Smoot

Intergovernmental Panel on Climate Change (IPCC)
CO₂ Min. of a S.F. Hospital

- large San Francisco health care building
  1.8 MW peak, 11 GWh/a
- flat loads, typical diurnal minimum ≈800 kW, 70% CF
- CO₂ minimizing lowers footprint by 39%
- 1.42 MW CHP (4 x 250 & 7 x 60), 404 kW PV
- 742 kWh bat., 265 kWt solar thermal
- 180 k$ or 9% increase in annual energy bill
- limited by solar area constraint & clean grid power
Electricity Balance

- Electricity from DG
- Electricity from utility
- Electricity from battery
- Electricity input to battery
- Absorption cooling

- PV Generation
- Electricity from battery

July weekday
Heat Balance

- Solar thermal heat
- Natural gas
- Waste heat from natural gas CHP
- Original total natural gas load
- Heat for absorption cooling

July weekday
UNM ME Building Thermal System

Solar Array

Hot Storage

Chiller

Cooling Tower

DES

cooling load kW

P4: cooling w
P5: primary ch
P6: absorber c
X2: DES heat in

hour of day

temperature degrees C
Scheduling Comparison

- Alternate weeks used standard scheduling and Operations DER-CAM schedules not dramatically different
- Use of absorption chiller is different
- Already low costs reduced by 30%
DER-CAM Web-Service for natural gas fired CHP, PV, solar thermal, electric storage, heat pumps, and absorption chillers

- no direct EMS coupling / feedback

http://microgrid.lbl.gov/der-cam/how-access-der-cam
Operations DER-CAM Data Flow

- Data acquisition:
  1. History
  2. Real time data
  3. Billing info
  4. Weather
  5. Central plant efficiency
  6. Equipment maintain schedule
  7. ...

- APIs:
  - Format Changer Macros

- Client Site:
  - Chiller storage
  - DG units
  - Signals
  - Delta controller

- DER-CAM week ahead operational code

- APIs:
  - Download Tool
  - Forecaster (load profiles)
  - Math-Solver

- Optimal operation schedule for next 7 days via ftp

- Berkeley Lab

- DER-CAM data

- Weather forecast