

# Sensitivity Analysis of Built Environment Integration of Distributed Generation

## OVERVIEW

The practicality of any particular distributed generation (DG) installation depends upon its ability to reduce overall energy costs. A parametric study examining the economic and operational behavior of DG was developed using an economic dispatch strategy that minimizes building energy costs. Varied parameters include building load, generator capacity, electrical efficiency, generator turndown, operations and maintenance cost (O&M), capital cost, and heat recovery ability.

## Parametric Study Assumptions

- Building energy is always provided from the least expensive source
- Southern California Edison and Southern California Gas are the utility providers
- DG is limited to meeting onsite electrical and thermal demand only

## Efficiency, O&M, and Fuel Costs

Due to time of use grid electricity costs, DG operation can either increase or decrease energy costs for entire portions of a year. As a result, a small efficiency improvement or O&M reduction can result in DG produced electricity to be economically desirable during periods where grid electricity was less expensive prior to DG improvement. Lower fuel cost experienced by buildings with high natural gas consumption also significantly improves the ability of DG to provide low cost electricity and improves the overall economic performance of any DG investment.

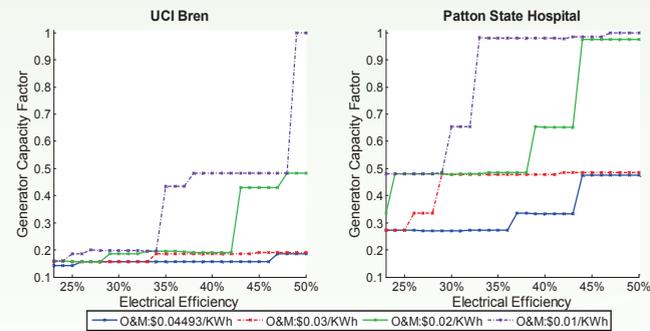


Figure 1: Capacity factor for a) UCI Bren and b) Patton State Hospital using economic strategy. Installed systems are sized to 50% of average building load. Patton State Hospital thermal demand is 34 times larger than UCI Bren

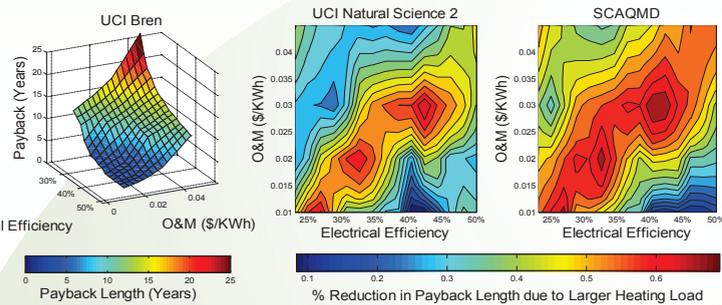


Figure 2: Payback period plot versus electrical efficiency and O&M for UCI Bren and the corresponding % difference in payback period due to larger heating load for UCI Bren compared to UCI Natural Science 2 (6.5 times larger heating load than Bren) and UCI Bren compared to SCAQMD (24 times larger). All buildings have a DG system sized to 50% of the maximum load, have 80% turndown, and cost \$2400/KW to install.

## Installed Capacity and Turndown

Increasing DG capacity requires larger total investment. Depending upon the building and generator selected, increased capacity may be desired. However, total savings start to decline if too much DG capacity is installed. For DG that always provides low cost electricity, total savings increase with increased capacity, but decrease after the average building demand has been met due to the inability to export electricity..

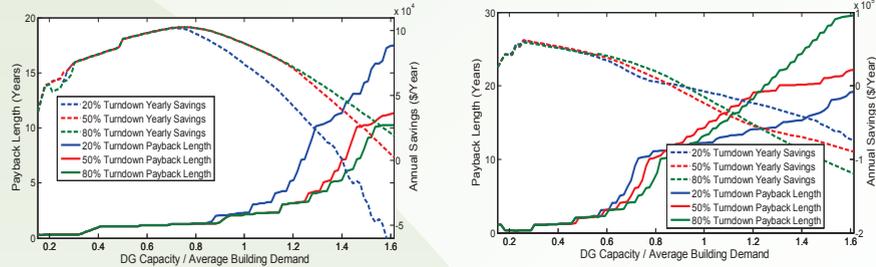


Figure 3: Impact of increased capacity on annual savings and payback for UCI Cal IT2. The system on the left has an electrical efficiency of 50% and O&M cost is \$0.01/KWh. The system on the right has an electrical efficiency of 25% and O&M cost is \$0.03/KWh Capital cost of DG was \$2400/KW

## Effect of Heat Recovery

Heat recovery can improve DG economics only if a large and consistent thermal demand exists that coincides with electrical demand. If either of these three requirements do not exist, heat recovery results in only marginal improvements to DG economics. Heat recovery can lead to increased operation only if the DG was not capable of produce electrical energy at a low cost and the savings produced from heat recovery surpass any losses from producing electricity onsite.

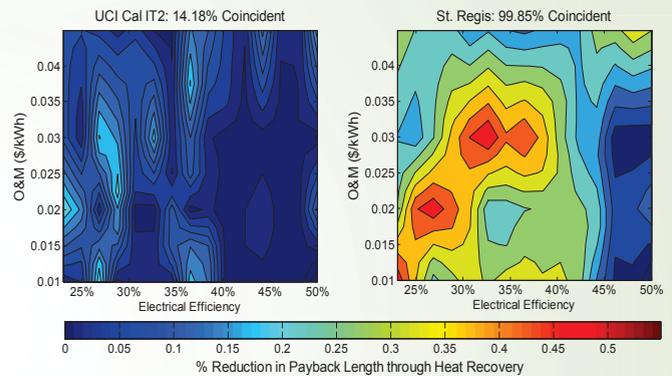


Figure 4: Percent reduction in payback due to waste heat recovery for UCI Cal IT2 and St. Regis. DG capital cost is \$2400/KW

## PERSONNEL

Graduate Students: Robert Flores  
Undergraduate Students: Dimas Avila, Aria Etemadieh  
Staff: Brendan Schaffer  
Investigators: Prof. J. Brouwer and Prof. G.S. Samuelsen