Modeling distributed premises-based renewables integration using HOMER

Nathan Johnson (HOMER Energy)
Peter Lilienthal (HOMER Energy)
Timothy Schoechle (Smarthome Laboratories, Ltd.)

Integrated modeling and control of smart microgrid power systems

Smart microgrids

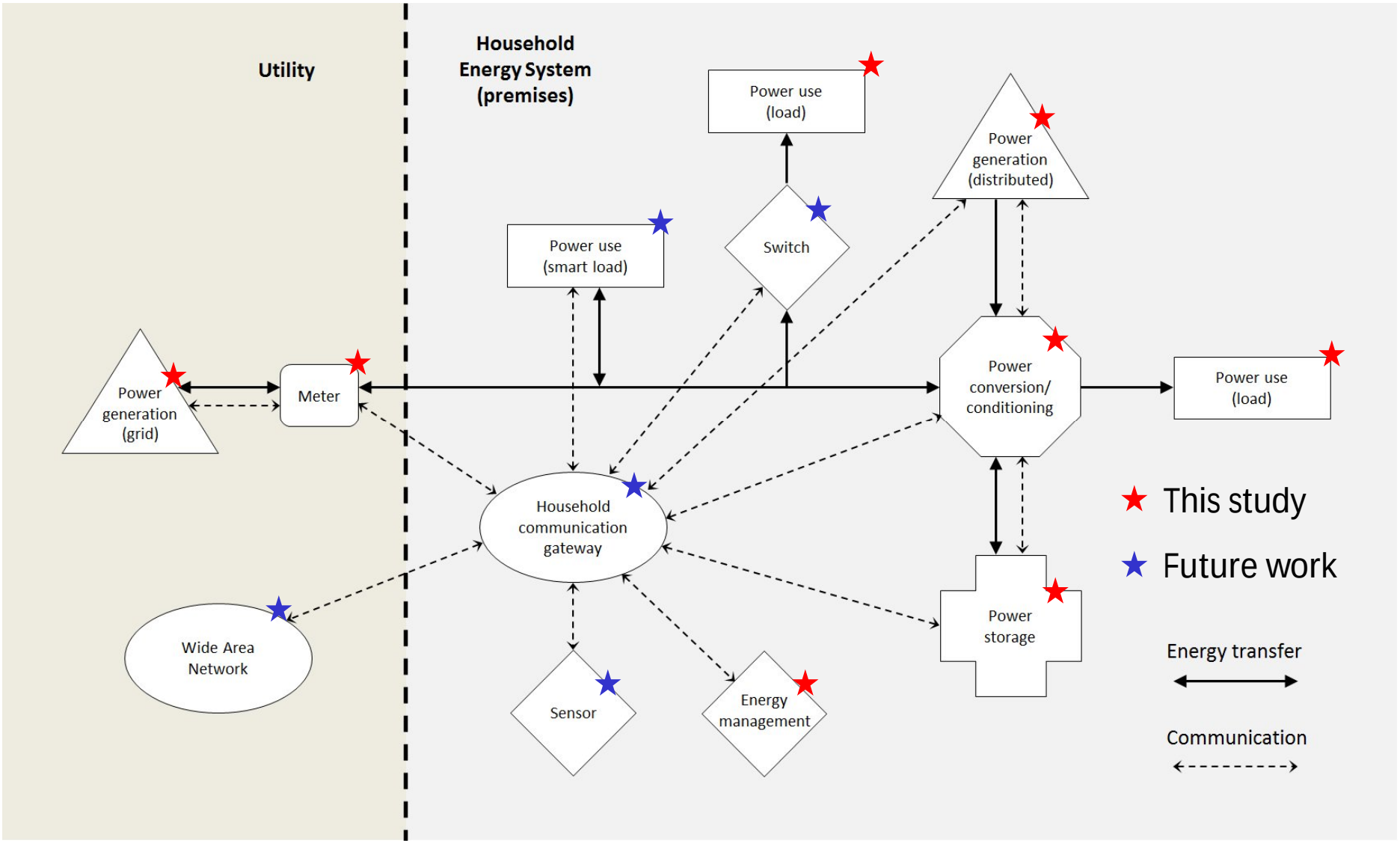
Energy management

- Arbitrage
- Demand response
- Frequency control

Distributed generation and storage

- Solar PV
- Combined heat and power
- Wind
- Electric vehicles
- Batteries, fly wheels, hydrogen tank, reservoir

Premises-based energy system architecture



HOMER modeling

Simulation	Hourly for one-year: generation, storage, use
Optimization	Lowest net present cost for each system configuration
Sensitivity	Test power system robustness

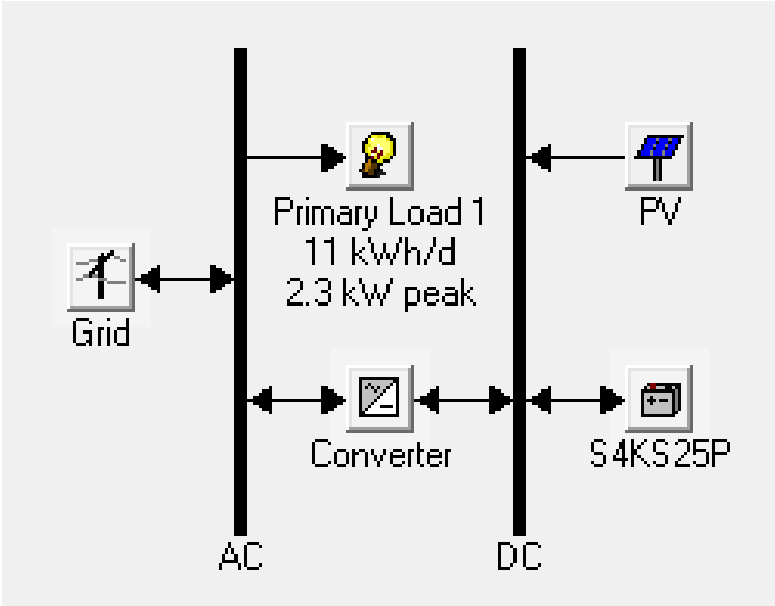
Residential solar PV in Boulder, Colorado

Use: single family, July peak

Generation: grid, PV

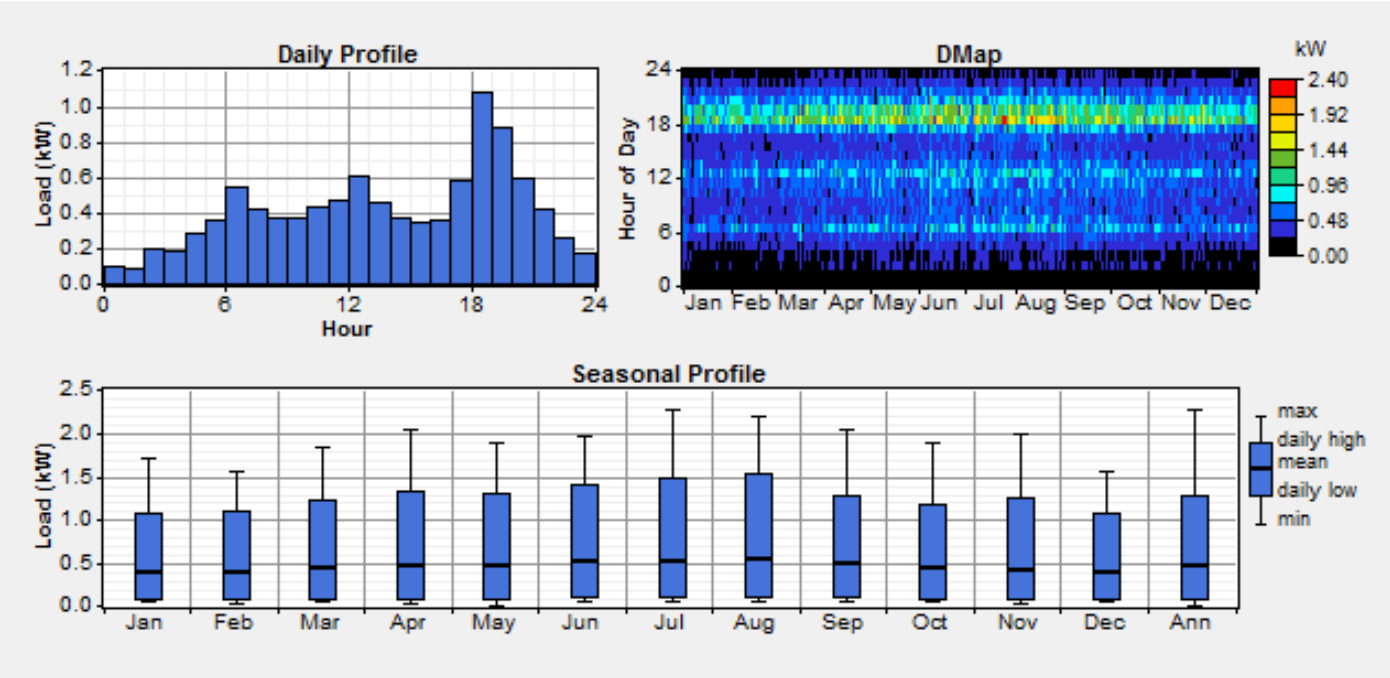
Storage: battery bank

Conversion: Transverter™

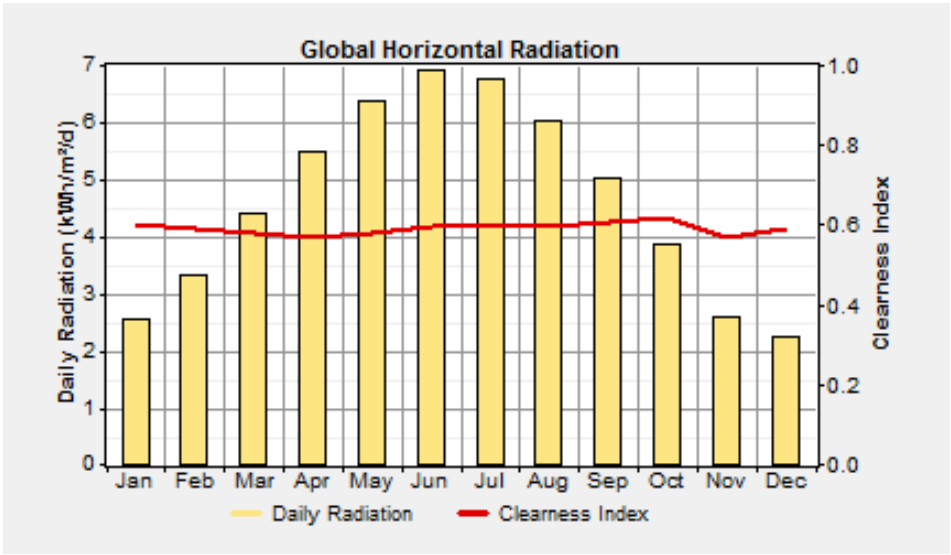


Power system configuration options

Load



Radiative flux



Technology parameters

Solar PV

2.6 kW max capacity, $4000/kW, 25-year lifetime

Transverter™

2 kW, 91% rectifier efficiency, $1500, 15-year lifetime

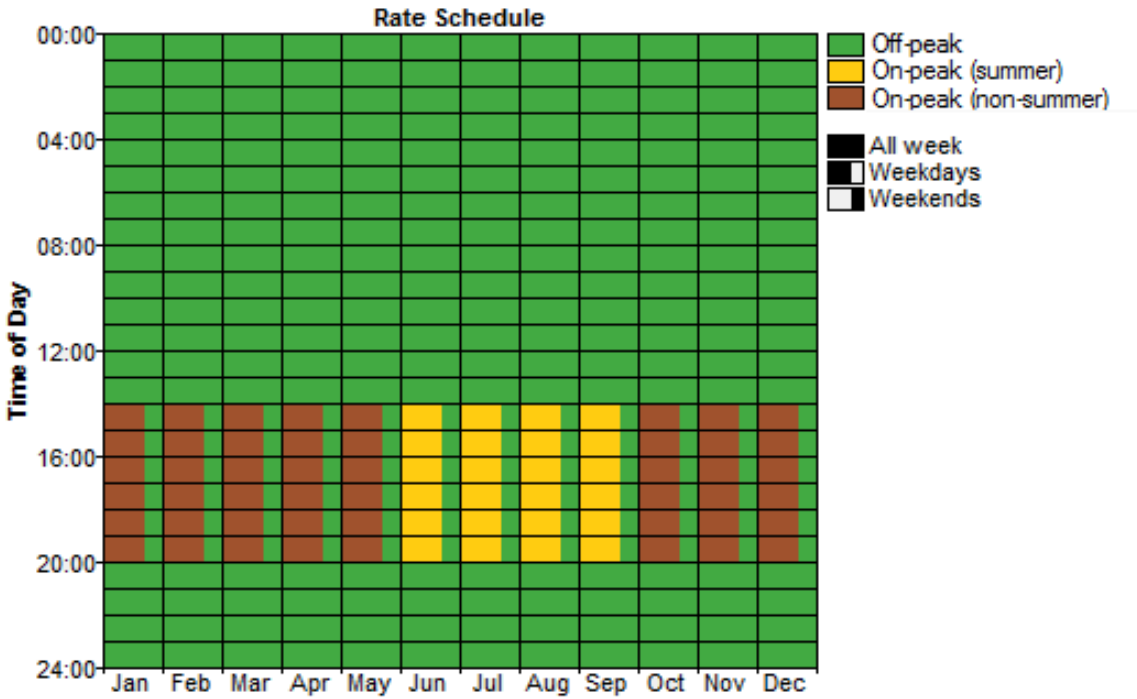
Battery

Surrette 4KS25P, flooded lead-acid, 7.6 kWh, $1200, $60/yr O&M, max throughput ~10,600 kWh

Time-of-use pricing

Time-of-use (pilot program)	Price ($ / kWh)
Off-peak	0.100
On-peak (summer)	0.249
On-peak (non-summer)	0.121

Tiered (typical rate)	Price ($ / kWh)
Non-summer	0.105
Summer (< 500 kWh)	0.107
Summer (>= 500 kWh)	0.157

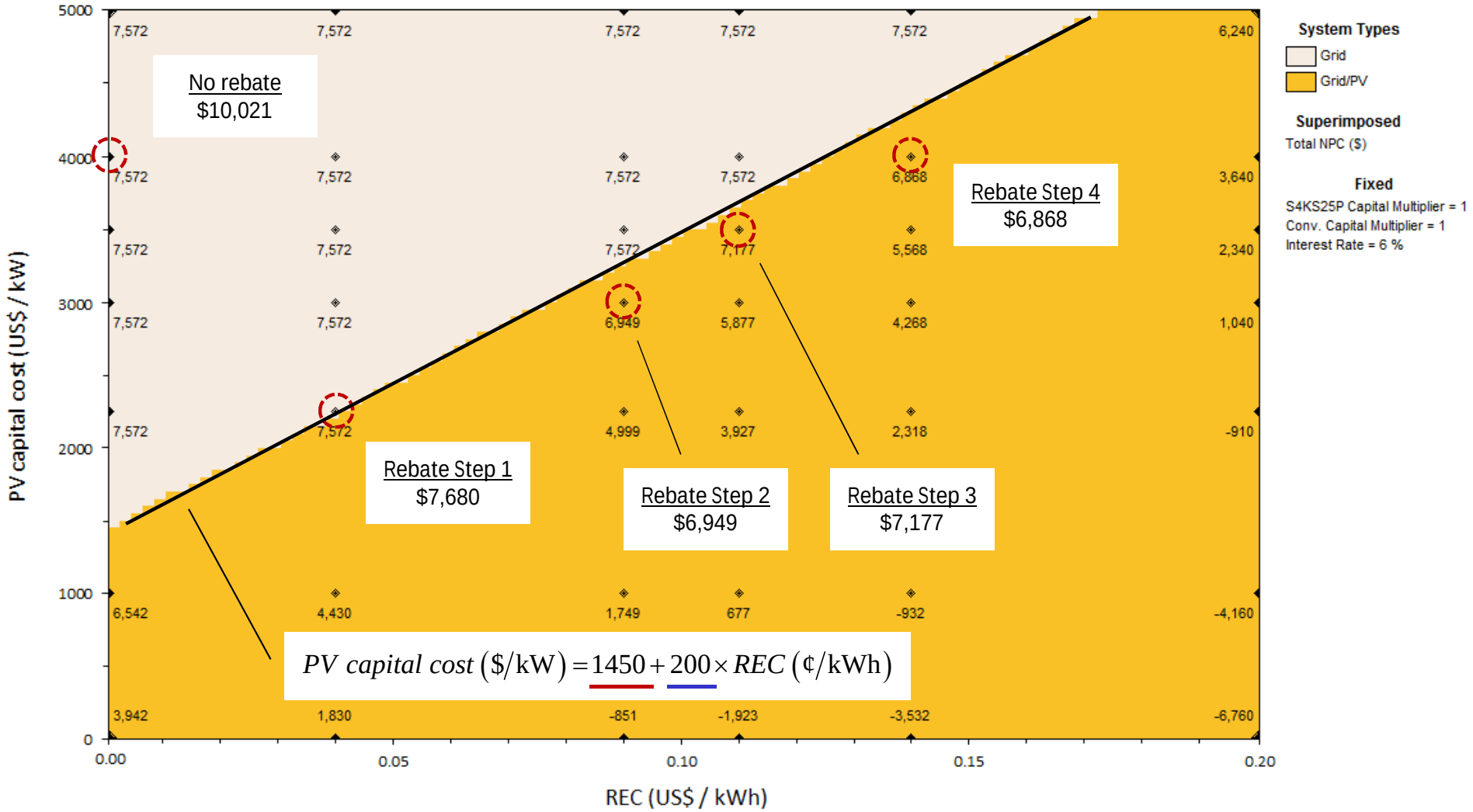


Sensitivity analysis

- PV capital cost (Xcel rebate)
- PV throughput credit (Xcel rebate)
- Transverter™ cost
- Battery cost
- Grid electricity price
- Real interest rate
- Energy management controls

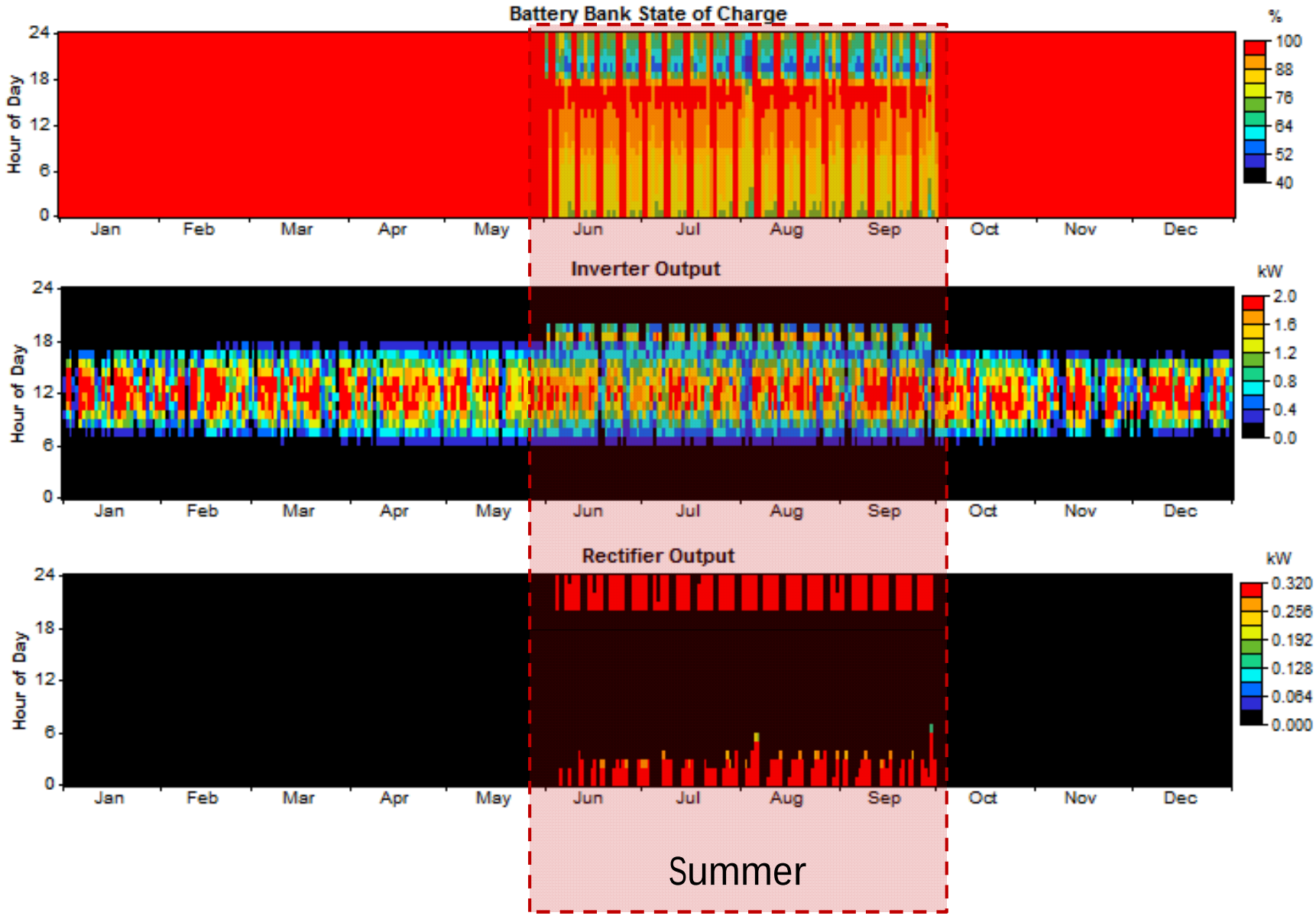
Step	Capacity rebate ($ / W)	REC ($ / kWh)
1	1.75	0.04
2	1.00	0.09
3	0.50	0.11
4	0.00	0.14

Optimal System Type graph (OST)



Net Present Cost for Grid only: $7,572

Battery and converter use



Sensitivity analysis

Battery cost needs to reduce by 90% to be cost-effective

A 10% increase in grid electricity price increases the cost of a grid-only system by $626, and a grid/PV system by $76

A $1,000 decrease in Transverter™ cost is equivalent to a reduction in PV capital cost of $500 to $800 / kW

Reducing the real interest rate improves the cost-effectiveness of a grid/PV system

Future work

Demand response

- Individual load modeling
- Prioritization of loads
- Controls for individual household loads
- Programmable dispatch decisions

Link microgrid modeling with real-time control

Intermittent grid failures

Questions?

Nathan Johnson
nathan@homerenergy.com

Peter Lilienthal
peter@homerenergy.com

Timothy Schoechle
timothy@schoechle.org

Download software at www.homerenergy.com