Title
Using DER-CAM to Assess the Economic Competitiveness of Microturbines

Authors
Firestone, Ryan
Marnay, Chris

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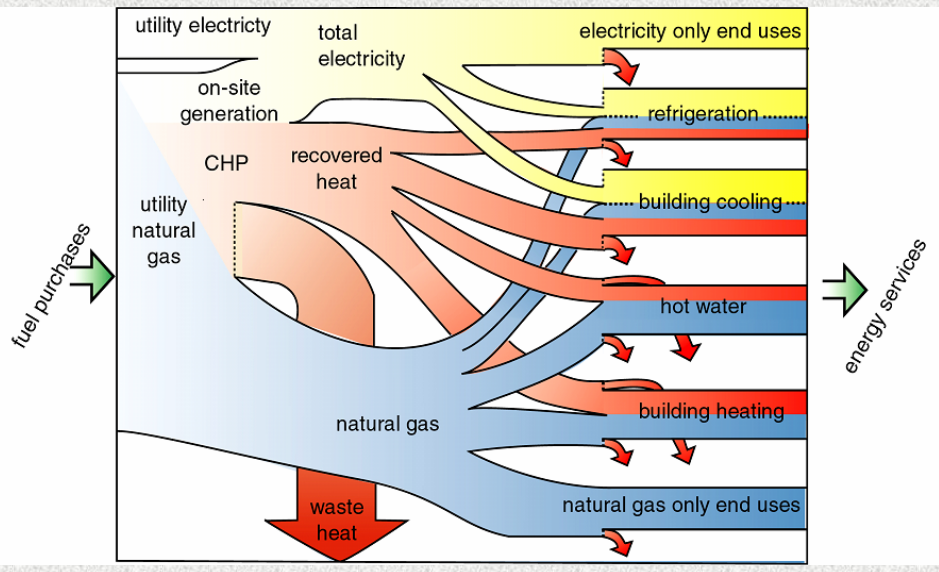
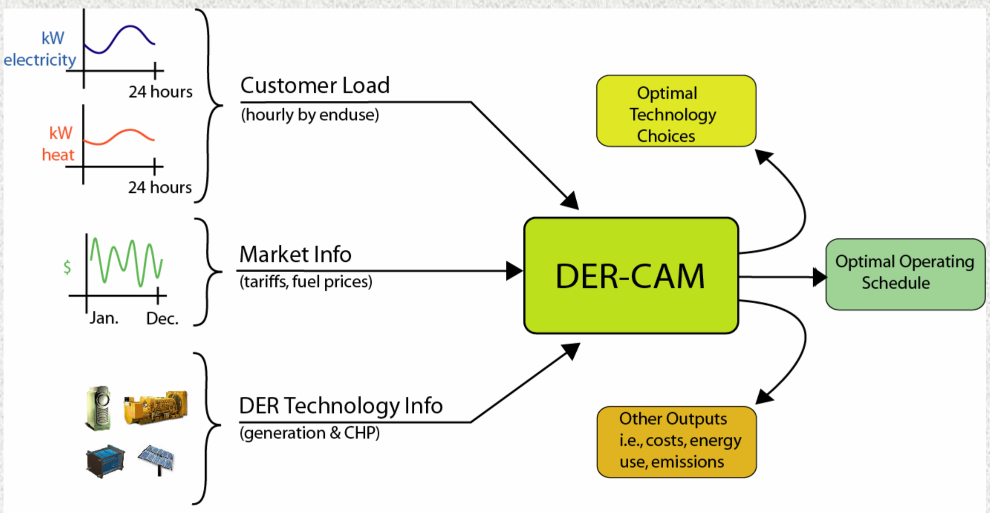
Distributed Energy Resources Customer Adoption Model (DER-CAM)

DER-CAM….

- has been developed at Berkeley Lab to evaluate the DER potential at individual sites, and to address policy questions involving the attractiveness of on-site power generation.
- takes a whole energy system approach and finds the cost minimizing option for meeting a site's energy requirements.
- finds the true global optimum solution over a test year.



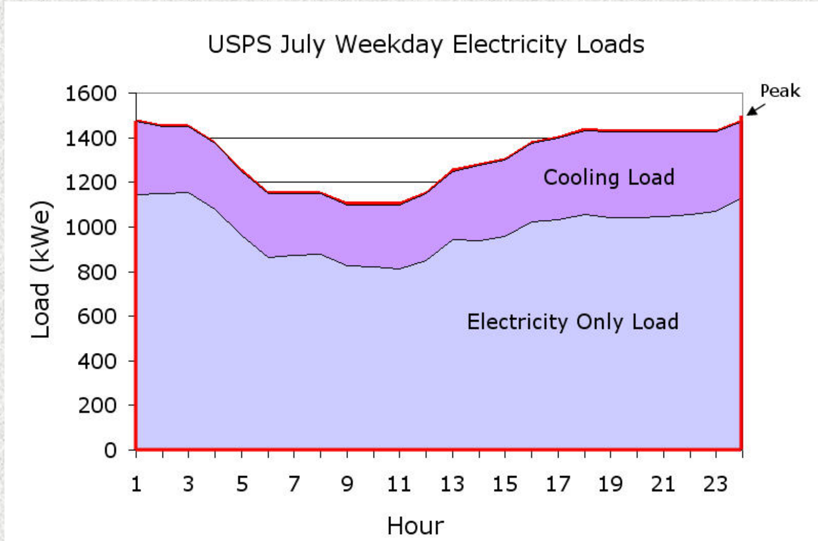
DER-CAM finds the cost minimizing equipment choice and operating schedule to meet the end use requirements on the right, given the prices of input fuels on the left.



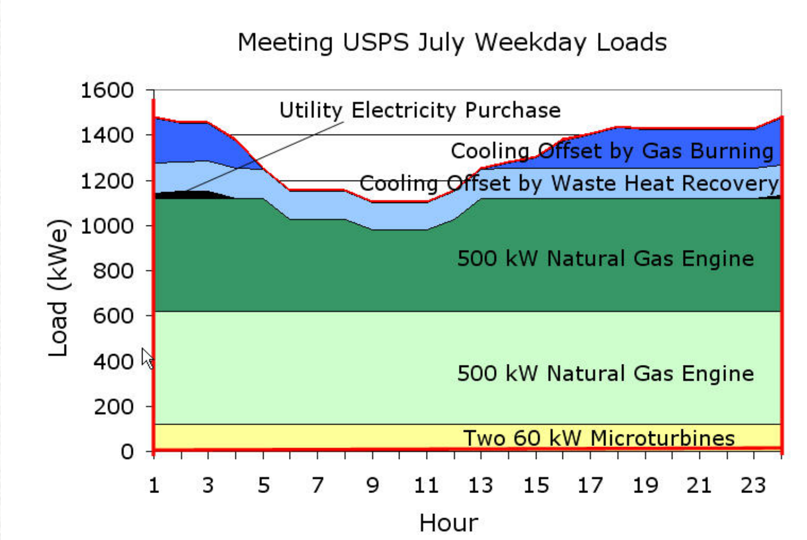
The inputs to DER-CAM describe the economic environment and the characteristics of equipment alternatives available for installation at a site. The outputs show the optimal system to install, an ideal operating schedule, and other results.

A DER-CAM Case Study: U.S.P.S. San Bernardino Facility

- The U.S. Postal Service operates many processing centers like its (32,000 m^2) San Bernardino facility.
- The climate is hot (average 40°C summer max) and frosts are rare.



Sorting equipment and cooling drive the annual electricity bill beyond a quarter million U.S. dollars, but natural gas use is minimal. Peak electricity use, 1500 kW, occurs at midnight when mail sorting is most active.



DER-CAM chooses two 500 kW gas engines and two 60 kW microturbines all with heat recovery for absorption cooling. Absorption cooling reduces the peak electricity load to 1150 kW, and residual electricity purchases are minimal.

Lessons Learned:

- reciprocating engines are the strongly incumbent technology
- mixed technology systems are sometimes economically attractive
- DER economics are driven more by electricity prices than fuel prices
- optimal systems are larger than ones typically built today
- systems tend to be sized to meet electricity and not heat loads
- in warm climates, cooling loads can justify CHP systems
- PV becomes economic with high subsidies and flat tariffs
- demand charges encourage bigger systems

Berkeley Lab

der.lbl.gov

Chris Marnay
C_Marnay@lbl.gov
Tel: +1.510.486.7028

Using DER-CAM to Assess the Economic Competitiveness of Microturbines

??? What $/kW subsidy on microturbines makes them economically competitive with natural gas internal combustion engines (ICEs)???

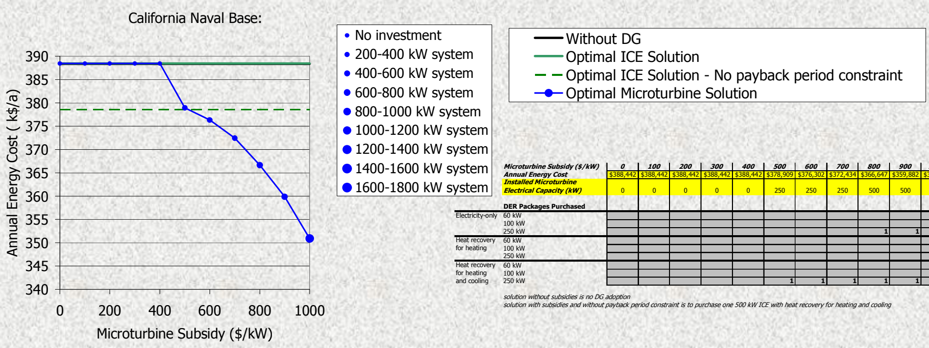
Assumptions

•ICEs require selective catalytic reduction (SCR) to reduce NOx emissions, which adds 20% to the capital cost and $0.008/kWh to the variable O&M costs of ICEs.
•Microturbines do not require exhaust after-treatment, but are constrained to run at 90% or higher of capacity to maintain low NOx rates.
•Microturbines and ICEs are both 98% reliable
•ICEs have a 20 year lifetime and microturbines have a 10 year lifetime.
•Unreliability affects only costs for the expected value of the demand charge.
•A 6 year simple payback period constraint is imposed.
•5% interest rate
•Electricity and natural gas tariff prices are from 2003.

Economic Details Of Packages

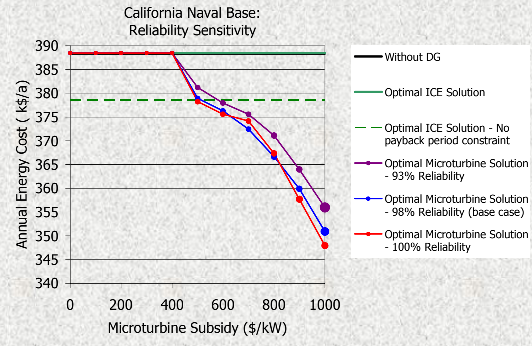
	Turnkey Capital Costs ($/kW)				
		CHP			
	Electricity Only	*Heating*	*Heating and Cooling*	*Lifetime (years)*	*O&M Cost ($/kWh)*
Internal Combustion Engines (with SCR)					
60 kW	1190	1560	2146	20	0.026
100 kW	1143	1494	1998	20	0.025
250 kW	1028	1330	1747	20	0.023
500 kW	996	1283	1571	20	0.021
Microturbines					
60 kW	1828	2125	2494	10	0.011
100 kW	1547	1828	2134	10	0.011
250 kW	1043	1295	1504	10	0.011

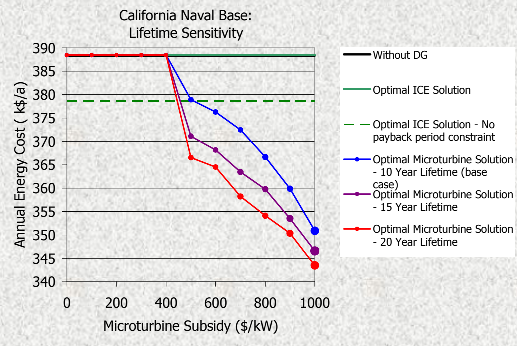
Naval Base Commissary: Port Hueneme, California
•13,000 m^2 of floor space
•contains a large retail store, supermarket, food court, and other small businesses
•peak electricity load (including cooling): 1050 kW
•electricity service:
  •*supply*: legacy direct access contract
  •*delivery*: SCE tariff TOU-8 Direct Access
•natural gas service:
  •*supply*: military direct access
  •*delivery*: SoCalGas transportation rate



Microturbine Subsidy ($/kW)		*0*	*100*	*200*	*300*	*400*	*500*	*600*	*700*	*800*	*900*	*1000*
Annual Energy Cost		$388,442	$388,442	$388,442	$388,442	$388,442	$378,909	$376,302	$372,434	$366,647	$359,882	$350,903
Installed Microturbine Electrical Capacity (kW)		0	0	0	0	0	250	250	250	500	500	1000
DER Packages Purchased												
Electricity-only	60 kW											
	100 kW											
	250 kW									1	1	3
Heat recovery for heating	60 kW											
	100 kW											
	250 kW											
Heat recovery for heating and cooling	60 kW											
	100 kW											
	250 kW						1	1	1	1	1	1

solution without subsidies is no DG adoption
solution with subsidies and without payback period constraint is to purchase one 500 kW ICE with heat recovery for heating and cooling



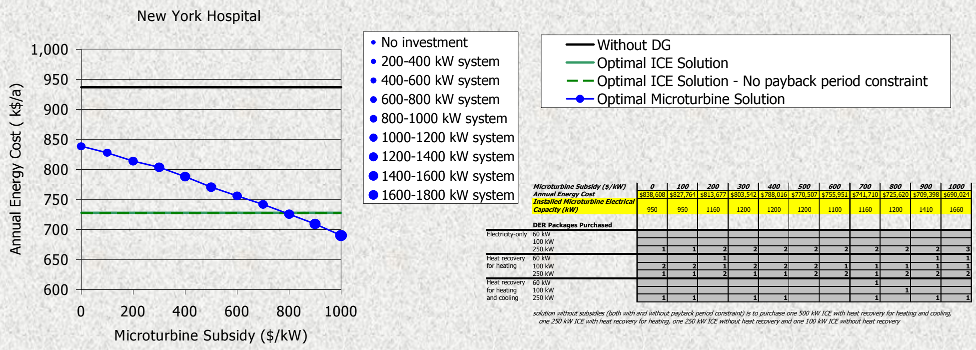


Scenario 1: MT and ICE reliability: 98%, 10 year MT lifetime, 20 year ICE lifetime

Scenario 2: MT reliability: 93%, 98%, and 100%

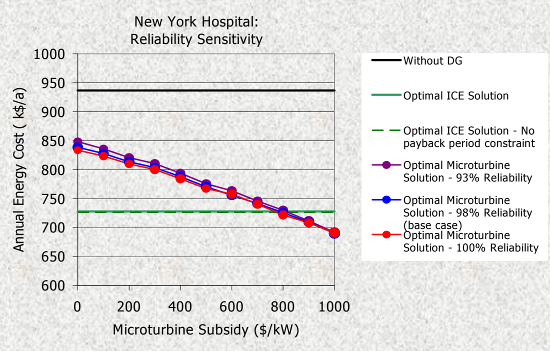
Scenario 3: MT lifetime: 10, 15, and 20 years

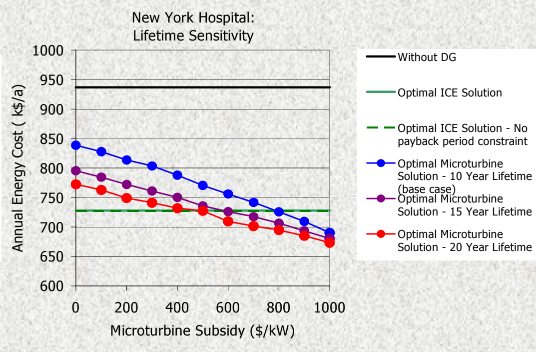
Hospital: New York City, New York
•prototypical small (90 beds) hospital loads based on Wyoming County Community Hospital in Warsaw, New York
  •peak electric load (including cooling): 1200 kW
  •heat loads comparable with electric loads year round
•*electricity*: ConEd tariff SC-9 (General-Large), Rate 3 (Time-of-day, optional)
•*natural gas*: ConEd tariff Rate 2 (General Firm Services) and Rider H, Rate 1 (distributed generation rate)
•60% minimum DER system efficiency to avoid standby charges



Microturbine Subsidy ($/kW)		*0*	*100*	*200*	*300*	*400*	*500*	*600*	*700*	*800*	*900*	*1000*
Annual Energy Cost		$838,608	$827,764	$813,677	$803,542	$788,016	$770,507	$755,951	$741,710	$725,620	$709,398	$690,024
Installed Microturbine Electrical Capacity (kW)		950	950	1160	1200	1200	1200	1100	1160	1200	1410	1660
DER Packages Purchased												
Electricity-only	60 kW											
	100 kW											
	250 kW	1	1	2	2	2	2	2	2	2	2	3
Heat recovery for heating	60 kW			1							1	1
	100 kW	2	2	1	2	2	2	1	1	1	1	1
	250 kW	1	1	2	1	1	2	2	1	2	2	2
Heat recovery for heating and cooling	60 kW								1			
	100 kW									1		
	250 kW	1	1		1	1			1		1	1

solution without subsidies (both with and without payback period constraint) is to purchase one 500 kW ICE with heat recovery for heating and cooling, one 250 kW ICE with heat recovery for heating, one 250 kW ICE without heat recovery and one 100 kW ICE without heat recovery





Scenario 1: MT and ICE reliability: 98%, 10 year MT lifetime, 20 year ICE lifetime

Scenario 2: MT reliability: 93%, 98%, and 100%

Scenario 3: MT lifetime: 10, 15, and 20 years

Key Findings:

******* For microturbines to start being economically competitive with ICEs under low NOx emissions regulations, microturbine costs must be ******* reduced by $500/kW for the California naval base and $800/kW for the New York City hospital.

•Microturbines with lower reliability (93%) only increase annual energy costs by about 0.5%-1.5% compared to microturbines with higher reliability (98%). Perfectly reliable (100%) microturbines would lower costs less than 1% (considering demand charge effect only).
•Microturbines with a 50% higher lifetime (15 years) than the assumed current 10 year lifetime microturbines can reduce annual energy costs from 1% to 5%. A 20 year lifetime can reduce costs by up to 8%.
•Systems with double-effect chillers do not provide significantly lower cost solutions than single-effect chiller systems.

Cost reductions can be realized through economies of scale in production, streamlined installation, and packaged systems.