Electric Reliability for Critical Infrastructure

Clean Air through Energy Efficiency Conference
CHP Workshop Agenda

Monday, December 15, 2008
Dallas, TX

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Significant Costs Are Associated With Electric Power Outages After Natural Disasters

- Hurricane Katrina was a “worst-case” scenario
  - Health systems
  - Public safety
  - Command and control
  - Shelter
- Hurricane Ike visited less severe but more widespread damage on Texas

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Traditional Emergency Generators Provide Limited Post-Disaster Support

- Designed for short-term (hours/days) outages
- Limited capacity and functionality
- Questionable reliability

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Risk Management Analysis of Traditional Backup Generation Supports the Stats Quo

- The probability of future disasters within the near term is too small to justify additional investment in traditional emergency generation
- No disaster = no benefits

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Combined Heat and Power (CHP) Technologies Change Emergency Power Risk Management Analysis

- CHP systems can provide financial benefits even in the absence of disaster situations
  - » Onsite electric production may cost more than purchased power; however, “free” onsite waste heat reduces natural gas costs
    - – Space heating, domestic water heating, air conditioning, desiccant dehumidification, air conditioning , process uses, laundry,etc.
- Appropriately designed CHP systems pay for themselves over time

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In Addition to Onsite Electric Generation, CHP Systems Can Provide Thermal Energy for Both Heating and Air Conditioning

United Technologies Packages 4-6 60 Kw Microturbines With Double-effect Absorption Chiller/Heaters

ISO (59 °F) Cooling Mode Performance of our Trigeneration Systems

PureComfort™ Solution	Number of Microturbines	Net Electric Power (kW_e)	Cooling Power (kW_c)	Supplemental Heating Power (kW_t)	Fuel Utilization (%)
240	4	227	500	70	91%
300	5	284	602	105	91%
360	6	341	696	100	86%

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Texas A&M Study Question: Can CHP Economic Benefits Pay For Expanding Critical Infrastructure Electric Reliability?

- CHP System economics
  - » Cost
    - – Equipment and installation
    - – Operating and maintenance
    - – Natural gas costs
  - » Benefits
    - – Avoided electricity costs ($/kWh, $/kW)
    - – Avoided natural gas costs
- CHP economics varies by facility
  - » Hourly electricity use profiles
  - » Hourly thermal energy profiles for appropriate end uses

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Analysis of Hurricane-Related Disasters

1. Identify critical service facility requirements

2. Determine hourly electric and thermal energy use characteristics for each facility type

3. Size CHP electric and thermal components as a function of hourly loads and energy prices in each facility at each location

4. Evaluate economic costs and benefits of providing emergency electric service for all critical services at each location

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Houston Critical Service Facilities

- Facilities
  - » Office (public safety, command and control), hospital, nursing home, schools (shelter)
  - » Capacity assumptions: 50% hospital beds, 75% nursing home beds, shelter for 5 % of population
  - » General facility characteristics developed from US DOE Commercial Buildings Energy Consumption Survey data

- MAISY Utility Customer Database Provided Facility Data

Building Type	Number of Buildings
Disaster Mgmnt/Pub Safety	5
Hospital	3
Nursing Homes	24
Shelter (schools)	82

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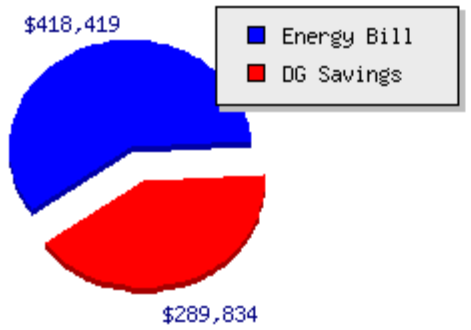
Study Conducted Financial Analysis of Individual Critical Services Buildings in Houston

DG Energy Bill Savings and New Energy Bill With DG System



Summary of Annual Energy Use and Bill Savings
Bill Savings: $289,834 Payback: 1.57 Years

	Before DG	After DG	Savings
1. kWh Use	3,373,854	1,244,933	2,128,922
2. Peak kW	992	488	504
3. Electric Bills	$675,443	$274,208	$401,235
4. Natural Gas/Oil Use (Mill Btu)	4,451	21,619	-17,168
5. Natural Gas/Oil Bills	$32,810	$144,211	$-111,400
Energy Bill and Savings With DG System (Add items 3 and 5)		$418,419	$289,834

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Results: Financial Analysis of CHP Investment to Ensure Electric Reliability for Houston Area Critical Services

Annual kWh Use Before CHP	224,221,813
Savings - kWh	138,990,827
System size (kW)	21,420
Annual Operating Benefits	
Avoided kWh Costs ($)	15,172,132
Avoided Natural Gas Costs ($)	2,994,891
Annual Operating Costs	
Generator Fuel Costs ($)	13,338,250
O&M Costs ($)	1,654,980
Total Net Annual Operating Benefits	3,173,793
System Installation Cost	19,843,323
Simple Payback (years)	**6.3**
Annualized Benefit/Cost Analysis	
Annual Energy Cost Savings	$3,173,793
Annual Amortized Equip Cost	$2,679,612
Annual Net Savings	**$494,181**
Marginal energy prices	
Electricity ($/kWh)	0.109
Natural gas ($/MMBtu)	10.00

- Installation of the 114 CHP systems would save the Houston area $494,181 per year (even after making annual amortized equipment costs)
- A CHP infrastructure development program will save money AND provide electric reliability for critical services

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Conclusions

- CHP should be viewed as a new way to provide emergency power to serve critical infrastructure needs
  - » Communications, public safety, health care, shelter, food storage/prepartion, etc.
- Economics of providing emergency power with CHP is different than with traditional backup generation
  - » CHP provides financial benefits even in absence of disasters
- Texas A&M study of Houston area shows that CHP installations can provide critical service electric reliability AND save money
  - » Cost savings are equivalent to tax revenue increases for municipalities, counties and the state

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