



GULF COAST  
**CHP**  
APPLICATION  
CENTER

# ***Resiliency to Hurricanes Through CHP: Fact or Fiction***

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Houston Advanced Research Center

IETC: May 11, 2006



***Moving knowledge to action  
to improve human well-being  
and the environment***



# Houston Advanced Research Center

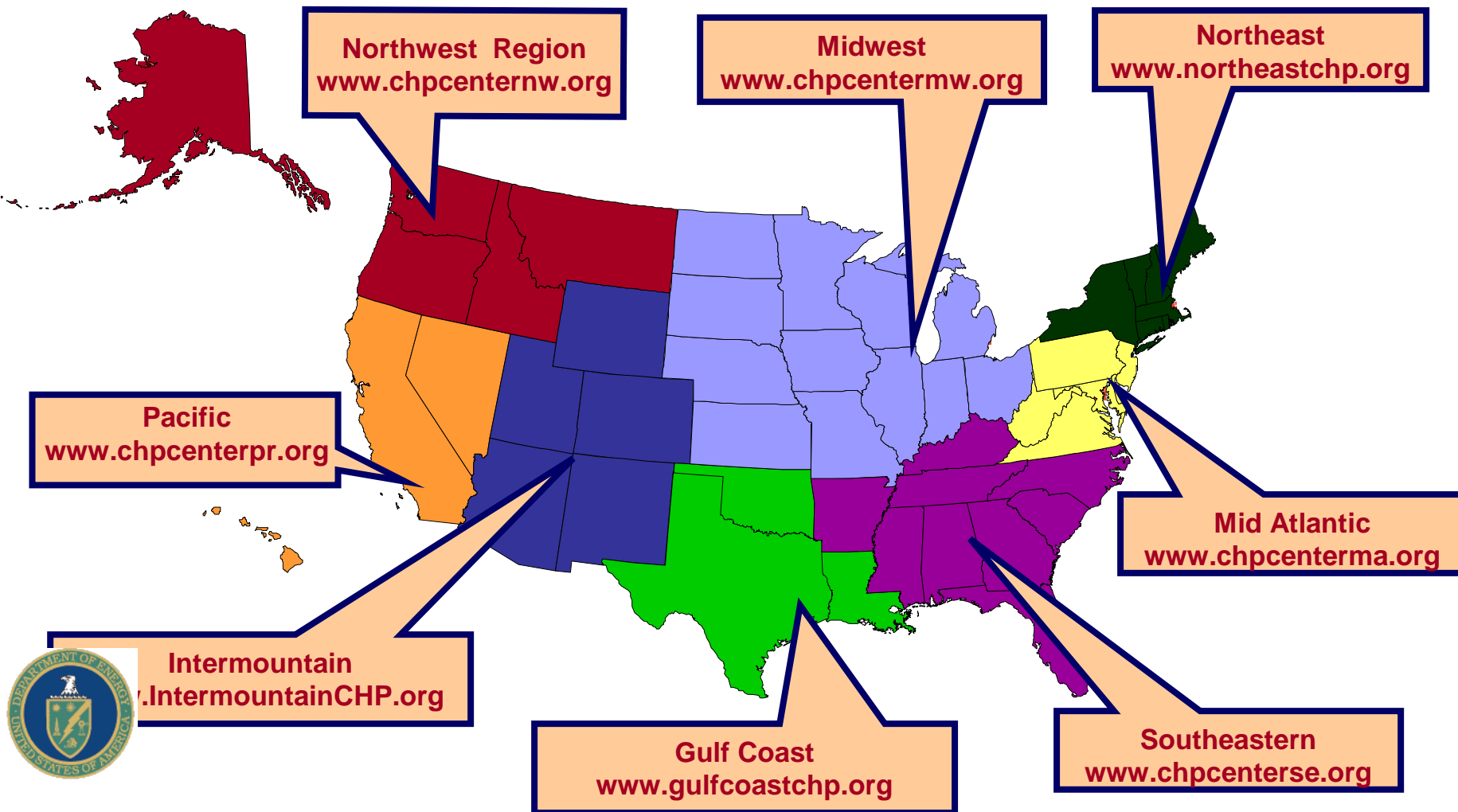


- Established 1982
- Non-profit scientific research institute
- Sustainable development mission
  - Environmental technology commercialization
  - Research Management
  - Air Quality focus
- Located in the Woodlands, TX
- Website: [www.harc.edu](http://www.harc.edu)



# Regional Application Centers

The regional application centers will promote combined heating and power (CHP) technology and practices, serve as a central repository and clearinghouse of CHP information, and identify and help implement regional CHP projects.



# What is Combined Heat and Power?



CHP is . . .

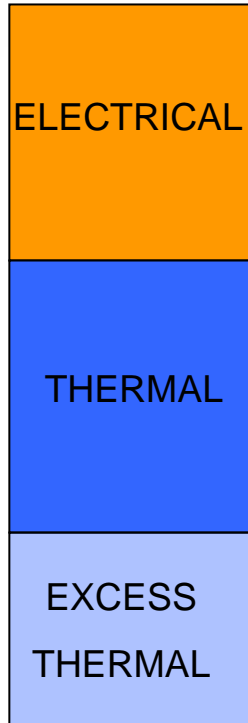
- An integrated system
- Located at or near a building or facility
- Provides at least a portion of the electrical load and
- Utilizes the thermal energy for
  - Cooling
  - Dehumidification
  - Water and space heat
  - Process heat



# CHP System Design Options

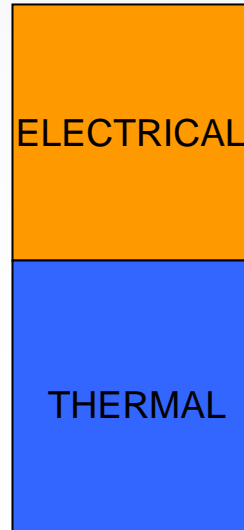


HIGHEST  
RELIABILITY  
OPTION



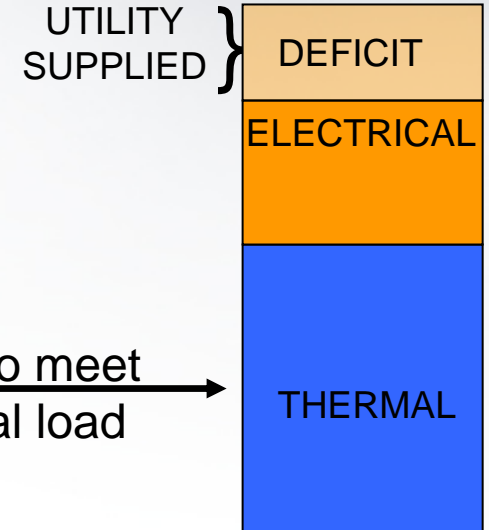
Sized to meet  
electrical load

FACILITY  
DEMAND



Sized to meet  
thermal load

HIGHEST  
EFFICIENCY  
OPTION



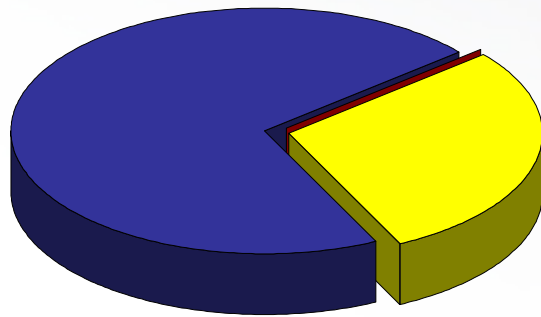
EXPORT  
or  
WASTE

# Synonyms

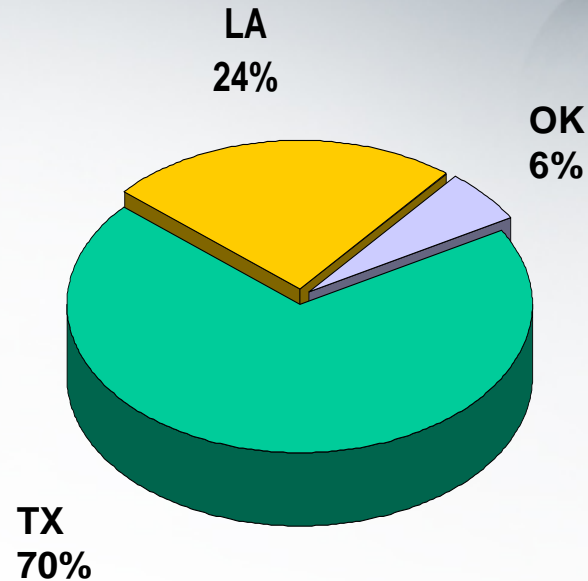
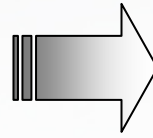


- Combined Heat and Power (CHP)
- Cogeneration
- Cooling, Heating, and Power (CHP)
- Trigeneration
- Integrated Energy Systems
- Building Cooling, Heating, and Power (BCHP)
- Recycled Energy

# One-quarter of U.S. CHP Capacity is in Texas & Louisiana



U.S. = 80,905 MW  
2,845 sites



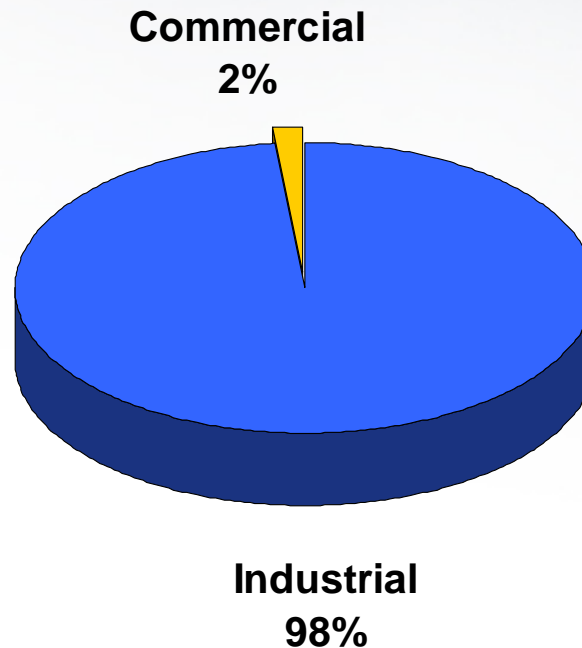
Gulf Coast = 23,365 MW  
213 sites

Source: EEA, Inc.

# Industrials Represent 98% of Existing CHP in the Region



- *Existing CHP Capacity (2004): 23,365 MW*



Source: EEA, Inc.

# CHP Market Potential: 49% Is Below 5 MW in Size



Gulf Coast Region	CHP Potential, MW			
	< 1MW	1-5 MW	5-20 MW	>20 MW
Commercial	3,738	2,619	1,831	544
Industrial	<u>1,099</u>	<u>2,184</u>	<u>3,158</u>	<u>4,631</u>
	4,837	4,803	4,989	5,175

Source: EEA, Inc.

**Gulf Coast CHP Applications Center initial focus is 1-10 MW projects.**

# CHP Candidates



- Hotels
- Prisons
- Airports
- Hospitals
- Universities
- Grocery Stores
- Wastewater Treatment
- Refrigerated Warehouses
- Emergency Management Facilities
- Homeland Security & Sanctuary Locations
- Industrials (Refineries, Chemical plants, Manufacturers)



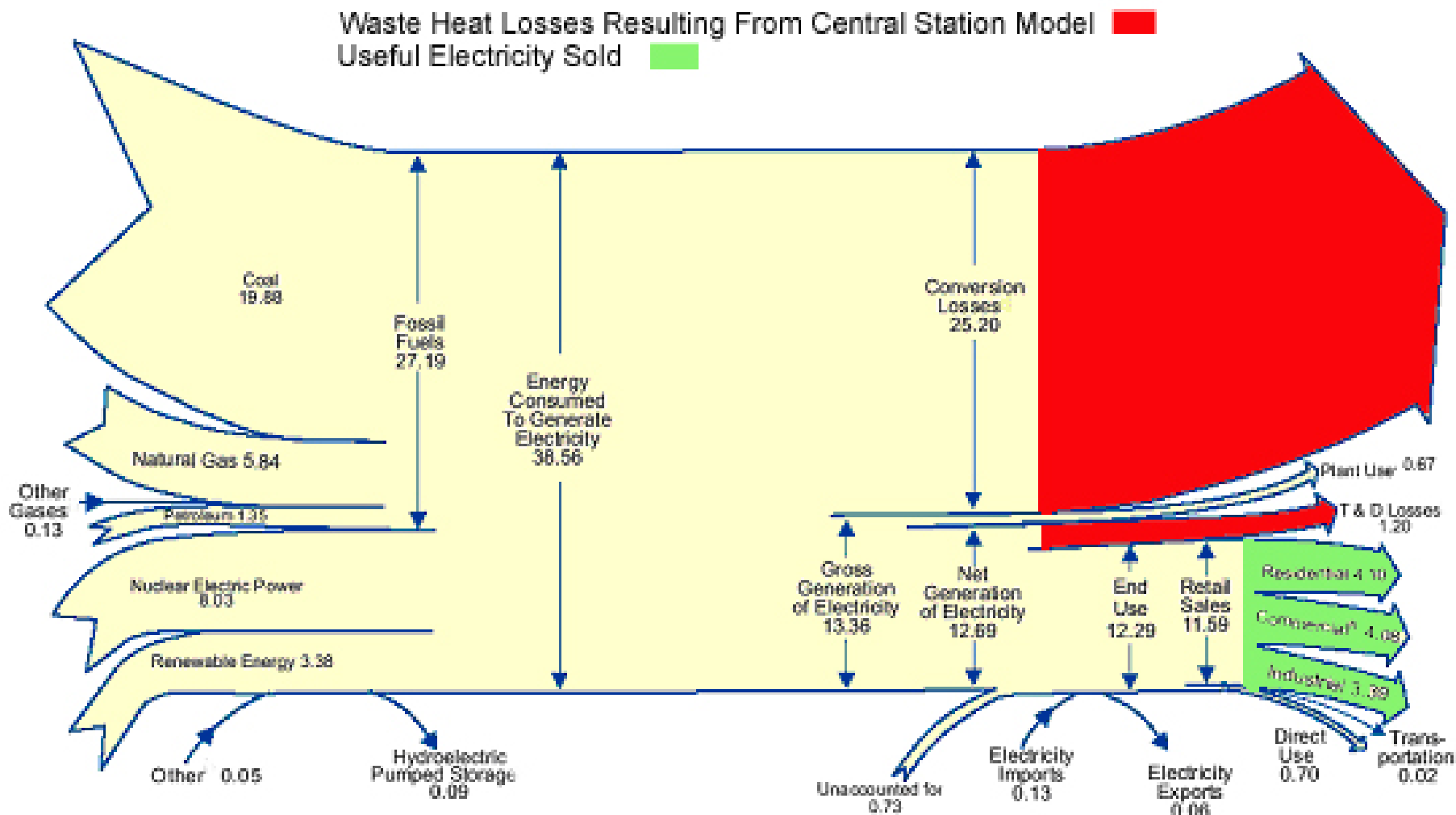
# Why CHP?



# Cost and Environmental Implications



Diagram 5. Electricity Flow, 2001  
(Quadrillion Btu)



Source: Energy Information Agency (EIA)

**After Hurricanes Katrina and Rita:**

**Think business continuity!**





09/25/2005

# Entergy Texas and Rita



- 1.5 million outages, days of rolling blackouts
- Portion of western section connected to ERCOT
- T&D Infrastructure Replacements
  - 981 wood transmission structures
  - 26 steel lattice transmission structures
  - 8970 wood distribution poles
  - 8040 distribution transformers
- 18,000 non-Entergy workers helped out
- Assets lost = \$380M (\$1.5B including Katrina)

# Utility Power is Unreliable



- Electricity Outages
  - Katrina: 2.75 million customers without electricity in LA, MS, AL, and FL (62% of LA without power)
  - Rita: 1.5 million customers without electricity
- Over 1 million customers were still without power after 14 days.
- Electricity restored to refineries within 7-10 days
- Rolling blackout in ERCOT (April 17<sup>th</sup>)

# What's the Solution?



# Backup Generators?



- Not so great for long duration outages
  - Not in working order when needed
  - Didn't hold up throughout the entire outage
  - Quickly exhausted on-site fuel supplies
  - Limited ability to resupply fuel tanks
  - Systems undersized
  - Limited spare parts inventory
  - Remotely located could not be delivered quickly or at all
  - Poor return on investment

# Hurricanes Katrina and Rita: A Tale of Two Hospitals



# Memorial Hermann Baptist Hospital Beaumont, TX



## Hurricane Rita

- **closed the hospital for one week**
- **caused over \$30M in costs and damages**

- In the days before landfall, the hospital was closed and patients were pre-evacuated to other facilities.
- Hurricane Rita made landfall near Beaumont-Port Arthur on Friday, September 23, 2005
- Back up generators started, but could neither power the chillers nor maintain power due to length of outage.
- As a result, the hospital was unable to provide services during the storm and could not reopen for about one week.
- The Hospital secured 22 natural gas engines staged in Houston. Full power restored by Sept. 30, 2005, although repairs took 3 months.
- The Hospital incurred over \$30M in hurricane costs and damages, primarily related to loss of HVAC. Humidity infiltration resulted in extensive damage to floors, ceiling tiles, medical supplies, and equipment.

# Mississippi Baptist Medical Center Jackson, MS



August 29, 2005  
Hurricane Katrina  
Hits Jackson, MS



- Connection to MPG Restored
- Load Shed performed (1.2 MW disconnected)
- Pumping Trucks Supply Water to Physical Plant

3 hr


- Connection to  
MPG Restored

57 hr

1 hr

- Main Power Grid (MPG) Failed
- Alternate Power Grid Enabled
- City Water Lost

5 hr

- 
- 52 hrs of 100% operation on CHP
  - Only Hospital in the Jackson Metro Area to be Nearly 100% Operational!!

- Power Reliability Problems
- Switched to CHP Operation Only
- Elevators on Emergency Generators
- Restricted use of MRI Equipment

# Value of On-site Generation (CHP)



## Mississippi Baptist Medical Center

- remained open and treated a high volume of patients
- provided clothing, food, and housing for displaced patients during the first night of the disaster
- received patients from other medical facilities not able to remain open

## Memorial Hermann Baptist Hospital

- provided no medical services during or immediately after the storm
- remained closed for seven days due to lack of power and water
- lost operating revenues and suffered damages of over \$30M primarily from humidity infiltration

# Tulane University CHP Plant



- Campus has a 9 MW electrical load
- 5 MW gas turbine provided “islanded” power and cooling to critical campus facilities throughout Katrina
- Cooling towers damaged, but remained operational
- Switched to well water
- 2000 ton chiller cannot be restarted if tripped
- Natural gas pressure available, but turbine switched to diesel (3.5 day supply) due to compressor problem
- Rising water forced system off as some switchgear went underwater in the days after levees were breached.
- University staff looking to add capacity and flood protection

# Outcomes



- Public relations coup for those facilities that operated during or immediately after the storms
- Spike in gasoline prices rewarded those refineries able to get back on line quickly
- Some organizations with CHP facilities fared much better than those that did not.

# Chertoff – Bodman Letter



- April 26, 2006

A letter to all US refiners demanded better electricity backup solutions throughout the gasoline supply chain.



April 26, 2006



Mr. William Klesse  
Chief Executive Officer  
Valero Energy Corporation  
One Valero Way  
San Antonio, Texas 78249-1112

Dear Mr. Klesse:

We are writing to you because your company has a vital role to play in preparing for the upcoming hurricane season by ensuring that your retailers have emergency power needed to operate their fuel pumps during periods of power outage.

When a storm strikes, access to fuel is critical -- for the first responders, for businesses, and for residents struggling to recover from the disaster. The best way to get fuel is to rely on the existing retailers and wholesalers, who often have substantial supplies on hand barring any supply distribution problems.

Last year's experience with Hurricanes Katrina, Rita and Wilma proved it is essential that fuel retailers be able to continue business operations seamlessly following disasters that might cause widespread and sustained power outages. Many stations had an adequate supply of fuel; too few had taken basic precautions to begin pumping that fuel after the entirely predictable loss of electricity that accompanied the storms. These businesses had

2

These are socially responsible actions and deserve praise. We hope that your company is among those who have acted. If not, we strongly urge that you take such measures immediately. We hope that we can count on you, your company, and your retail partners to take these important steps to increase significantly the reliability of our fuel supply.

With your help, first responders and citizens will not face the deep frustration and potential tragedy of finding that your terminals and retailers have plenty of fuel but no way to provide it when needed most.

Sincerely,

Michael Chertoff  
Secretary of Homeland Security

Samuel W. Bodman  
Secretary of Energy

# Is CHP Your Hurricane Solution?

MAYBE



# Emergency Planning Guidelines



- Hurricane Impacts – what are you going to encounter
  - Facility, community, infrastructure
- Facility Needs – what are you trying to accomplish
  - Electricity, steam, cooling, reliability
- CHP Factors – what do you want a CHP plant to provide?
  - Critical needs, full operation, motor starting, etc.

# Hurricane Problems



- Wind damage, storm surge, and flooding:
  - Power Grid: Down up to 2-3 weeks
  - Transportation: Roads, rail, air, shipping impacted
  - Labor: Limited labor supplies **regionally**
  - Water: Lack of potable water or municipal water pressure
  - Fuel: Supplies could be difficult to access or expensive
  - Damage: Wind and flood damage to plant and facilities
- All of these issues **MUST** be addressed for CHP to be successful

# What Did Memorial Hermann Hospital Need?



- Financial damages due to:
  - Humidity infiltration and inventory losses (not wind!)
  - Hospital shut down one week (lost revenues)
  - Cost of emergency operations (22 gensets)
- The Hospital needed:
  - Air conditioning: Chillers >> power (or heat), make up water, cooling towers, ability to start to motor
  - Lights and equipment: Power
  - Patient Care: Potable Water
- Without all of these needs addressed >> same outcome

# CHP System Factors



- Ability to operate CHP in “island mode” is HUGE, but you still need to address:
  - “Black Start” capability, motor starting, location, etc.
  - Loss of water pressure or fouled water supplies
  - Cooling tower integrity
  - Spare parts inventory
  - Fuel supplies: Natural gas, dual fuel capability
  - Cogen Size: Too large (can’t export or turn down effectively) or too small (can’t operate enough critical facilities without utility power)
- Don’t let unrelated systems render CHP useless!

# Lessons Learned



- Central station utility model is inherently unreliable in a hurricane zone
- CHP can deliver **BUSINESS CONTINUITY** in the face of hurricanes, provided you holistically address:
  - How facility, infrastructure, and community damages will impact your ability to operate the CHP plant
  - You must understand your operation's needs
  - What CHP configuration will best meet facility needs
- Don't rely on:
  - remotely staged materials and inventory
  - regional offices & vendors for critical needs
  - state and federal government bailouts

# For more information:



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