STATE OF CONNECTICUT
GOVERNOR DANNEL P. MALLOY

The Two Storm Panel
Special Meeting Minutes
Wednesday, December 7, 2011
Room 2C, Legislative Office Building – 9:30 a.m.

Members Present: (Co-Chair) Joe McGee, (Co-Chair) Major General James Skiff, Peter Carozza, Terry Edelstein, Lee Hoffman, Scott Jackson, Robert McGrath and Cathy Osten (joined meeting at 9:50 a.m.).

Members Absent: None

1. **Call to Order:** Major General James Skiff called the meeting to order at 9:36 a.m.

2. **Telephone Conference with Erik S. Sonju, P.E., VP Power Delivery Planning & Design, Power Systems Engineering, Madison ,Wisconsin; and**
   Steve Fenrick, Leader, Benchmarking and Economic Studies, Power Systems Engineering:
   - Measuring Electric Power Reliability
   - Causes of Extreme Outages
   - Mitigation Measures for Major Event Outages and Restoration
   - Benchmarking
   - Value Base Planning
   - Self Incentives and External Incentives

   Erik S. Sonju and Steve Fenrick gave their presentation to the Panel (see attachment A).

   (Cathy Osten arrived as voting member at 9:50 a.m.)

   Joe McGee said that on this issue of minimum standards, he noted that Erik S. Sonju had worked on a project in New Hampshire. He asked whether New Hampshire upgraded their standard of wire.

   Erik S. Sonju said that the New Hampshire Electric Cooperative have mainly gone to what is called spacer cable. They have done this because of the tree issues and he noted that spacer cable has increased their reliability.

   Erik S. Sonju continued to give his presentation to the Panel.

   Joe McGee asked where most states fit on the curve of the five areas of regulatory approaches to reliability as shown on slide 15.

Steve Fenrick said that we could almost break it into thirds; 1/3 fits into monitoring, which is where CT is; 1/3 sets the targets; and 1/3 have a reward/penalty system in place.

Joe McGee asked to look at the target setting/benchmark goal, and noted that the standards are good and weather standards and storm standards are put aside as separate. He asked whether these states benchmark performance during major storms.

Steve Fenrick said that it is typically normalized; during major event days there will be an investigation of the procedures that were followed. The targets are on the normalized value and not on the major event day due to the diversity of the intensity that utilities must deal with; it makes it difficult for the utility to set a target.

Joe McGee asked how we judge the utility's performance. If there is no benchmark and everything is unique he asked where we go.

Steve Fenrick suggested that we look at the practices to see if the utility acted reasonably and look at other utilities in the area to see how they performed in the same type of circumstances. Also, look at other events that have happened across the country or historically and look at the various intensities and compare that to the utility's performance.

Steve Fenrick continued to give his presentation the Panel.

Joe McGee discussed minimum engineering standards. He noted that we're looking at the state's preparedness for severe weather. He asked if the minimum national standard is a prudent standard for CT as an engineering standard.

Erik S. Sonju said that the code also has to look at extreme wind conditions. Much of the extreme wind standards are for structures of a certain height. The shorter lines don't typically fall under that rule and they go back to the minimum standard. He said the national code gets updated about every five years. He said that a state will start with adopting a national safety code, but it might have additional provisions beyond that, but he hasn't seen a state that has said that the new construction needs to meet extreme wind condition standards in addition to the ice standards.

Joe McGee noted that we have had information that 46% of the infrastructure is past its lifetime. He noted he wasn't sure what to make of this number. He asked what the experience is with the age of infrastructure.

Erik S. Sonju said that this percentage is not uncommon with the rest of the industry. He noted that there is a lot of old infrastructure out there; and if old infrastructure is not addressed, inspected and maintained properly, then there will be reliability issues. He noted that where systems are old and they are getting older, and the rate to change out the existing facility would be a considerable amount of construction. He also noted that vegetation management is also a critical component. The 46% is not unique to CT and is something that deserves some serious consideration from an engineering standard.

Joe McGee asked if there is a correlation between an aging system and storm damage. He asked if an aging infrastructure is more vulnerable to the storm events CT experienced.

Erik S. Sonju said it is not necessarily how old the facilities are and that it depends on how the facility was built. Lines that are built in today's setting are much stronger than they were 50 years ago. They may be reliable in a normalized situation, but in an extreme weather event, a 50 year old line is going to be more susceptible to issues than a newer line.

Joe McGee noted that CT needs to analyze the existing infrastructure to see how it was built and to review the code under which it was built.

Erik S. Sonju said that this is one approach. It is also important to look at the condition of the facilities and look at the right-away including vegetation management is important.

Joe McGee noted that four states had implemented a performance compensation system. He asked which states took this approach.

Steve Fenrick said that Massachusetts is one that will have a reward and a penalty system and will have established benchmark targets to hit.

Joe McGee asked Steve Fenrick to send that information to us in regards to the other states.

Joe McGee asked if there are states that hold executives accountable for the poor performance or compensate them for superior performance.

Steve Fenrick said there were not any states that he is aware of that hold executives accountable for poor performance or reward them for superior performance; this is generally left to the shareholders.

Scott Jackson asked Steve Fenrick if he could further discuss the value base planning model. He asked what factors are identified as being critical and he asked about the decision making pertaining to that model.

Steve Fenrick said there are a couple of areas. One is the cost side where the following is considered: where are all of the outages occurring; is it focused on the aging of the infrastructure; and what types of investments can be made to address those issues to increase reliability. The other side is the benefit side. For example if you undertake project A, consider the following: the estimated reliability benefit; how many outages could be avoided; and the value of that to consumers. This information may be obtained by surveying residential and business customers to see how much they would value that improvement of reliability. Then consider the estimated cost and the benefits and balance that out and see if the benefits outweigh the cost.

Joe McGee said that in terms of low hanging wires, is the spacer cable an obvious choice.

Erik S. Sonju said that in a heavily treed area, where vegetation maintenance is difficult, he would say that the spacer cable or underground should be considered.

Joe McGee said that the underground lines are very expensive and spacer cable must be less costly. He also asked the cost of spacer cable.

Erik S. Sonju agreed the spacer cable will cost less than the underground solution, but he is unable to provide a figure due to the various factors that must be considered.

Major General James Skiff noted that in the response area, CT had a problem with coordination in clearing routes of access for emergency vehicles. He asked whether they look at this in their assessment to see how utilities respond.

There were technical difficulties with the phone system and the presentation ended.

3. **The University of Connecticut's Experience with Distributive Generation and the Undergrounding of Utilities:** Lee S. Langston, Professor Emeritus, Dept. of Mechanical Engineering

Lee S. Langston gave his presentation to the Panel (see attachment B).

Joe McGee asked about the issue of cost in 2005 and he asked what the costs are today.

Lee S. Langston said he was not sure as a faculty member, he doesn't know about the contracts negotiated. He noted that in his handout, the savings claimed after paying off the $80 million, the projected savings are $100-200 million in the life of the plant. He said that he knows that they are burning much less high grade fuel compared to what they would if they were doing the two things separately. He also said that in terms of maintenance and reliability, they are changing out the gas turbines now, they run about 5 years. He said they only shut down for 2 weeks when they do maintenance on the facilities. They are tied in to CL&P so if something goes wrong they can switch over to external power.

Joe McGee asked if there has been any reliability issues with the utilities all being in the same tunnel.

Lee S. Langston said no, none of which he is aware.

Major General James Skiff asked about the replacement of the three turbines and their life cycles.

Lee S. Langston said that they change them out at the same time. He noted that the turbines will cycle through and when they first started the plant, the average peak load was as high 22 megawatts, but through conservation the average high load is 18-19 megawatts. He noted that during the night they might take down one of the turbines and they have a schedule on which one to do. He said that the three turbines may not be as sufficient as a Pratt and Whitney bigger engine, but there wouldn't be the flexibility.

Major General James Skiff asked whether they use actual aircraft engines anymore.

Lee S. Langston said that no, a turbine does not come off an aircraft after it has run its useful life.

4. **District Energy - Essential Infrastructure for Sustainable Communities:** Robert Thorton, President, International District Energy Association

Robert Thorton gave his presentation to the Panel (see attachment C).

Joe McGee noted that in the seawater air conditioning situation, we would essentially be eliminating the peaker rates.

Robert Thorton said yes, that is essentially correct.

Joe McGee said that Hartford, CT was a national leader in District Heating and Cooling. He asked whether it was still successful. He also noted that there hasn't been another community the size of Hartford move to this model. When the City of Stamford was looking at District Heating and Cooling, there were some concerns about the safety of the system. The utilities have invested money in the system lines for improvement and reliability. There was an issue with the crossing of rights-of-way. He said that he is sensing that around the country this is an issue. Large supplies of natural gas have been discovered in New York and Pennsylvania. Perhaps the utility companies will want to pipe into the natural gas to send to Connecticut. So In Connecticut if we're looking at a reliable and cheaper grid, then District Heating and Cooling becomes a serious option. He asked what prevents this from growing and how does it improve grid reliability.

Robert Thorton said that there are some challenges to launching a new system. Utilities have not always looked at co-generation on campus favorably in the past. They have commercial density where it makes good sense and is desirable and competitive, so we look at load centers. Across the world, people are putting their data centers in remote locations that are supplied by highly reliable energy sources. Having a district energy network takes the load off the wires and essentially enhances the reliability. The investment in the last twenty years in the US was driven by the electric utilities.

Joe McGee noted that this Panel is looking at investments that the state can make to improve the reliability of the electric distribution systems.

Robtert Thorton said when we look at the centers of economic activity, and where people look to locate their assets, they want assurances that the utilities are reliable. Some commercial organizations invest in their own energy production. In Calgary, they have kept their tax rates 4.5% lower as their own utility provides power for some of their own assets. Over 75% of plants in the US are driven by natural gas due to emission standards.

Joe McGee asked if they are seeing utility companies moving toward this while financing themselves.

Robert Thorton said we have not seen evidence of it, but are seeing much more discussion.

Joe McGee asked if there is any regulator interest.

Robert Thorton said there is interest ,but no pushing. He said Ohio recently introduced a bill that said thermal energy can qualify for credits for their renewable standard. In New Jersey, Governor Corzine signed into law that if you are supplying thermal energy to customers, the utility will have to wield the power to them. He said that if you're co-generating ,the utility has to allow you to have access to those wires to allow you to wield power to those customers.

Lee Hoffman said that in terms of the Denmark experience, the distance of transport was up to 25km. He noted that combined heat and power has a more direct impact on grid reliability. He asked whether there was any data of the cost of shipping heat and power for any distance in the US.

Robert Thorton said that it varies depending on whether it is a dense downtown. $1000-3000 per trench foot, $400-500 per trench foot. In Europe they use hot water, so you are able to pump water long distances. District cooling radius is about a four mile radius, as you are moving a lot of volume of water with a low temperature differential. Sometimes the pipe diameters become prohibitive. But, you would not put chillable water outside a dense commercial district. When the plant in the capitol district was brought on line, it converts 90% of the steam into the hot water network, which is very efficient.

Robert Thorton said that capital cost to put the pipe in ground varies $2,000-$3,000 a trench foot or as little as $500 a trench foot. It varies as to the complexities underground. In Europe they use hot water, so you are able to pump water long distances. District cooling, generally it's around a 4 mile radius because you're moving a lot of volume of water at a low temperature; the differential temperature affects the size of the pipes used for transmitting. He noted that you wouldn't put chilled water outside a dense urban area and chilled water flows at 15ft/second. He said it only gains less than a degree and there is really no thermal degradation. When you have a hot water network, there is cooling required and you can vary how much heat you put into the networks, the buildings determine how much heat to take out.

Major General James Skiff thanked both Lee S. Langston and Robert Thorton for coming. He asked if a co-generation system is more resilient to a natural disaster.

Robert Thorton said that these plants have become an asset for the local community to convert waste stream into energy. They have seen in some cities the district cooling system would provide for the convention center and could then become a resource. Resiliency and reliability is driving this.

5. **Break:** Major General James Skiff called recess at 12:12 p.m.
   Major General James Skiff reconvened at 1:05 p.m.

6. **Department of Transportation: Storm Preparation and Recovery, Lessons Learned and Recommendations:** James Redeker, Commissioner

   Commissioner James Redeker gave his testimony to the Panel (see attachment D).

Lee Hoffman said that Commissioner Redeker talked about having to wait for the power companies to clear down wires from the roads. He asked whether it would it make sense to have the DOT have trained individuals to clear the lines.

Commissioner Redeker said there are severe risks and safety hazards involved. He noted that this requires specialized training and specialized tools and equipment; which are not within the DOT mission and that service is best handled by the utility. The partnership with the utility companies is critical.

Cathy Osten said that the utilities had to contract a lot of their services. She asked whether DOT would consider contracting some of that work out to get state highways cleared.

Commissioner Redeker said that they could consider it, but they are not sure that it would be effective. Working through the infrastructure and the management of the grid is primarily something that the power companies can accomplish. He said that it is a responsibility that is not core to the DOT mission. He said they are certainly able to augment their resources, and happy to do so. He said that coordination is the best answer.

Cathy Osten noted that Commissioner Redeker said they were 30 crew members short. She asked whether DOT was in the process of resolving this and she asked what is the estimated time these positions be filled.

Commissioner Redeker said that this is a process happening in the next couple of months. He noted that from a manpower perspective, they were able to handle these storms in the meantime. They also have some contracting capabilities to assist as well.

Peter Carozza said that he understands that the DOT is divided into four districts and a representative would have been in the EOC.

Commissioner Redeker said that yes, and there is 24/7 coverage in the EOC.

Peter Carozza asked if there were any communication problems with those staff and crews in the field.

Commissioner Redeker said that the DOT has a storm room in Newington that dispatches directly to staff in addition to the Bridgeport traffic control facility. There is a good exchange back and forth and there was no breakdown at all in terms of communication.

Peter Carozza asked if all of the DOT contractors were in-state contractors.

Commissioner Redeker said yes they were. He said the ideal would be to have 256 trucks available for snow storms as that is what they would need to keep the roads clear on a regular basis. There are currently 100, which has gotten them through both of these storms.

Peter Carozza asked Commissioner Redeker to talk through the preparation in the staging of their assets. He asked whether it is done prior to the storm.

Commissioner Redeker said that there is a separate contract for weather reporting. He said they may act conservatively by calling out resources early, rather than getting caught off guard. One of the lessons learned is to pre-stage people for recovery. There is a cost/benefit trade off; when you call people out, you must pay. But they do this conservatively because it is difficult if they fall behind it is difficult to catch up. Those decisions are made from a district perspective.

Joe McGee asked about communications. He asked how many persons are in the crews.

Commissioner Redeker said that there is one person.

Joe McGee asked how they communicate and how that information is gathered and put back on a map.

Commissioner Redeker said that they communicate with a radio back to the dispatcher. He said there is a log that gets translated into an incident map; this map gets put up on the website. The log that goes on and the dispatching are in real-time, but the map is slightly behind, but it is close to real-time.

Joe McGee noted that it is a concern to the Panel that there are no design standards being implemented at the national/regional level in regards to climate change and the effects on the infrastructure assets. He noted that the DOT's design standards are based on climate standards that are 40 years old.

Commissioner Redeker said that knowing what the impacts are and what the response should be and knowing what the standards should be is something that has not been seen in the industry. He said that he would be happy to adopt this standard if it were available.

Joe McGee asked who at the state adopts that standard. Discussing the sea rise level he noted that it will put a great deal of the state underwater.

Commissioner Redeker said that if we have to redo the entire infrastructure based on new standards this is going to be costly. If standards are changing, typically these are industry standards. He noted that there are guidelines and books and industry standards, and this is where climate change issues are considered. Changing of these standards would require coordination across many agencies in terms of what we build and how we build it.

Joe McGee said that the 100 year flood standard is occurring every 33 years.so there is certain urgency to this conversation.

Commissioner Redeker agreed, but there are needs today that have to be met, that are urgent such as bridge conditions and highway conditions that can't wait until new standards are developed. There are various bridges that are in need of maintenance; sometimes it's just maintenance that could protect an entire area of flooding, not just replacement.

Scott Jackson asked if a tree falls on a state road in a community, how should the community respond.

Commissioner Redeker said that the town should notify DOT and they will respond immediately. The practice has been because DOT is organized geographically, when DOT receives a call, they log the call and respond. He noted they need to reinforce this, but this is how it typically works – a call comes into their storm room and they immediately dispatch.

Scott Jackson said that in large measure, the state roads are the primary modes of transportation within the community. He asked whether Commissioner Redeker saw any benefit to prior establishment of authority on state roads in the case of a declared emergency.

Commissioner Redeker said he would be happy to discuss priorities if the Panel did not believe the DOT was handling the priorities correctly. They currently work with towns for access to hospitals, schools, etc to clear the public access roads.

Scott Jackson said he wants to come up with a mechanism and take all of the workers and assign them out in a way that makes sense and meets common goals. He noted that if a community official could be useful to assist in dispatching staff for emergencies, he would certainly be open to that conversation.

Commissioner Redeker agreed, but noted this mechanism hasn't existed. In terms of what they have done has been working well routinely; it's when they add in other workers and utilities, that's when the communication becomes difficult. This is an area they need to address.

Major General James Skiff noted that the starting point seems to be the lack of common ground in terms of the standard of preparedness.

Commissioner Redeker said that every incident creates a new challenge. There are going to be future events that will provide new challenges and the exercises could help them prepare.

Joe McGee noted that it has been suggested to the Panel that when a CEO is elected of a municipality, that within 30 days they take training on how to handle an emergency. He asked whether there should also be a training requirement for the Commissioner level.

Commissioner Redeker said it is important to understand what responsibilities are to start, what plans are in place and when they were last tested and know what authority a Commissioner has in an emergency as well. For him, it was important to know what broader issues and responsibilities are involved. The exercises and testing really do make the difference

Joe McGee asked what the issue is with the Merritt Parkway in terms of trees and road closures.

Commissioner Redeker said that it is a historic facility that was designed to standards that are not today's standards. So when the drivers are driving too fast and the clearing is only 18 feet; the clearing is not going to prevent a driver from hitting an object. He noted that because of the number of trees and an area along the coastline it is an area that is more vulnerable. His challenge is that he came after a significant incident and he has to avoid that. He would recommend doing more trimming than they have done.

Cathy Osten noted that he does more in DOT than snow removal and tree trimming, including permitting for oversized vehicles over roads. During the storm, some of those vehicles were initially denied access to CT. She asked whether there is a way to flag permits needed in emergency situations.

Commissioner Redeker said that during the event, he waived fees and directed permits to be granted without the same processing. But on some of the routes, certain vehicles cannot be permitted. He said that they have to be careful, but they are moving in the direction with a new feature in terms of oversized vehicles they press a button to receive the permits. This is a tool for the everyday use still in the process of developing.

7. **Department of Energy and Environmental Protection:** Daniel Esty, Commissioner

Commissioner Daniel Esty presented his testimony to the Panel (see attachment E).

Robert McGrath noted that during earlier testimony there was a possibility that contracting crews from other states may have been a delay because of licensing issues.

Commissioner Esty noted that there are regulatory issues and they tried to work quickly to respond to any regulatory issues. He is unaware that any line crews were delayed due to this. He will check on the line crew issue. He discussed the arborist issue and suggested having a little bit of flexibility by saying that there is an emergency situation and it could be taking down by a non-arborists.

Major General James Skiff asked whether the representative was at the EOC.

Commissioner Esty said they had an average of three people, two from different wings of the department and one from PURA. Also, they put together a communications task force. People were tracking debris, including risk of failure of dams.

Major General James Skiff noted that there was no ESF12 in the state or local plans. And he noted that the Commissioner's testimony will resolve this issue. He thanked the Commissioner for his thorough testimony. He also said that planning and training is a necessary part of lessons learned.

Commissioner Esty agreed that a plan is critical; had plans that were well thought out and executed.

Joe McGee said that they are trying to figure out where the responsibility lies. He asked who takes the lead in establishing the issue of trees and vegetation management. He believes it may be DEEP; he wouldn't want to put it in DOT because it's not really in their purview.

Commissioner Esty said there are some key components. First, the standards in regards to tree cutting, and with the standard setting issue in mind, DEEP has a great deal to do with this. Second, another critical answer is not purely a state responsibility, the tree wardens town by town have an important role to play as well. Beyond the standards, it's the process for implementing the standards, such as the role for the utilities and for the cities and towns. He

said the hard issue is where a tree needs to be removed, but the private property owner has refused. We have to find a way to balance the private owner's rights and the public safety and needs.

Joe McGee noted that all of the parties come together in a tree removing/tree trimming program. The standards will be established and attached to this will be a hazardous tree standard that encourages the property owner with incentives to remove that tree. There has to be somebody who runs this program.

Commissioner Esty noted that the forest and tree expertise that exists within DEEP probably has the best foundation, and it may be a reasonable recommendation that DEEP be in charge of this type of program.

Joe McGee addressed the issue on telecommunications policy. He discussed the issue with the Siting Council in terms of cell towers and backup power. Siting Council personnel apparently indicated that in terms of policy, it was a federal issue. He said that when Commissioner Esty raised questions about telecommunications policy, the Panel agrees. PURA doesn't regulate telecommunications companies.

Commissioner Esty said there has been a shift in some categories out of state regulation to federal regulation. As a matter of public safety, he has an inquiry underway to explore whether and how we could insist some level of backup power.

Lee Hoffman characterized the Siting Council's viewpoint to mean that once the certificate is approved or petition is granted, then it loses a great deal of authority and that authority is with the federal government. He said he thinks it is fully within the Siting Council's purview to come up with new standards. He believed the Siting Council is having difficulties getting the cell companies to recognize authority. He asked whether there is a way to have continuing authority in this deregulated environment to provide utility-like services.

Commissioner Esty agreed with the concerns. He said that during the hurricane he was dissatisfied with the response from all of the cell phone carriers to get COWs into place. He does not have an answer, but it is an area that needs to be highlighted and an area where more needs to be done.

Joe McGee asked if the regulatory structure is appropriate for the modern communication system.

Commissioner Esty said this is a good question. He noted that it was better to have decision makers locally stationed as opposed to in another state. He noted the concern regarding accountability as the lines lengthen from the decision maker to those affected.

Joe McGee asked how we pay for an infrastructure. If we need to make these significant investments in hardening the infrastructure, he asked how we make these decisions to a rate case, when the constant concern is that CT already pays expensive electric rates.

Commissioner Esty said this is a fundamental challenge. It is difficult when CT does have some of the highest rates, and yet there is a push to have cleaner energy and we need to pay for hardening the infrastructure. How to pay for this is a critical issue.

Joe McGee said that he was assuming that the discovery of natural gas in New York and Pennsylvania may yet change the fuel usage in the state of Connecticut.

Commissioner Esty said the speed at which the distribution system is built will impact this as well. His own thought is that when the streets are opened up to put in electric lines, broadband could be added to those who want internet of the future, expand the natural gas mains, and water. This is how we spread the cost of that out.

Joe McGee said that we're looking at a distribution system that fell down during both storms. If we're going to be trenching up the roads then there is the opportunity to combine utilities.

Commissioner agreed. We put in the various utilities and the cost spreading opportunity across the various elements is one way to handle this project.

Joe McGee noted that coordination is difficult. He asked how the Commissioner in the current structure with the current staff, how does this ever get coordinated.

Commissioner noted that we think we can drive it from a coordination point of view; the bigger challenge is going to be the financing and spreading the cost.

Lee Hoffman noted that there seems to be an additional problem with building up the natural gas infrastructure. He asked if it is possible that to take this as a bite-sized chunk.

Commissioner Esty noted that he has had this conversation with the gas companies. There are a significant number of people within a couple of thousand of feet of a natural gas line, this is where we start. This could be a step by step process over the next decade or two. Getting those that are the biggest number of beneficiaries keyed up, may be the best place to begin.

Lee Hoffman wondered how to link the policy piece to the rate making piece. The reality is that the rate case deals with exigent needs to allocate resources. The policy needs say we will do better later if we put in the time and sweat now.

Commissioner Esty noted that Governor Malloy's implementation of the DEEP is a good basic framework where PURA sits as an independent body. It should build on policy choices that the Governor determines. We are building out an integrated resources plan. A good starting point is a comprehensive energy strategy.

Lee Hoffman noted that the idea of distributed generation seemed like an interesting option. He asked if the 2005 model has been looked at as a model for infrastructure hardening and can a case be made for it financially.

Commissioner Esty said it's that legislation and the legislation in 2007 that provided a foundation for which to build. There is already a platform available and he is finding a very

positive response from the municipalities. He said there is a value in at least fleshing out the cost/benefit analysis and whether this would make sense. DEEP is working on this every day, working with other states to get the details.

Lee Hoffman discussed the sea wall sizes, and in terms of sea walls and protections as we look at sea level rise and surges. He asked whether DEEP is looking at building these walls up, and the permitting change.

Commissioner Esty said that they are looking at these areas in terms of climate change. He noted that it is not just sea walls, but all design standards need to be assessed in terms of climate change. The backward looking is not useful in trying to figure out what the requirements are for looking forward.

Joe McGee noted that DOT's drainage standards are based on DEEP's rain standards which haven't been revised since mid 1960s.

Commissioner Esty said this is correct, and he believed that they are looking at the 100 year flood levels that need to be reexamined. We have to go back and look at past practices and see if they still hold. He noted that we have a Governor who insists on not accepting past presumptions as a basis for the right way to do things for the future.

Scott Jackson thanked Commissioner Esty for his testimony. He said that 1/3 of the states have moved toward a reward/penalty model. He asked the Commissioner his thoughts for how to apply an equitable standard and if you have failed to meet the standards you should be penalized.

Commissioner Esty said that the challenge is when you dig into the details in a particular case it is hard to say that this is what we had in mind when we set these standards. Still, he noted that there needs to be standards and there needs to be a way to provide discipline that would otherwise be provided by the marketplace. DEEP has to provide the framework and the PURA must hold them to the standards. We need to have an investment in infrastructure and we need to have standards in place.

Cathy Osten said that there is an issue in her community of at risk dams. She asked the Commissioner to discuss this issue.

Commissioner Esty said that dams were a big issue of concern and that they are aging is also concern. There are a number of towns that don't feel they have the capabilities to resolve these issues and a number of private parties who also do not feel responsible. This is an area we need to discuss.

Cathy Osten noted dams are expensive to maintain and not easy to repair and this is difficult for some municipalities to undertake. She asked the Commissioner to look at this issue a little more extensively.

Commissioner Esty noted that again this is a cost/benefit analysis. This issue needs to be addressed.

Cathy Osten said that one problem that has been noticed is the case of invasive vegetation. In Southeastern CT a lot of trees came down as a result of invasive vegetation. She was wondering if the commissioner has looked at this.

Commissioner Esty said this is something they have looked at, but he does not have a good answer on the cost of how much it would cost to clear out the invasive vegetation. It is something they would continue to look into.

Joe McGee thanked Commissioner Esty for his testimony.

8. **Department of Construction Services:** Joseph Cassidy, Acting State Building Inspector and Director of Technical Services

Bud Salemi was available to answer the Panel's questions.

Bud Salemi noted that one of the issues is that damage was pretty much limited to lost days. The power outages slowed down a few of the projects. There were not that many days lost to either of the storms. There was no damage to the buildings that they know of and they asked all of the project managers to report on this. The worst that may have happened was that some trees may have fallen on the worksites.

Joe McGee asked about the issue of building standards and asked whether they set the standards.

The presenters said that it is essentially a national code that CT has adopted. The state of CT has modified the national codes in order to adopt them. Their department has the ability to modify the national code.

Joe McGee addressed climate change, sea rise level and storm surge. He asked if they are using a standard that reflects these issues. If the answer is that we do not, then the question is why not, and should we.

The presenters said that again it's a national consensus code that is put together by a committee. Generally they're using nationally accepted weather data that gets put into the model code and we generally take that as accepted for wind speed, earthquake, etc. He said for storm surge, etc. they leave that to the local level.

Joe McGee read from Commissioner Redeker's testimony in regards to design standards.

The presenters said that the rainfall amounts will determine the size of storm drains. They noted that their system has changed dramatically in the last ten years. They could not say that it was driven by climate change. It is driven by the national code.

Joe McGee said that the Panel is trying to get at the impact of extreme storms. The state makes long term investments. He noted that what has been presented is that rain standards, etc. have not been changed in 40-50 years and yet climate change is a factor.

The presenter said that industry weighs in on these issues and these are driven by insurance risk management assessment as well. They end up building state buildings a little bit higher than state standards.

Joe McGee said so that if there was going to be an increase of the standard at the state level, who makes that decision.

The presenters said that the code follows what gets adopted nationally. They look at the model code and take into account all proposals and the information necessary to modify the code so that all areas can work together. The presenters said that the vast majority of the building code is built around public safety. The code only requires the installation of backup generations of buildings of certain sizes that cannot be served well by batteries. Those buildings are required to have a standby generator that safely gets people out of the building if there's a fire or if there's an explosion or if there's a collapse. Those buildings are designed to protect people from hurricanes and strong winds. Newer buildings built to the newer codes tend to be a little more robust.

Joe McGee asked whether the local building official adopts state code.

The presenters said yes, when the code is adopted it is the code.

Major General James Skiff noted that insurance comes into play in this issue as well.

Joe McGee asked about the public port, and what role they would play. Let's say it's a waste water facility funded under the Free Water Act. He asked if the municipality has the authority.

The presenter said, no, that would be under the municipality. The building code should be enforced within the municipalities the same throughout the state. The towns are required to have a building director who is certified and they have to get continuing education so that the building codes can remain homogenous across the state.

Joe McGee clarified that they set the state building code for everybody in the state. So when the concern is the sea level rise and the storm surges we would like to know that the building code is modified.

The presenters agreed. Especially after hearing Commissioner Esty's testimony, this is an area that they will look into further. They need to let the national committees know that by looking at the science, CT has experienced this, and this should be considered when creating the national building code.

Joe McGee said that when discussing with the Siting Council, the Panel was informed that the building code is responsible for the towers and the backup generation goes back to the building code.

The presenter said to remember that the code is built around safety. Some of the issues have to do with commerce. In a gas station there have to be 90 minutes for the lights to go on to get the people out, but there isn't anything to run the pumps because there isn't a safety reason to require them to have generators.

Joe McGee said that in terms of cell phones the companies get to set the standards as to the backup standards. He asked whether this a building code issue.

The presenters said it is not a building code issue, in the contractual obligation we can make the cell phone provider put in the appropriate backup system.

Joe McGee asked why the building code doesn't require the backup generators when they require them in other buildings for safety purposes. He noted that If he has to call a hospital and he needs his cell phone to do so, that is a safety purpose.

The presenters noted that the issue is that there are not people in the cell phone towers and that is why the building code is not able to force the cell companies to get back up generators.

Cathy Osten said they have built a lot of senior housing. She said that one area she couldn't get as priority was senior housing. They are not required to have generators. Several people were not able to get up and down the stairs because there was no generator required in those buildings.

The presenters said that this is a sensitive issue. They said first, for a high-rise building, it's extremely difficult to be mobile and second, where else can you go even when you have the ability to get in and out. If there were generators they would have the ability to stay in their homes. They said that we may find the generator only comes on to run emergency lighting and to run the elevators, but that is about it and they may not run a heating or ac system; it's really there to get the people out of the building. There is not likely a requirement for congregate housing or multi-family housing as a real life safety issue in terms of the codes requirement.

Cathy Osten said yes, but we have to look at some system to keep people in their homes. When we remove people who are in senior housing we're looking at the need for handicap accessible areas. And it becomes a cost effective issue, it makes more sense to keep the people in rather than to remove people. She noted that this should be something that the building code should look into.

The presenters said that the state is currently looking at new building codes and noted that this is a possible recommendation for the Panel to propose to require the state to look at this issue when they adopt a new building code. Various committees of the legislative with cognizance over various issues will be valuable in reviewing the state building code proposals.

Joe McGee requested that in terms of GIS we would love to have their comments on GIS, the Panel is looking at the idea that there has to be a much stronger cooperation at that level. He asked them to add to this, strengthen it or disagree.

The presenters said they are willing to provide written testimony regarding this.

9. **Approval of the November 30, 2011 Special Meeting Voting Record:** Cathy Osten moved to approve the November 30, 2011 special meeting voting record, seconded by Lee Hoffman. All members present voted in favor. The motion carried.

10. **Approval of the November 30, 2011 Special Meeting Minutes** Lee Hoffman moved to approve the November 30, 2011 special meeting minutes with the following amendments: to change the heading from "Special Meeting Agenda" to "Special Meeting Minutes"; on page 4 of 14 to change "Lee" to "Lee Hoffman"; on page 8 of 14, to change the word from "Pane" to "Panel"; on page 11 of 14 to change "Newburg" to "Newburgh"; and on page 12 to change "members paying more to ensure liability" to "members paying more to ensure reliability", seconded by Cathy Osten. All members present voted in favor. The motion carried.

11. **Approval of the December 2, 2011 Special Meeting Voting Record:** Cathy Osten moved to approve the December 2, 2011 special meeting voting record, seconded by Lee Hoffman. All members present voted in favor. The motion carried.

12. **Adjournment:** Lee Hoffman moved to adjourn the meeting, seconded by Cathy Osten. All members present voted in favor. The motion carried. The meeting was adjourned at 4:06 p.m.

Attachments

A. **Power system Engineering, Inc., Major Event Outage & Restoration Mitigation, Reliability Incentive Concepts, Benchmarking, and Value Base Planning, Presented by: Erik S. Sonju and Steve Fenrick, December 7, 2011**
B. **UCONN Cogen Plant, UCONN Utility Tunnels, Lee Langston, December 7, 2011**
C. **District Energy: Essential Infrastructure for Sustainable Communities, International District Energy Association, Robert Thornton, President & CEO, December 7, 2011**
D. **Connecticut Department of Transportation Testimony, Commissioner James Redeker, December 7, 2011**
E. **DEEP Commissioner's Testimony to The Two Storm Panel Regarding Opportunities for Improved Storm Response and Potential Strategies for Improving Infrastructure Resiliency, Submitted by Commissioner Daniel C. Esty, December 7, 2011**

Submitted By:
Mike Caplet
Lauren Mauer

Ⓐ

Power System Engineering, Inc.

PSE

Major Event Outage & Restoration Mitigation, Reliability Incentive Concepts, Benchmarking, and Value Base Planning

Presented by:

Erik S. Sonju and Steve Fenrick

Power System Engineering, Inc.
Web Site: www.powersystem.org

December 7, 2011

Introductions

Erik S. Sonju – Vice President of Power Resource and Delivery Planning and Design

- Over 15 years of working experience in the power industry as a utility engineer and consultant
- Licensed professional engineer in 15 states
- Experience in transmission and distribution line design and construction included FEMA funded projects.
- Experience in utility system planning with the purpose of identifying capital projects to accommodate growth and improve reliability.

Introductions

Steve Fenrick – Leader, Benchmarking & Economic Studies

- Over a decade of consulting experience in the utility industry
- Master's degree in Applied Economics from the University of Wisconsin
- Conference chair of a semi-annual EUCI conference dealing with measuring, balancing, and improving cost and reliability for electric utilities
- Expert witness testimony experience

Purpose and Outline of Presentation

Purpose

To provide a summary of measures, mitigative solutions, planning, benchmarking, and incentives for improving power system reliability.

Outline

1. Measuring Electric Power Reliability
2. Causes of Extreme Outages
3. Mitigation Measures for Major Event Outages and Restoration
4. Self Incentives and External Incentives
5. Benchmarking
6. Value Base Planning

Measuring Electric Power Reliability

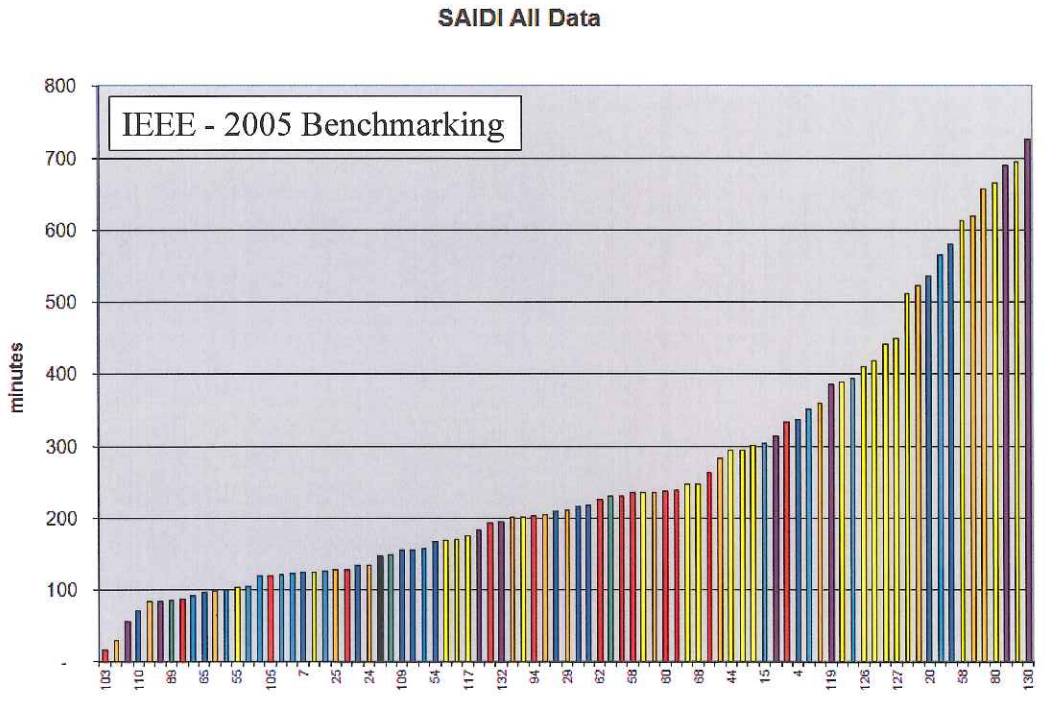
IEEE Std 1366 - Electric Power Distribution Reliability Indices

SAIDI – Total outage time an average customer experiences over a measured duration.

SAIFI – Number of interruptions (typically > 5 min.) an average customer experiences over a measured duration.

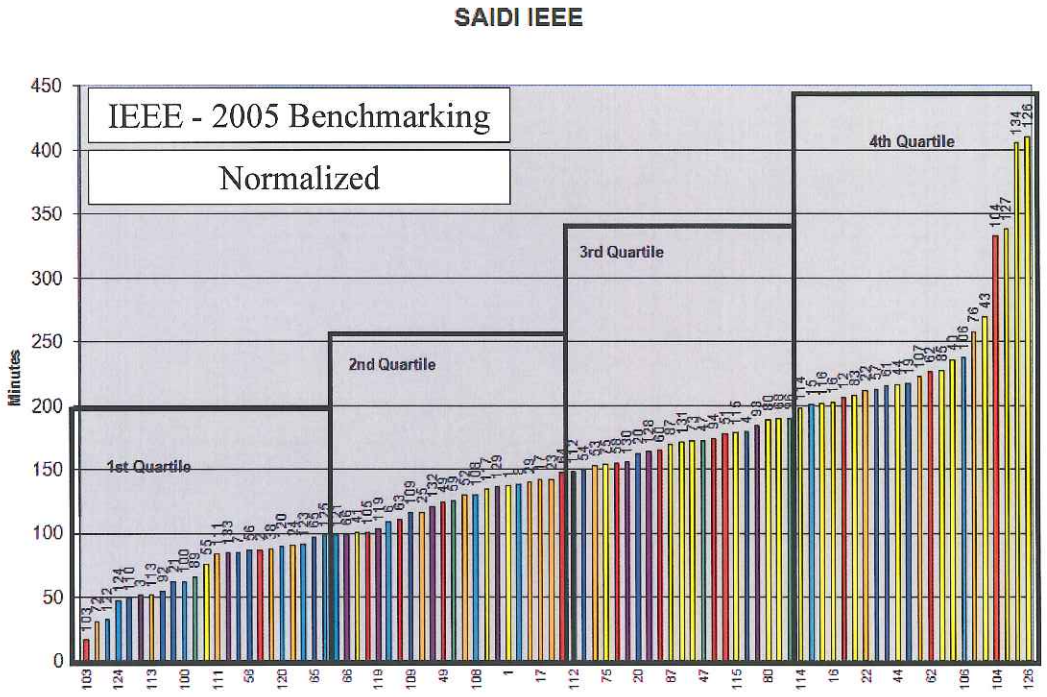
CAIDI – Outage time an average customer experiences for an average outage.

Measuring Electric Power Reliability



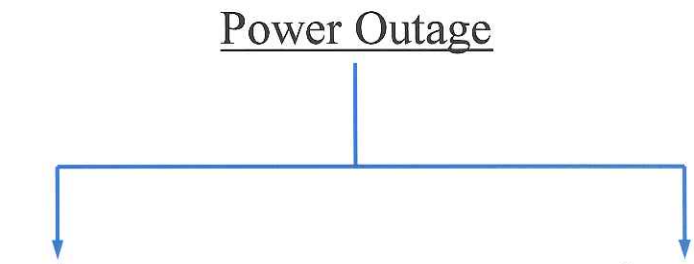
Power System Engineering, Inc. PSE

Measuring Electric Power Reliability



7

Categorizing Normal and Major Events



Normal Event

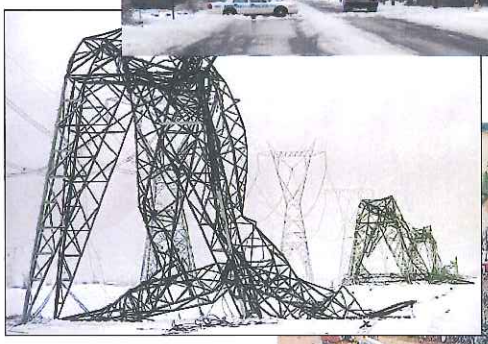
- Regular occurrence
- Small geographic areas
- Few customers affected
- Day-to-day performance

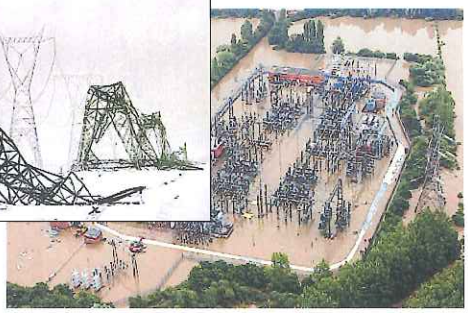
Major Event

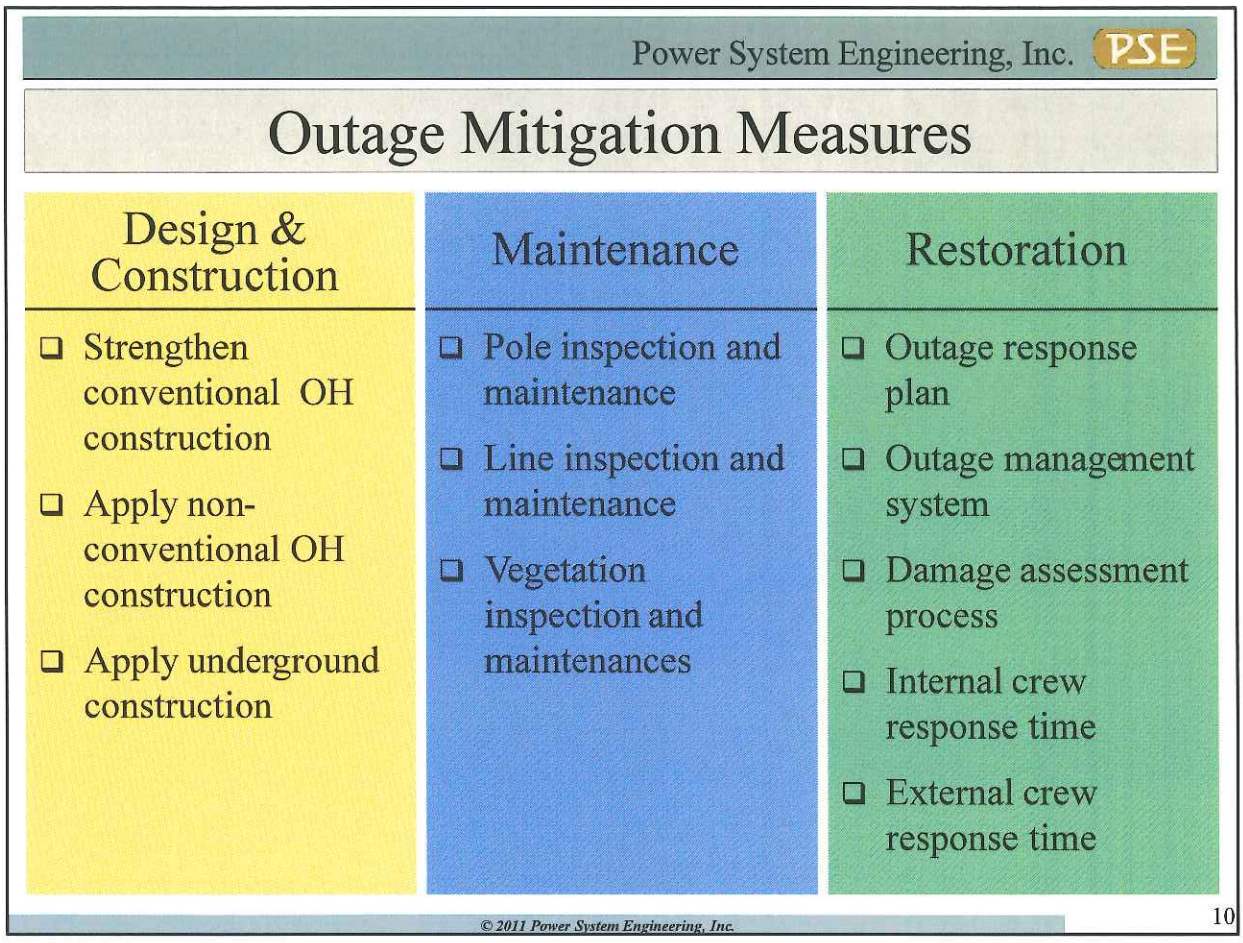
- Infrequent occurrence
- Large geographic area
- Significant number of customers affected
- Crisis mode

Typical Causes of Major Events

- Extreme Winds
- Ice Storms
- Early Snow Storms
- Forest Fires
- Floods
- Cascading Blackout






Power System Engineering, Inc.
PSE
Outage Mitigation Measures
Design & Construction
Strengthen conventional OH construction
Apply non-conventional OH construction
Apply underground construction
Maintenance
Pole inspection and maintenance
Line inspection and maintenance
Vegetation inspection and maintenances
Restoration
Outage response plan
Outage management system
Damage assessment process
Internal crew response time
External crew response time
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Power System Engineering, Inc. PSE

Hardening Conventional Construction

- National Electrical Safety Code minimum requirements
- Heavy zone 0.5" of radial ice and 40 mph concurrent wind
- NESC safety factors are defined for distribution and transmission lines (grade C and grade B).

- NESC has additional requirements for structures over 60 feet in height.
- Some utilities have adopted internal standards that exceed NESC strength requirements per past events.
- Recent FEMA funded mitigation projects have required more stringent designs.

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Non-Conventional Construction

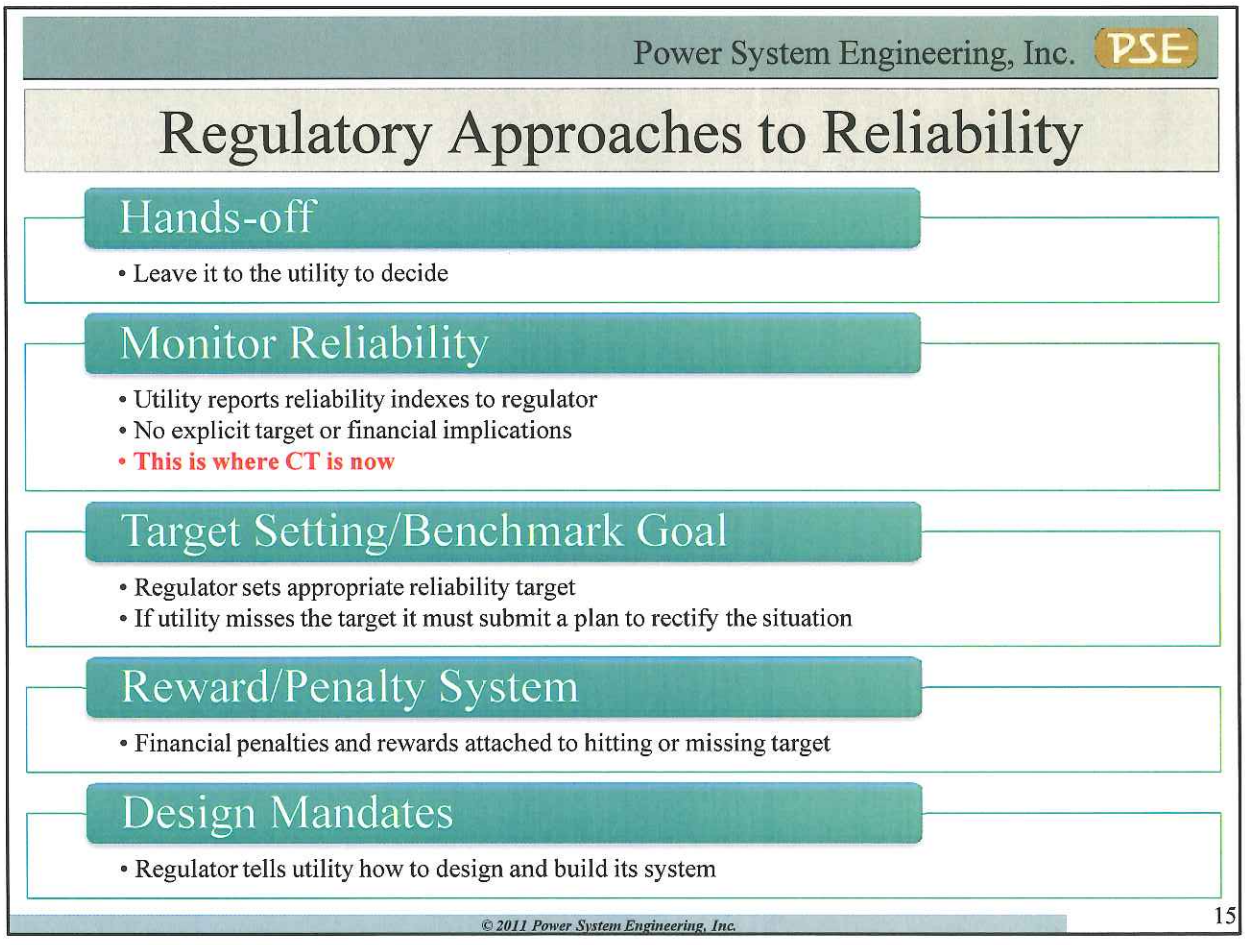
- Conventional construction includes open wire, insulators, and crossarms.
- Motion resistant wire construction.
- Spacer cable construction includes covered cable, brackets, and messenger wire.
- Fallen trees on line impact conventional, motion resistant wire, and spacer cable construction differently.

Underground Construction

- Minimal to no impact from extreme winds, ice storms, or early snow.
- Pre-mid 1970's vintage underground cable experienced premature failures.
- Significant improvements in cables manufactured after that mid 1970's.
- Can be difficult and costly to modify and sectionalize.
- Cable faults are typically difficult to track and repair.

Overall Considerations

- The electric power infrastructure is capital intensive and requires a long term payback to keep electric rates stable.
- Large scale replacement initiative should be carefully planned to avoid unnecessary costs, upgrades before facilities depreciate, or low value projects.
- Best approach to improve reliability is typically a combination of capital and non-capital investments.
  - Hardening conventional construction
  - Non-conventional construction
  - Undergrounding
  - Line and vegetation inspection and maintenance
  - Outage management system
  - Internal and external crews
  - Outage response plan


Power System Engineering, Inc.
PSE
Regulatory Approaches to Reliability
Hands-off
• Leave it to the utility to decide
Monitor Reliability
• Utility reports reliability indexes to regulator
• No explicit target or financial implications
• This is where CT is now
Target Setting/Benchmark Goal
• Regulator sets appropriate reliability target
• If utility misses the target it must submit a plan to rectify the situation
Reward/Penalty System
• Financial penalties and rewards attached to hitting or missing target
Design Mandates
• Regulator tells utility how to design and build its system
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15

Reliability Benchmarking (Target-Setting)

- Need to adjust for circumstances of the service territory for an "apples to apples" comparison
- Benchmarking can help answer 2 questions:
  1. How do CT utilities compare to the country?
  2. What targets would be appropriate if financial rewards and penalties are implemented?

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Underground Example

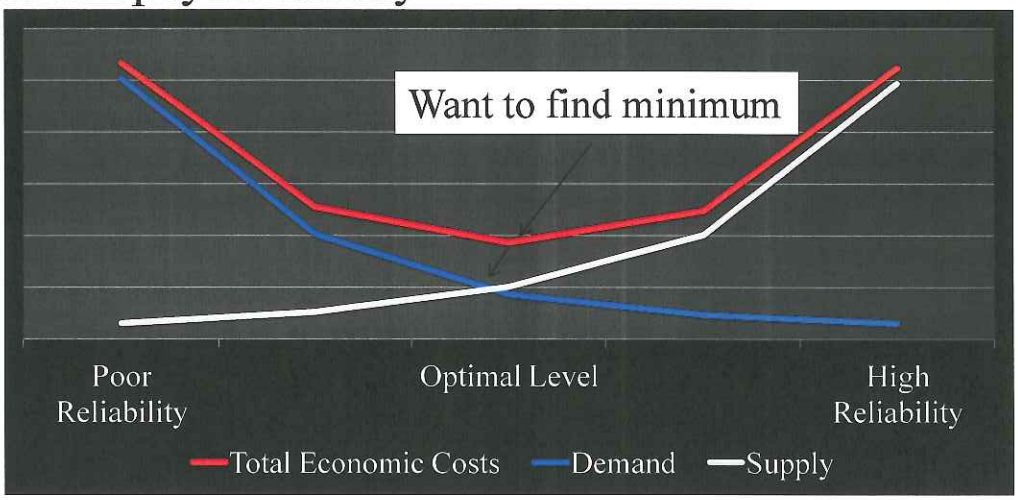
- The upfront cost of most overhead installations are considerably less than their underground equivalents.
- However, reliability is typically much better for underground lines, especially during severe weather

- **Key Question:** Is the reliability impact worth the extra costs?
- **Answer:** It depends, some feeders should be others should not

Supply and Demand of Reliability

Demand-side: Customers demand reliable service and incur economic losses when outages occur

Supply-side: Improving reliability costs utilities and their ratepayers money



How Serious are Outages?

- Lawrence Berkeley National Laboratory (LBNL) estimated power outages cost the U.S. economy $80 billion annually (over $250 per capita per year)
- However, this will vary dramatically by the preferences and types of consumers served by a given utility

How to Estimate Economic Damages from Outages

Most popular method is the "Stated Preference" approach

- Surveys used to ask consumers their "*willingness to pay*" for reduced outages or their "*willingness to accept*" compensation for higher levels of outages
- Businesses likely to have higher impacts than residential customers
- These are rough estimates used to guide decisions on design and investment options

What is Value Based Reliability Planning (VBRP)?

- VBRP is considering the societal benefits of reducing outages in the decision-making process
- Reliability-driven projects cost $ and reduce the expected amount of outages

What are the costs to the utility (ratepayers)?

What is the value of reducing outages to consumers (ratepayers)?

Key Questions

1. What have been the economic damages resulting from outages in recent years (i.e. what is the demand curve)?
   - During major weather events
   - During "normal" years
   - **What is the likelihood of such events?**
2. What would be the added costs to lower or eliminate outages during such events? How do these stack up to the benefits? Where does the supply meet the demand curve?
3. What potential projects are available that would have a benefit-cost ratio well above one (i.e. demand exceeds supply)?
4. What mechanisms would provide incentives for utilities to provide the optimal level of reliability supply?
5. What is the industry standard for reliability supply given the circumstances (e.g. high forestation) faced by CT utilities?

Discussion

B

UCONN COGEN PLANT
UCONN UTILITY TUNNELS

Lee Langston
Professor Emeritus
Mechanical Engineering Department
University of Connecticut

Two Storm Panel – Dec. 7, 2011

University of Connecticut

Storrs Campus

Energy Usage up to 2006

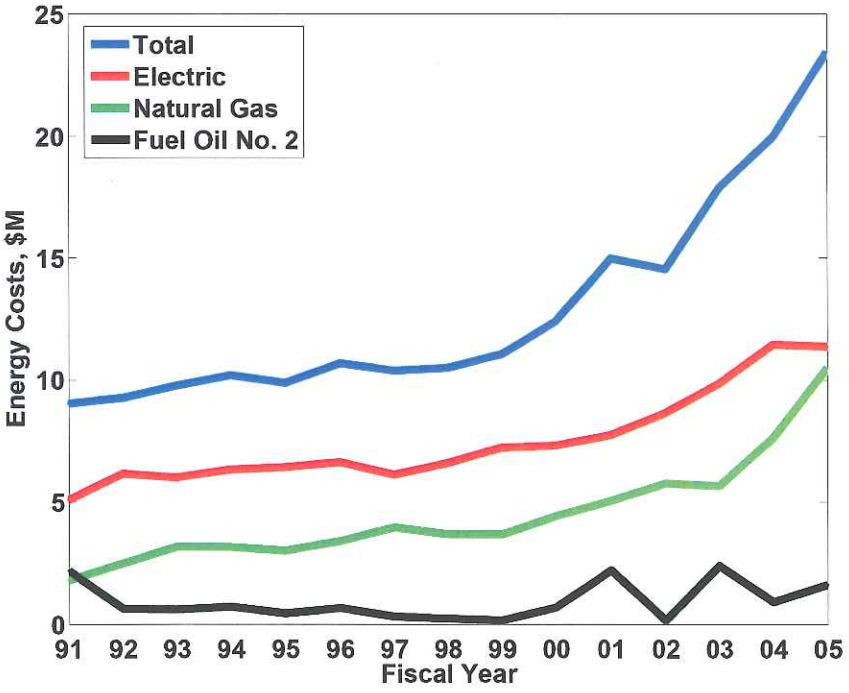
Electricity: Supplied by CL&P, power line and substation on North Eagleville Road

Heat: Six (6) steam boilers in Central Utility Plant fueled by natural gas (75-90 psig) with No. 2 fuel oil as backup

Air Conditioning: chilled water, 4000 tons of refrigeration supplied by electrical and gas engine powered centrifugal compressors. Also there are many small electric power air conditioners scattered across campus

UConn Energy Costs

Storrs Campus



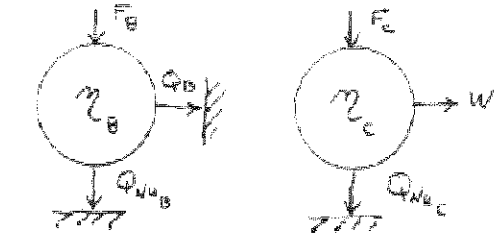
UCONN ENERGY COSTS (Storrs)

For Electricity, Natural Gas, and No. 2 Oil

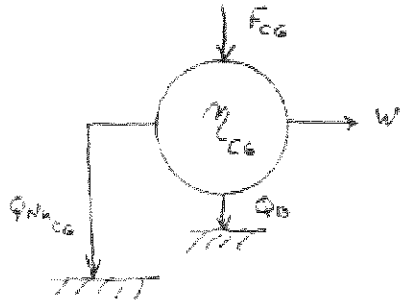
Fiscal Year (July-July)	Total Cost
2002	$14,525,186
2003	$17,874,404
2004	$19,964,455*
2005	$23,439,119

*About 3% of Storrs $688m FY 2004 Budget and 19% of $104m FY 2004 Physical Plant Budget

Cogeneration



$$F_{ECF} = F_B + F_C$$



The production of more than one useful form of energy (such as heat and electric power) from the same energy source.

(Also called "Combined Heat and Power" (CHP).)

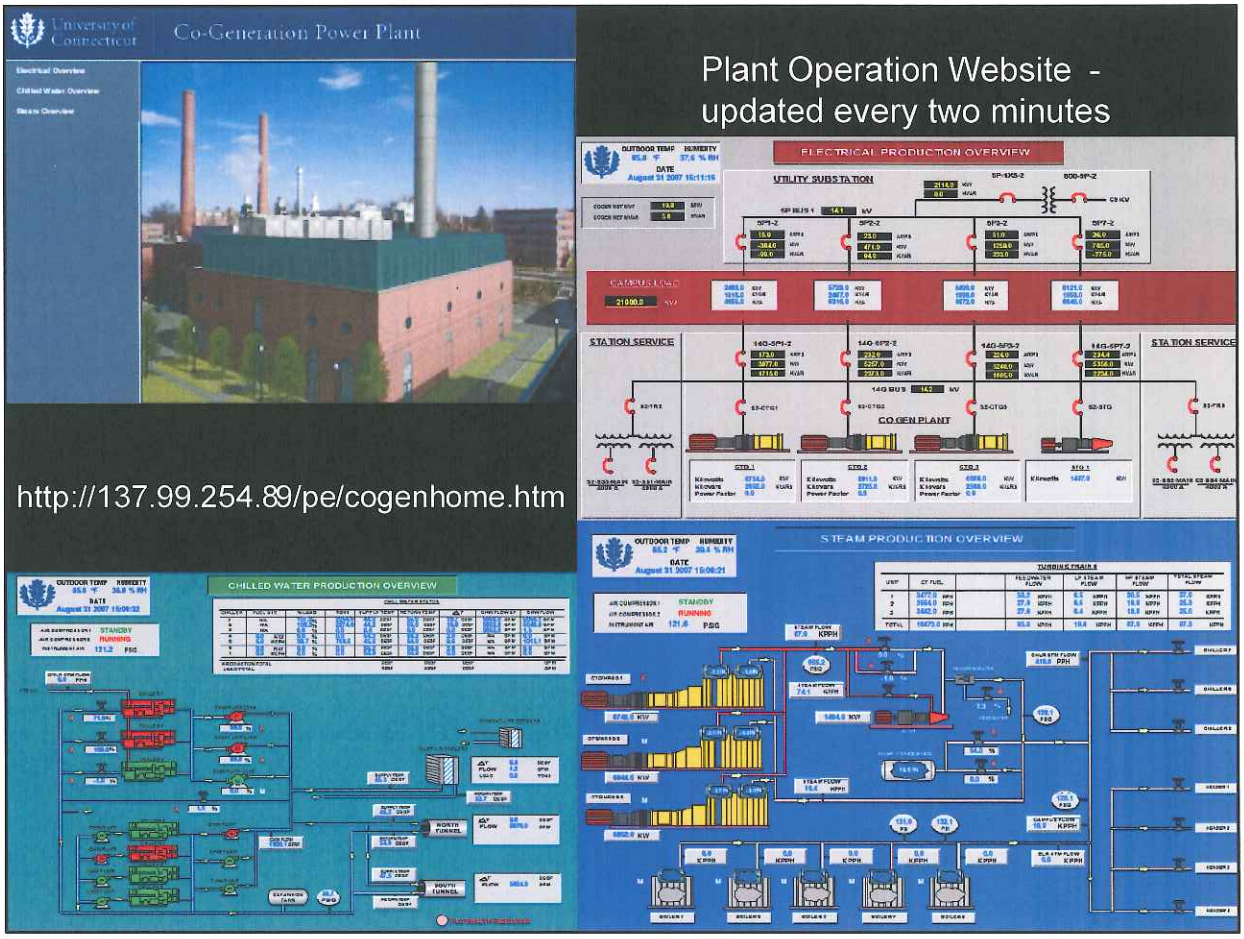
UConn Cogen Plant Specifications

Electrical Power	25 MW
Steam	200,000 lbm/h
Cooling	6,000 Refrigeration Tons
Fuel	Natural gas (No. 2 fuel oil as backup)

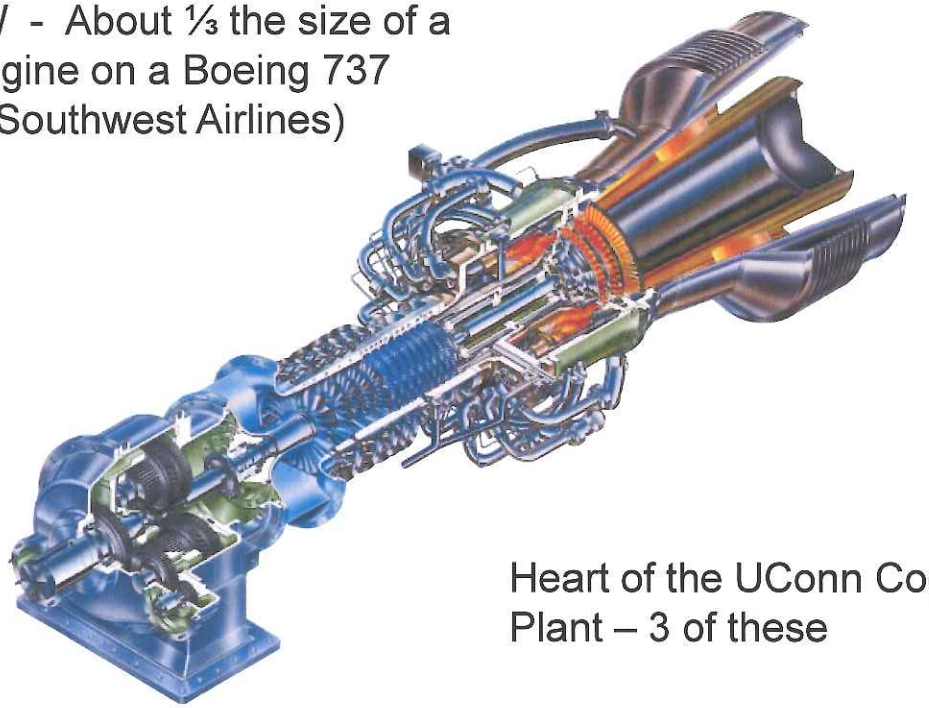
2002	Request for Proposals
2003	Construction Started
2004	Construction Completed
2006	Plant Online

Cost – About $80M
Design Life – 40 years


Class Room


University of Connecticut
Co-Generation Power Plant
Electrical Overview
Chilled Water Overview
Steam Overview
http://137.99.254.89/pe/cogenhome.htm
Plant Operation Website - updated every two minutes
ELECTRICAL PRODUCTION OVERVIEW
UTILITY SUBSTATION
STATION SERVICE
COGEN PLANT
CHILLED WATER PRODUCTION OVERVIEW
STEAM PRODUCTION OVERVIEW

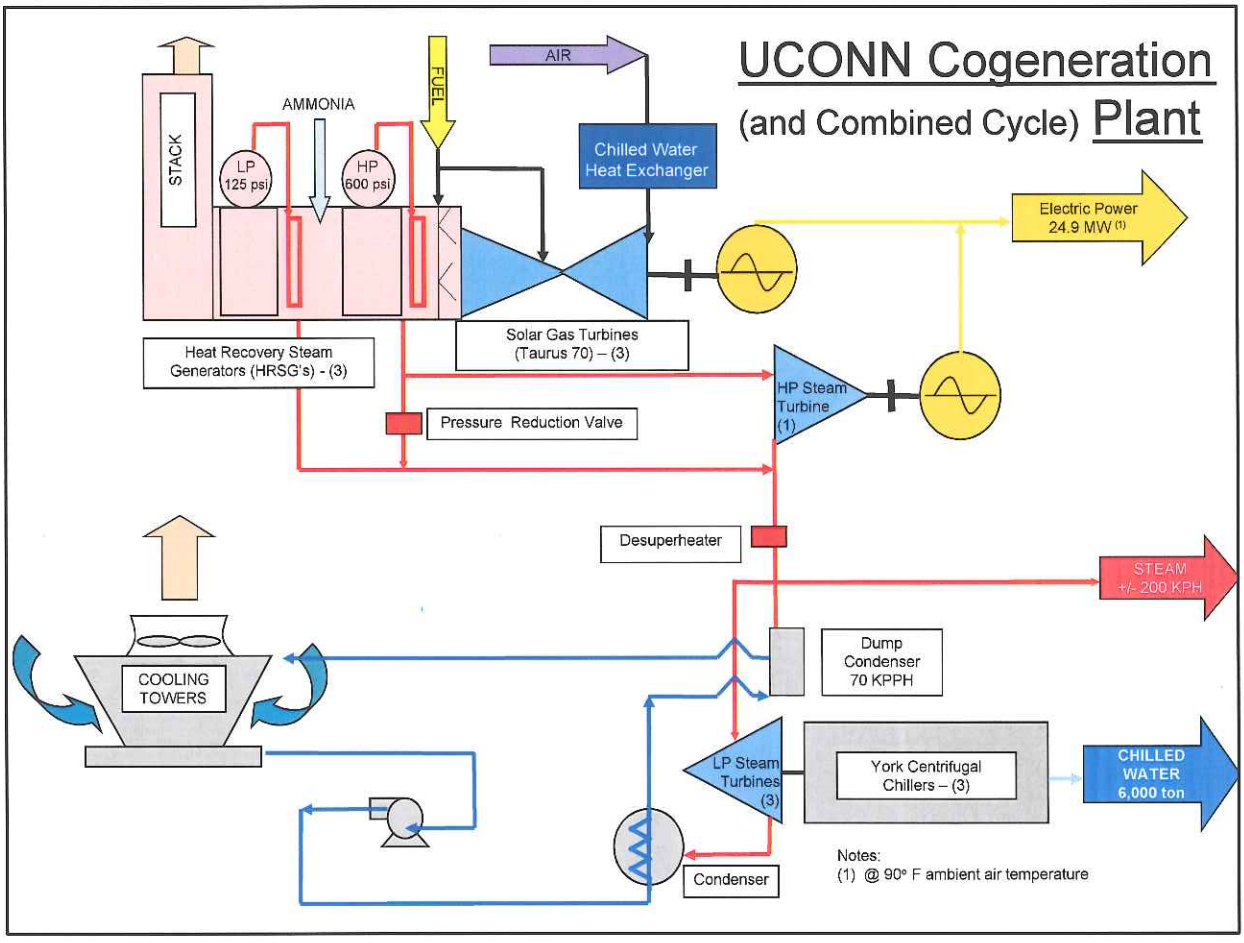
7 MW - About ⅓ the size of a jet engine on a Boeing 737 (*e.g.* Southwest Airlines)



Heart of the UConn Cogen Plant – 3 of these

Solar Turbines
A Caterpillar Company

Taurus 70 Gas Turbine
for Generator Applications


UCONN Cogeneration
(and Combined Cycle) Plant
STACK
AMMONIA
FUEL
AIR
LP
125 psi
HP
600 psi
Chilled Water
Heat Exchanger
Electric Power
24.9 MW (1)
Heat Recovery Steam
Generators (HRSG's) - (3)
Solar Gas Turbines
(Taurus 70) – (3)
HP Steam
Turbine
(1)
Pressure Reduction Valve
Desuperheater
STEAM
+/- 200 KPH
COOLING
TOWERS
Dump
Condenser
70 KPPH
LP Steam
Turbines
(3)
York Centrifugal
Chillers – (3)
CHILLED
WATER
6,000 ton
Condenser
Notes:
(1) @ 90° F ambient air temperature

Cogeneration

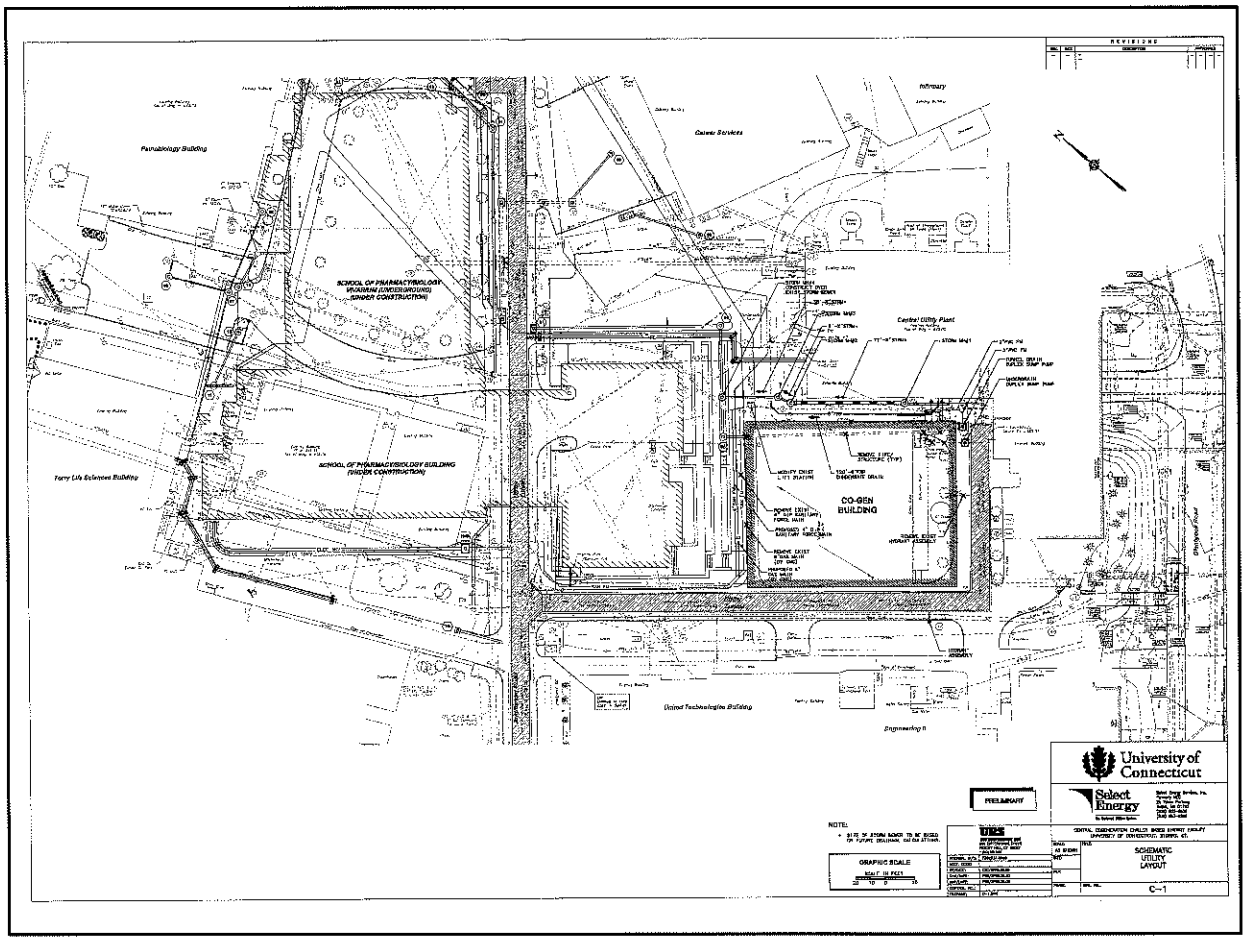
Fuel Energy Savings Ratio (FESR)

$$FESR = \frac{F_{ref} - F_{CG}}{F_{ref}} = 1 - \frac{\eta_B \eta_C}{(\eta_B + \lambda_D \eta_C)\eta_{GC}}$$

UConn Cogen Power Plant (25MW) Example:

η_C = conventional (utility) efficiency = 40%
η_B = conventional boiler efficiency = 80%
η_{CG} = cogeneration plant efficiency = 34%
λ_D = demand ratio (heat over work) = 2.3

FESR = 48%


Pathobiology Building
Gaines Services
Infirmary
SCHOOL OF PHARMACY/BIOLOGY
UNDERGROUND
UNDER CONSTRUCTION
Central Utility Plant
SCHOOL OF PHARMACY/BIOLOGY BUILDING
UNDER CONSTRUCTION
Torrey Life Sciences Building
CO-GEN
BUILDING
United Technologies Building
Engineering II
N
University of
Connecticut
Select
Energy
PRELIMINARY
NOTE:
GRAPHIC SCALE
SCHEMATIC
UTILITY
LAYOUT
C-1


FIRE PROTECTION WATER
CHILLED WATER SUPPLY

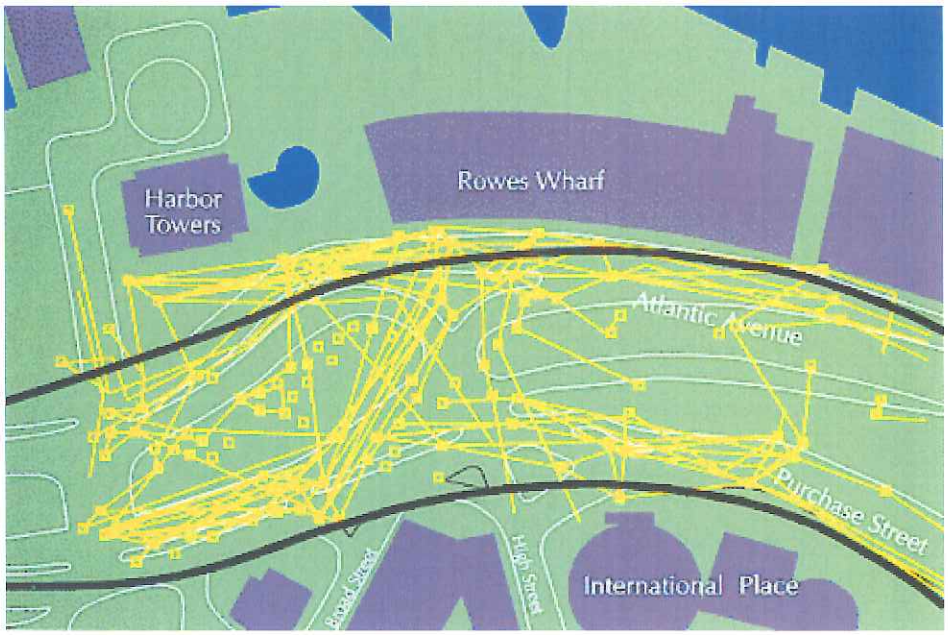

SWAN LAKE
CHEMISTRY BLDG
PATHOLOGY & ATWATER LAB BLDG
LIFE SCIENCES
CENTRAL RECEIVING & STORAGE
INFIRMARY
HEATING & POWER PLANT
CHILLED WATER FACILITY
STORRS HALL
WOOD HALL
WILBUR CROSS BLDG
KOONS HALL
ALLIED HEALTH
ASIAN AMERICAN CENTER
WILLIAM BENTON MUSEUM OF ART
UTE
ENG II
ARTHUR BRONWELL ENGINEERING III
CASTLEMAN
STUDENT UNION
HOMER BABBIDGE LIBRARY
IT BUILDING
SCHOOL OF BUSINESS
THOMAS J. DODD RESEARCH CENTER
HAWLEY ARMORY
HUGH S. GREER FIELDHOUSE
STADIUM FACILITIES
GAMPEL PAVILION

Thank You.

Questions?

Lee Langston
Professor Emeritus
University of Connecticut
Department of Mechanical Engineering
191 Auditorium Road, U-3139
Storrs, CT 06269-3139 USA
Phone: (860)486-4884 Fax: (860)486-5088
langston@engr.uconn.edu
http://www.engr.uconn.edu/me

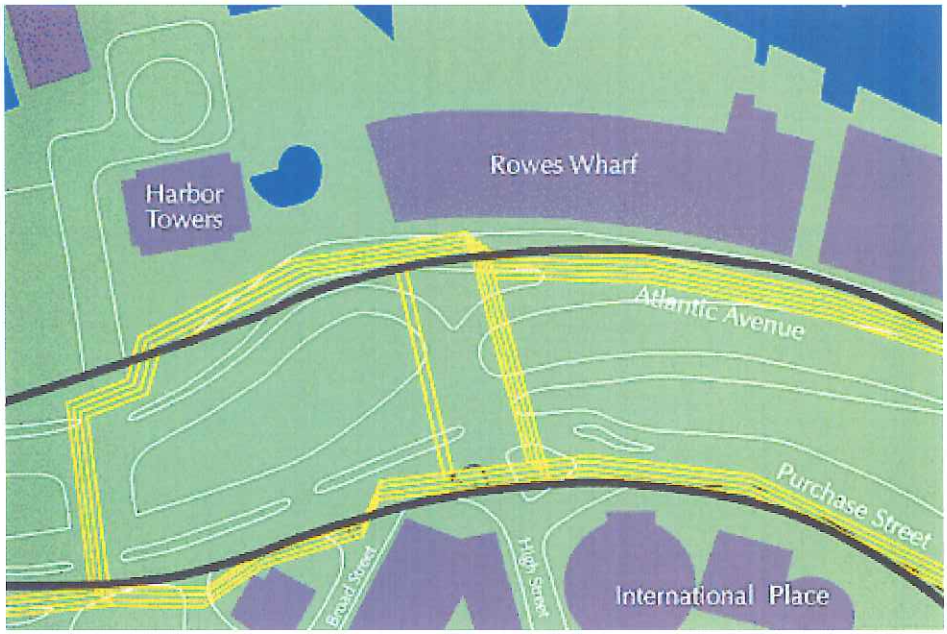
Boston – Big Dig
Before Construction



Source: Massachusetts Turnpike Authority Website

Boston – Big Dig

After Construction – Modern Utility Corridors



Source: Massachusetts Turnpike Authority Website

(C)

District Energy: Essential Infrastructure for Sustainable Communities

Robert Thornton, President & CEO

Governor Dannel P. Malloy

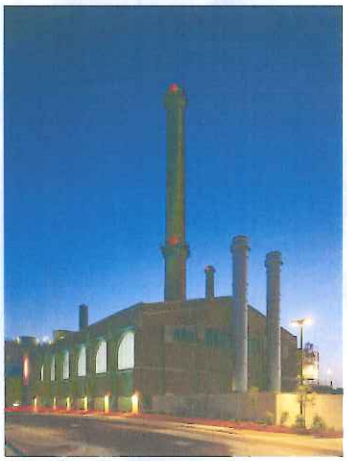
Two Storm Panel Special Meeting

Legislative Office Building

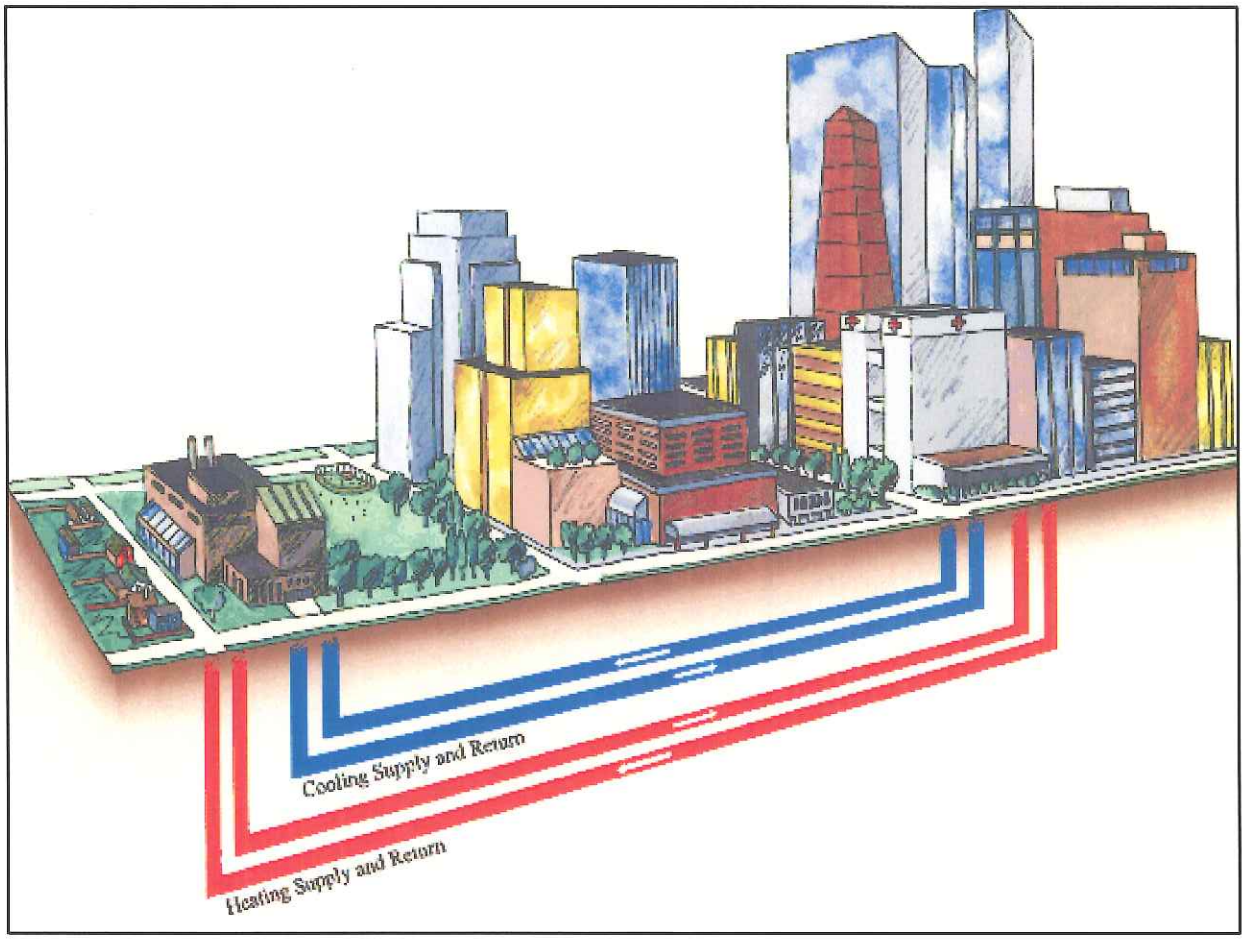
Hartford, CT

December 7, 2011

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

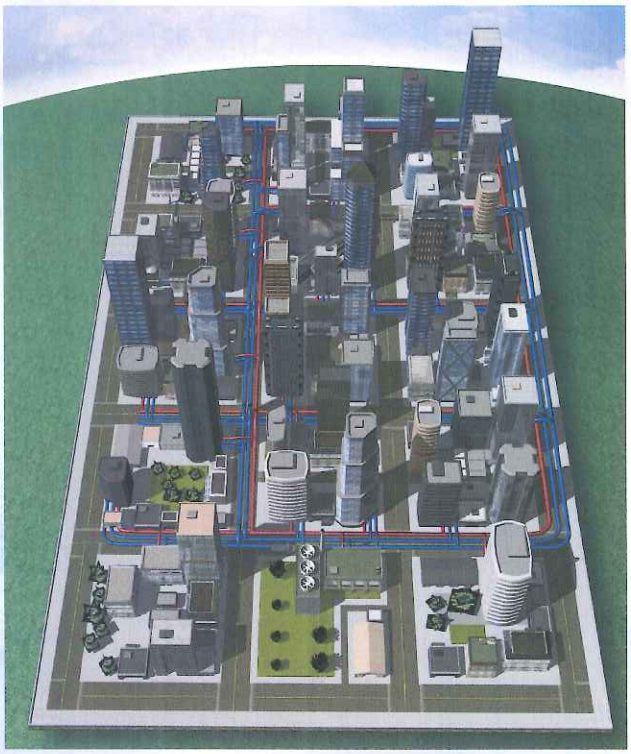


- Formed in 1909 – 102 years in 2011
- 501(c)6 industry association
- 1500+ members in 25 nations
- 56% end-user systems; majority in North America; 42 states
- Most major public & private colleges and universities; urban utilities.

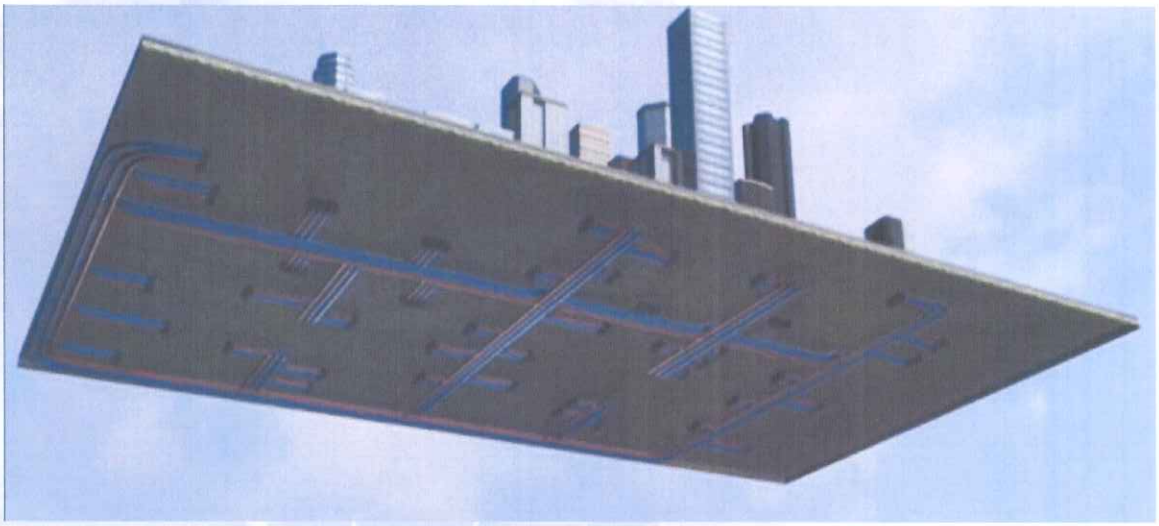

Cooling Supply and Return
Heating Supply and Return

District Energy – Community Scale Heating and Cooling

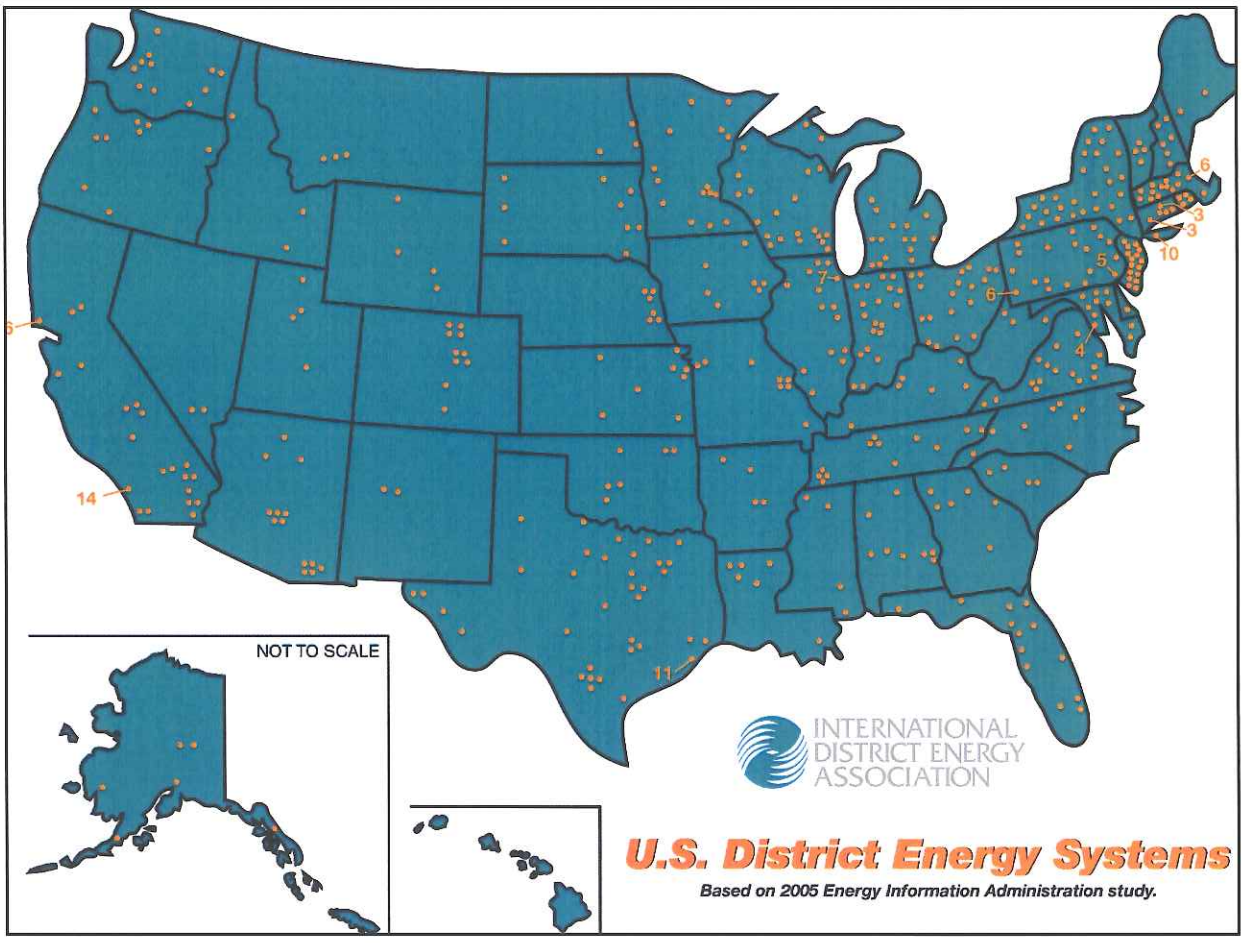
- Underground network of pipes "combines" heating and cooling requirements of multiple buildings
- Creates a "market" for valuable thermal energy
- Aggregated thermal loads creates scale to apply fuels, technologies not feasible on single-building basis
- Fuel flexibility improves energy security, local economy



Infrastructure for Local Clean Energy Economy



- Connects thermal energy sources with users
- Urban infrastructure – hidden community asset
- Robust and reliable utility services
- Energy dollars re-circulate in local economy

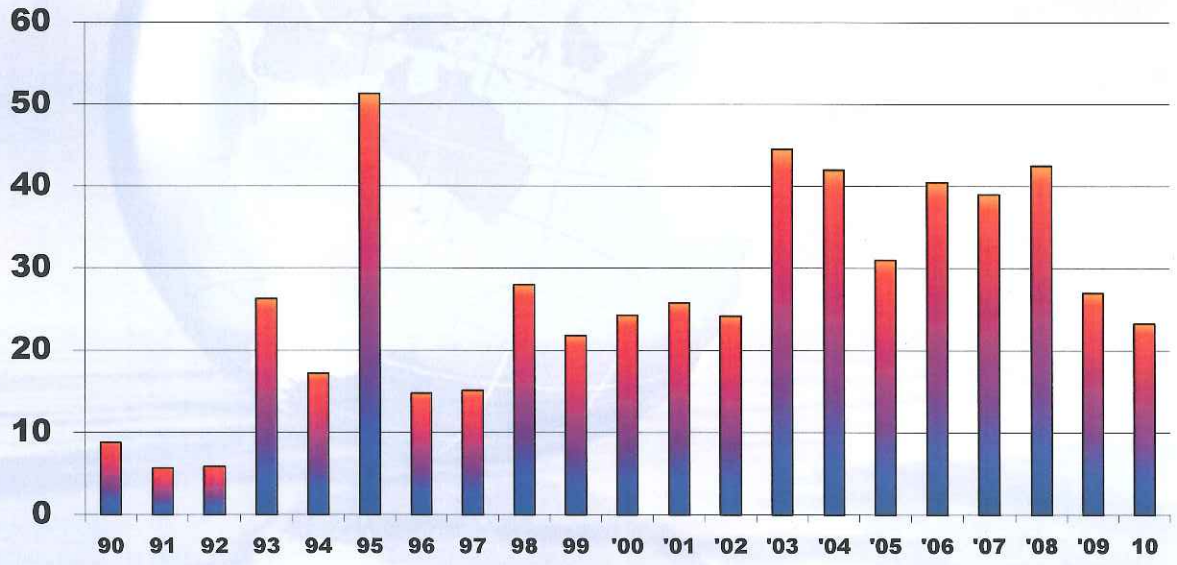

6
3
3
10
5
7
6
4
6
14
11
NOT TO SCALE
INTERNATIONAL DISTRICT ENERGY ASSOCIATION
U.S. District Energy Systems
Based on 2005 Energy Information Administration study.

District Energy Industry Growth

(Million sq ft customer bldg space connected/committed)

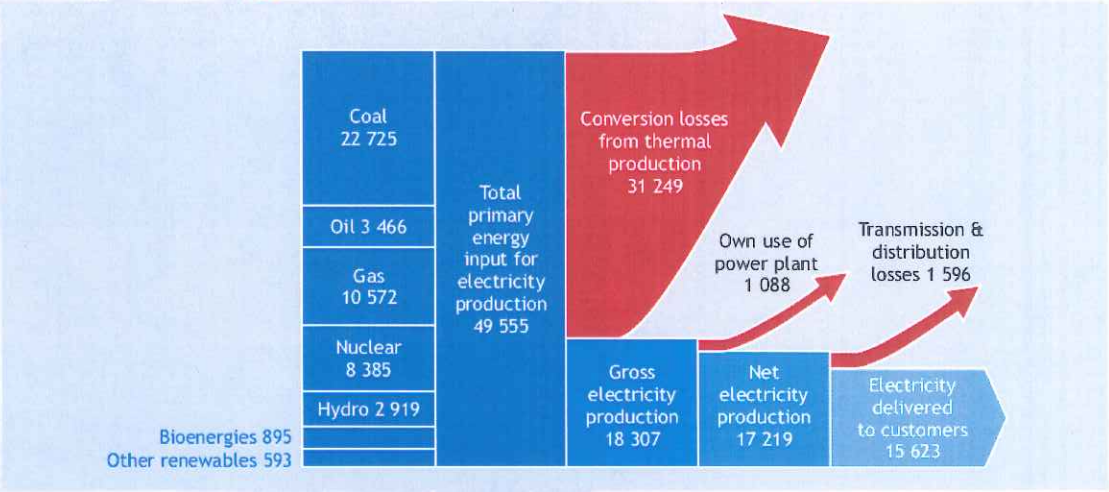
Aggregate SF reported since 1990 – 518,461,287 SF

(Annual average 24.7 Million SF/Yr – North America)



Wasted Energy
Is a Huge Challenge and Opportunity

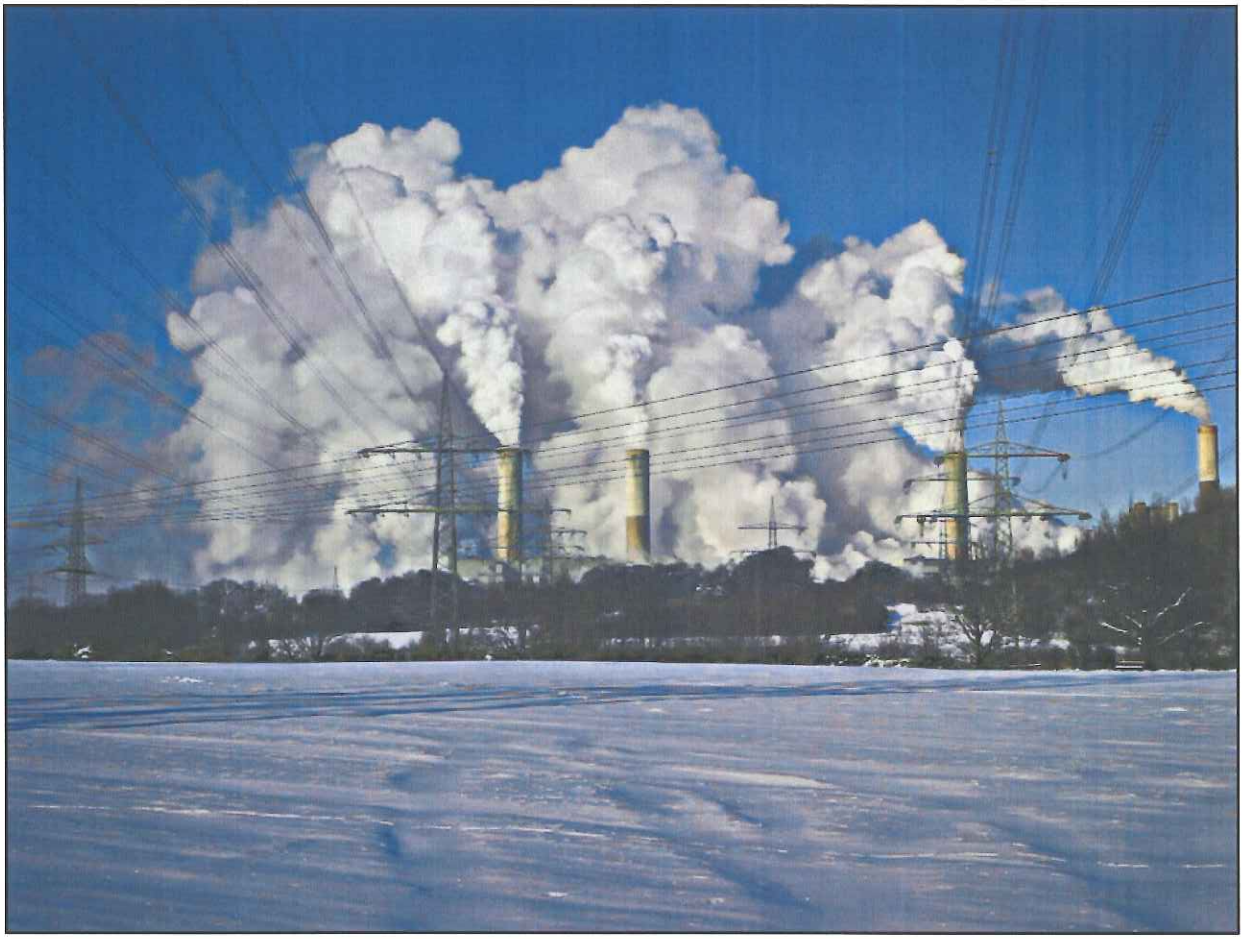
Energy Flows in the Global Electricity System

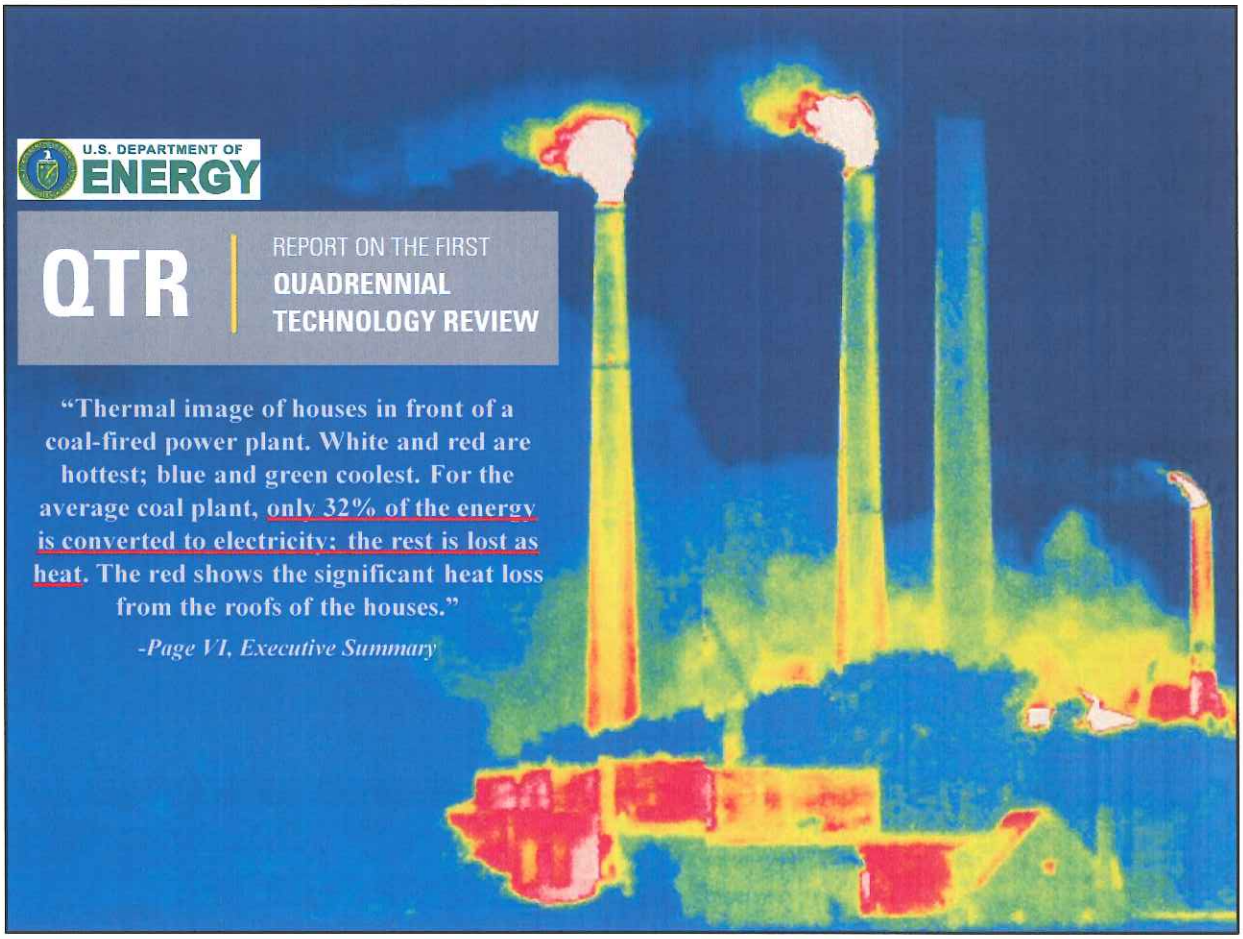


Source: IEA, *CHP: Evaluating the Benefits of Greater Global Investment* (2008).

2/3 of the fuel we use to produce power is wasted --

CHP can more than double this efficiency




U.S. DEPARTMENT OF
ENERGY
QTR
REPORT ON THE FIRST
QUADRENNIAL
TECHNOLOGY REVIEW
"Thermal image of houses in front of a coal-fired power plant. White and red are hottest; blue and green coolest. For the average coal plant, only 32% of the energy is converted to electricity; the rest is lost as heat. The red shows the significant heat loss from the roofs of the houses."
-Page VI, Executive Summary

Efficiency of US Power Generation

U.S. COAL-FIRED POWER PLANTS RANKED BY EFFICIENCY

Decile	No of units	Net nameplate capacity (GW)	Capacity factor	2007 total generation (BkWh)	2007 generation-weighted efficiency (HHV)
1	181	30	67%	177	26.5%
2	108	30	70%	180	30.0%
3	90	30	73%	189	31.0%
4	73	30	73%	189	31.7%
5	84	30	75%	194	32.4%
6	75	30	69%	181	33.2%
7	79	29	71%	182	34.0%
8	70	30	70%	186	34.9%
9	57	29	72%	184	35.9%
10	46	30	74%	192	37.9%
Overall	863	297	71%	1,856	32.5%

Power Engineering Magazine, November 2009

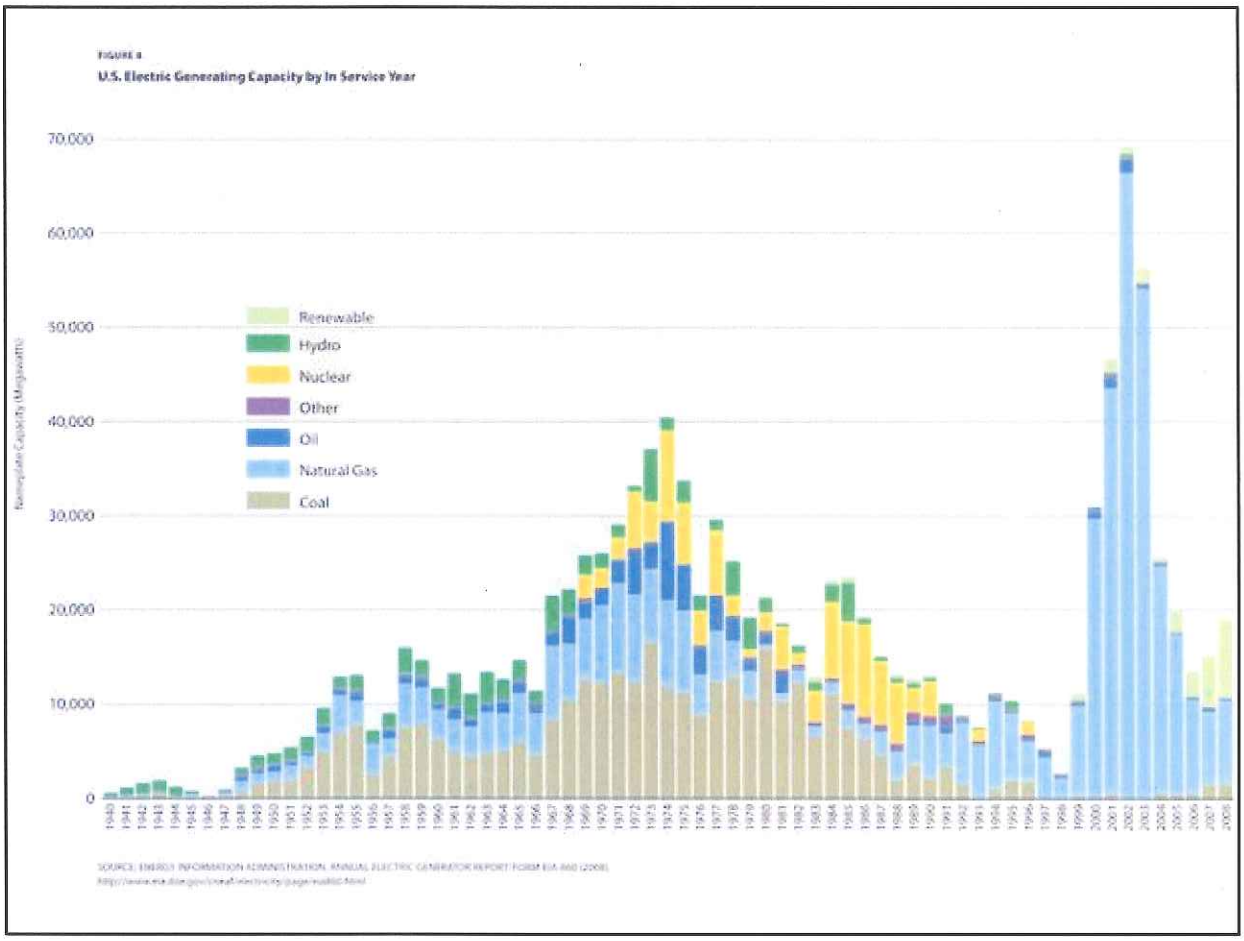


FIGURE 8
U.S. Electric Generating Capacity by In Service Year
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Renewable
Hydro
Nuclear
Other
Oil
Natural Gas
Coal

Opportunity: **District Energy**

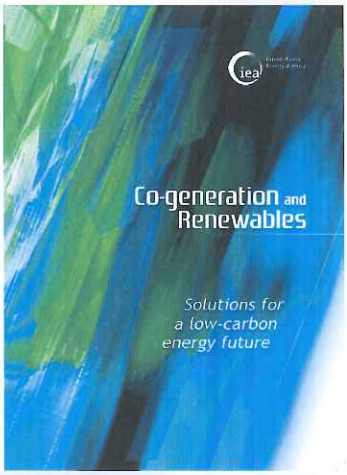
"District heating and cooling is an integrative technology that can make significant contributions to reducing emissions of carbon dioxide and air pollution and to <u>increasing energy security</u>."

International Energy Agency DHC/CHP Executive Committee
District Heating and Cooling: EnvironmentalTechnology for the 21st Century

Opportunity – Use Surplus Heat

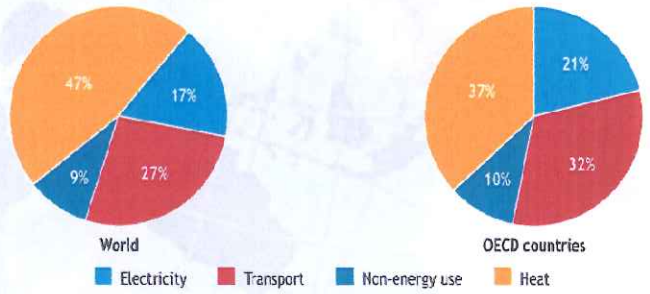
International Energy Agency (IEA)

- **May, 2011 Report *"Co-generation and Renewables – Solutions for a low-carbon energy future"***
- **Renewables: garnering more and more attention and support, and rightly so**
- **Proven low-carbon solutions like CHP/DE should not be forgotten**
- **Analyzed cases where CHP and renewables are complementary and share common goals**

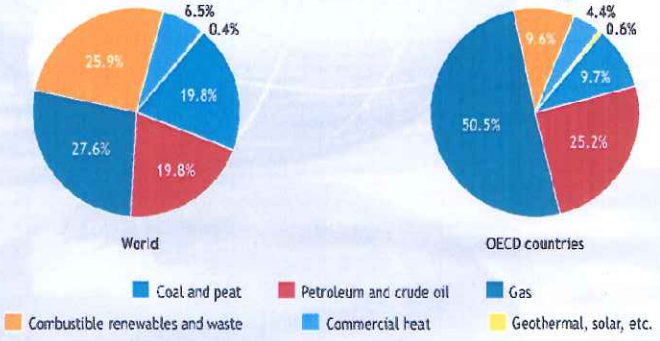


IEA 2011 Report – Spotlight on *Heat*

- **Heat dominates all other energy uses**



- **Heat production is dominated by fossil fuels**



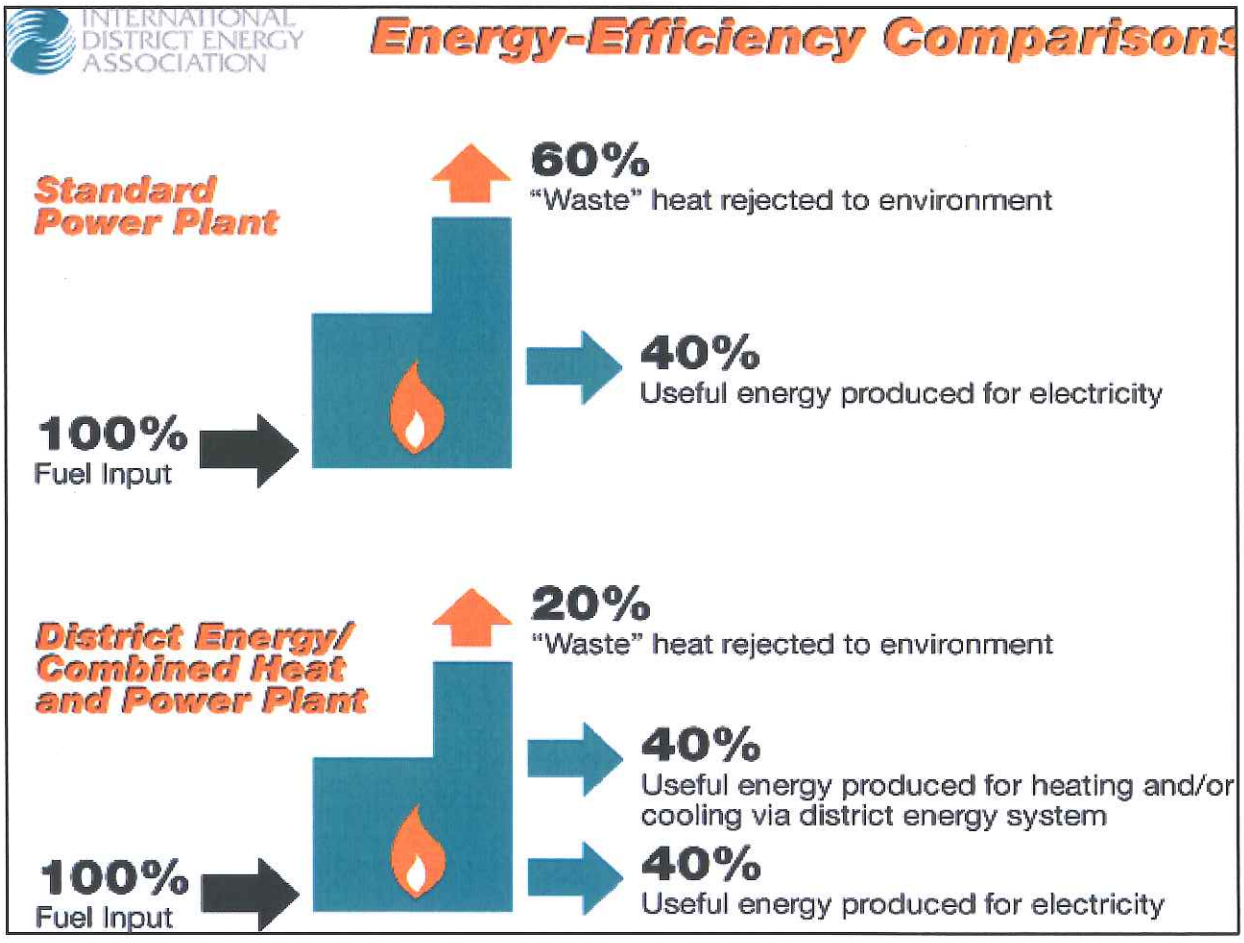
IPCC Cites District Energy

"Measures to reduce greenhouse gas (GHG) emissions from buildings fall into one of three categories: reducing energy consumption and embodied energy in buildings, switching to low-carbon fuels including a higher share of renewable energy or controlling the emissions of non-CO2 GHG gases."

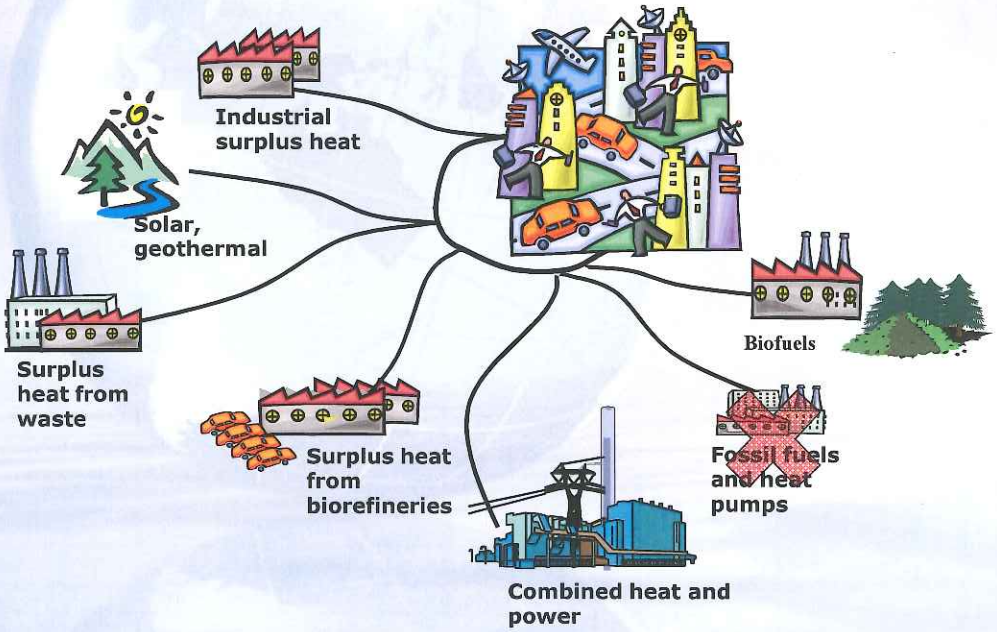
"Community-scale energy systems also offer significant new opportunities for the use of renewable energy."

ipcc
INTERGOVERNMENTAL PANEL ON climate change

Intergovernmental Panel on Climate Change
Chapter 6 - Residential and Commercial Buildings


INTERNATIONAL DISTRICT ENERGY ASSOCIATION
Energy-Efficiency Comparisons
Standard Power Plant
60%
"Waste" heat rejected to environment
40%
Useful energy produced for electricity
100%
Fuel Input
District Energy/ Combined Heat and Power Plant
20%
"Waste" heat rejected to environment
40%
Useful energy produced for heating and/or cooling via district energy system
40%
Useful energy produced for electricity
100%
Fuel Input

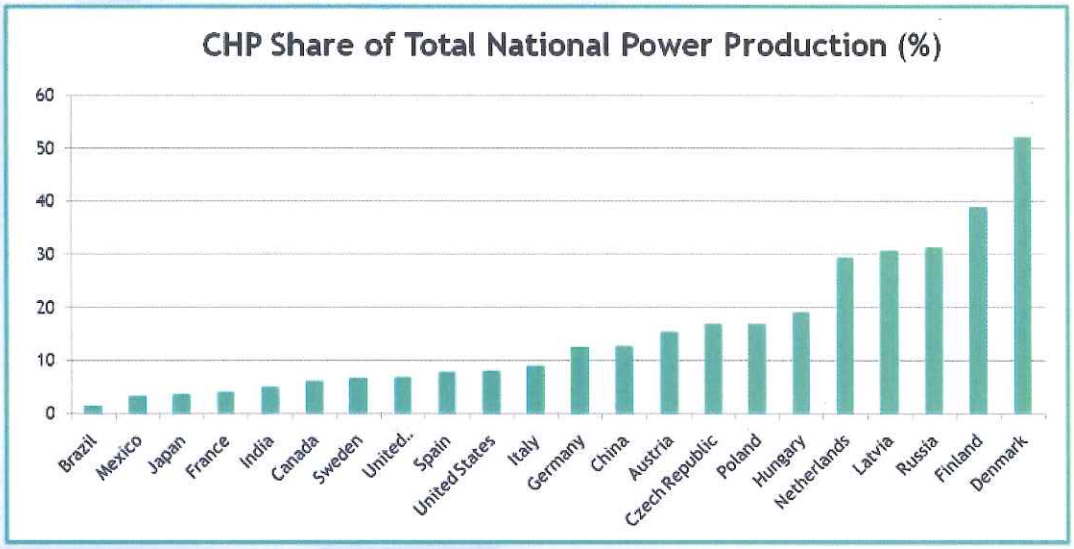
District Energy Networks Make Efficient Use of Local Renewable Energy Sources and Surplus Heat



District Energy: Creating Scale for Efficient and Cleaner Energy Solutions

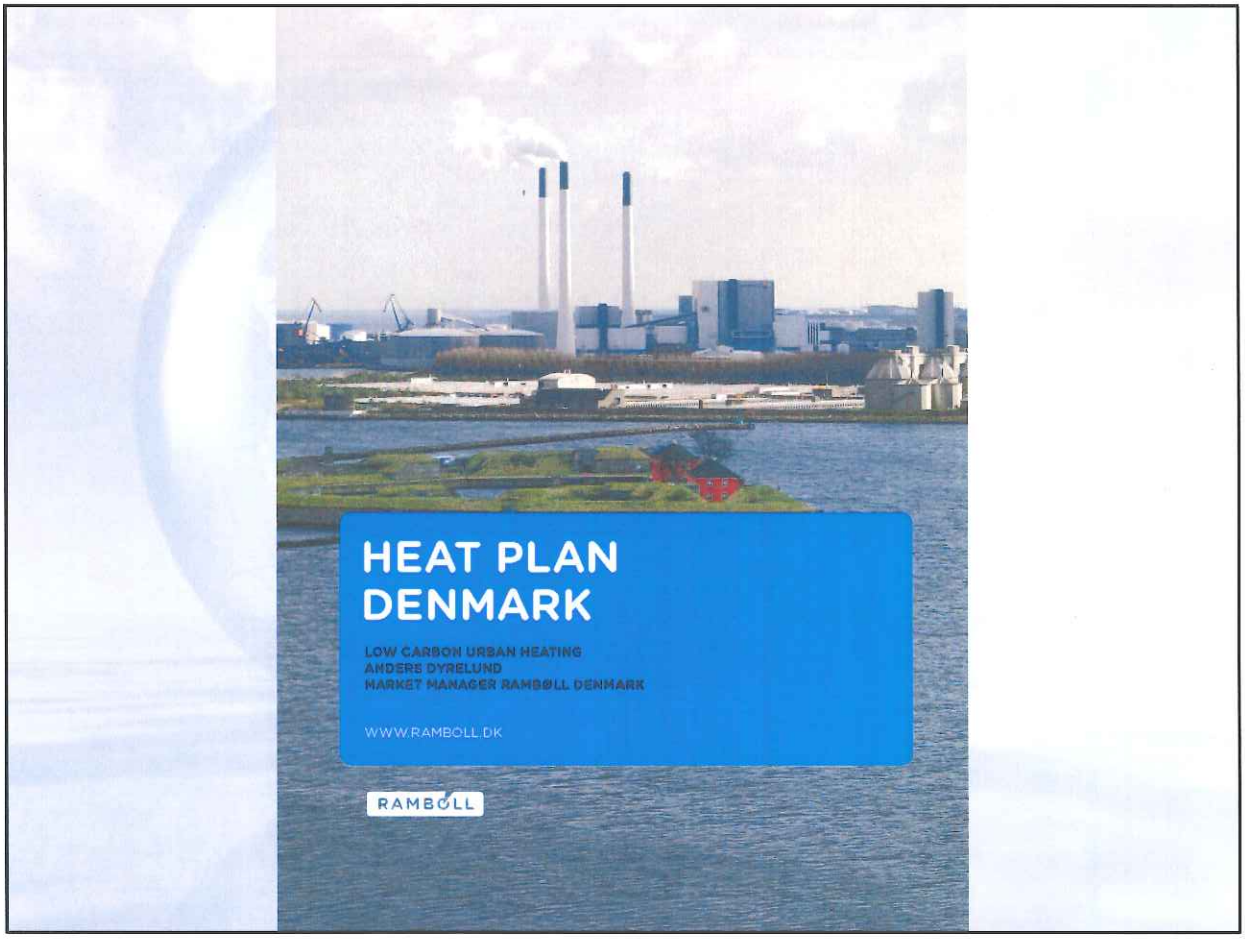
- **Promotes Energy Efficiency and Grid Reliability**
- **Increases Energy Security Through Fuel Flexibility**
- **Eases Transition to Alternative Energy Sources**
  - Local fuel supplies (biomass, surplus wood, waste, etc)
  - Renewable thermal (lake/ocean/river cooling; geothermal)
- **Enables Use of Surplus Thermal Energy**
  - Heat from power generation stations
  - Excess industrial heat sources
- **Decreases Emissions of Carbon**
- **Energy Dollars Re-circulate in Local Economy**
- **Improves Air Quality**

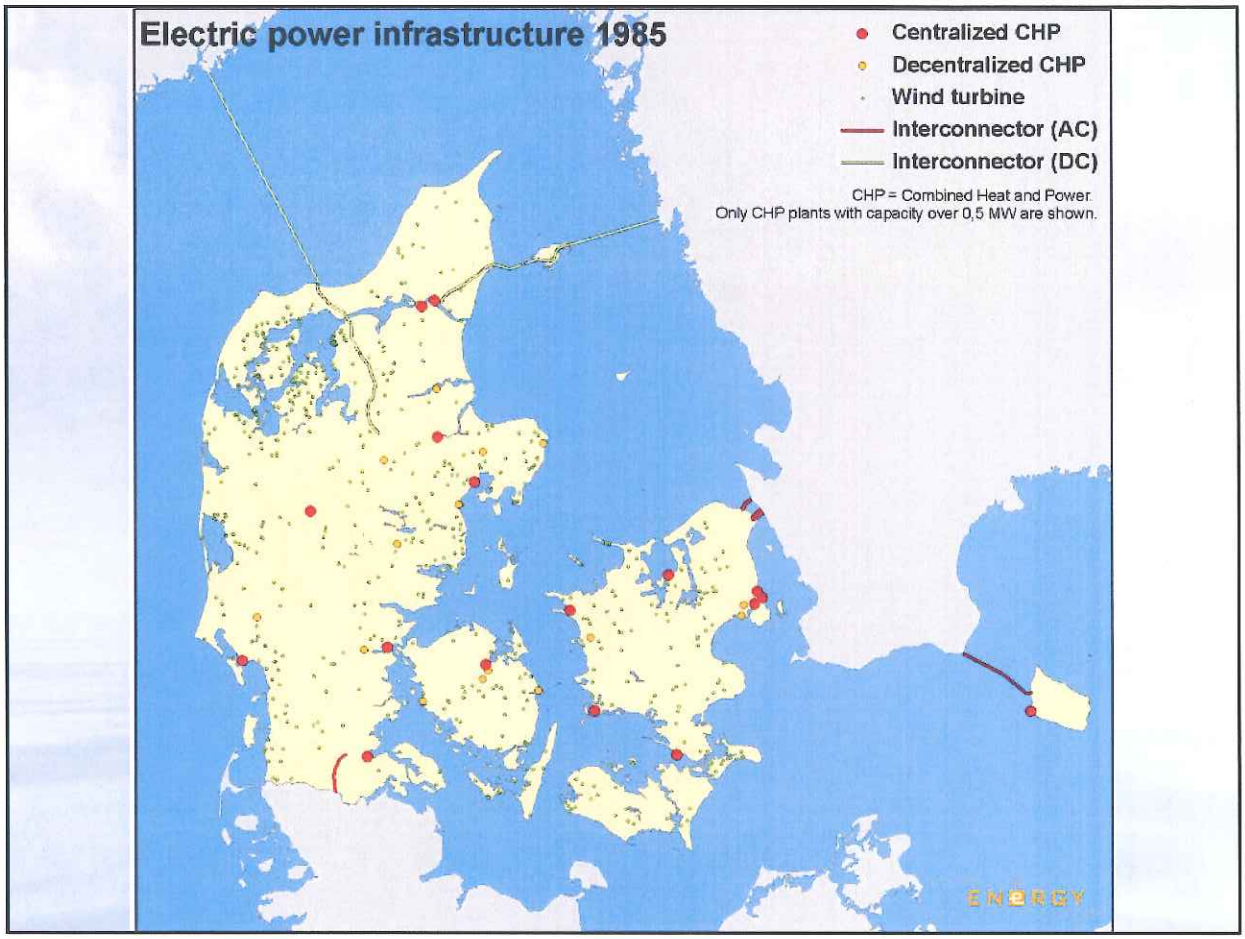
CHP as a Share of Total National Power Generation

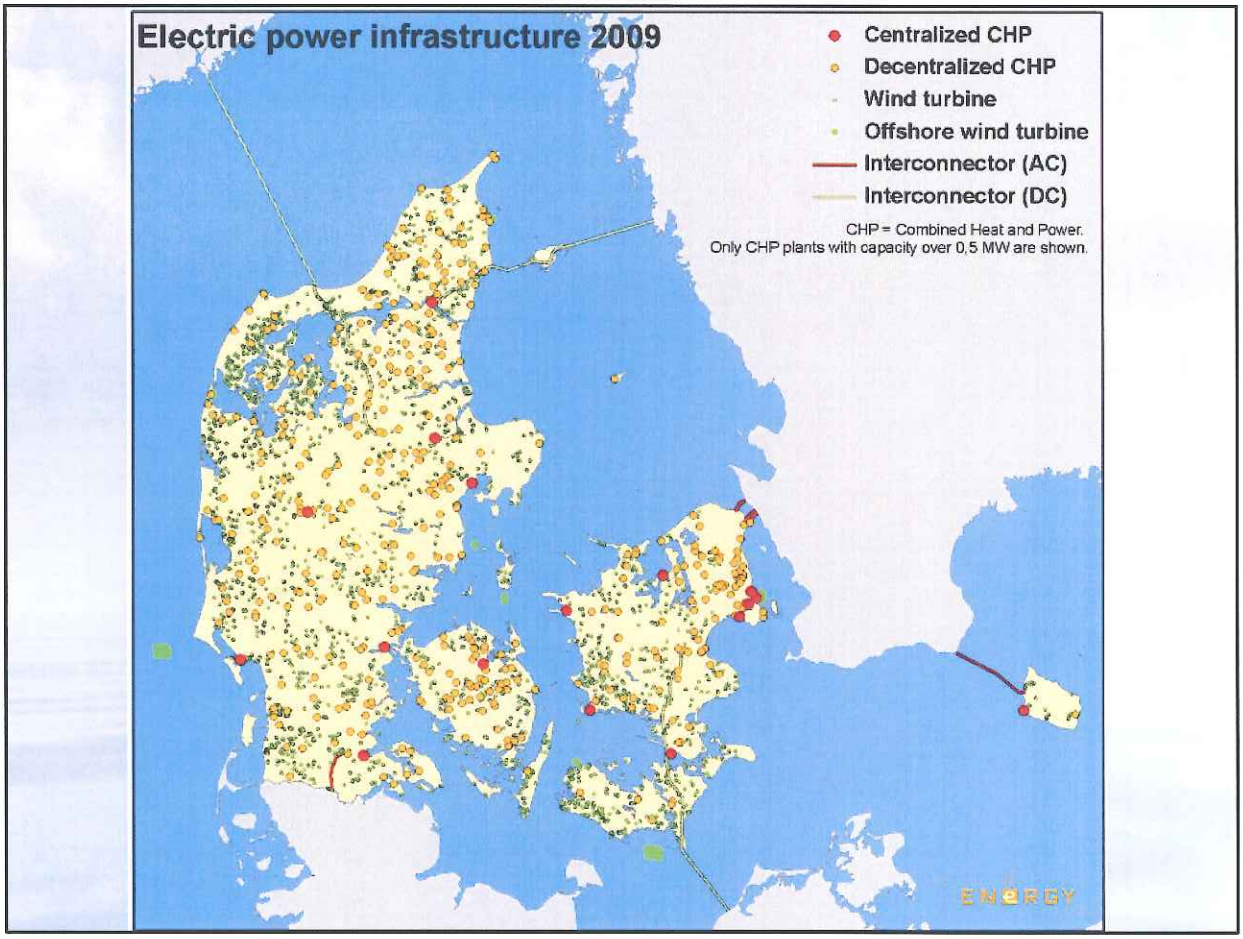


Source: IEA, *CHP: Evaluating the Benefits of Greater Global Investment* (2008).

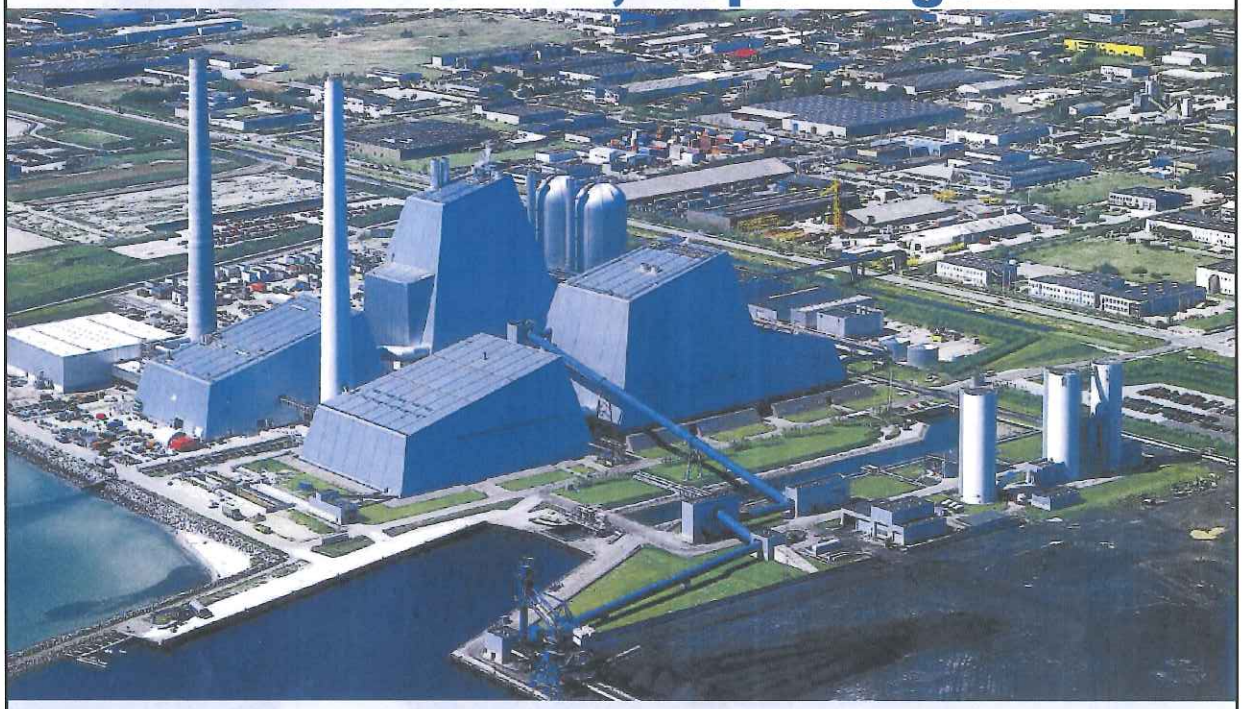
The global average is just 9%


HEAT PLAN
DENMARK
LOW CARBON URBAN HEATING
ANDERS DYRELUND
MARKET MANAGER RAMBØLL DENMARK
WWW.RAMBOLL.DK
RAMBØLL


Electric power infrastructure 1985
Centralized CHP
Decentralized CHP
Wind turbine
Interconnector (AC)
Interconnector (DC)
CHP = Combined Heat and Power.
Only CHP plants with capacity over 0,5 MW are shown.
ENERGY


Electric power infrastructure 2009
Centralized CHP
Decentralized CHP
Wind turbine
Offshore wind turbine
Interconnector (AC)
Interconnector (DC)
CHP = Combined Heat and Power.
Only CHP plants with capacity over 0,5 MW are shown.
ENERGY

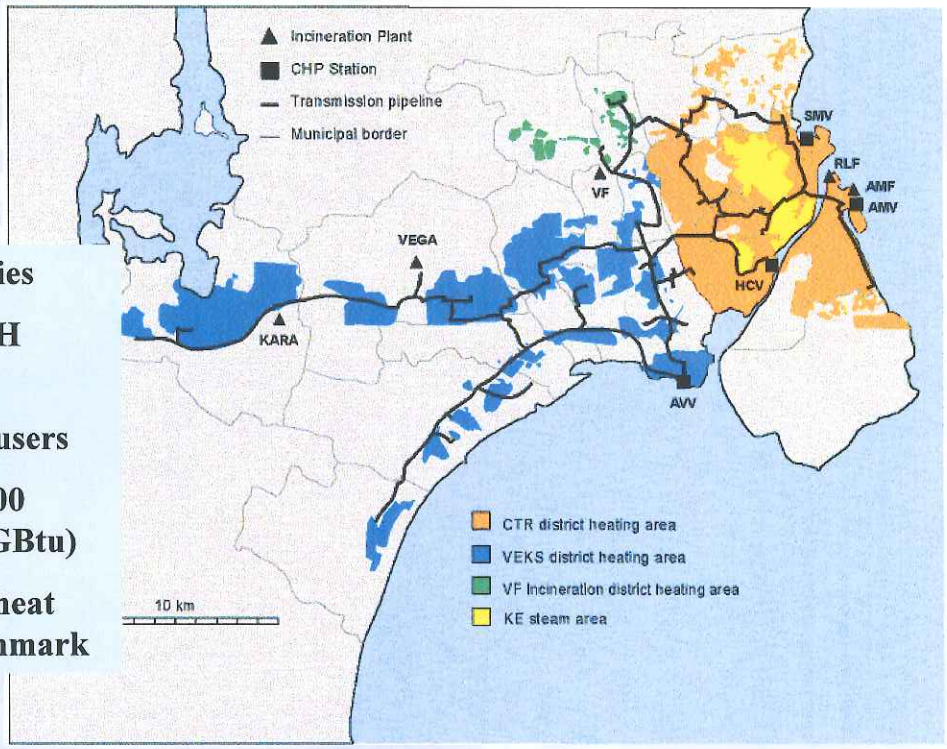
CHP World Class Efficiency – 90%+
Avedore 1&2, Copenhagen



Unit 1 (810MW) – Coal; Unit 2 (900 MW) – Multi-Fuel (straw; biomass, etc)

Heat Transmission Systems

The Greater Copenhagen DH System



18 municipalities

4 integrated DH systems

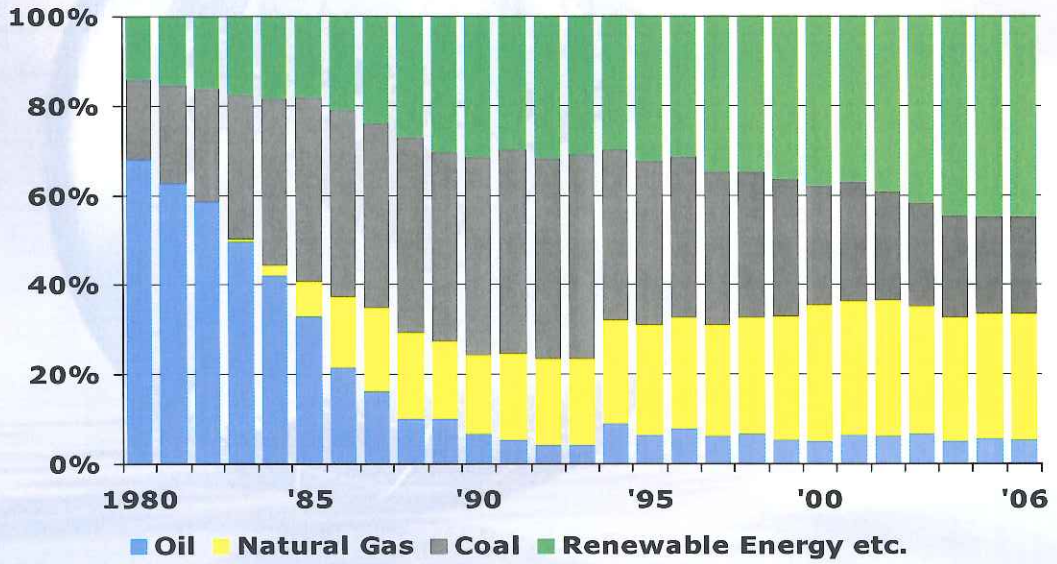
500,000 end – users

34,500 TJ (9,600 GWh, 32,700 GBtu)

Approx 20 % heat demand in Denmark

District Heating and RE

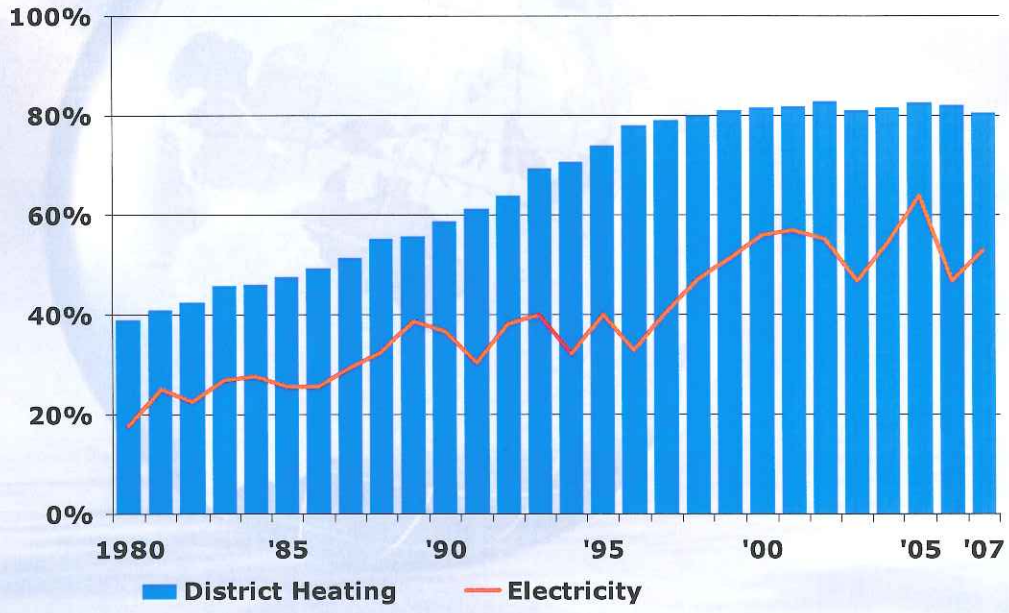
- Composition of Fuels for District Heating Production



Source: Danish Energy Authority

DBDH

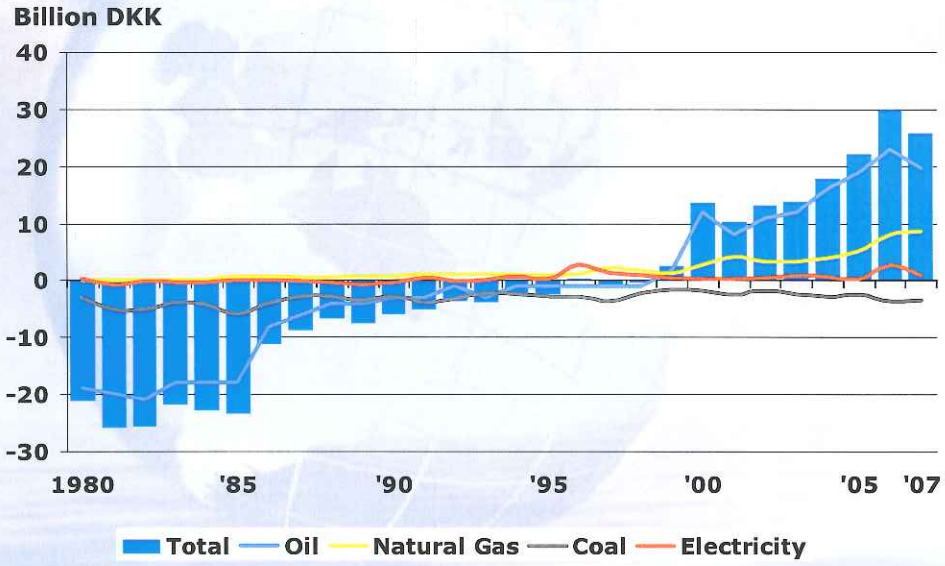
CHP share of DH and Power



Source: Danish Energy Authority

DBDH

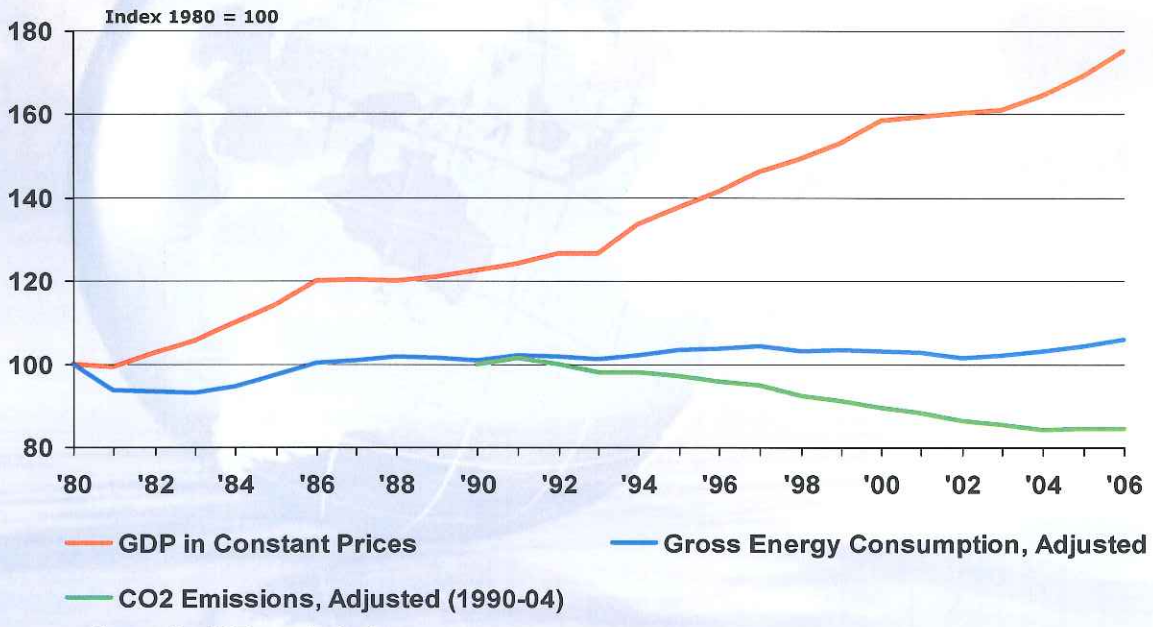
National Energy Account



Source: Danish Energy Authority

DBDH

Economic Impact in Denmark
- GDP, CO_2 and Energy Consumption

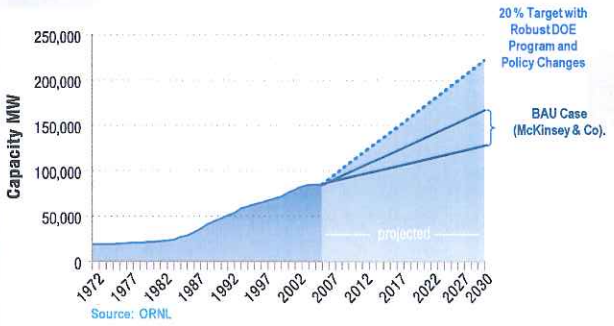


Source: Danish Energy Authority

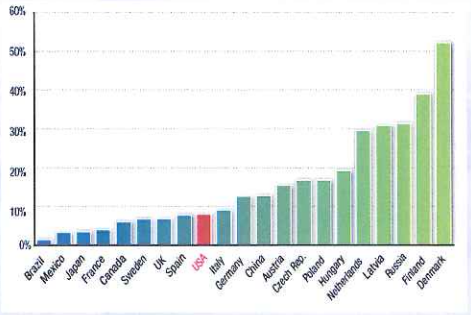
DBDH

US Policy at DOE - CHP 20% of US Generating Capacity in 2030

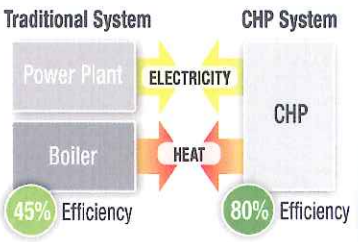
CHP	2006	2030 Target
Total Electricity Generating Capacity	85 GW (9% of current capacity)	240.9 GW (20% of projected capacity
Annual Energy Savings	1.9 Quads	5.3 Quads
Annual CO_2 Reduction	248 MMT	848 MMT
Number of Car Equivalents Taken Off Road	45 million	154 million



CHP in a Global Context – 20% Capacity Goal is Reachable

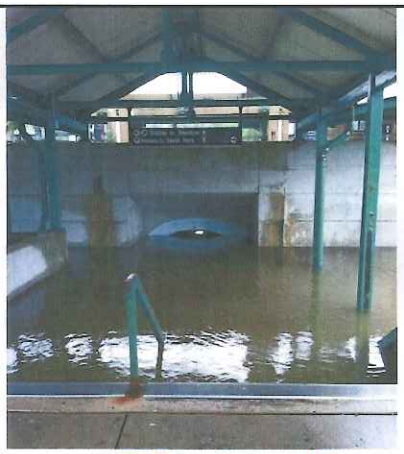


CHP Process Flow Diagram



Project contractors install District Energy chilled water pipes in St. Paul, MN in February 2010

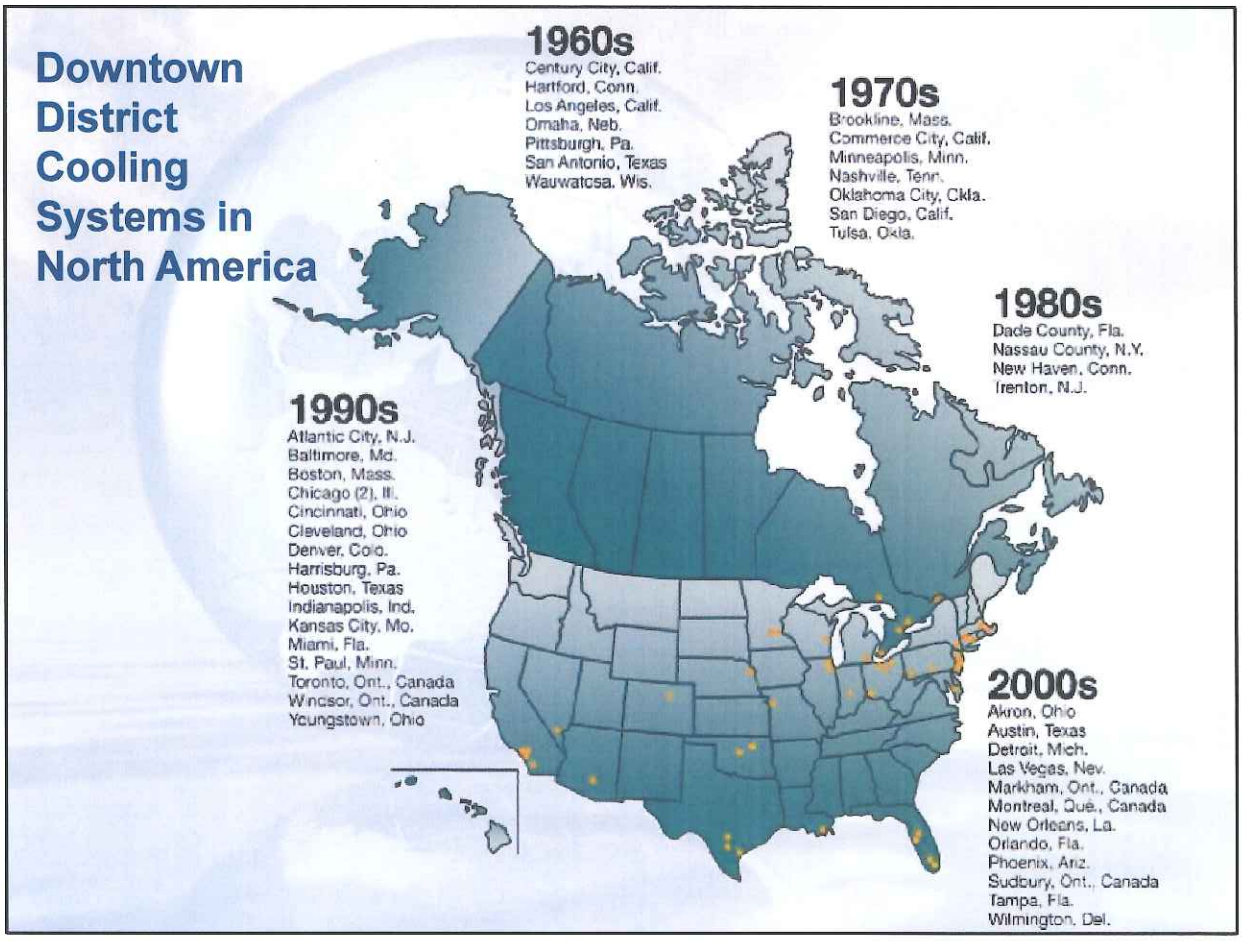
Northridge Earthquake 1994

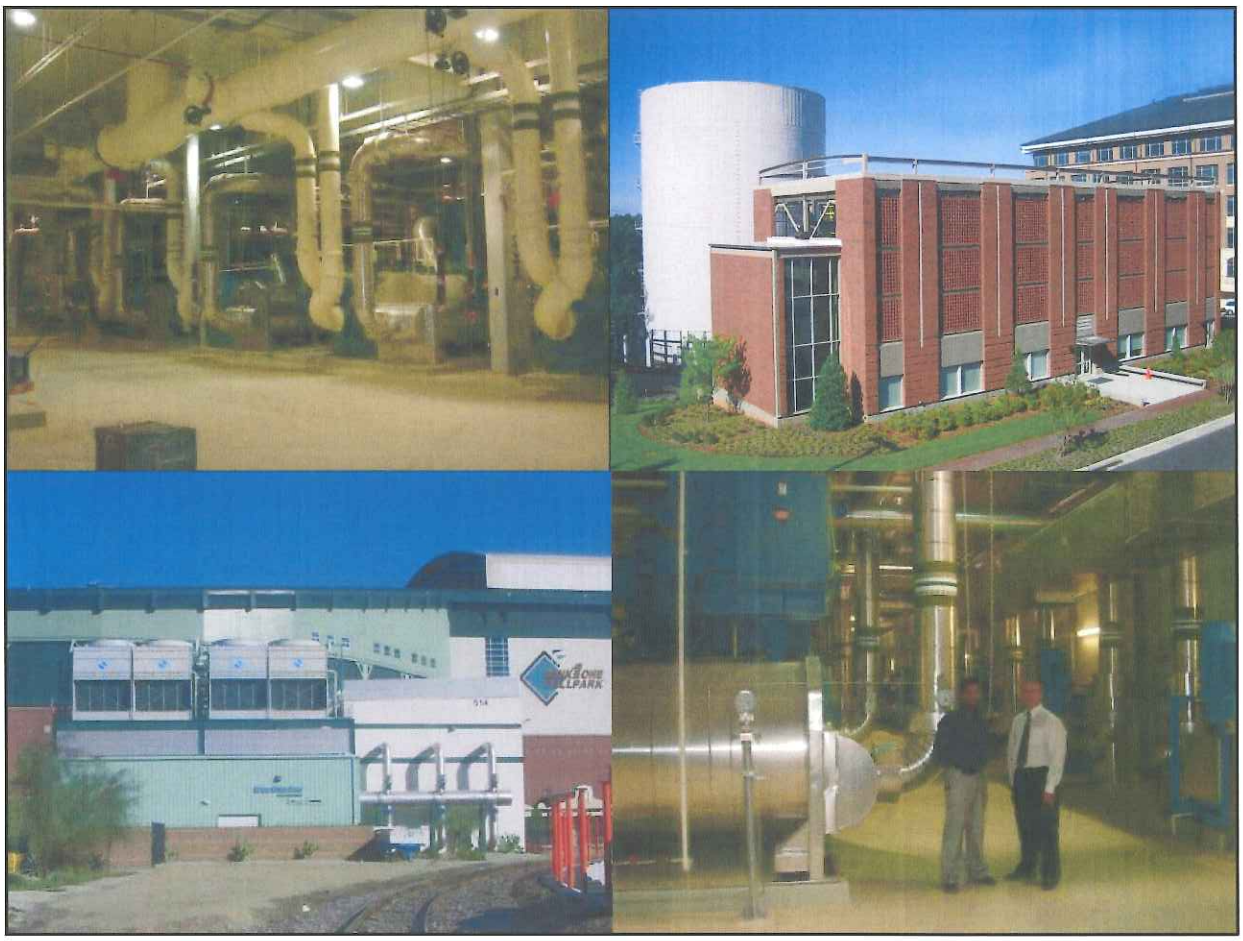


Princeton, NJ
Hurricane Irene 2011

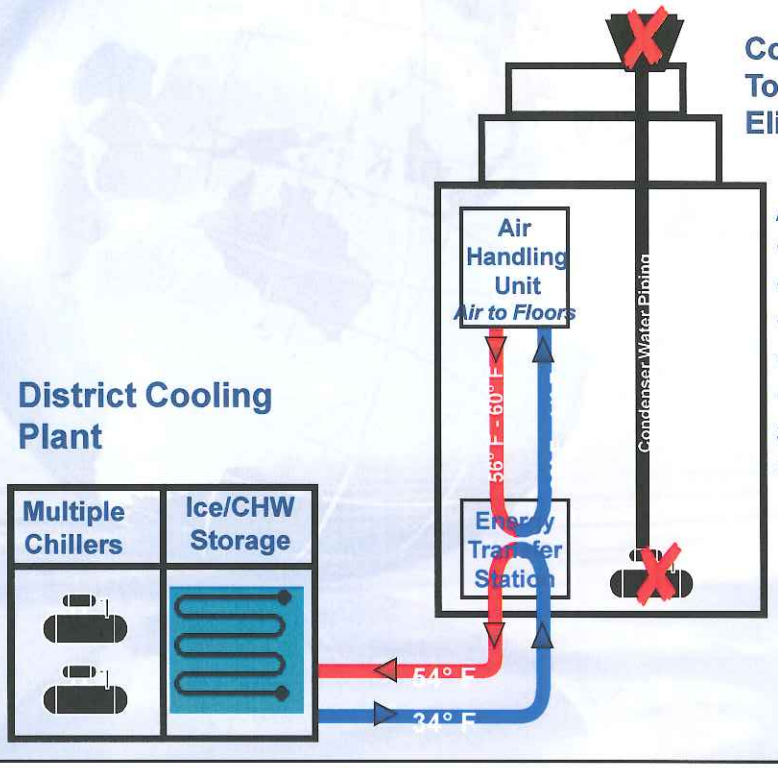
Ottawa Ice
Storm 1998

Loma Prieta
Earthquake
1989


Downtown District Cooling Systems in North America
1960s
Century City, Calif.
Hartford, Conn.
Los Angeles, Calif.
Omaha, Neb.
Pittsburgh, Pa.
San Antonio, Texas
Wauwatosa, Wis.
1970s
Brookline, Mass.
Commerce City, Calif.
Minneapolis, Minn.
Nashville, Tenn.
Oklahoma City, Okla.
San Diego, Calif.
Tulsa, Okla.
1980s
Dade County, Fla.
Nassau County, N.Y.
New Haven, Conn.
Trenton, N.J.
1990s
Atlantic City, N.J.
Baltimore, Md.
Boston, Mass.
Chicago (2), Ill.
Cincinnati, Ohio
Cleveland, Ohio
Denver, Colo.
Harrisburg, Pa.
Houston, Texas
Indianapolis, Ind.
Kansas City, Mo.
Miami, Fla.
St. Paul, Minn.
Toronto, Ont., Canada
Windsor, Ont., Canada
Youngstown, Ohio
2000s
Akron, Ohio
Austin, Texas
Detroit, Mich.
Las Vegas, Nev.
Markham, Ont., Canada
Montreal, Que., Canada
New Orleans, La.
Orlando, Fla.
Phoenix, Ariz.
Sudbury, Ont., Canada
Tampa, Fla.
Wilmington, Del.



Building Interconnection (CHW)

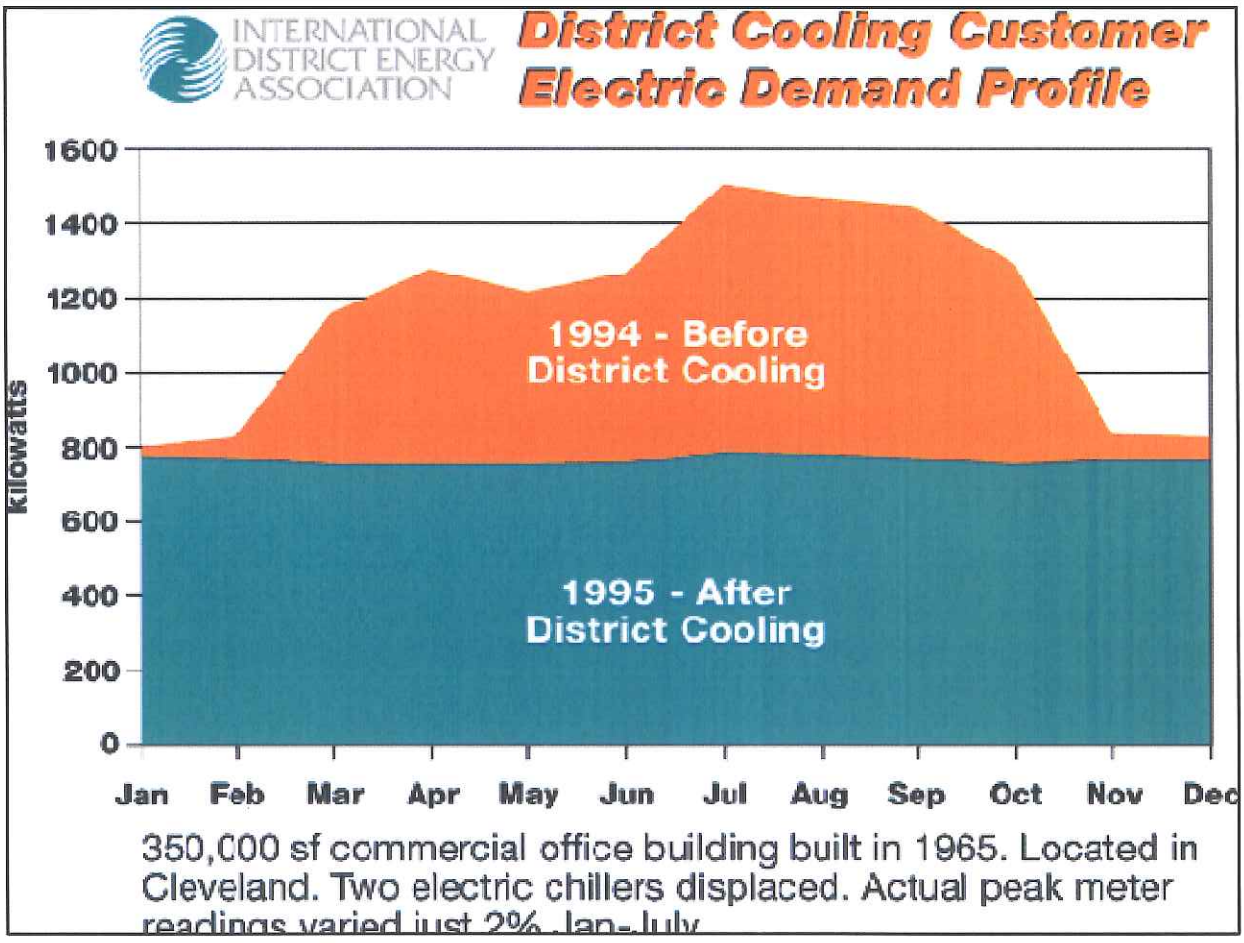


AVOIDED
- Boilers/Chillers
- CFC's
- Fuel Combustion
- Stacks/Chimney
- Fuel Delivery & Storage
- Emissions

REDUCED
- Electrical Vault
- Water Use
- Chemicals
- Mechanical space

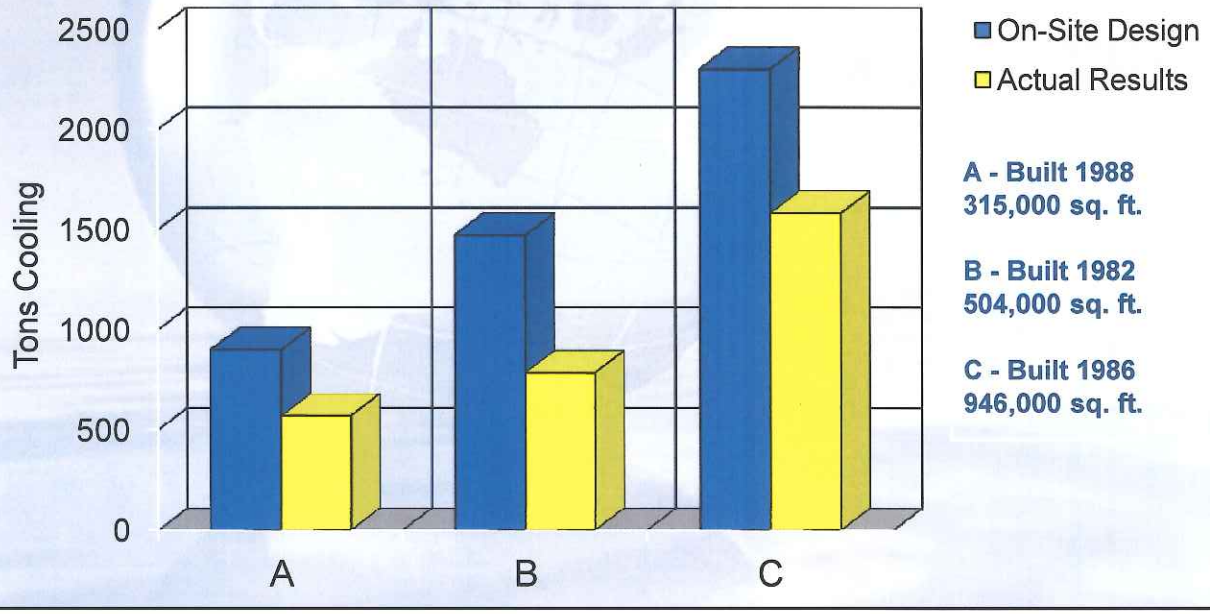
Impact on End User

- Customer capital costs reduced or amortized over long term service agreement
- Reduces size mechanical room; electrical vaults; condenser shafts and roof loads
- Colder CHW supply improves HVAC performance
- Lower owning, operating and maintenance costs
- More leasable space


INTERNATIONAL DISTRICT ENERGY ASSOCIATION
District Cooling Customer Electric Demand Profile
kilowatts
1600
1400
1200
1000
800
600
400
200
0
1994 - Before District Cooling
1995 - After District Cooling
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
350,000 sf commercial office building built in 1965. Located in Cleveland. Two electric chillers displaced. Actual peak meter readings varied just 2% Jan-July

Customer Cooling Requirements

On-Site Chiller Capacity vs. System Contract Capacity
(Annual Peak)



Higher Value Buildings

Without District Energy

With District Energy

Downtown Phoenix System

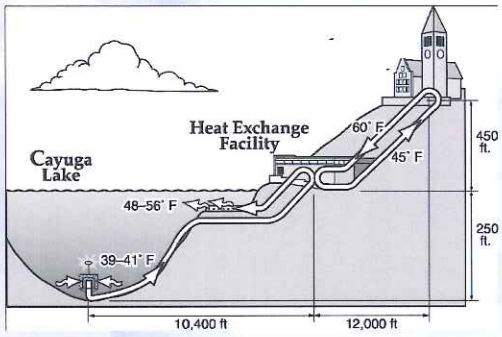
Chase Field Plant

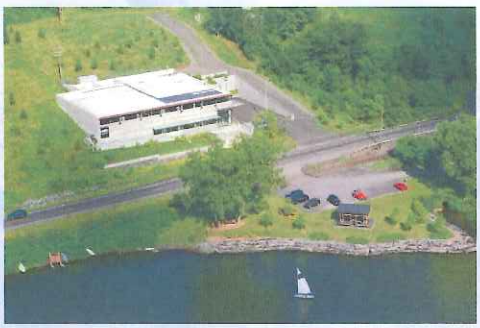
NRG Energy Center Phoenix District Energy Plant

Phoenix Convention Center Plant

- System serves buildings ranging in size from 3,000 ft^2 to over 1,900,000 ft^2.
- 20,500 ft of 24" chilled water pipeline circulates 2.2 million gallons of 34° F water to more than 12,000,000 ft^2 of building space.
- A total of 14 chillers and two thermal storage tanks are employed.
- The downtown system currently has a total capacity 40,000 tons, which will likely be sold out by 2012.

Cornell Lake Source Cooling



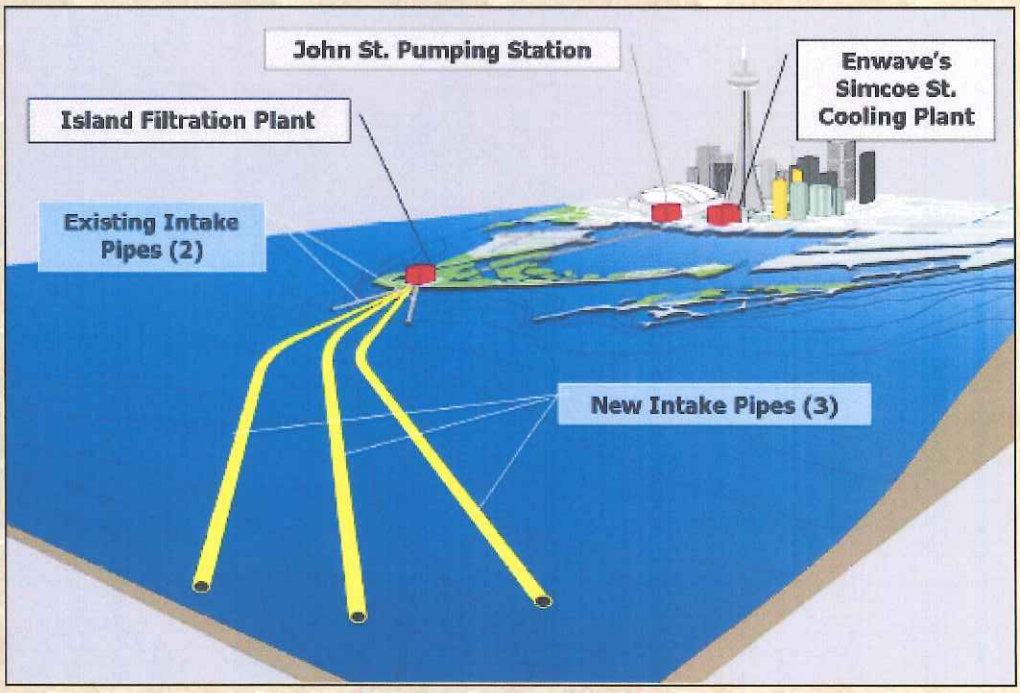


- 16,000 Tons Capacity - $58,000,000
- Lake source water: 39-41° F
- Lake return water : 48-56° F
- Campus loop supply/return : 45° - 60° F
- Lake source intake pipe: 10,400 ft long, 250 ft deep
- Campus S/R loop pipe: 12,000 ft

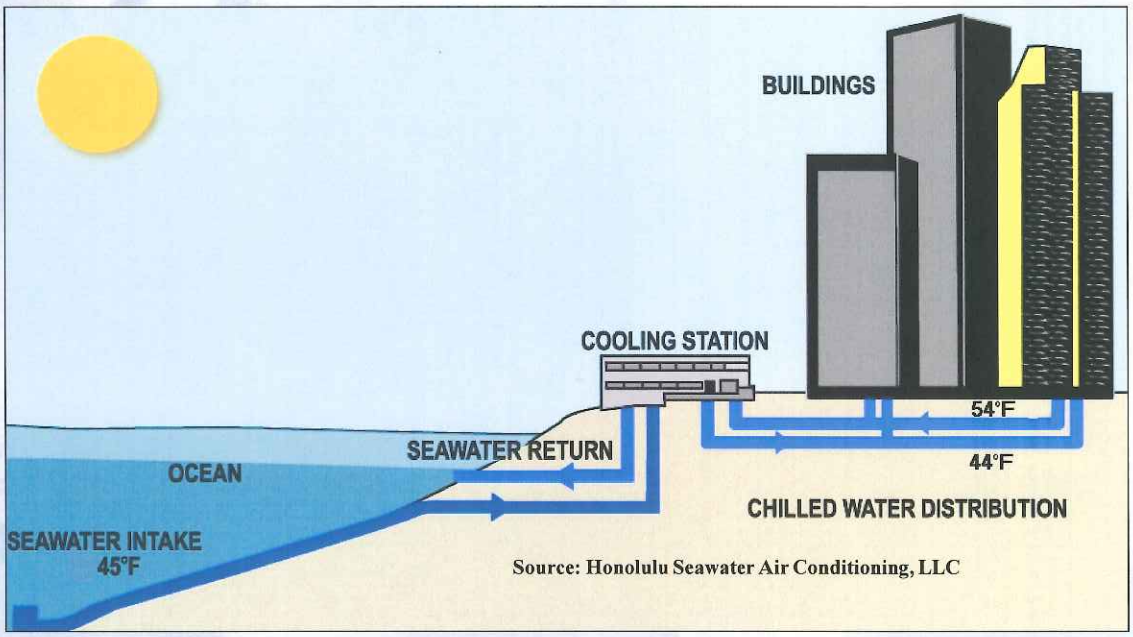
Benefits:

- Reduced cooling electricity by 87% - cutting 25 million kwh/yr
- Efficiency - production at 0.1 kW/ton; fully automated (no operators)
- CO2 emissions cut 56 million #'s/yr
- Sulfur oxides cut 654,000 lbs/yr
- Nox reduced 55,000 lbs/yr
- 40,000 lbs CFC eliminated
- Traded op expense for amortization

Toronto Deep Lake Cooling – Enwave Energy Corp



Honolulu Seawater Air Conditioning



Source: Honolulu Seawater Air Conditioning, LLC

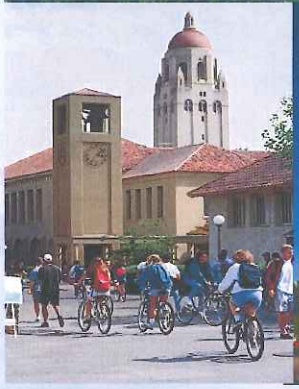
Palm Jumeirah Island – District Cooling

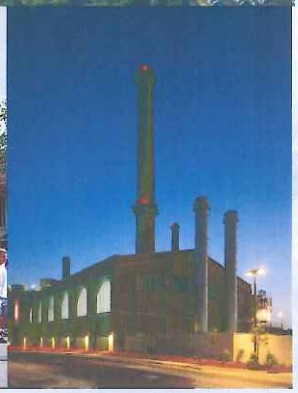

free spirited style
EMAAR


WE'VE
SET
OUR
VISION
HIGHER


INTERNATIONAL
DISTRICT ENERGY
ASSOCIATION

Institutions - Campus Energy Systems





- Load growth driven by building construction
- "Mission-critical" research & care facilities - reliability is paramount
- Common ownership between plant/buildings
- Able to retain 100% energy savings
- Longer investment horizon
- History of success with combined heat & power (CHP)

Thermal Energy Corp. (TECO)

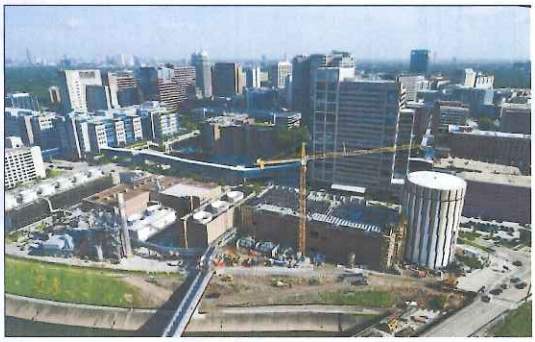
Thermal Energy Corp. (TECO)

- District Energy System provides thermal energy, (chilled water & steam) for air conditioning, heating and process for Texas Medical Center – largest health care campus in the world
- Now, largest district cooling system in US – 120,000 Tons
- 18 Institutions, 18.9 million sq ft; all not-for profit
  - 7 hospitals
  - 2 medical schools
  - 3 nursing schools
- 6,800 hospital beds; mission-critical loads; research; surgeries

TECO Combined Heat and Power

TECO District Energy/CHP

- $377M utility master plan expansion added 48 MWe CHP
- Increased fuel efficiency to over 80%
- Further improved system & grid reliability
- Will save $200 million over 15 years
- Reduced CO^2 by 302,000 tons per year
  - equivalent to taking 52,000 cars off the streets
  - or planting 83,000 acres of new forest



Texas Summer 2011

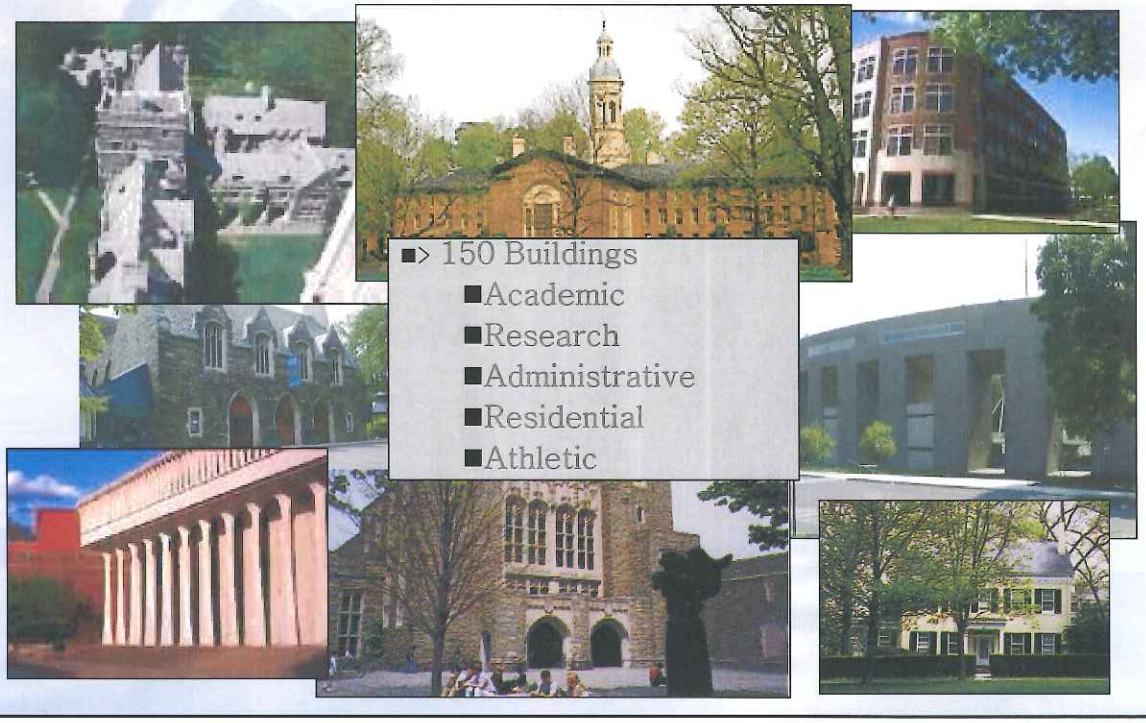
- Texas has set record demands for electricity this summer:
  - Over 70 days over 100 deg F.
  - ERCOT (grid) at maximum capacity charge for much of summer ($3000/MW hr)
- TECO was able to produce 100% of their electric requirements and still support the power grid
- Benefited a congested transmission area

Robust and Reliable Thermal Utility

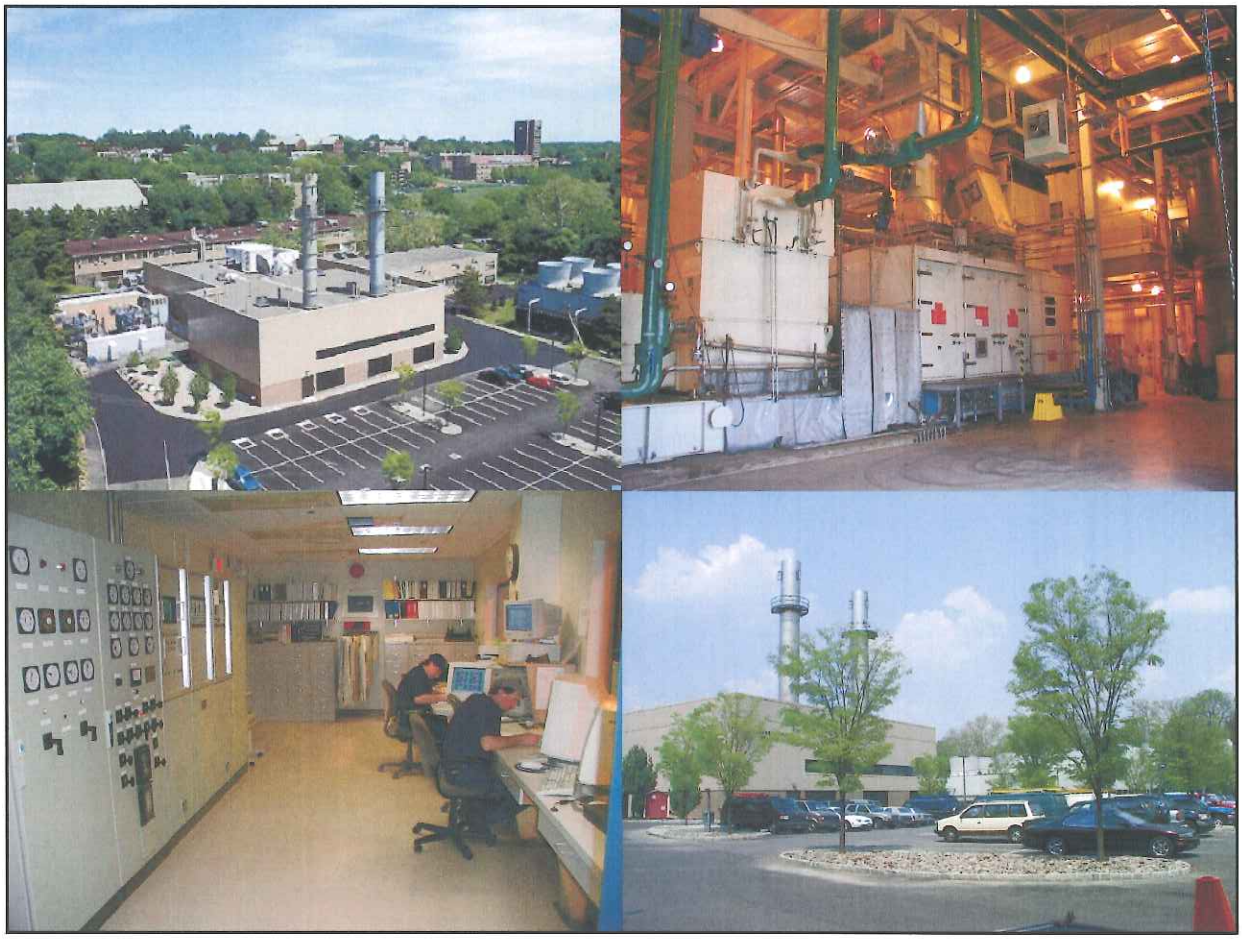
Texas A&M University: 2011 CHP Project

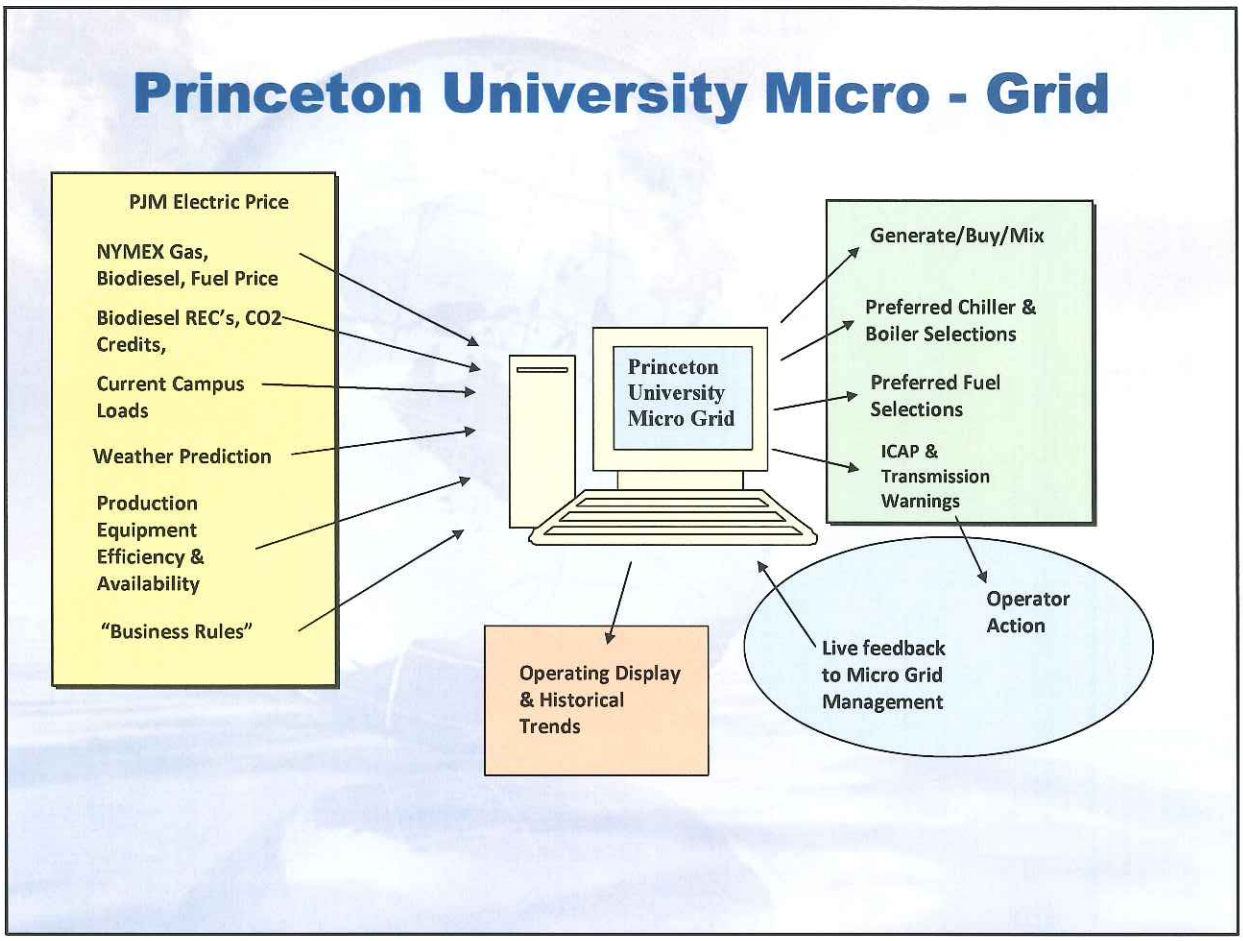
- District energy system:
  - 710,000 lb/hr steam
  - 458 MMBtu/hr HW
  - 52,000 tons CHW
  - 45 MW e
- Supplies 50-75% campus electricity/steam, 90% cooling
- Reduced CO2 emissions by 30% (143,000 tons/year)
- Total cost: $73.25 Million
- $10 Million DOE Grant
- Annual savings: $6 – 9 Million
- $250,000 avoided cost in the first week of operation (Aug. 1-2011)

Cogeneration & District Cooling – Princeton University



- 150 Buildings
  - Academic
  - Research
  - Administrative
  - Residential
  - Athletic

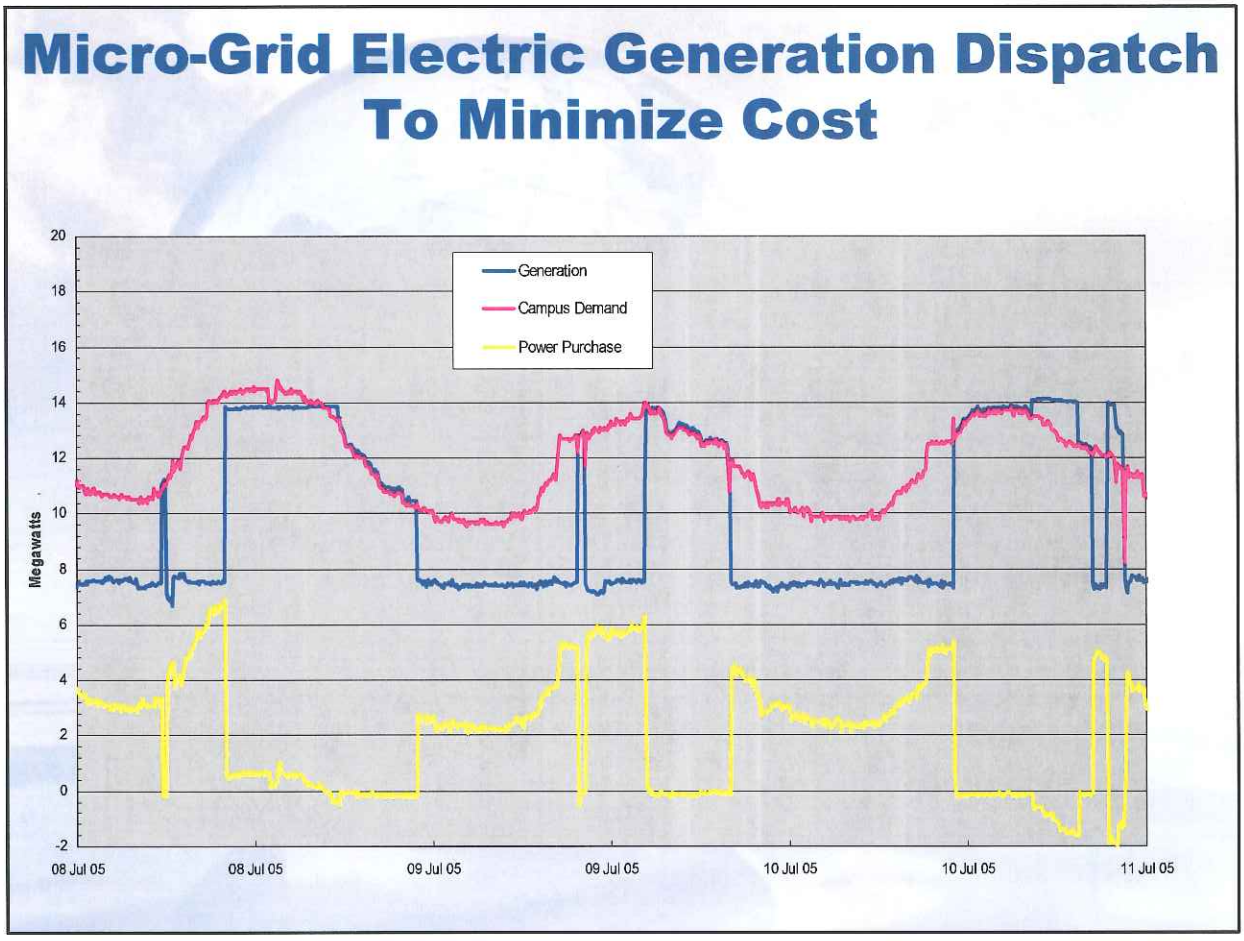



Princeton University Micro - Grid
PJM Electric Price
NYMEX Gas, Biodiesel, Fuel Price
Biodiesel REC's, CO2 Credits,
Current Campus Loads
Weather Prediction
Production Equipment Efficiency & Availability
"Business Rules"
Princeton University Micro Grid
Generate/Buy/Mix
Preferred Chiller & Boiler Selections
Preferred Fuel Selections
ICAP & Transmission Warnings
Operator Action
Live feedback to Micro Grid Management
Operating Display & Historical Trends

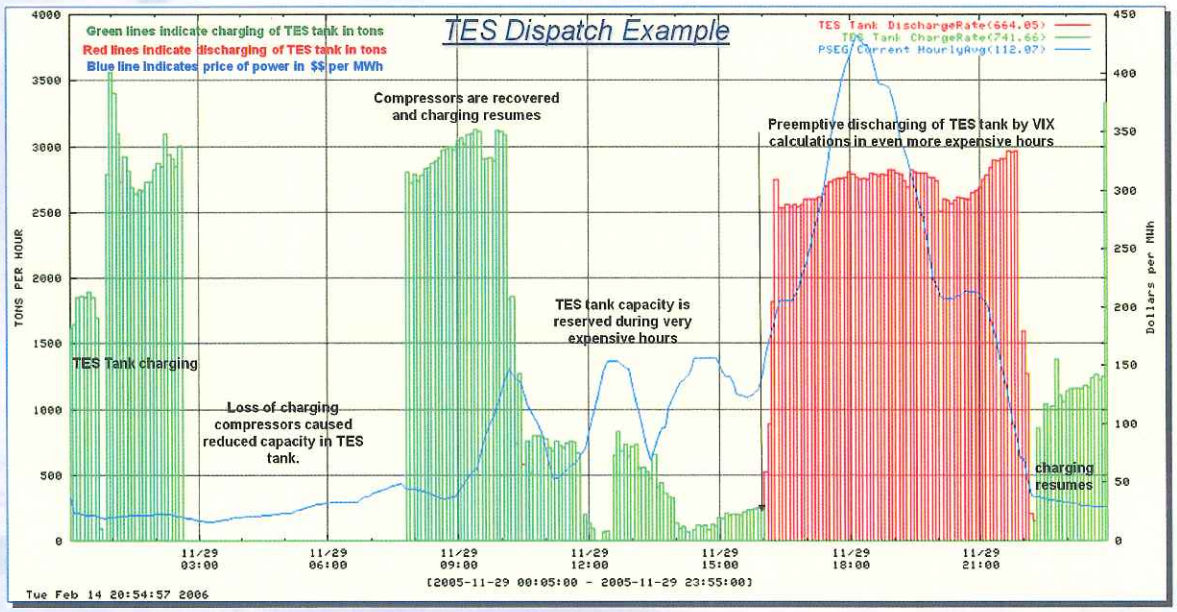
Wholesale Market Price vs. Capacity ($ per MWh)

Regional Electric Grid ISO

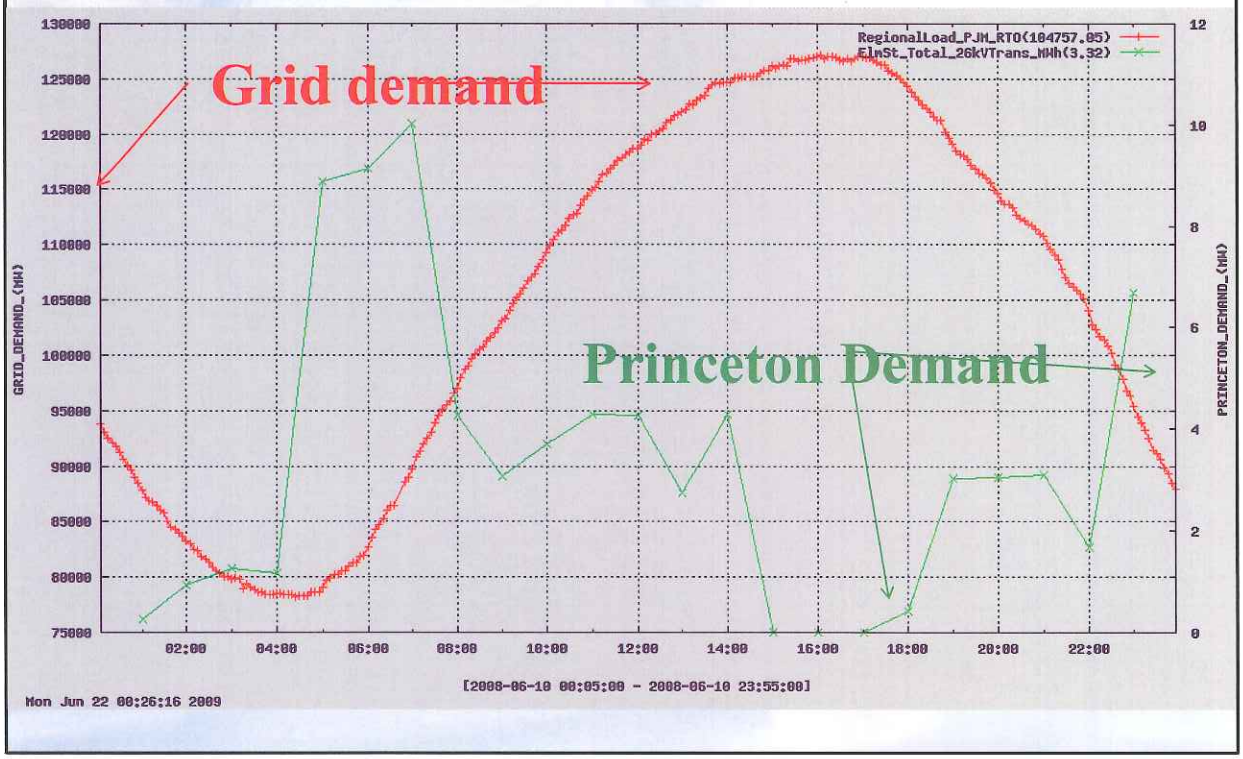
Micro-Grid Electric Generation Dispatch To Minimize Cost



Optimal TES Dispatch in Real Time Electric Market



CHP/District Cooling Reduces Peak Demand on Local "Smart" Grid



Princeton University District Energy – Benefit to Local Grid

- 2005 campus peak demand on grid 27 MW
- 2006 campus peak demand on grid 2 MW
- Campus energy system "freed up" 25 MW to local grid
- District energy reduces peak load on local wires, avoids brownouts, enhances reliability and benefits local economy

Role of Local & State Government

- Catalyst for early stage feasibility study; market development; up to RFQ/RFP
- Anchor Customer/Partner in early project phase
- Provide Franchise Agreement; right of way; development coordination
- Owner/Developer through Municipal Utility
- Sponsor/Issuer of Economic Development Bonds or tax exempt financing
- State Energy Office resources & program support
- Align clean energy policies to support thermal energy; EERS
- Enabling legislation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Thank you for your attention. Questions?

www.districtenergy.org

Rob Thornton

rob.idea@districtenergy.org

+1-508-366-9339

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION
2800 BERLIN TURNPIKE, P.O. BOX 317546
NEWINGTON, CONNECTICUT 06131-7546

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D

GOVERNOR MALLOY'S TWO STORM PANEL

CONNECTICUT DEPARTMENT OF TRANSPORTATION
TESTIMONY
COMMISSIONER JAMES REDEKER
DECEMBER 7, 2011

Good afternoon, Chairman McGee and members of the panel. My name is James Redeker, Commissioner of the Connecticut Department of Transportation (DOT). Thank you for the opportunity to address the panel on the response of the Department to Hurricane Irene and October Storm Alfred.

By way of introduction, prior to joining the DOT in 2009, I had a 30 year career with NJ TRANSIT. One of my charges in that organization was to coordinate our emergency response and to be the lead person for our Emergency Operations Center. I am no stranger to emergencies, as I had a leadership role in responding to the blackout in the Northeast in 2003, evacuating New York City on 9/11, addressing a fire on the Portal Bridge on the Northeast Corridor which shut down all rail service on the entire Northeast Corridor, and handling many, many snow storms and weather events. Each of those incidents and the responses to them provided many critical lessons learned. Storms Irene and Alfred were no different. Connecticut was hit with two very unusual events, each one testing our infrastructure and our preparedness with challenges to all of our prior experience and contingency planning.

When I spoke with Joe McGee prior to this meeting, he asked me to address several issues:

1) The DOT emergency plans and responsibilities.
2) The DOT strategy and program for addressing highway and transit service and safety related to trees, tree maintenance and safety standards.
3) The impact of climate change conditions on our highway and public transportation infrastructure, vulnerability of critical facilities particularly along the coastline, and engineering standards related to sea level, storm surges, and overall climate change conditions.

DOT Emergency Response

I'd like to start with an overview of our highway system responsibilities. To give a sense of scale, over 32 billion vehicle miles of travel occur on our network every year. Our number one goal is keeping the roads and bridges safe and open for travel. The state has 11,400 lane miles of highway, 3,900 state bridges,1,200 local bridges, and 1,900 overhead sign supports in the network. We maintain a 24/7 response to storms, emergencies, and road and bridge repairs. Our operations and maintenance crews are also responsible for paving, signs, guiderails, pavement markings, lighting, traffic signals, brush clearing, bridge repairs, mowing, tree removal, catch basin and gutter cleaning and culvert maintenance.

When a storm strikes Connecticut, the DOT stands ready to keep Connecticut's roads open and safe. The Department maintains several contingency and emergency plans that assist us with keeping the state's transportation infrastructure operational.

The Department is organized geographically, dividing the state into 4 districts, each with a north and south section. The statewide maintenance forces are assigned to 48 garages, 62 maintenance facilities and 6 satellite facilities including specialty units such as equipment repair, bridge maintenance, electrical services and signs and markings. They also operate 16 CHAMP (Connecticut Highway Assistance to Motorists) trucks along selected high-volume corridors. Each district section has one manager responsible for overseeing the coordination of storm response on 725 miles of road, 6 maintenance facilities and 21 municipalities. With storms Irene and Alfred, we had 900 committed field staff, 632 DOT trucks, 48 garages and up to 100 contractor trucks that worked tirelessly to get Connecticut's roads cleared. This included working with several agency partners including DAS and DEEP who assisted with contracting out for services.

The Department takes great pride in its responsiveness and flexibility in getting the job done. We are adaptive and responsive. When a hurricane or snowstorm requires resources beyond our base staff and equipment, we are able to expand our response immediately using contracted tree services or snow removal trucks to respond.

DOT prepares annually for storm events. For example, we prepare an annual snow book per district and each employee is designated a specific snow assignment (on average a 16-mile run). DOT has snow and ice training every November 1st for all maintenance employees. DOT Repair gears up and starts to prepare snow and ice equipment on August 1st for the upcoming snow and ice season. DOT resupplies both liquid and solid deicing material by November 1st.

DOT has two operation centers in Newington and Bridgeport. DOT has its own Emergency Operations Center (EOC) or Storm Room and staffs two employees at the state's EOC. All facilities are staffed 24/7 during a storm event and road reports are completed every 2 hours.

DOT is always adapting and changing to better handle storm events.

- During major winter storms, the DOT and the motor transport industry have a verbal agreement to enact a voluntary ban of tandem trucks on the interstates.
- During high-wind events over 50 mph, we enact a tractor trailer ban on the interstates and DOT (for safety reasons) pulls all maintenance employees off the state roadways. We coordinate any major closure or ban with the regional traffic management agency, Transcom, and the motor transport Industry. During Hurricane Irene, the DOT took a leadership role with all neighboring states to coordinate this ban.
- A voluntary travel ban is imposed on the Merritt Parkway during high winds or tree incidents. Safety is the reason for the ban.

Hurricane Irene resulted in truck bans and closure of the Merritt and Wilbur Cross Parkways. Over 400 road closures were experienced due to downed trees and flooding. One road, Route 72 in Bristol, was washed out and an emergency road detour was constructed. DOT opened all roads except for Route 72 in 48 hours.

Snow storm Alfred was obviously highly unusual, challenging Connecticut with heavy, wet snow and trees that were compromised due to the heavy leaf cover. This storm also involved not just snow, but downed trees and wires. This storm was far more challenging and complicated by the need to work around downed trees and power lines than even last year's record snowfall exceeding 80 inches of snow over the season.

During snow storm Alfred, DOT had over 500 road closures and partial closures at the height of the storm. By Monday morning, all roads were clear of snow and trees except for 100 total closures and 200 partial closures that involved downed power lines. While DOT forces work with power companies to clear those roads, we cannot independently clear any roads that have downed power lines for safety reasons. Working with power company forces, all state roads, including those with downed power lines, were cleared by Friday morning.

DOT reached out to municipalities in several ways. On Monday October 31, we opened fuel stations to municipal emergency vehicles. On Wednesday November 2, DOT started sending crews (8 four-man crews with trucks, chainsaws and chippers) to municipalities for road clearing and chipping. On Thursday, November 3, as our

primary responsibilities were winding down, DOT contacted all storm-affected municipalities to offer further assistance. On Saturday November 5, DOT had a total of 14 crews assisting municipalities.

DOT staff did yeomen's work responding to this unusual fall snowstorm. Frankly, this was in spite of our reduced staffing that resulted from unprecedented retirements this summer and fall. Our basic minimum field staffing need is 1,008 employees to meet basic highway maintenance needs. We currently have 779 maintenance truck drivers and are in the process of refilling our essential maintenance ranks.

DOT's normal tree crew is made up of 5 employees per crew in 11 statewide tree crews - right now we are down by 30 employees. This staff performs the day-to-day tree maintenance for the state and emergency tree work.

So while we are actively addressing our staffing needs, we continue to stay prepared and ready to respond to storm and other emergency events in the state working with our other state and federal partners to ensure that mobility can be provided in a safe manner.

Let me turn briefly to public transportation services. Connecticut's public transportation system provides vital mobility to 37.2 million rail trips a year, 36.5 million bus trips a year, 826,000 paratransit trips per year, and 909-thousand vanpool trips per year. This is accomplished with a fleet of over 400 locomotives and rail cars and a fleet of 720 buses. We are responsible for maintaining over 395 track miles and 335 rail bridges. Rail service is provided by Metro-North and AMTRAK under contract to the state. Bus and paratransit service is provided by more than 20 separate contract operators across the state.

As with our highway system, safety is paramount for our bus and rail systems. Our goal is to sustain all services, especially in a storm, when highway systems may have travel limitations or closures. The DOT, Metro-North, AMTRAK and our bus operators all maintain emergency and storm contingency plans. Metro-North and AMTRAK have updated plans based on the extraordinary storms during the winter of 2010-2011. These plans are continuously being updated to reflect best practices.

Metro-North activates senior staff to a Situation Room in Grand Central for all emergencies. Calls among railroads and DOT begin well before storms actually hit and communication is continuous throughout the events.

DOT coordinates with all bus operators during storms to assess road conditions, service levels and necessary service detours and/or curtailments.

Hurricane Irene resulted in suspension of rail service at noon on Saturday, August 27. This provided time to secure infrastructure and equipment before the hurricane arrived. The storm brought significant storm damage due to trees down along the rail lines and in overhead wires. Signal and power systems failed due to commercial power outages and damage to signal and power system components. There was minimal flooding along the New Haven Line or branch lines. Service on the New Haven Line was restored on Monday, and branch line services were fully operational by Thursday.

In preparation for snow storm Alfred, a pre-storm meeting was held, railroad forces were pre-positioned to assist in system recovery, and communications to the customers was initiated and sustained throughout the storm. The storm resulted in some service delays on the New Haven line due to signal circuit failures, but service was never suspended. Branch line service was suspended due to fallen trees and debris and failed signal circuits. By Wednesday, November 2, all rail service had resumed.

With regard to bus operations during Irene, services were terminated at various times around the state on Saturday due to road conditions and advice received from the state EOC. Buses were held at several bus facilities in the event any public evacuations were ordered and buses were required to assist. On Sunday, all services were cancelled. However, all CTTransit operators in Hartford, New Haven and Stamford were called in and reported in case any assistance was required. None was requested. On Monday, most services were restored, though some started late in the morning. Bus replacement services were provided for those rail services that were not able to be restored.

During snow storm Alfred, most bus services were operated throughout the storm, though some service areas cancelled service due to road conditions. Detours were established as necessary.

DOT Tree Program and Strategy

A critically important function of the Department is our tree removal program along our roadways. The two recent storms; Tropical Storm Irene and Storm Alfred have brought a lot of focus on trees. For the Department, our tree program is about motorist safety, protecting motorists from hitting fixed objects should they leave the traveling roadway, providing sight lines and removing dead tree limbs, cutting down trees that are leaning, diseased or dying, and trees that the Department believes might be at risk of falling on to the traveling roadway. We also have a program of trimming tree limbs on each side of the road to a vertical clearance of 16 feet from the pavement surface to protect tractor trailers and other high vehicles from hitting branches.

The Maintenance General Supervisors are responsible for performing regular patrols of their respective areas. They patrol the entire length of each road under their jurisdiction, making sure they vary the direction of travel, so that each route is examined in both directions. This patrol includes the inspection of roadside trees and limbs that may pose a potential hazard to the public, block sight lines, etc. Any trees or limbs that pose a hazardous condition are addressed immediately.

The General Supervisors also depend on input received from their crew leaders and other DOT personnel as to tree conditions and deficiencies that need attention. Sometimes tree complaints come from abutting property owners to the state right of way and from the traveling public.

Upon finding a tree or limb that needs attention, the General Supervisor fills out a Tree Report which gets forwarded to the District Landscape Designer. The District Landscape Designer makes a field inspection to verify ownership, condition of the tree, identifies work that needs to done and prioritizes by condition. Anything identified as hazardous would by-pass this analysis and would be handled immediately as mentioned earlier. The Landscape Designer completes a work order which is sent to the appropriate Tree Crew by the District Maintenance Director.

Historically, the Department has employed 11 tree crews that were each staffed by 5 workers. Due to current staffing levels, these tree crews are now understaffed. Currently the Department is operating with 10 tree crews, with 25 employees -- a deficit of 30 employees.

At our current staffing levels, the Department is currently performing 4,000 tree cuts a year. This number includes the department general tree maintenance program as well as tree complaints which are vetted for removal as well as emergency work, but does not include recent emergency work during the two storms. Tree maintenance is a continuous and iterative process. Each tree crew moves from one section of road to another each year addressing the brush and tree conditions. The Department is committed to the tree removal program and is in the process of increasing contractual services and refilling staff resources to reduce the backlog we are currently experiencing.

The Merritt Parkway

The standards associated with the design of our roadway network are geared to providing the safest environment possible as a result of the actions of the drivers. The primary issue is how close trees are to the roadway. A design standard that involves the proximity of trees is what we refer to as the "clear zone;" but the clear zone standards are predicated on the reaction times of the operator and driving speeds. The Department strives to achieve 30 feet of clear zone along the sides of an expressway

facility. However, the 30 feet has nothing to do with the height or size of trees; it is a measure to any solid, fixed object whether it's a utility pole, a bridge or a rock outcropping. On our state's expressways you will find the roadside either clear of trees and fixed objects or you will see the driver protected from the roadside obstacles by guiderail or concrete barrier curb.

The Merritt Parkway is the exception to the rule. The entire facility is a designated historic landmark. In cooperation with Parkway preservation advocates, an agreement was made allowing for an 18 foot clear zone for fixed objects including trees. In this environment, it is extremely important for the Department to continuously monitor the health of the tree canopy and reach back beyond the 18 feet to remove high risk vegetation. There are no power lines or utility services along the Parkway. The issue is limited to the safety of the motorists. In recent years, the Department has allocated approximately 40% of its tree cutting budget ($200,000 of $550,000) to the Merritt corridor in an expanded program to enhance safety. Even absent the recent storms, the rate of dead tree falls is significant and the Department has been active in developing a program to remedy the situation. The Department believes there is a need for approximately $1.5 million over the next two years to fund an aggressive maintenance recovery program along the Merritt Parkway.

The Department's emergency action plan includes closures of the Parkway if conditions warrant. The enhanced tree-cutting program will not preclude that potential action. There are of course options to reduce the occurrence of road closures. A more aggressive program to remove tree cover further off the roadway would reduce potential road closures, but it would not eliminate risks entirely. It is our estimate that an extremely aggressive program would cost several million dollars, take at least 4 years, and would be performed exclusively by contract services, augmenting the Department's resources.

Climate Change

At a national level, there is a broad effort to get all levels of government to understand and participate in developing standards and action plans related to climate change. Much of those efforts have involved ways to reduce greenhouse gases (GHG) as an underlying cause, but more specific to this discussion is how the effect of potential climate change issues are being addressed by the DOT. Most importantly, Connecticut has a very valuable, but vulnerable coastline, and a rise in sea level and the impact of a storm surge could be catastrophic for our state. Other issues that the federal government asks us to consider are the impacts of more intense heat waves and increased storm intensity as a result of changing climate patterns.

The Department is actively engaged, along with DEEP, in the climate change initiative. We participate in regional as well as national forums related to climate change. One area of keen interest relates to our infrastructure and our engineering design standards related to storms and flooding. Frankly, there are no new design standards being implemented at the national or regional level that address the impact of climate change on our infrastructure assets. This is a discussion that impacts not only the DOT, but also impacts all decisions regarding land use, zoning and engineering at all levels of public and private enterprise. The most practical approach to addressing much more robust infrastructure investments is to incorporate new standards into all major new construction, using those opportunities to upgrade and protect our infrastructure.

With regard to our current infrastructure, there are several important observations to make. During a major hurricane, it is our practice to lock all of our moveable highway bridges in a closed position to protect them from damage. However, that practice means closing many navigable waterways to travel. Long-range planning must address potential solutions to that situation, including elevated fixed structures and strategies to protect our maritime interests. Critically, our rail infrastructure is also vulnerable. The New Haven Line has an infrastructure of overhead wire, signal and bridge systems that are over 100 years old. Winds of over 40 miles per hour can result in suspension of rail service because the old overhead wire systems are susceptible to high winds. In addition, in both Irene and Alfred, the signal and grade crossing systems were impacted by lack of commercial power. Investments in upgrading overhead wire, signal and bridge infrastructure are critical and at a faster pace than current funding streams can support. Finally, we have several bus maintenance facilities that are prone to flooding. . CTTransit Stamford lies in the coastal flood zone. There are plans in place to evacuate buses to higher ground and plans were prepared for any necessary relocation of necessary operational functions. CTTransit Waterbury's facility is in the flood zone of the Naugatuck River. For Irene, they moved a portion of the bus and paratransit fleet to higher ground. Long term, we need to consider investing in new facilities that are not prone to such conditions, while in the meantime developing standard practices that protect the assets and allow continuity of operations.

On the other end of the spectrum, it is critical that we undertake a complete reassessment of our contingency plans as they relate to major weather events. Most of our contingency plans are based on our historic experience with storms. For example, we currently base our hurricane plans on a Category 2 storm. All indications from the climate change perspective are that Connecticut must plan for a Category 3 storm. Understanding the impacts of climate change requires a comprehensive review of all our contingency plans. Included in that process should be a commitment to conduct periodic table-top reviews and field exercises to ensure we have the most robust contingency plans in place and ready for deployment.

Summary Statement

There are some key observations from the recent storms that deserve highlighting for the panel.

1) The DOT is organized and has a demonstrated record of responding to storms of all kinds and magnitude. The Department sets it optimum staffing level for the Bureau of Highway Operations to ensure year-round coverage of our maintenance and emergency responsibilities. We are able to augment our resources quickly and effectively, whether for snow clearing, or road clearing challenges.
2) A key issue to ensuring that all our roads are safe and clear relates to the issue of power lines and the related vulnerability of our network when power lines are down.
3) A strategy that addresses trees along our highway network and our rail system is critical to sustaining safe, sustainable transportation.
4) Investments in our rail infrastructure are critical to ensure the ability to deliver consistent service, particularly during major storms. This includes investments in overhead wire, signals, bridges and maintenance facilities.
5) Contingency planning in the context of multiple failures in the power and communications systems is critical.
6) Contingency planning in the context of climate change is essential.

In summary, the mission of the Connecticut Department of Transportation is to provide a safe and efficient intermodal transportation network that improves the quality of life and promotes economic vitality for the State and the region.

With every action we take we are mindful of our mission. A storm or emergency can come in all shapes and sizes. The Department takes its obligations seriously. We understand the impact mobility has on the state, its citizens, our economy, and the regions around us. Above all else, we are committed to safety and customer service. We try hard to continuously work smarter and better. It means we do not implement closures for rail, bus or roadways unless absolutely essential. Then we do our best to bring services back on line safely and expediently. We prioritize the routes to clear during storms making sure there is a safe path for emergency services and broadening access to all as we work our way through the event.

We demand excellence in all we do and are solution-oriented and focused. We continuously re-evaluate our priorities to ensure that the Department is ready and able to be responsive to changing needs.

These past few storms have been challenging and have been reminders of how important our services are to the traveling public. Rest assured that even as I speak, the Department is reviewing our storm plans -- which could come as early as tonight with predictions for snow in the state. The bottom line is that DOT is prepared, dedicated and committed as an organization to get the job done.

E

DEEP Commissioner's Testimony to The Two Storm Panel Regarding Opportunities for Improved Storm Response and Potential Strategies for Improving Infrastructure Resiliency

Testimony Submitted by Commissioner Daniel C. Esty
Department of Energy and Environmental Protection

December 7, 2011

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I. Introduction:

Good afternoon Chairman McGee, Chairman Skiff, and esteemed Members of the Panel. I am grateful that the Governor has convened such a distinguished group to guide the state toward better storm preparations and response, and I am pleased that the Department of Energy and Environmental Protection (DEEP) has a chance to offer its thoughts on the matter before you. I see my role as trying to share my perspective on the shortcomings that affected the response to both Tropical Storm Irene and the October snowstorm, and to present a range of policy options for consideration. We must also weigh the costs of better preparing Connecticut – not in a vacuum, but against the very real financial toll of the storms we experienced this fall. We look forward to continuing to work with you, and with all key stakeholders, to advance a consensus resiliency agenda.

The two recent historic storms and subsequent power outages had a profound impact on the lives of the people of our state. The storms and outages caused major hardships as well as personal financial losses. The storms also had a significant impact on many of our state's businesses. It is the responsibility of all of us in public service – especially this panel and my agency – to make certain we learn the lessons our storm experiences offer, and put Connecticut on a path that reduces the possibility of future power outages and disruptions of the magnitude we have now seen.

DEEP is a new department with an energy mission to deliver on Governor Malloy's goal of cheaper, cleaner, and more reliable energy for residents and businesses in Connecticut. For the first time, the state of Connecticut has an energy department with the ability to develop a comprehensive and coherent energy policy framework that will guide strategic choices and

provide the underpinnings for the decisions of the Public Utilities Regulatory Authority (PURA). The PURA, itself a component of the new department, serves as an independent regulatory body implementing DEEP's policy framework through its adjudicatory proceedings. In addition to energy, DEEP has regulatory responsibility for a range of other storm response functions and infrastructure components, including wastewater facilities, dams, debris management, and communications.

The impacts of Tropical Storm Irene and the subsequent October snowstorm have sharpened DEEP's focus on infrastructure resiliency. Integrating resiliency into Connecticut's future infrastructure investments calls for a new accounting in which the costs of added resiliency are balanced against the costs of future (and perhaps repeated) infrastructure failures.

II. Framing thoughts:

For most private industries, market forces drive innovation and adaptation. For public utilities, however, regulators have a major role in setting incentives and standards to drive adaptation. Today, we have an opportunity to integrate our approach to utility regulation with long-term policy goals to ensure that incentives are put in place for cheaper, cleaner, and more reliable power and other utility services.

Our reassessment of incentive structures must be based on a more accurate assessment of risk. The likelihood of more frequent and severe weather events in coming years argues for implementing new preparedness and adaptation strategies for the state's utilities. Clearly, Connecticut Light and Power did not build appropriate risk calculations into its storm and outage planning process given that it considered a "worst-case scenario" to be anything above 100,000 outages (less than 10% of its customer base), with no incremental identification of action items

for situations far above this number. In contrast, United Illuminating did have contingency plans in place for the loss of power by up to 70% of its customers.

At the direction of the Governor, keeping the cost of electricity low continues to be a policy priority that will be incorporated into our evaluation of options for resiliency investments. Fortunately, Connecticut has achieved generation savings through wiser procurement of power for standard service customers, as well as lower prices in the competitive generation market. These rate decreases should allow for some resiliency upgrades while we continue to bring electric rates and bills down.

To evaluate the costs and benefits for any of these options, we need to do a full accounting of the two storms' economic burden—not just the cost of restoring wires and poles, but the total impact on Connecticut businesses and citizens. A more comprehensive accounting would include the cost of debris removal, lost wages, spoiled food, hotel costs for those forced out of their homes, closed businesses, and diminished productivity in many companies, among other factors.

III. Observations on storm response and potential remedies:

Now, I would like to address some of the Department's individual observations and recommendations on the utilities' response to the storms. These observations focus on three broad areas: the shortage of trained line crews during the first four days of the storm, management shortcomings, and inadequate communications.

a. *Informal cooperation among utility companies was not sufficient.* The system through which companies loan each other work crews in times of emergency, known as "mutual aid," is a system of compacts and subcompacts which tend to restrict

availability of crews. Connecticut's utilities need to lead an effort to restructure regional mutual aid compacts with greater transparency and reporting so that all in the region know exactly who is going where and when during a disaster event, particularly when that event affects the entire region.

b. *The variety of rules across the region governing the movement of skilled line crews needs to be re-thought.* In addition to the voluntary compacts among private companies, many neighboring states, such as Massachusetts, New York and New Jersey, impose rules through statute or executive order restricting crews to in-state operations. There are opportunities for regional compacts that can be better utilized to ensure predictable and speedy access to line crews from out of state.

c. *Resource deployment was not optimized in advance of and during storm response.* Most notably in the October snowstorm, the utilities did not fully pre-deploy resources in advance of the storm, and were caught flat-footed when the storm actually hit. Crews need precise electronic maps and work orders—and cutting-edge communications to utility managers- to be effective. Too much was done on paper. There was too little modern information technology equipment, like an iPad, and too little geo-spatial data deployed to guide crews.

d. *Many existing work practices should be re-examined.* The lack of line crews proved to be a significant bottle-neck in both Tropical Storm Irene and the October snowstorm. Options to expand the reach of the trained lineman in a crunch must be explored, including pairing trained linemen with local electricians or retired linemen, and greater use of trained firemen and DPW workers.

e. *Transparency matters for effective storm response.* Electronic maps of downed distribution systems, GPS locators on trucks, and data provided through a "smart grid" would provide real time data for emergency response managers, to help coordinate efforts and communicate accurate information.

f. *Community relations and communications can be improved.* I personally witnessed the frustration of Mayors, First Selectmen, and Town Managers as they struggled to manage the storm response in their communities, highlighting the need for a broader base of real-time information to be made available to the public.

IV. Options to improve infrastructure resiliency:

I turn now to focus on how we develop a strategy for Connecticut's future resiliency investments. There is no single solution that will address all of our vulnerabilities. Many of the options entail trade-offs and cost-consequences that must be carefully analyzed. There is, however, a range of potential actions that can improve near-term resiliency and set into motion a transition toward longer-term solutions.

a. Infrastructure hardening

There are a number of conventional measures that could be taken to upgrade our electrical transmission and distribution system. Each of these measures would harden our existing infrastructure without significantly changing the way our distribution grid operates or the way in which utilities, regulators, or ratepayers do business.

First, we could invest in undergrounding our existing wires. Undergrounding wires would be very expensive. Industry cost estimates run to tens of billions for full undergrounding – though some question whether these estimates are still accurate. Regardless, the costs could be

spread over a long period of time. Or, electric costs could be coupled with the replacement of existing water and sewer infrastructure, the expansion of natural gas mains to currently un-served areas, and the installation of fiber optic cables that will allow for the dissemination of a 21st century broadband internet communications structure. When combined, all of these sub-surface infrastructure investments may present sufficient overall economic benefit to be cost effective.

Undergrounding also has limits. For example, it does not make sense in areas subject to flooding. Additionally, outages that occur in undergrounded lines will be significantly more difficult to access in order to restore, and maintenance and upkeep will also be very expensive.

Second, we could invest in more robust wires and poles. The age of the pole, the depth of its placement, and its thickness all affect the pole's sturdiness in a storm. We need to compare the sturdiness of Connecticut's utility poles relative to other states, and develop an appropriate state standard. Also, over 50% of our electrical wires are older, uncoated wires, such that a single touch of a tree branch will cause "arcing" and thus an outage. To enhance poles and wires, PURA could mandate the replacement of non-coated wires with coated wires on an accelerated schedule, and require all poles replaced in the future to be more durable, planted deeper underground, or reinforced with steel or cement.

Third, Connecticut needs coherent, state-specific standards for tree-trimming. Developing these standards might best be done through a collaborative effort by tree wardens, utilities, and DEEP forestry personnel and energy policy. Of course, any expansion of tree-trimming and cutting will entail costs and aesthetic trade-offs.

b. Distributed generation

There are additional, and potentially more transformational, opportunities to make our electrical system more resilient – and reduce the burden of outages on our citizens. Distributed generation offers a notable opportunity in this regard. It is worth exploring whether "mission critical" sites (hospitals, prisons, sewage treatment plants, etc.) and town centers (covering police/fire, a warming center, a gas station, and a grocery store) should have a small-scale independent power source (fuel cells or gas turbines) to provide power when transmission or distribution fails. Such a structure of "micro-grids" would need to have a system of transfers and trips to isolate (and protect) the generation assets in a crisis. The cost of a distributed generation system for Connecticut, which might be $500 million to $1 billion, would need to be understood as, in part, an investment in infrastructure resilience and insurance against the costs and hardships from a prolonged power outage.

An organizational structure for these micro-grids might already exist in the form of Energy Improvement Districts (EIDs), established by the Legislature in 2007. EIDs allow local communities, or even neighborhoods, to invest in more robust energy generation or distribution infrastructure. The state could provide technical assistance to enable many more communities to establish EIDs that deploy clean, locally controlled electricity and heat to critical emergency infrastructure. The goal of these EIDs is to allow neighboring businesses or institutions such as schools and municipal buildings – think fire, police – to share the benefits of local generation and conservation opportunities. Another enabling policy component for "micro-grids" might be to better specify rules around sub-metering, which could allow private entities to invest in distributed generation and offer power to neighboring consumers.

For other components of critical infrastructure – such as wastewater treatment facilities, prisons, airports, or command and control centers – other small scale generation technologies may be appropriate. Newly developed small fuel cells or modular gas turbine generators could be used to power targeted gas stations and communication networks. Larger fuel cells could be deployed to provide reliable service to a core cluster of critical services, such as hospitals.

c. Smarter grid

Another long-term strategy would be the phased deployment of a "smart-grid" system, which would enable a much more reliable assessment of outages than is provided today. The key to many improvements lies in the application of information technology to better manage and control the grid machine. Sensors can tell when lines are down, and systems can seal off faults and provide alternative routes for power to travel. Also, individual "smart meters" can provide a real-time map of power outages. As it stands, the location of outages is tracked through phone-calls pouring in to the utility and the utilization of decidedly 20th Century technologies (such as paper maps) to track the information. The lack of accurate, real-time information regarding outages in the field hampered the response by the utilities. A smarter grid can provide this real-time data that will enable instant analysis and action. This information will allow the utility and the state to identify problem areas, and quickly deploy adequate resources where necessary and in a coordinated fashion.

d. Regulatory incentive approaches

Private utilities in Connecticut have responded to incentive structures implemented through a series of rate cases that focused narrowly on keeping rates down at the expense of other goals, including energy efficiency investments to lower bills, storm preparation, tree-

trimming, and ensuring adequate investment in infrastructure. The Governor's vision that led to the creation of an energy policy wing within the new DEEP now positions us to redefine policy priorities in ways that will then guide regulatory decisions regarding utility cost recovery and incentives. With the right incentives in place, we can implement policies that encourage decoupling, submetering, executive compensation linked to performance, and a re-structured utility business model that engages our power companies in new commitments to efficiency, resiliency, and distributed generation. We also see the need for the state to assume a greater role in ensuring utility compliance with a new set of performance standards.

V. Additional DEEP storm response work and recommendations:

The primary focus of my testimony today has been an analysis of the electric utilities' responses to the two storms, and strategies for increasing resilience of our electric utility infrastructure. However, I would also like to briefly discuss some of the additional roles DEEP played in supporting the statewide response to the debris generated by both storms, and monitoring other (non-electrical) elements of the state infrastructure, such as communications systems, wastewater treatment facilities, and dams. I also offer a few lessons learned from these other DEEP activities.

a. Air quality

As a result of the over-usage of dirty generators and wood-burning for heat, air quality proved to be an issue in the wake of both storms. DEEP quickly issued air pollution waivers for emergency generators, given the need for emergency power, but also assisted the Governor in his successful communications effort warning residents of the poor air quality. Going forward, the real solution to this kind of trade-off lies in some of the other recommendations found in this

testimony- namely use of cleaner sources of back-up generation and implementation of preparedness and response protocols that will further a quicker restoration of power.

b. Wastewater treatment facilities

In the event of a loss of power, wastewater treatment facilities are at risk of failure or diminished effectiveness. In the course of the two storms, keeping these systems up and running emerged as a high priority – and a challenge, as back-up power failed at a number of facilities, causing several discharges of untreated sewage into the environment. A better structure of back-up (or primary) power for wastewater facilities should be explored. DEEP will also investigate the proper protocol for the periodic communication of wastewater facility status during an emergency event.

c. Dams

The intense rainfall Connecticut (and the rest of New England) experienced during Tropical Storm Irene, and the subsequent flooding, tested the resiliency of the state's 4500 dams. DEEP staff performed inspections at virtually all 227 high hazard dams in the days following the storm. According to the Northeast Climate Center at Cornell, regional rainfall totals are increasing, and flooding events are likely to become more frequent. One option is that DEEP can request that Connecticut Academy of Science and Engineering (CASE) evaluate dam safety rainfall standards and recommend dam safety measures that could be implemented in emergency situations such as Tropical Storm Irene. The Department will continue to dig deeper into what the best management strategies would be for the state's dams.

d. Debris management

As part of the Governor's Interagency Debris Management Task Force, DEEP helped implement a well-crafted intergovernmental debris management plan that, in both storms,

provided a clear framework for quickly activating and mobilizing the state's debris management contractors. DEEP staff worked closely with DESPP, DOT, DAS, and the municipalities, providing information and technical support on use of the state debris removal and monitoring contracts. DEEP also helped locate and authorize debris management sites. Approximately 1.5 million cubic yards of debris have been collected from state roads, state property, and the 16 municipalities who have used the state contractors. Though the statewide debris management program has worked well, I would recommend, however, that we take a closer at how the timing of the FEMA disaster declaration may make a municipality's decision whether or not to hire the state contractors more difficult. We will also investigate whether the utilities can make better use of the state debris removal contractors' equipment and personnel by pairing them with utility crews.

e. Communications systems

Going forward, we need to ensure the communications structure is robust in the state during emergency events. The two storms certainly revealed weaknesses in the resiliency of the statewide communications infrastructure. Many of the largest issues cropped up 2 or 3 days after the storm, as backup power at cell towers and other communications sites failed around the state. When cell phone coverage began to fade, the communications network in the state was greatly over-taxed, leading to public frustration and a potentially dangerous lack of communications capability. Interestingly, customer complaints regarding cell phone service gaps during the storms were far greater than complaints regarding "landline" telephone outages. DEEP plans to further investigate the robustness and longevity of backup power systems at cell tower sites. Once again, there is an opportunity for PURA to set standards for accelerated replacement of older, less powerful battery backups, to enhance the diversity of cell towers in cooperation with

the Siting Council, and to introduce software to better respond when battery backup power does fail. Collaborative work with the Department of Consumer Protection may also be needed to ensure that out-of-state technicians are allowed to work in Connecticut during emergency events.

VI. Closing:

Thank you for the opportunity to testify. The issues that we are exploring here today – and others you are wrestling with – are critical to ensuring proper preparations and response to any future extreme weather events in our state. DEEP looks forward to working with all partners – especially state agencies, public service companies, municipalities, major institutions, and others – to revise and reshape policies and practices in ways that improve our ability to withstand and recover from future storms. We are at a watershed moment in the state. These two storms have alerted us that many past practices are not workable going forward. Fortunately, with respect to the need for comprehensive and coherent state energy policy, the Governor positioned us well to adapt to the issues raised here, and deal with these challenges better in the future. I have no doubt that the focus being placed on this issue will help us create a more resilient Connecticut, and I pledge that the Department of Energy and Environmental Protection will be engaged in these matters as a top priority, as we seek to meet our charge from Governor Malloy to bring this state cheaper, cleaner and more reliable energy.