Develop & Demonstrate an Advanced Low Temp Heat Recovery Absorption Chiller Module

DOE Award #: 09EE0000068

EXERGY Partners Corp./Integrated CHP Systems/United Technologies

D.E.N.T. LLC Site Owner and Co-Funder

Project Period: Revised Project Not Started – Duration is 3 Years

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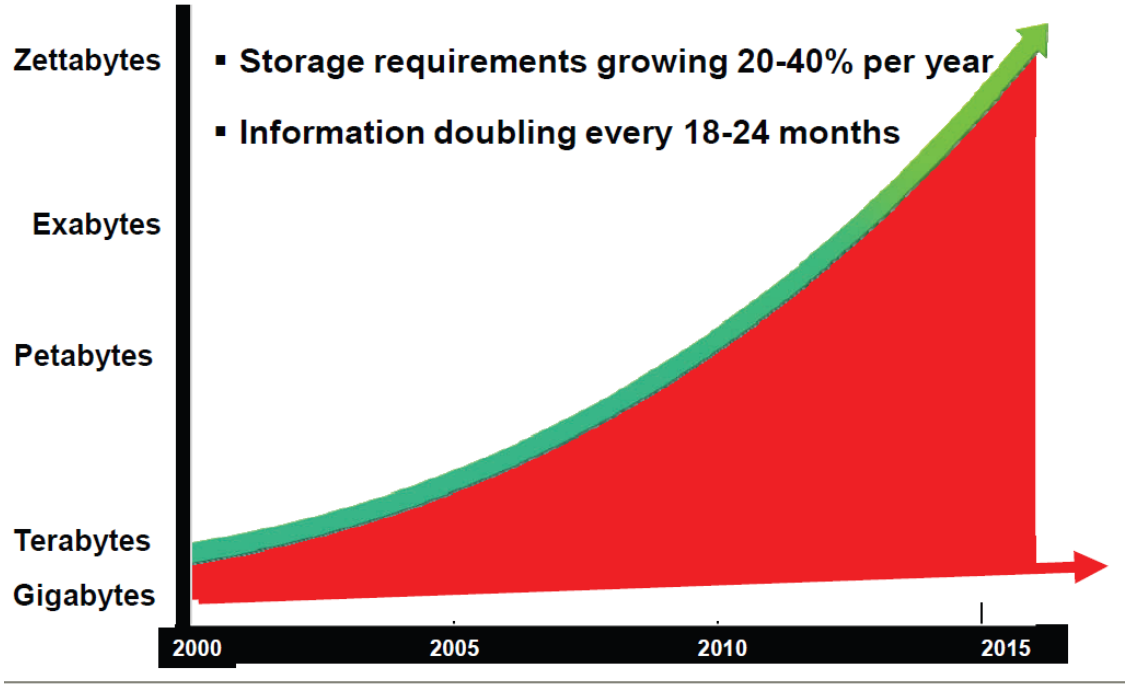
Executive Summary

"The truth is that data growth is rapidly outpacing our ability to process, analyze and store the data we're collecting. In fact, enterprise storage needs are increasing by up to 40 percent per year. That means up to 40 percent more equipment; 40 percent more rack space; 40 percent more people; 40 percent more power; 40 percent more budget dollars. Every year." March 2011 Stratecast



Source: IBM

Executive Summary

Data center spaces can consume up to 100 to 200 times as much electricity as standard office spaces. The critical nature of data center loads elevates many design criteria—chiefly reliability, high power density capacity and speed to market—far above energy efficiency. CHP systems could provide the reliability and power density – especially if power and thermal systems are properly integrated.

Applying just 100 MWs of advanced CHP power and cooling modules to new data centers would result in 17.3 billion Btus of primary energy savings and 2.3 million tons of CO_{2e} reduction per year.

The Advanced Low Temperature Heat Recovery Absorption Chiller Module will provide the next level of performance and economics that could accelerate the deployment of CHP systems into high reliability data centers of the future.

Project Objective

- **Objective:** Extensively performance test an absorption chiller beyond previous thermal boundaries to create performance algorithms, create performance calculator for the chiller series covering all UTC model sizes, modularize the system to reduce cost and increase reliability and test the system in the field for one year.

- **Statement of the problem:** Hot water-fired single-stage absorption chillers have not been performance tested to meet the low return temperatures of engine prime movers providing no reliable means of optimizing chiller /prime mover performance. Secondly, modularization of chillers with prime movers is not current practice. Finally, field engineered and erected solutions to not meet construction schedule requirements for data centers.

- **Risk:** Performance test measurements do not meet the theoretical performance predictions.

State of the Art

"Co-generation systems, also known as combined heat and power, involve the use of a heat engine or power station to simultaneously produce electricity and useful heat.…Waste heat can be used directly or to supply cooling required by the data center through the use of absorption or adsorption chillers, reducing chilled water plant energy costs by well over 50%. The higher the cooling air or water temperature leaving the server, the greater the opportunity for using waste heat.…Single stage, lithium bromide desiccant based chillers are capable of using the low grade waste heat that can be recovered from common onsite power generation options including microturbines, fuel cells, and natural gas reciprocating engines.…Earlier absorption chiller model operations have experienced reliability issues.…Modern controls on newer absorption chiller models, though more complicated, remedy this problem. However, start-up and maintenance of absorption chillers have often been viewed as significantly more involved than that for electric chillers." FEMP "Best Practices Guide for Energy-Efficient" Data Center Design, Revised March 2011

State of the Art

State of the Art

- CHP (power and cooling) systems are not considered by the data center specifying community as viable energy solutions for high reliability data centers. In fact, there are few CHP systems installed in data centers through the marketplace and none of these are replicable.

Company	Location	kW Capacity	Prime Mover
Fujitsu America	Sunnyvale, CA	200	Fuel Cell
Guaranty Savings Building	Fresno, CA	600	Fuel Cell
Flint Energies Service Center Facility	Warner Robins, MT	5	Fuel Cell
hevron Texaco Corporate	San Ramon, CA	200	Fuel Cell
Verizon Communications	Garden City, NY	1,400	Fuel Cell
30 N LaSalle Office Building	Chicago, IL	1,100	Gas Engine
Telecommunications Facility	Burlingame, CA	120	Microturbine
Citibank West FSB Building	La Jolla, CA	60	Microturbine
WesCorp Federal Credit Union	San Dimas, CA	125	Microturbine
Verizon Ontario	Ontario, CA	360	Microturbine
Verizon Pomona	Pomona, CA	240	Microturbine
Chevron Accounting Center	Concord, CA	3,000	Recip. Engine
Network Appliance	Sunnyvale, CA	825	Recip. Engine
Zoot Enterprises	Bozeman, GA	500	Recip. Engine
AT&T	Basking Ridge, NJ	2,400	Recip. Engine
Continental Insurance	Neptune, NJ	450	Recip. Engine
Verizon Communications	Garden City, NY	1,400	Recip. Engine
Total		12,985	

Technical Approach

- Absorption chillers were designed for space conditioning and have not been performance tested to meet the low return temperatures of new generation of engine prime movers coupled with data center specific high chilled water temperature requirement, providing no reliable means of optimizing chiller /prime mover performance.
- Considering there is no perceived market for CHP based cooling in data centers, there is no reason to assess and/or test these units for low temperature heat sources.
- We need to study the Carrier/Sanyo unit (heat and mass transfer capabilities) and develop predicted results.
- The chiller will require extensive parametric testing to prove out performance under all conservable operating conditions.
- The results will then need to be scaled throughout the family of sizes.
- Secondly, modularization of chillers with prime movers is not current practice. This is an essential element in moving CHP systems into the data center energy space by driving down cost and delivery times while also driving up reliability.

Technical Approach

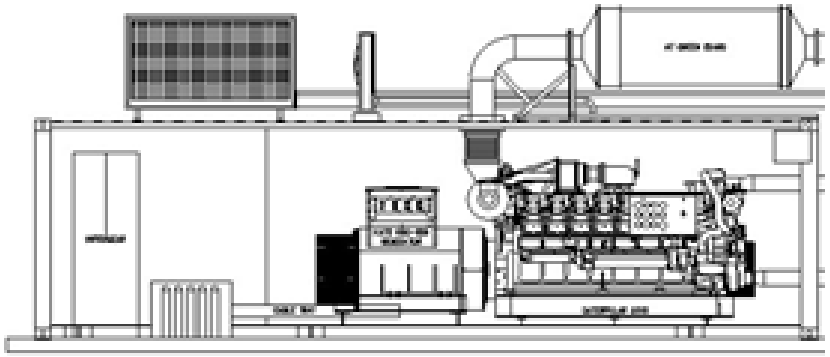
- **Address scientific/technological approach:** Blending small business innovation (Exergy and ICHPS) with the world leader in HVAC (Carrier/UTRC) and demonstrating the technology at the Great Lakes Center for Energy Smart Communities ("GLC") is the nation's first carbon neutral All-Digital Community.

- **Address unique execution attributes:** the project team includes market leader in HVAC systems, nationally recognized CHP application experts, using best in class data center designer, and nationally recognized computer expert.

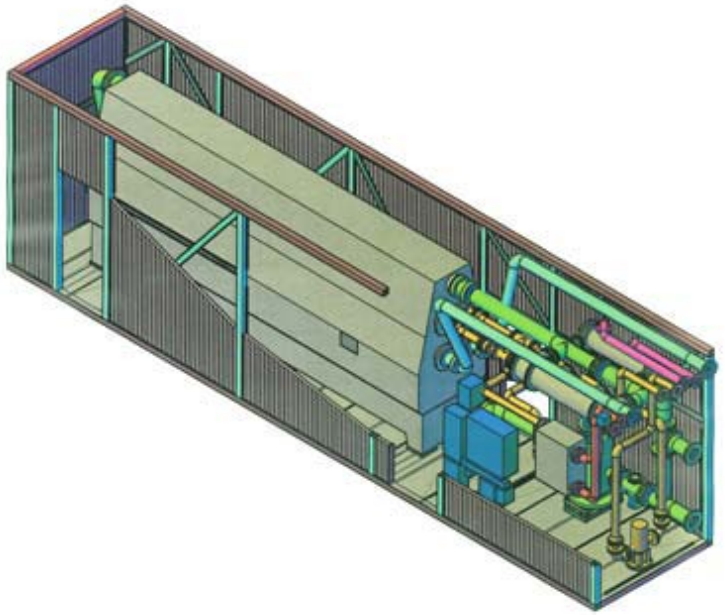
Technical Approach – Benchmarking

Technical Approach - Modularization

Modular Prime Mover



Modular Thermal Cooling



Transition and Deployment

- **Who cares?** Data center industry is clearly focused on reducing energy density and cost.
- **Who is the end user?** Principle end user is the data center owner, however the key focus must be the data center design engineer who takes the specification risk.
- **How will they use it?** The specifying engineer can provide a very energy efficient electric and thermal energy supply for data centers using CHP provided there is little or no risk of failure.
- **Does it improve their mission/capabilities?** If the technology works, the specifying engineer is successful by providing a good energy efficient solution to the client who saves money, energy and further "greens" the data center.
- **What is the technology sustainment model?** The Carrier single-effect low temperature chiller performance mapping will enable the entire chiller family to be applied to all reciprocating engine prime movers opening up this new application for Carrier and stimulating others to investigate this market.

Measure of Success

- **If you're successful, what difference will it make?** The project has not started and detailed estimates of market penetration have not been made. The parties, however, believe that considerably more CHP systems will be applied than the 24 MW in the DOE database.
- **What impact will success have?** Every 100 MWs of advanced CHP power and cooling modules applied to new data centers would result in 17.3 billion Btus of primary energy savings and 2.3 million tons of CO_2e reduction per year.
- **How will it be measured?** Initial success will be measured during a 12 month M&V period. Ultimate success will be measured near-term through specified CHP systems and long-term by installed CHP systems.

Benefits

- Projected Energy/Environmental Savings

Number of	Primary Energy	CO_2e	NOx	SOx	PM10	N_2O
CHP Systems	TBtu per year	tons/year	tons/year	tons/year	tons/year	tons/year
1	0.011	1,239	4	15	0	0
10	0.11	12,385	37	150	1	1
100	1.10	123,854	368	1,505	14	7
250	2.74	309,634	919	3,762	36	17
500	5.49	619,268	1,838	7,525	72	33
750	8.24	928,902	2,756	11,287	108	50
1,000	10.99	1,238,536	3,675	15,050	143	67

- Economic Benefits
  - 20% lower installed cost
  - 30% reduction in field labor (time)
  - 25% reduction in operating cost
- Project Development Schedule
  - Modular approach allows fast deployment

Commercialization Approach

- **Describe commercialization approach:** demonstrating the technology at the Great Lakes Center for Energy Smart Communities ("GLC") is the nation's first carbon neutral All -Digital Community will provide a high profile platform for the modularized CHP system.
- After successful demonstration, it is the intent of D.E.N.T. LLC to move forward in the data center space with aggressive marketing of modular CHP systems for data centers.
- D.E.N.T. LLC will have strategic allies, in particular EYP Mission Critical (an HP Company), Carrier and the TDB prime mover manufacturer to assist in the commercialization efforts.
- There are significant details to be completed when the project starts, but key entities including: the Uptime Institute, ASHRAE, DOE FEMP and EPA will be educated regarding the salient benefits of modularized CHP for reliable data center energy supply.

Results and Accomplishments

- **Where are you in the project?** Project has not started
- **What milestones have you completed?** None
- **What accomplishments have been made to-date?** None
- **What results do you have to report?** None

Project Management & Budget

- **How much will it cost?** $1,187,155
- **How long will it take?** 3 years max including 1 year field demonstration period.

- Project task and milestone schedule: We will develop final project plans for the chiller research and development, module integration and development and the field demonstration and a master Gantt chart covering all tasks and subtasks identifying the critical path when the project starts.

- Project budget (DOE investment, cost share, total)

Project Budget				
	FY11	**FY12**	**FY13**	**FY14**
DOE Investment	$117,306	$341,527	$205,974	**$664,807**
Cost Share	$50,273	$146,367	$325,707	**$522,347**
Project Total	$167,579	$487,895	$531,681	**$1,187,155**

Path Forward

- Subtask 1.1 Establish Subcontracts
- Subtask 1.2 Develop Stage/Gate Process
- Subtask 2.1 LT Absorber Design Review & Modeling
- Subtask 2.2 LT Absorber Site Selection and Design Requirements
- Subtask 2.3 LT Absorber Design Development & Fabrication Drawings
- Subtask 2.4 LT Absorber Chiller Fabrication
- Subtask 2.5 LT Absorber Performance Testing
- Subtask 3.1 LT Absorber Module Design
- Subtask 3.2 LT Absorber Module Fabrication Drawings
- Subtask 3.3 LT Absorber Module Fabrication & Functional Testing

Path Forward (2 slides max)

- Subtask 4.1 Balance of Plant Design Development
- Subtask 4.2 Installation Drawings:
- Subtask 4.3 Site Layout and Preparation and CHP Plant Installation
- Subtask 4.4 CHP Plant and ICHM Commissioning
- Subtask 4.5 CHP Plant Field Performance Measurements
- Subtask 4.6 Final Report

Questions