



CHP for Buildings IES Peer Review

May 2, 2002



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Goals per DOE Request for Proposal

- **Integrated Energy System** for Commercial Buildings
- **Focus on Pre-Engineered Package - Optimized to:**
 - ✓ Improve Efficiency
 - ✓ Increase Reliability
 - ✓ Reduce First Cost
 - ✓ Reduce Maintenance Costs
- **Phase 1 R&D Statement of Work:**
 1. Plan
 2. Concept (including market analysis)
 3. Optimization
 4. Test Standards
 5. Prototype
 6. Lab Testing
- **Phase 2 Commercial Demonstration**



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Project Team

Initial Team Members:

- Gas Technology Institute
- University of Illinois at Chicago
- Takuma Co., Ltd.
- Broad USA, Inc.
- Capstone Turbine Corp.

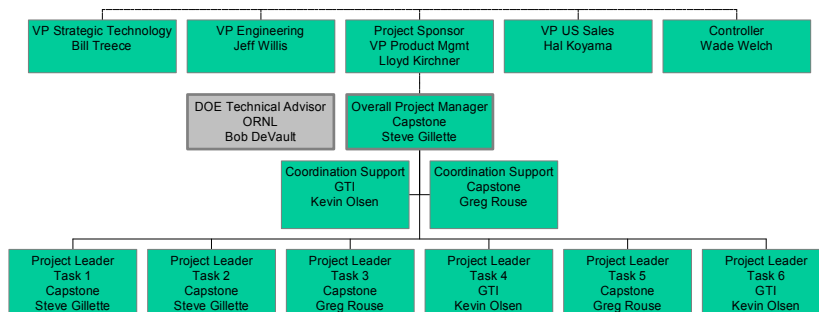
Additional Team Members TBD

- Focus on Optimum System

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Project Organization



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Development Plan Summary

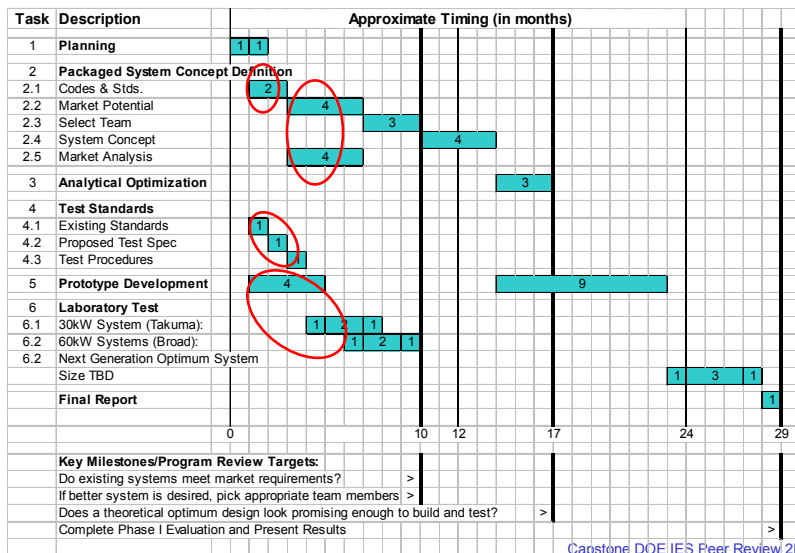
- Test Near-Commercial Absorption Products Early
 - ✓ Utilize Direct Exhaust Firing
 - ✓ 30kW Capstone with Takuma 12-14RT
 - ✓ 60kW Capstone with Broad 23-25RT
- Complete Market Analysis in Parallel
- Define Concept & Partner for Optimum Prototype
- Expand Team as Needed

- Benefits:
 - ✓ Potential Early Commercial Product Availability
 - ✓ Strong Basis for Optimum Concept Development

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Overview of Major Tasks



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Packaged Concept Definition (Task 2)

Codes & Standards Review (Task 2.1)

- GTI Compiling Relevant Local Building Codes into Searchable Document
- Expected Completion May

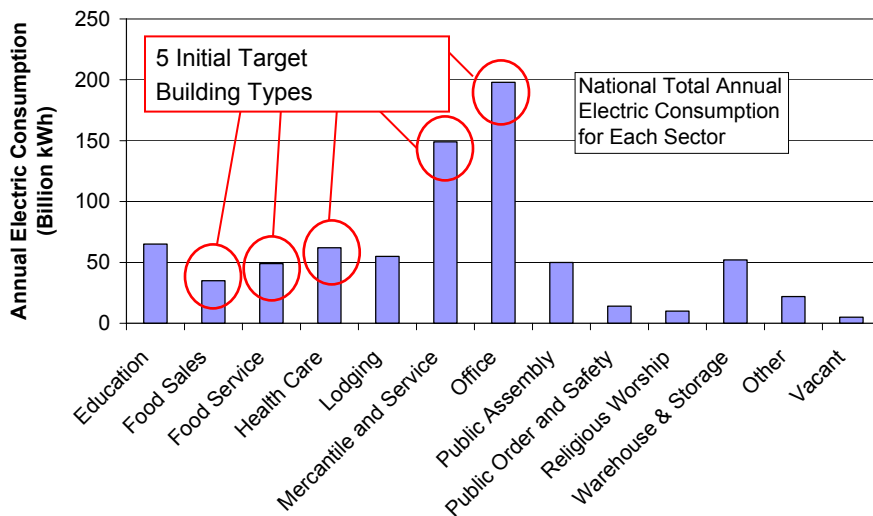
Market Assessment (Tasks 2.2 & 2.5)

- Initial Target Building Types Defined
- Details for 2 of the 5 Initial Target Segments Defined
- Initial Model for IES Package Completed
- Preliminary DOE-2 Simulation for One Building Type

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Initial Target Building Types

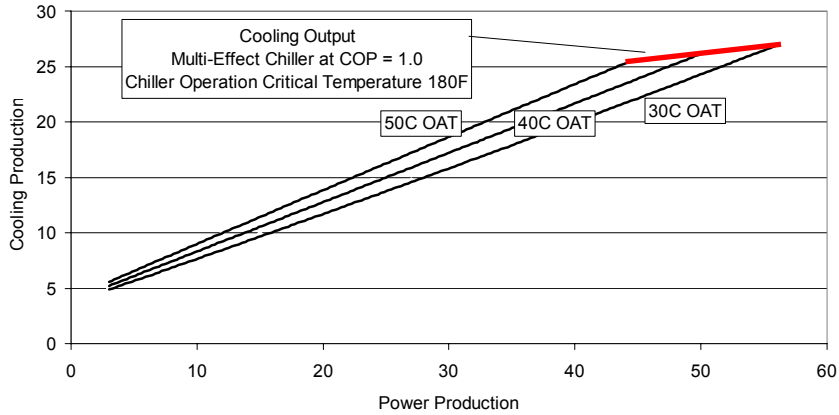


Source: EIA 1995 Survey

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Preliminary IES Performance Model

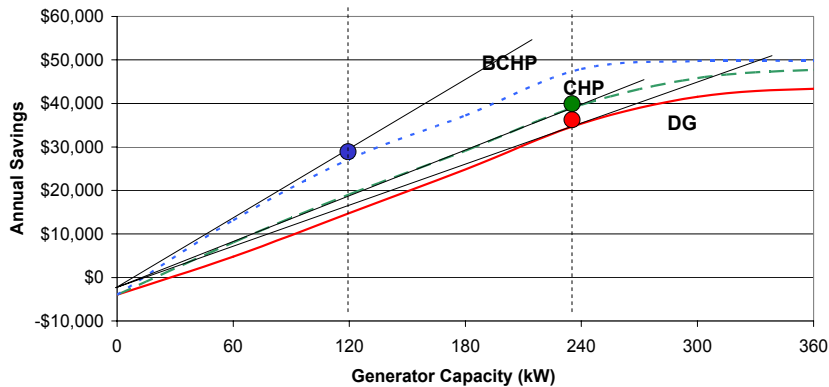


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Example DOE-2 Simulation Result

Estimated Savings



Optimum Economic Situation
Largest System Along Constant Slope Section of Graph
Slope Declines to Maximum Indicating Deteriorating Value
Of Each Added Unit of Capacity

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Test Standards (Task 4)

Existing Standards (Task 4.1)

- Relevant Distributed Generation (IES) Equipment Performance Standards Compiled by GTI

Proposed Test Spec (Task 4.2)

- GTI to Complete in Combination with Separate Project
- GTI working in conjunction with a nationally recognized standards organization for standards development.

Test Procedures (Task 4.3)

- Procedures for Initial Prototype Testing Completed
- Revisions to be made based on Task 4.2 and experience testing first two prototypes

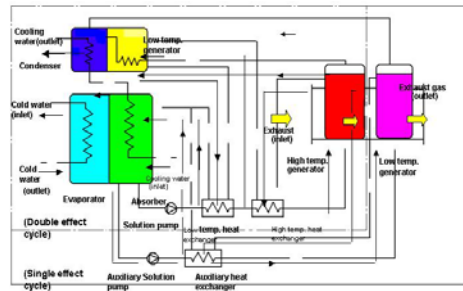
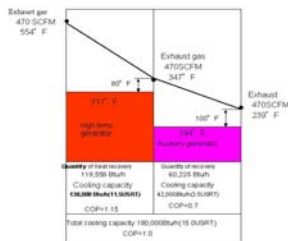
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Prototype Development (Task 5)

Takuma/Capstone Prototype (Task 5.1)

- Expected Performance:
30kW Electrical
12-14 RT Chilling
- Prototype Delivered
- Commissioned at GTI
- Testing Underway



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Prototype Development (Task 5)

Broad/Capstone Prototype (Task 5.2)

- Expected Performance:
 - 60kW Electrical
 - 23-25 RT Chilling
- Prototype Design Completed
- Expected Shipment June
- Similar to System at Univ. of Maryland
(due to start operation May, 2002)

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Laboratory Testing (Task 6)

Takuma/Capstone Prototype (Task 6.1)

- Testing Underway



Purpose of Testing

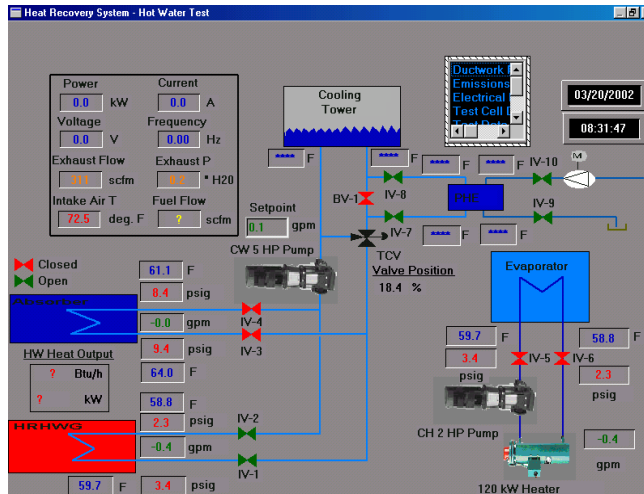
- Performance
 - ✓ Unit Efficiency
 - Turbine
 - Chiller
 - ✓ Overall System Efficiency
 - ✓ Emissions (NO_x, SO₂, CO, CO₂)
- Verification/Collection of Application Data
 - ✓ Gas Consumption
 - ✓ Heat Rejection Rates
 - ✓ Part Load Performance
- Recommendations for Improvements
 - ✓ Identify Lessons Learned in Installation
 - ✓ Package Improvements
 - ✓ System/Control Scheme Improvements
 - ✓ Recommendations for Building Sector Application Designs (Conceptual)

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Laboratory Testing – (continued)

GTI MT-Chiller Test Configuration



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Project Challenges

End-User Value

- Focus on Direct Exhaust Fired Thermally Activated Technologies
- Confirm Economics of Current Prototypes
- Investigate Technology Options
 - ✓ Performance/Cost Tradeoffs
 - ✓ Maintenance & Reliability (e.g. Air Cooling)
 - ✓ Addition of Desiccant Technologies

Integration with Existing HVAC systems

- Mix with Traditional Technologies
- Building Control & Communications to Optimize Savings

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Remaining Tasks for FY2002

Complete Market Analysis and Confirm Viability

- Modeling of 5 Building Types in Different Geographies
- Interviews with Prospective Target Customer Types

Complete Laboratory Testing

- Takuma/Capstone
- Broad/Capstone

Propose Integrated Energy System Test Standard

Select Team for Optimum Design Concept

- Define Contributions from Each Team Member
- Schedule & Budget for FY2003
- Define Specific Technology Challenges

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Project Summary

Prototype Performance Encouraging

- DOE Efficiency Targets of 70% Seem Achievable
- Clean Emissions and Simple Interconnections

Significant Total Market Opportunity

- Looks Attractive for the Target Building Types Selected

Potential for Early Commercial Installations

- Prototypes can Confirm Reliability and Total End-User Value

Optimum Design Could Improve Economics

- Technical Risk and Opportunity will be Clear this FY

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