# Final Research Performance Progress Report (RPPR) for DOE/EERE

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| **Project Title:** | Thermal Demonstration Project |
| **Covering Period:** | July 1, 2012 to September 30, 2012 |
| **Approved Project Period:** | Oct 30, 2009 to Oct 30, 2012 |
| **Submission Date:** | October 30, 2012 |
| **Recipient:** | Clark County School District<br>5100 W. Sahara Ave.<br>Las Vegas, NV. 89146 |
| **Website (if available)** | www.ccsd.net |
| **Award Number:** | DE-EE0000427 |
| **Working Partners:** | N/A |
| **Cost-Sharing Partners:** | CCSD (see background) |

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**DOE Project Team:**

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| DOE Contracting Officer | - | Nancy Kiyota |
| DOE Project Officer | - | Jim Payne |
| Project Engineer | - | Suzanne Baca |

**Project Objective:** The overall objectives of this project are to increase usage of alternative/renewable fuels, create a better and more reliable learning environment for the students, and reduce energy costs. Utilizing the grant resources and local bond revenues, the District proposes to reduce electricity consumption by installing within the existing limited space, one principal energy efficient 100 ton adsorption chiller working in concert with two 500 ton electric chillers. The main heating source will be primarily from low nitrogen oxide (NOX), high efficiency natural gas fired boilers. With the use of this type of chiller, the electric power and cost requirements will be greatly reduced. To provide cooling to the information technology centers and equipment rooms of the school during off-peak hours, the District will install water source heat pumps. In another measure to reduce the cooling requirements at Clark High School, the District will replace single pane glass and metal panels with 'Kalwall' building panels. An added feature of the "Kalwall" system is that it will allow for natural day lighting in the student center. This system will significantly reduce thermal heat/cooling loss and control solar heat gain, thus delivering significant savings in heating ventilation and air conditioning (HVAC) costs.

**Background:** The existing high school was originally constructed in 1964. Major additions were added including an auxiliary gym and classrooms in 2001 and a new theater in 2004 bringing the total area to 357,229 SF in a one-story facility. There have been several modernizations including a partial HVAC upgrade in 1998. Various additions and modernization projects have resulted in a mixture of HVAC systems, some of which are still original.

The central heating/cooling plant will be upgraded by replacing existing low pressure steam heating boilers with gas-fired low NOx high efficiency hot water heating boilers and existing chiller replacements will be done with the adsorption chiller as lead and the remaining equipment with frictionless magnetic bearing compressor chillers. The central plant will be provided with energy saving all variable frequency drives and central plant optimization DDC controls, with DDC controls provided throughout the school.

The project is currently funded using a capital improvement bond at $31 Million and represents the district's cost share contribution to the project. Construction was estimated to take 16 months and is currently on schedule for completion by the end of the 2012 calendar year.

The current project addresses two of the US Department of Energy project objectives aimed to diversify the country's energy supply, reduce dependence on foreign imported fuels, improve air quality, and offset greenhouse gas emissions. The project will also stimulate the local economy by creating/preserving jobs in the construction industry.

**Work Planned for this Quarter:**

*None as all work was completed on or before September 30, 2012*

**Significant Accomplishments This Period:**

*N/A. All work was completed prior to September 30, 2012*

PHASE 1: UPGRADES TO EXISTING INFRASTRUCTURE

**Task 1.0 Replacement/consolidation of existing HVAC systems**
The general scope of work includes replacement and consolidation of several of the HVAC systems including replacement, with capacity as required to suit the current facility size and use, of central plant chillers and boilers, 4-pipe hydronic piping system and air handling units with associated ductwork modifications.

**Subtask 1.1 Interior modifications**
The work will also include general lighting replacement, day lighting, plumbing upgrades, some interior modifications and outside civil site work to accommodate.

*Update: This on-going portion of the project was completed in September 2012.*

**Task 2.0 Boiler upgrades**
The central heating/cooling plant will be upgraded by replacing existing low pressure steam heating boilers with gas-fired low NOx high efficiency hot water heating boilers and existing chiller replacements will be done with the absorption/adsorption chiller as lead and the remaining equipment with frictionless magnetic bearing compressor chillers. The central plant will be provided with energy saving all variable frequency drives and central plant optimization DDC controls, with DDC controls provided throughout the school.

*Update: This sub-task was complete in December of 2011 as planned.*

PHASE 2: INSTALLATION OF A NEW ADSORPTION CHILLER

**Task 3.0 Chiller replacements**
With the funds to be provided it is proposed to install an absorption or adsorption chiller to be a primary lead chiller in providing space conditions.

**Subtask 3.1**
Remove existing chillers, pumps, and piping
*Completed on April 1, 2012.*
**Subtask 3.2**
Prepare infrastructure for new equipment
*Completed on May 1, 2012.*

**Subtask 3.3**
Install new chiller(s), pumps, piping and controls
*Completed on May 15, 2012.*
**Subtask 3.4**
Performance test
*Completed on May 28, 2012.*
**Subtask 3.5**
Commissioning of systems
*Completed in July 2012.*

PHASE 3: INSTALLATION OF NEW WATER SOURCE HEAT PUMPS

**Task 4.0 Cooling plant upgrade of water source heat pumps**
The cooling system will be upgraded to utilize water source heat pumps to provide conditioned air to areas of the school like technology rooms or equipment rooms that require 24/7 cooling during, even duting the school off hours; these areas will be able to have constant conditioning utilizing the massive water volume in the hydronic piping, with minimum need to operate central plant. Water source heat pump systems are among the most efficient, economical and environmentally friendly methods to heat and cool buildings. Self-contained, high efficiency units make maximum use of building diversity, transferring heat from where it is not needed to where it is needed, thereby minimizing the amount of energy required for heating or cooling.

**Subtask 4.1**
Prepare infrastructure for new equipment.
*Completed in August 2012.*
**Subtask 4.2**
Install heat pumps and connecting piping and pumps.
*Completed in July 2012.*
**Subtask 4.3**
Install conduit and piping.
*Completed in July 2012.*
**Subtask 4.4**
Performance test.
*Completed in August 2012.*
**Subtask 4.5**
Commissioning of system.
*Completed in August 2012.*

PHASE 4: INSTALLATION OF NEW COOLING TOWERS

**Task 5.0 Cooling plant upgrade of Cooling Towers**
The cooling plant will be upgraded to utilize enclosed fiberglass cooling towers with variable flow rotary spray nozzels. These towers are designed with special water collection system that reduces the water volume in basin (channels) and therefore, the chemicals used for water treatment. These towers with closed basin design eliminates

air inlet louvers, blocks sunlight reducing algae growth, reduces tower splash-out emissions and icing that accure during cold weather operation. The bottom mounted variable speed multiple fan design, makes it easier and safer for maintenmace and service access. These towers are more environmetally friendly due to their reduced "drift" (almost 10% of the towers normally used in this industry) and reduction in water and chemical use.

**Subtask 5.1**
Remove existing cooling towers, pumps, and piping
*Completed on April 1, 2012.*
**Subtask 5.2**
Prepare infrastructure for new equipment
*Completed on May 1, 2012.*
**Subtask 5.3**
Install new cooling towers, pumps, piping and controls
*Completed on May 15, 2012.*
**Subtask 5.4**
Performance test
*Completed on May 28, 2012.*
**Subtask 5.5**
Commissioning of systems
*Completed in July 2012.*

All of the above includes:
Removal and installation of supporting electrical systems.
Removal and installation of DDC control systems and connection to a central Energy Management
System (EMS)

*All of the water source heat pumps are operational and are currently in use providing cool air to the technology and equipment rooms which require 24/7 climate control.*

**Task 6.0 Kalwall installation**

**Subtask 6.1**
Remove existing steel frame windows and panels.
**Subtask 6.2**
Prepare infrastructure for 'Kalwall' panels.
**Subtask 6.3**
Install 'Kalwall' panels and seal.

*Update: All kalwall tasks were completed on June 30, 2012.*

**Plans for Next Quarter:** *None as the project is 100% complete.*

**Patents:** N/A

**Training and Professional Development:** N/A

**Publications/Presentations/Travel:** N/A

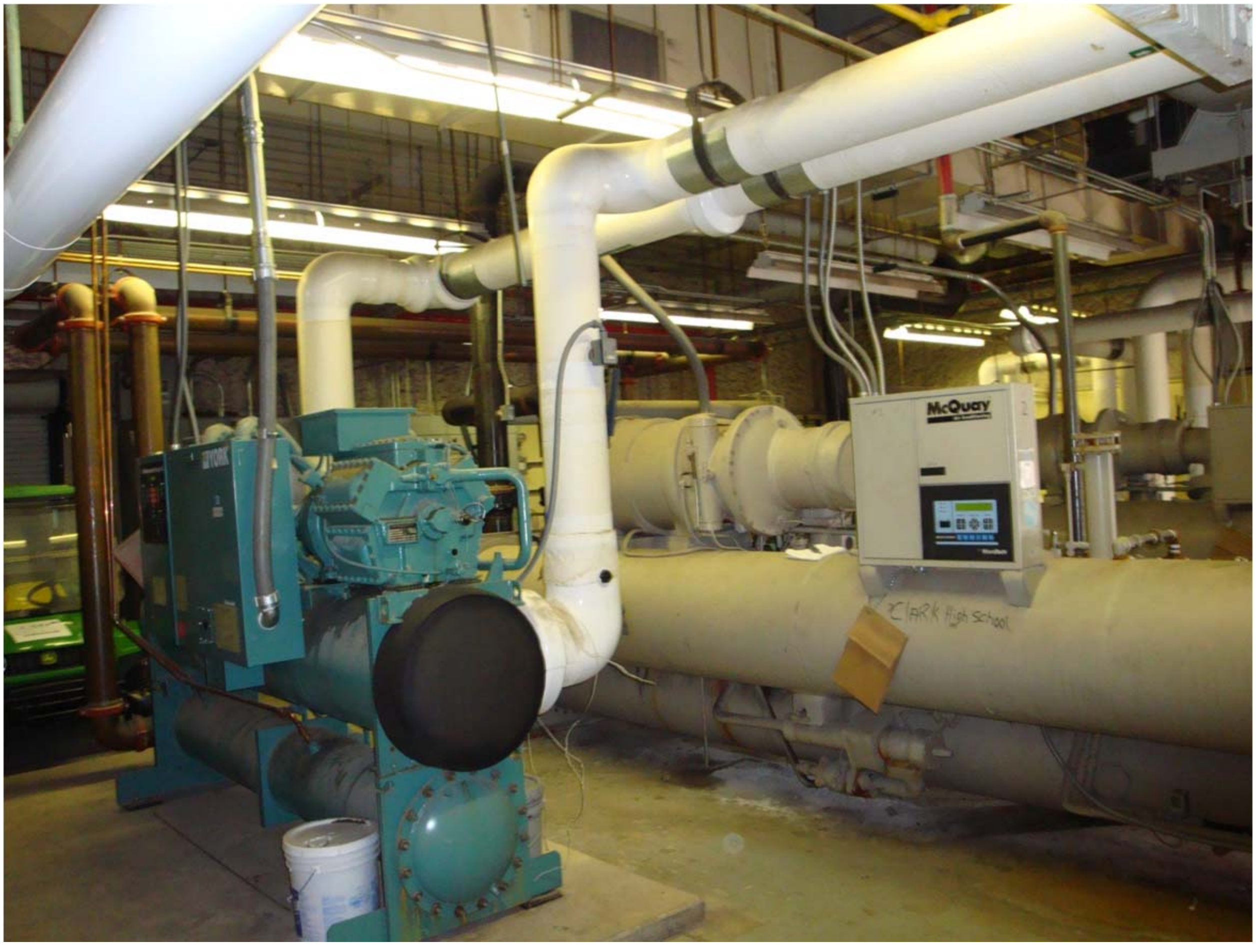
**Other Required Reports:**

Update the RPPR Part II Excel spreadsheet and submit with this report. The Part II report is submitted in native Excel format.

Update the SF-425 Federal Financial Report and submit with this report. The document requires a signature. Please scan and submit as a .pdf document.

Photos before project

Previous boiler and hot water storage




Previous (McQuay) chiller

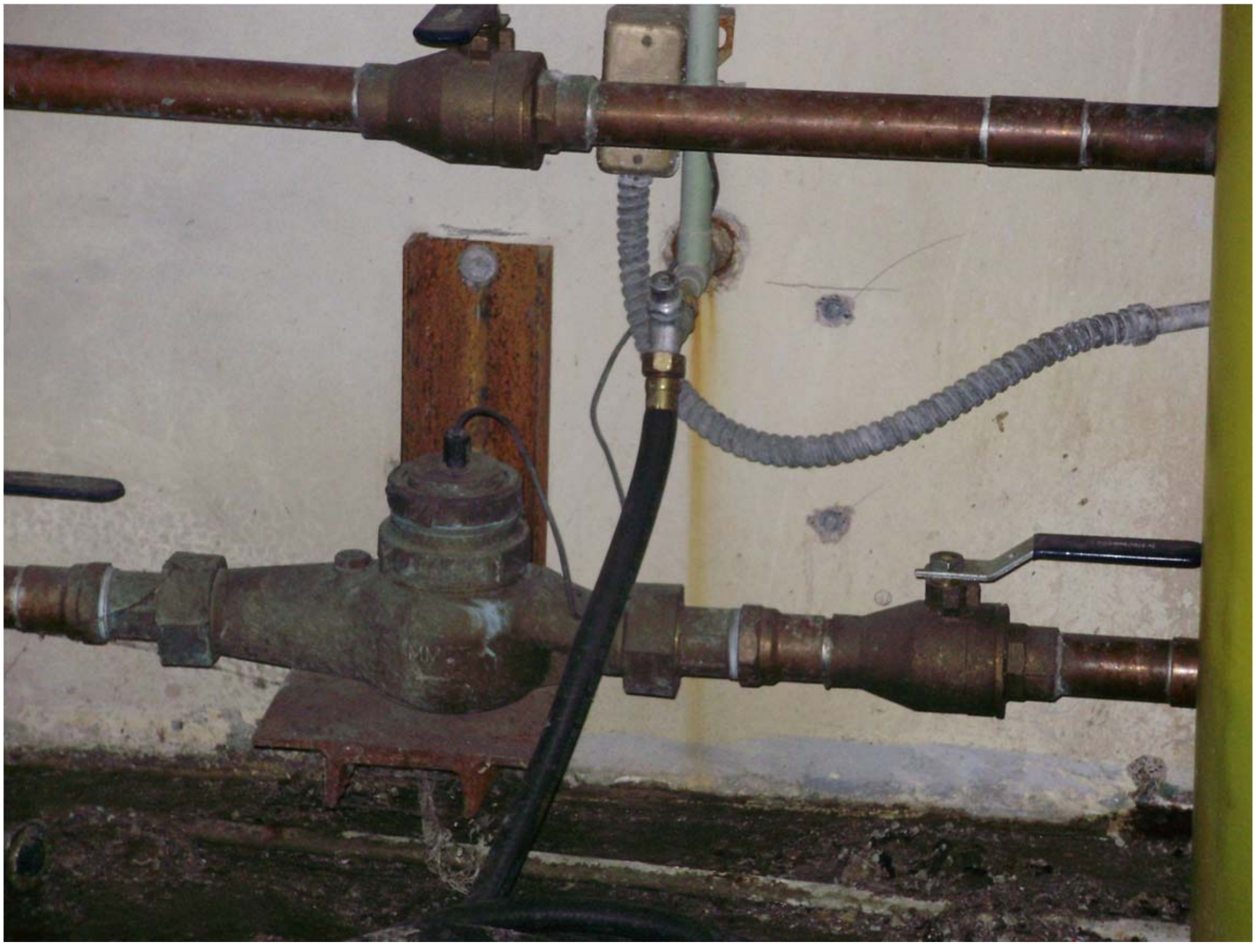

Previous (McQuay) chiller (same as last image)

Previous hot water and chilled water pumps

Previous condenser water pump


Previous central plant custodial closet and restroom

Previous cooling tower



Previous central plant interior


Previous central plant interior

Photos after project

New adsorption chiller

New adsorption chiller (on right) and new chillers (frictionless magnetic bearings)

New water source heat pump

New cooling tower

The Clark County School District (CCSD) in Las Vegas, Nevada was selected to receive a $1,189,375.00 award (original request $5.7M) from the US Department of Energy to increase usage of alternative/renewable energy sources. The project aimed to create a more efficient cooling system leading to a more comfortable learning environment for students, while reducing energy costs for the District. The original goal of this project was to replace the existing central chilled water system at Clark High School with a more efficient parallel flow adsorption chiller. This new chiller would operate using power from a combination of sources; a concentrating solar collector, and biomass power, thus reducing energy costs and landscape waste.

Due to a significant disparity between the grant funds requested and the amount awarded for the proposed project, a revised scope of work was submitted to the funder in June of 2010 and approved by the U.S. Department of Energy in September of 2010. Due to these reductions made in the overall award amount, low nitrogen oxide, high efficiency natural gas boilers were to be used as the main heating source rather than solar and biomass methods. Additionally, the maintence costs associated with a biomass boiler would have proven to be too taxing due to continual labor costs associated with delivering landscape waste to the facility. The project was awarded approximately 1/5 of the originally requested amount, which overall proved to be the largest implementation obstacle. Biomass boiler also create air pollutants and add high quantities of carbon to the atmosphere.

The project successfully reduced electricity consumption by installing within existing limited space, one principal energy efficient 100 ton adsorption chiller (The actual capacity of this adsorption chiller has been measured and verified as providing 150 tons of chilled water.)

working in concert with two 500 ton electric frictionless magnetic bearing chillers. The main heating source is now primarily from low nitrogen oxide (NOX), high efficiency natural gas fired boilers. With the use of this type of chiller, electric power and cost requirements were greatly reduced. Adsorption chillers are significantly different from the more traditional "absorption" chillers. Whereas absorbtion chillers completely dissolve molecules to form a new solution, "adsorption" chillers leave these molecules held loosely on the surface of the adsorbant, in this case, a silicone-based gel substatance. This process is a more energy efficient, less maintenance intensive and quiet method of providing cool air to the building. The water and chemical usage also were reduced by utilizing environmetally friendly enclosed fiberglass cooling towers.

More importantly, Nevada Energy (the local power company) significantly increases per kilowatt hour fees during "peak" periods. This is usually between 1 and 7 PM during the hotter months when temperatures in Southern Nevada consistently exceed 100 degrees. Because of these funds, the school now can utilize the adsorption chilller as always the lead chiller to cool the building during these peak hours rather than depend on more traditional methods using electrical power. Since natural gas costs do not fluctuate during peak vs. non-peak hours, these savings can be re-channeled into other needed items in our schools such as classroom supplies, teacher training, and additional academic enrichment activities for students.

Since the adsorption chiller will work in concert with other energy efficient structures recently installed in the building, the water source heat pumps used in areas of the school like technology rooms or equipment rooms that require 24/7 cooling during, even duting the school off hours, it is difficult to accurately predict a dollar amount savings that will be realized, and a true energy savings cannot be obtained until the systems have been in operation for at least one year, whereas all systems were only fully operational in late 2012. Additionally, Nevada Power has the authority to request rate changes quarterly through the Utilities Commission. Other factors that can impact costs savings include the climate, the building type, and scalar ratios. It is our understanding from an informal interview with one of the sub-contractors that this is the only adsorption chiller of this magnitude on the west coast and only one of two are currently operating within the continental United States.

With all this said it is estimated that energy savings, from the adsorption chiller and the water source heat pumps utilizing the large volume of water in the system, will be 447,000 kWh per year, which at our current blended rate will save us $46,000 per year in energy costs.

The Southern California Gas Company, in partnership with the New Buildings Institute and Stanford University published a guidline document about adsorption chillers in 1998, and estimated an energy savings over the life of a product of this nature to be between 3.8 and 5.2, where any savings factor greater than one is considered to be cost effective. For a complete copy of this report, the reader is refered to http://www.stanford.edu/group/narratives/classes/08-09/CEE215/ReferenceLibrary/Chillers/AbsorptionChillerGuideline.pdf.

In another measure to reduce the cooling requirements, single pane glass and metal panels were replaced with ‘Kalwall’ building panels. An added feature of the “Kalwall” system is that it will allow for natural day lighting in the student center.  This system has significantly reduced thermal heat/cooling loss and controls solar heat gain, thus delivering significant savings in heating ventilation and air conditioning (HVAC) costs.  The estimated energy savings from this technology is 81,000 kWh per year or $8,000 per year.

The total savings from all work associated with this Thermal Demonstration Project is 528,000 kWh or $54,000 per year.

A site visit conducted by US Department of Energy staff in January of 2013 provided the awardee with an opportunity to give a tour of the newly remodeled facility. An interview with the assistant principal revealed that the project not only saved taxpayer dollars on monthly energy costs, but imrpved the overall climate of the school and made for an improved learning environment. While the HVAC improvements made are not readily visible to students and staff, the Kalwall structures installed in the main student center/cafeteria definitely encompass a more welcoming environment. Indeed, the Kawall installations were made over what used to be brick wall, which made this area dark and gloomy. Kalwall is a fiberglass based composite material that refracts sunlight to provide quality daylighting, even on cloudy days. This technology saves costs for lighting the area while simultaneously keeping in warm or cold air due to a gel insulation infused into the panels. The costs of installation were reasonable, and the material is shatterproof, does not require extensive cleaning, and is virtually tamper proof from vandalization.

This school also utilized LED lighting for classrooms with an additional $782,000 federal award from the US Department of Energy to provide more efficient learning environment for students, while reducing energy costs for the District. The original goal of this project was to replace the existing T8 lamps with new LED lighting for classrooms and learning environments. This project is estimated to save an additional 233,000 kWh or $24,000 per year in operating costs.

The following is the list of the Owners represenatitives, design and construction team, that helped to build this project.

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| Owner's Representative: | H Richard Cuppett, PE, CEM, Director I, Energy Manager<br>Steve Johnston, Design Manager<br>Ken Baker, Construction Project Manager |
| Prime Consultant and MP Engineer: | Sigma Mechanical Engineering Consultants, Inc.<br>Bijan Salimi, PE, Principal Engineer and Project Manager |
| Architect: | Nick Antrillo Architecture |
| Structural Engineer: | Calder Richards Consulting Engineering Inc. |
| Civil Engineer: | Lochsa Engineering |
| Electrical Engineer: | TJ Krob Consulting Engineers Inc. |
| Fire Protection: | Aon Fire Protection Corp. |
| General Contractor: | McCarthy Builders |
| Mechanical Subcontractor: | Bombard Mechanical |
| Electrical Subcontractor: | ARCO Electrical Contractors, Inc. |