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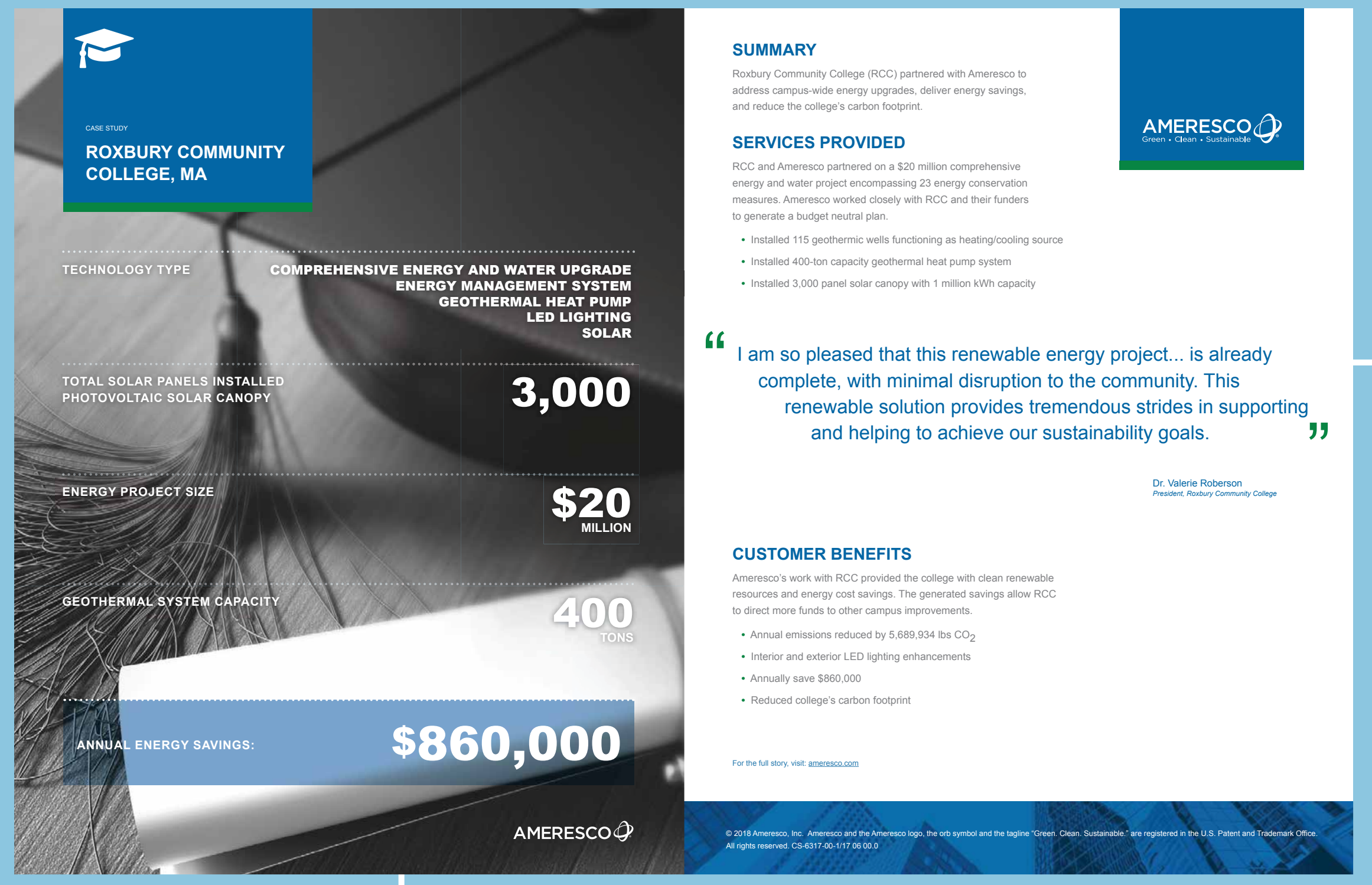
ROXBURY COMMUNITY COLLEGE, MA



CASE STUDY

ROXBURY COMMUNITY COLLEGE, MA

TECHNOLOGY TYPE	COMPREHENSIVE ENERGY AND WATER UPGRADE ENERGY MANAGEMENT SYSTEM GEOTHERMAL HEAT PUMP LED LIGHTING SOLAR
TOTAL SOLAR PANELS INSTALLED PHOTOVOLTAIC SOLAR CANOPY	3,000
ENERGY PROJECT SIZE	$20 MILLION
GEOTHERMAL SYSTEM CAPACITY	400 TONS
ANNUAL ENERGY SAVINGS:	$860,000

AMERESCO

SUMMARY

Roxbury Community College (RCC) partnered with Ameresco to address campus-wide energy upgrades, deliver energy savings, and reduce the college's carbon footprint.

SERVICES PROVIDED

RCC and Ameresco partnered on a $20 million comprehensive energy and water project encompassing 23 energy conservation measures. Ameresco worked closely with RCC and their funders to generate a budget neutral plan.

- Installed 115 geothermic wells functioning as heating/cooling source
- Installed 400-ton capacity geothermal heat pump system
- Installed 3,000 panel solar canopy with 1 million kWh capacity

> "I am so pleased that this renewable energy project... is already complete, with minimal disruption to the community. This renewable solution provides tremendous strides in supporting and helping to achieve our sustainability goals."
>
> Dr. Valerie Roberson
> *President, Roxbury Community College*

CUSTOMER BENEFITS

Ameresco's work with RCC provided the college with clean renewable resources and energy cost savings. The generated savings allow RCC to direct more funds to other campus improvements.

- Annual emissions reduced by 5,689,934 lbs CO_2
- Interior and exterior LED lighting enhancements
- Annually save $860,000
- Reduced college's carbon footprint

For the full story, visit: ameresco.com

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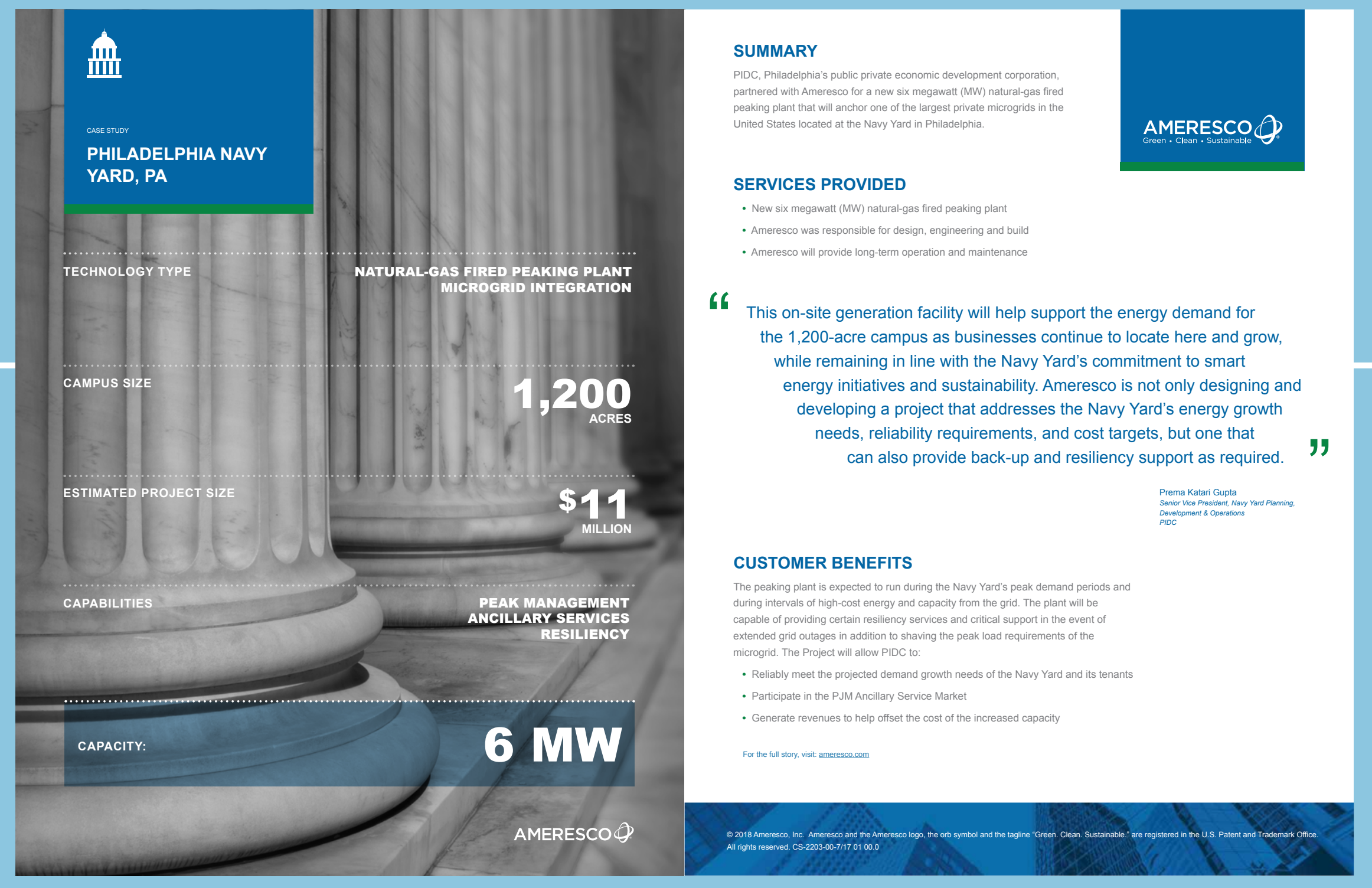
PHILADELPHIA NAVY YARD, PA



CASE STUDY

PHILADELPHIA NAVY YARD, PA

TECHNOLOGY TYPE	NATURAL-GAS FIRED PEAKING PLANT MICROGRID INTEGRATION
CAMPUS SIZE	1,200 ACRES
ESTIMATED PROJECT SIZE	$11 MILLION
CAPABILITIES	PEAK MANAGEMENT ANCILLARY SERVICES RESILIENCY
CAPACITY:	6 MW

AMERESCO

SUMMARY

PIDC, Philadelphia's public private economic development corporation, partnered with Ameresco for a new six megawatt (MW) natural-gas fired peaking plant that will anchor one of the largest private microgrids in the United States located at the Navy Yard in Philadelphia.

SERVICES PROVIDED

- New six megawatt (MW) natural-gas fired peaking plant
- Ameresco was responsible for design, engineering and build
- Ameresco will provide long-term operation and maintenance

> "This on-site generation facility will help support the energy demand for the 1,200-acre campus as businesses continue to locate here and grow, while remaining in line with the Navy Yard's commitment to smart energy initiatives and sustainability. Ameresco is not only designing and developing a project that addresses the Navy Yard's energy growth needs, reliability requirements, and cost targets, but one that can also provide back-up and resiliency support as required."
>
> Prema Katari Gupta
> *Senior Vice President, Navy Yard Planning, Development & Operations*
> *PIDC*

CUSTOMER BENEFITS

The peaking plant is expected to run during the Navy Yard's peak demand periods and during intervals of high-cost energy and capacity from the grid. The plant will be capable of providing certain resiliency services and critical support in the event of extended grid outages in addition to shaving the peak load requirements of the microgrid. The Project will allow PIDC to:

- Reliably meet the projected demand growth needs of the Navy Yard and its tenants
- Participate in the PJM Ancillary Service Market
- Generate revenues to help offset the cost of the increased capacity

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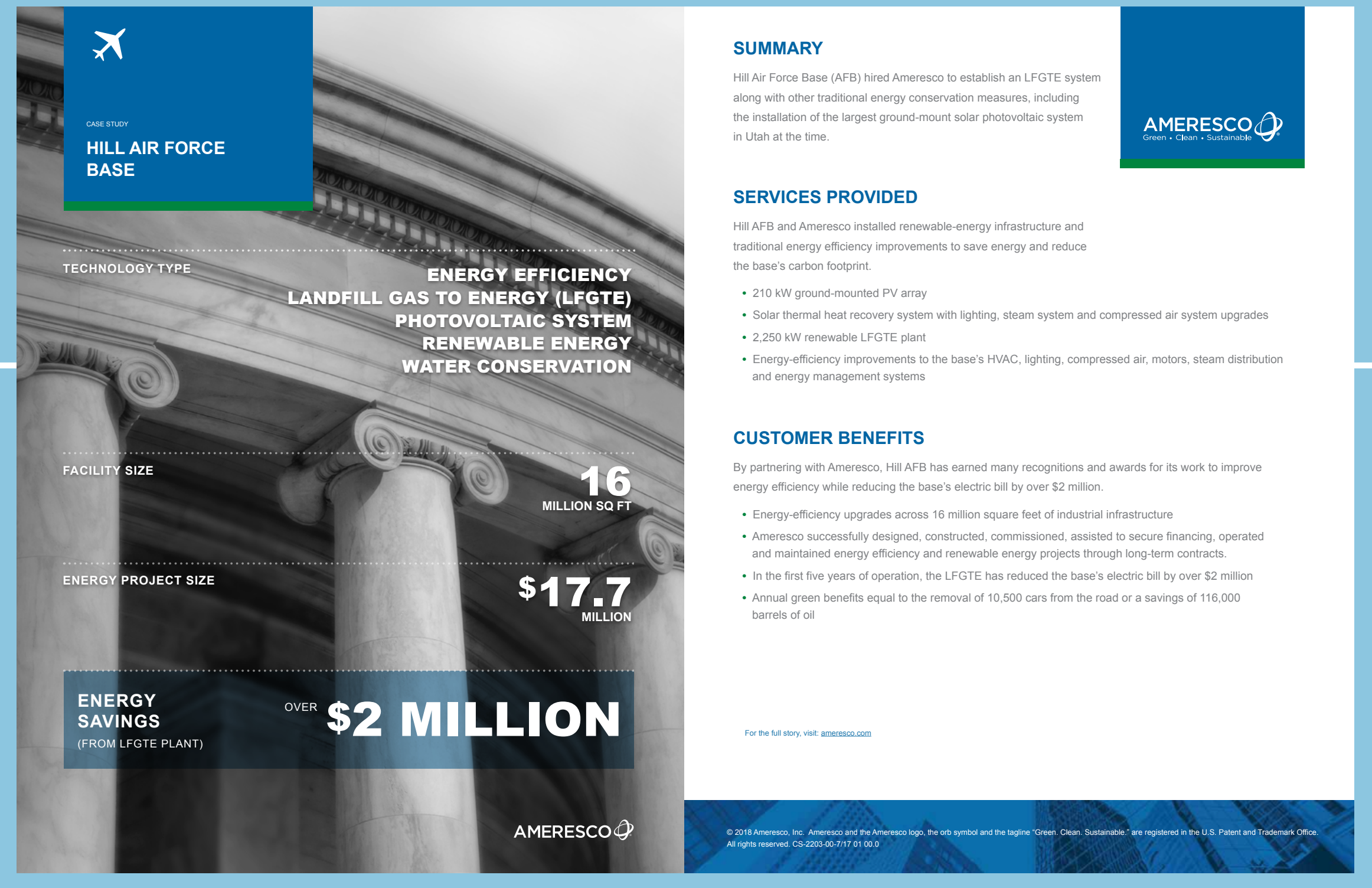
HILL AIR FORCE BASE



CASE STUDY

HILL AIR FORCE BASE

TECHNOLOGY TYPE	ENERGY EFFICIENCY LANDFILL GAS TO ENERGY (LFGTE) PHOTOVOLTAIC SYSTEM RENEWABLE ENERGY WATER CONSERVATION
FACILITY SIZE	16 MILLION SQ FT
ENERGY PROJECT SIZE	$17.7 MILLION
ENERGY SAVINGS (FROM LFGTE PLANT)	OVER $2 MILLION

AMERESCO

SUMMARY

Hill Air Force Base (AFB) hired Ameresco to establish an LFGTE system along with other traditional energy conservation measures, including the installation of the largest ground-mount solar photovoltaic system in Utah at the time.

SERVICES PROVIDED

Hill AFB and Ameresco installed renewable-energy infrastructure and traditional energy efficiency improvements to save energy and reduce the base's carbon footprint.

- 210 kW ground-mounted PV array
- Solar thermal heat recovery system with lighting, steam system and compressed air system upgrades
- 2,250 kW renewable LFGTE plant
- Energy-efficiency improvements to the base's HVAC, lighting, compressed air, motors, steam distribution and energy management systems

CUSTOMER BENEFITS

By partnering with Ameresco, Hill AFB has earned many recognitions and awards for its work to improve energy efficiency while reducing the base's electric bill by over $2 million.

- Energy-efficiency upgrades across 16 million square feet of industrial infrastructure
- Ameresco successfully designed, constructed, commissioned, assisted to secure financing, operated and maintained energy efficiency and renewable energy projects through long-term contracts.
- In the first five years of operation, the LFGTE has reduced the base's electric bill by over $2 million
- Annual green benefits equal to the removal of 10,500 cars from the road or a savings of 116,000 barrels of oil

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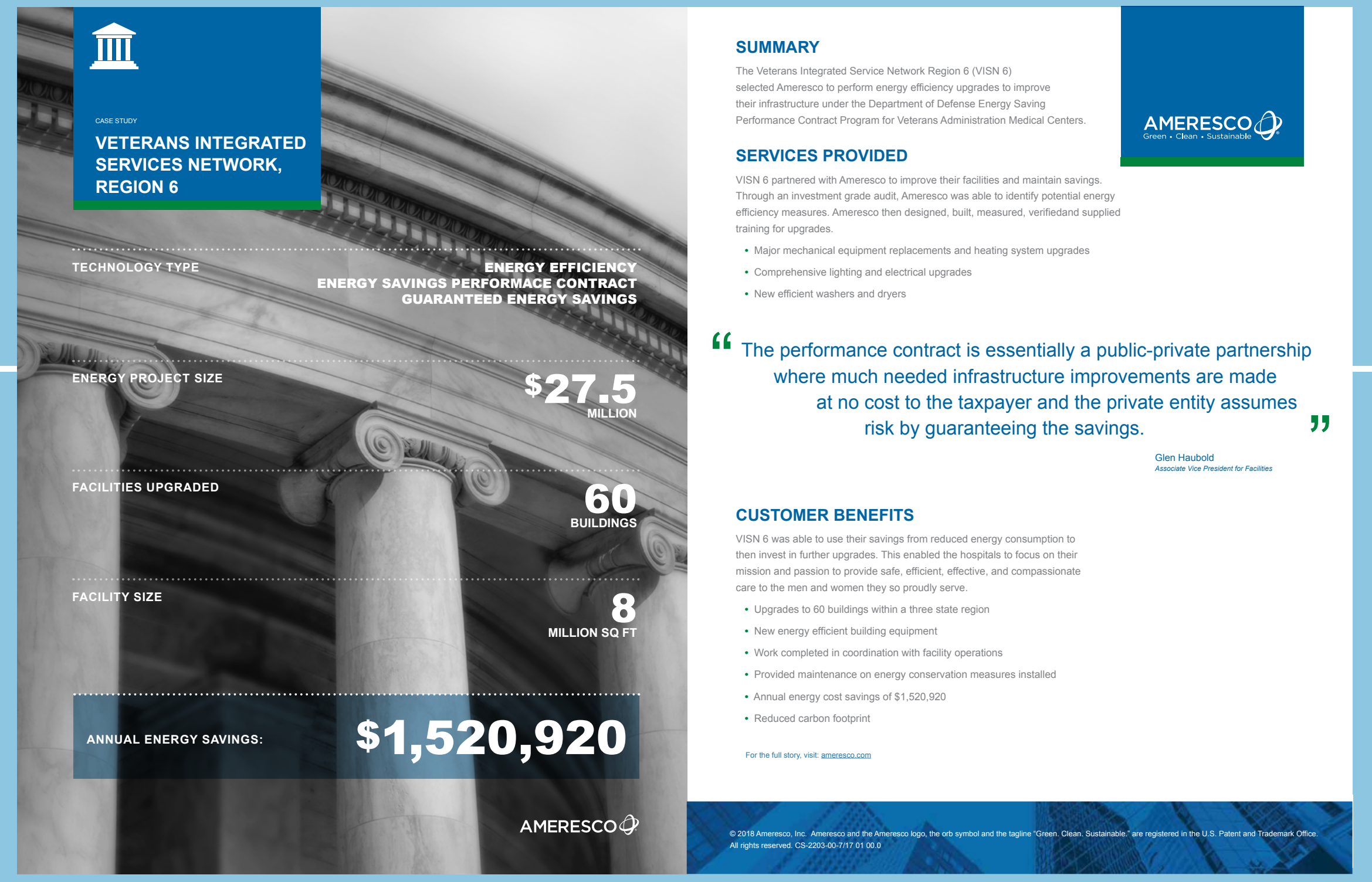
VETERANS INTEGRATED SERVICES NETWORK, REGION 6



CASE STUDY

VETERANS INTEGRATED SERVICES NETWORK, REGION 6

TECHNOLOGY TYPE	ENERGY EFFICIENCY ENERGY SAVINGS PERFORMACE CONTRACT GUARANTEED ENERGY SAVINGS
ENERGY PROJECT SIZE	$27.5 MILLION
FACILITIES UPGRADED	60 BUILDINGS
FACILITY SIZE	8 MILLION SQ FT
ANNUAL ENERGY SAVINGS:	$1,520,920

AMERESCO

SUMMARY

The Veterans Integrated Service Network Region 6 (VISN 6) selected Ameresco to perform energy efficiency upgrades to improve their infrastructure under the Department of Defense Energy Saving Performance Contract Program for Veterans Administration Medical Centers.

SERVICES PROVIDED

VISN 6 partnered with Ameresco to improve their facilities and maintain savings. Through an investment grade audit, Ameresco was able to identify potential energy efficiency measures. Ameresco then designed, built, measured, verifiedand supplied training for upgrades.

- Major mechanical equipment replacements and heating system upgrades
- Comprehensive lighting and electrical upgrades
- New efficient washers and dryers

> "The performance contract is essentially a public-private partnership where much needed infrastructure improvements are made at no cost to the taxpayer and the private entity assumes risk by guaranteeing the savings."
>
> Glen Haubold
> *Associate Vice President for Facilities*

CUSTOMER BENEFITS

VISN 6 was able to use their savings from reduced energy consumption to then invest in further upgrades. This enabled the hospitals to focus on their mission and passion to provide safe, efficient, effective, and compassionate care to the men and women they so proudly serve.

- Upgrades to 60 buildings within a three state region
- New energy efficient building equipment
- Work completed in coordination with facility operations
- Provided maintenance on energy conservation measures installed
- Annual energy cost savings of $1,520,920
- Reduced carbon footprint

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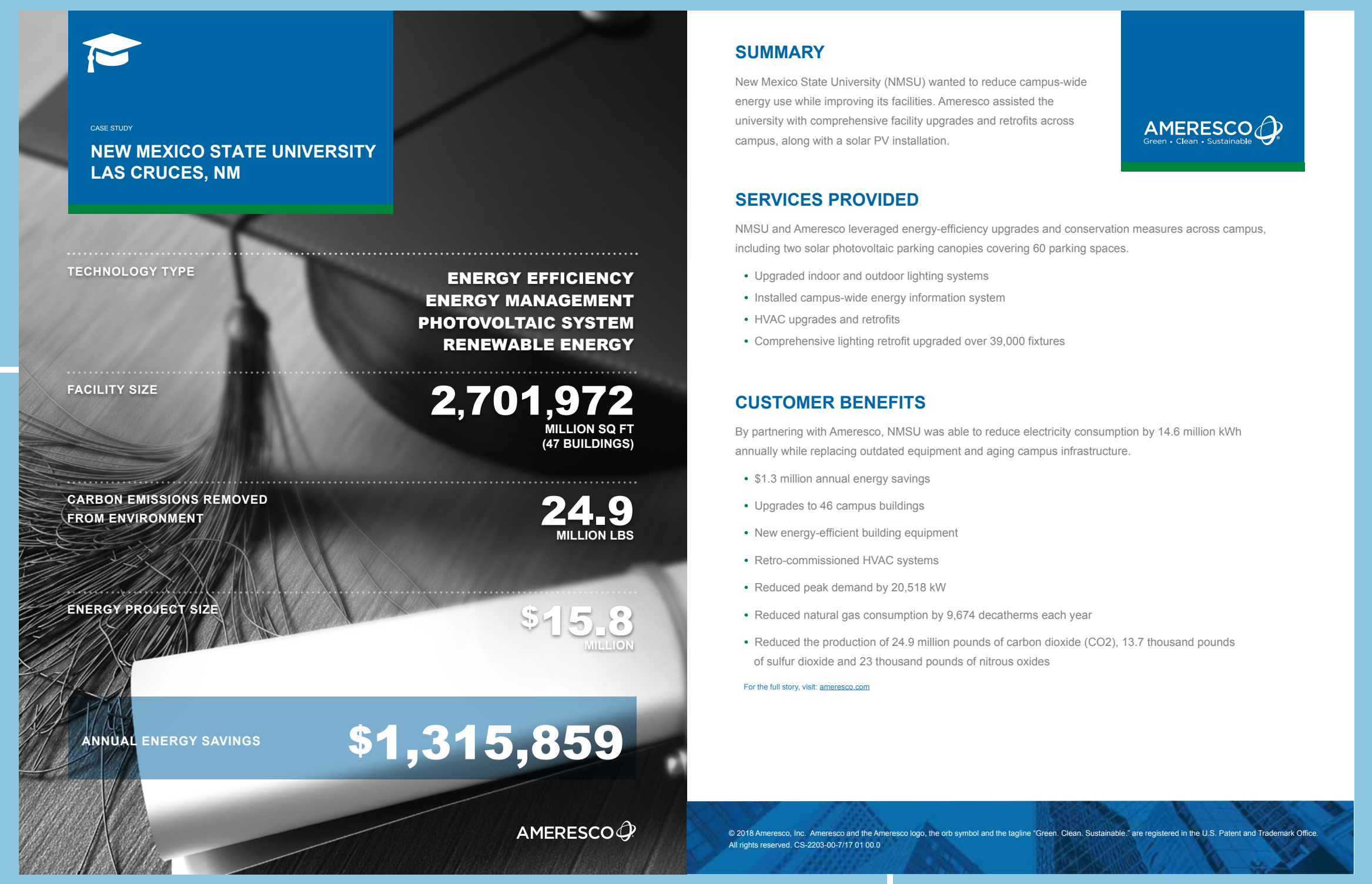
NEW MEXICO STATE UNIVERSITY - LAS CRUCES, NM



CASE STUDY

NEW MEXICO STATE UNIVERSITY LAS CRUCES, NM

TECHNOLOGY TYPE	ENERGY EFFICIENCY ENERGY MANAGEMENT PHOTOVOLTAIC SYSTEM RENEWABLE ENERGY
FACILITY SIZE	2,701,972 MILLION SQ FT (47 BUILDINGS)
CARBON EMISSIONS REMOVED FROM ENVIRONMENT	24.9 MILLION LBS
ENERGY PROJECT SIZE	$15.8 MILLION
ANNUAL ENERGY SAVINGS	$1,315,859

AMERESCO

SUMMARY

New Mexico State University (NMSU) wanted to reduce campus-wide energy use while improving its facilities. Ameresco assisted the university with comprehensive facility upgrades and retrofits across campus, along with a solar PV installation.

SERVICES PROVIDED

NMSU and Ameresco leveraged energy-efficiency upgrades and conservation measures across campus, including two solar photovoltaic parking canopies covering 60 parking spaces.

- Upgraded indoor and outdoor lighting systems
- Installed campus-wide energy information system
- HVAC upgrades and retrofits
- Comprehensive lighting retrofit upgraded over 39,000 fixtures

CUSTOMER BENEFITS

By partnering with Ameresco, NMSU was able to reduce electricity consumption by 14.6 million kWh annually while replacing outdated equipment and aging campus infrastructure.

- $1.3 million annual energy savings
- Upgrades to 46 campus buildings
- New energy-efficient building equipment
- Retro-commissioned HVAC systems
- Reduced peak demand by 20,518 kW
- Reduced natural gas consumption by 9,674 decatherms each year
- Reduced the production of 24.9 million pounds of carbon dioxide (CO2), 13.7 thousand pounds of sulfur dioxide and 23 thousand pounds of nitrous oxides

For the full story, visit: ameresco.com

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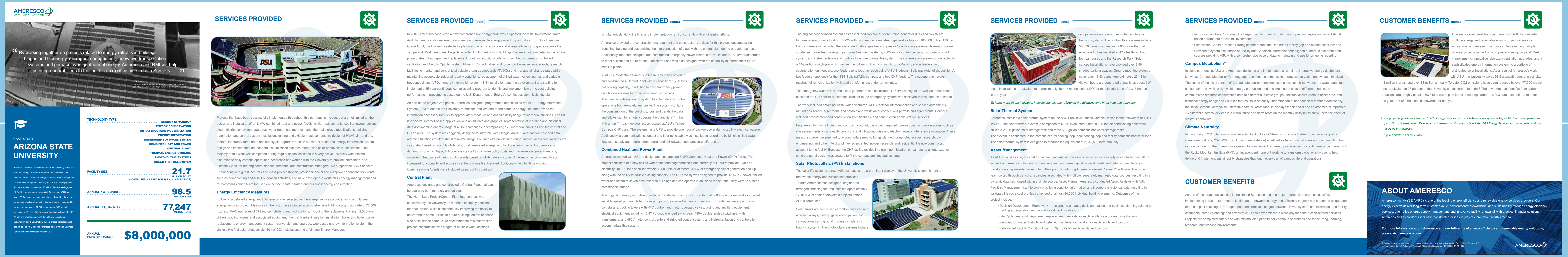
ARIZONA STATE UNIVERSITY



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> "By working together on projects related to energy retrofits in buildings, biogas and bioenergy, microgrid management, innovative transportation systems and perhaps even geothermal energy, Ameresco and RMI will help us bring our ambitions to fruition. It's an exciting time to be a Sun Devil."
>
> Nick Brown
> *Director of University Sustainability Practices, Arizona State University*
> *Senior Sustainability Scientist, Global Institute of Sustainability*

CASE STUDY

ARIZONA STATE UNIVERSITY

Since the partnership between Arizona State University (ASU) and Ameresco[1] began in 1999, Ameresco's responsibilities have included detailed facility and energy analyses, and the design and construction management of facility and infrastructure upgrades that have resulted in more than $8 million of annual savings over 21.7 million square feet of University infrastructure. ASU has saved 98.5 gigawatt hours of electricity and 1.4 million therms of natural gas, significantly reducing its annual energy usage and its carbon footprint by over 77,247 metric tons of CO2 annually – equivalent to 23 percent of the University's total carbon footprint[2]. As part of a broader commitment of attaining institutional sustainability and a University-wide goal of zero net greenhouse gas emissions, ASU selected Ameresco as its Strategic Business Partner to become climate neutral by 2025.

TECHNOLOGY TYPE	ENERGY EFFICIENCY ENERGY CONSERVATION INFRASTRUCTURE MODERNIZATION ENERGY INFORMATION DASHBOARD SOFTWARE SYSTEM COMBINED HEAT AND POWER CENTRAL PLANT THERMAL ENERGY STORAGE PHOTOVOLTAIC SYSTEMS SOLAR THERMAL SYSTEM
FACILITY SIZE	21.7 MILLION SQ. FT. (4 CAMPUSES, 1 RESEARCH PARK, 438 BUILDINGS)
ANNUAL KWH SAVINGS	98.5 MILLION KWH
ANNUAL CO_2 SAVINGS	77,247 METRIC TONS
ANNUAL ENERGY SAVINGS:	$8,000,000

SERVICES PROVIDED

Projects that have been successfully implemented throughout this partnership include, but are not limited to, the design and installation of an 8 MW combined heat and power facility; chiller replacements; cooling towers; boilers; steam distribution system upgrades; water treatment improvements; thermal storage modifications; building automation and control system installation; lighting and exit sign replacements; re-design of HVAC air handlers; motors; laboratory fume hood and supply air upgrades; outside air control measures; energy information system design and implementation; economic optimization dispatch model; and solar photovoltaic installations. The majority of this work was completed during regular school sessions in a very active university with minimal disruption to daily campus operations. Ameresco has worked with the University to provide internships, and ultimately jobs, for ten engineers, finance personnel and construction managers. We support the ASU School of Engineering with guest lecturers and class project support, provide financial and manpower donations for events such as homecoming and ASU Foundation activities, and have developed a world class energy management and retro-commissioning team focused on the occupants' comfort and buildings' energy consumption.

Energy Efficiency Measures

Following a detailed energy audit, Ameresco was selected as the energy services provider for w a multi-year energy services project. Measures in the first phase included a comprehensive lighting system upgrade of 72,000 fixtures; HVAC upgrades of 379 motors; chiller plant modifications, including the replacement of eight 2,000-ton chillers, cooling towers and associated equipment; thermal blanket insulation installation; boiler and boiler burner replacement; energy management system conversion and upgrade; web based energy information system; the University's first solar photovoltaic (30 kW DC) installation, and a full-time Energy Manager.

SERVICES PROVIDED (cont.)

In 2007, Ameresco conducted a new comprehensive energy audit which updated the initial Investment Grade Audit to identify additional energy efficiency and renewable energy project opportunities. From this Investment Grade Audit, the University selected a plethora of energy reduction and energy efficiency upgrades across the Tempe and West campuses. Projects included lighting retrofits in buildings that were not completed in the original project; steam trap repair and replacement; controls retrofit; installation of an Aircuity demand controlled ventilation and Aircuity OptiNet system, Phoenix Control valves and fume hood zone sensors in eight research facilities to monitor and control total volatile organic compounds (TVOCs) and manage air change rates while maintaining acceptable indoor air quality conditions; replacement of chilled water valves, pumps and variable frequency drives (VFDs); energy information system (EIS) installation; and the development and staffing to implement a 15-year continuous commissioning program to identify and implement low or no cost building performance improvements based on the U.S. Department of Energy's continuous commissioning plan.

As part of the projects 2nd phase, Ameresco designed, programmed and installed the ASU Energy Information System (EIS) to enable the University to monitor, analyze and report campus energy use and provide the information necessary for ASU to appropriately measure and analyze utility usage to individual buildings. The EIS is a secure, internet-based application with an intuitive and graphical representation of real-time and historical data documenting energy usage at all four campuses, encompassing 170 individual buildings and the central and CHP plants. The system was originally designed to integrate with Google Maps™, and has forecast and data alarming functions to alert staff if resource usage it outside of a pre-defined range. Individual building invoices are calculated based on monthly utility bills, total generated energy, and facility energy usage. Furthermore, a dynamic Economic Dispatch Model assists staff to minimize utility costs and maximize system efficiency by optimizing the usage of various utility plants based on utility rate structures. Ameresco has continued to add increased functionality and scope since the EIS was first installed. Additionally, two full-time ongoing Commissioning Agents were included as part of this contract.

Central Plant

Ameresco designed and constructed a Central Plant that can be operated both remotely and on-site.

The North Loop Project/Central Plant Interconnect was conceived by the University as a means to supply additional thermal utilities, while simultaneously improving the ability to deliver those same utilities to future buildings on the opposite side of its Tempe campus. To accommodate this fast-tracked project, construction was staged at multiple work locations simultaneously along the line, and implementation ran concurrently with engineering efforts.

Ameresco provided pre-construction management and construction services for this project, encompassing trenching, burying and customizing the interconnection of pipes with the central plant during a regular semester. Additionally, the team designed and constructed emergency power distribution, vaults and a 750 kVa transformer to meet current and future needs. The North Loop was also designed with the capability to interconnect future satellite plants.

At ASU's Polytechnic Campus in Mesa, Ameresco designed and constructed a Central Plant with a capacity of 1,200 tons bof cooling capacity, in addition to new emergency power distribution systems for three new campus buildings.

The plant includes a control system to automate and control operations both remotely and onsite. The system monitors the consumption of the buildings, logs and trends the data and allows staff to remotely operate the plant via a T-1 line with a non-T-1 back-up connection located at ASU's Tempe Campus CHP plant. The system has a UPS to provide one hour of backup power during a utility electrical outage. Additionally, a communications conduit and fiber optic cable was installed to record the building's chilled water flow rate, supply and return temperature, and chilledwater loop pressure differential.

Combined Heat and Power Plant

Ameresco worked with ASU to design and construct an 8 MW Combined Heat and Power (CHP) facility. The project consisted of a new chilled water plant and cogeneration plant, currently built-out to provide 8 MW of electricity; 10,000 tons of chilled water; 80,000 Mlb/hr of steam; 4 MW of emergency diesel generation backup, along with the ability to double existing capacity. The CHP facility was designed to provide 12.47 KV power, chilled water and steam to seven new research buildings and can operate in an island mode if the utility were to suffer a catastrophic outage.

The original chiller system design included 12 electric motor-driven, centrifugal, 2,000-ton chillers and associated variable speed primary chilled water pumps with variable frequency drive control, condenser water pumps with soft-starters, cooling towers with VFD control, and motor-operated valves; piping and ancillary equipment; electrical equipment including 12.47 kV double-ended switchgear, 480V double-ended switchgear with transformers, and 480V motor control centers; distributed control system; and instrumentation and controls to accommodate this system.

SERVICES PROVIDED (cont.)

The original cogeneration system design included two combustion turbine-generator units and two steam turbine-generator units totaling 16 MW with two heat recovery steam generators totaling 160,000 pph at 150 psig. Each cogeneration included the associated natural gas fuel compressor/conditioning systems, deaerator, steam condenser, boiler feedwater pumps, water treatment systems, 480V motor control centers, distributed control system, and instrumentation and controls to accommodate this system. The cogeneration system is connected to a 14-position switchgear which serves the following: two incoming Arizona Public Service feeders, two cogeneration unit feeders, two feeders (one loop) for each pair of ASU Biodesign Buildings (total of six positions), two feeders (one loop) for the ISTB Building/ASU campus, and two CHP feeders. The cogeneration system reached full synchronization with load transfer in just under ten minutes.

The emergency system included diesel generators and associated 4.16 kV switchgear, as well as transformer to backfeed the CHP chiller equipment. Transfer to the emergency system was achieved in less than ten seconds.

The work included obtaining wastewater discharge, APS electrical interconnection and service agreements, natural gas service agreement, and potable and wastewater connections permits and agreements. Services included procurement and construction specifications, and construction administration services.

Engineered to fit on a limited and compact footprint, the project required complex design considerations such as site assessments for air quality provisions and vibration, noise and electromagnetic interference mitigation. These measures were implemented to accommodate new buildings planned for nanotechnology research, bio engineering, and other interdisciplinary science, technology research, and residential life now constructed adjacent to the facility. Because the CHP facility resides in a prominent location on campus, a unique exterior concrete panel design was created to fit the campus architectural scheme.

Solar Photovoltaic (PV) Installations

The solar PV systems across ASU campuses are a prominent display of the University's commitment to renewable energy and sustainable practices.

To date Ameresco has designed, engineered, arranged financing for, and installed approximately 17.19 MW of solar photovoltaic projects across ASU's campuses.

Solar arrays are comprised of rooftop ballasted and attached arrays, parking garage and parking lot canopy arrays and ground mounted single axis tracking systems. The photovoltaic systems include

SERVICES PROVIDED (cont.)

canopy arrays and ground mounted single axis tracking systems. The photovoltaic systems include 56,378 panel modules and 2,000 solar thermal evacuated tubes installed at 47 sites throughout four campuses and the Research Park. Solar canopy installations have provided over 3,904 shaded parking spaces. Ground-mounted systems cover over 18.83 acres. Approximately 29 million kilowatt hours are generated annually as a result of these installations- -equivalent to approximately 15,447 metric tons of CO2 or the electrical use of 2,313 homes in one year.

To learn more about individual installations, please reference the following link: https://cfo.asu.edu/solar.

Solar Thermal System

Ameresco installed a solar thermal system on the ASU Sun Devil Fitness Complex which is the equivalent of 1,411 kW DC. The solar thermal system is comprised of 6,976 evacuated tubes, a 220-ton air conditioning absorption chiller, a 2,000-gallon solar storage tank and three 600-gallon domestic hot water storage tanks.

The system is connected to the campus central cooling loop, pool heating loop and facility domestic hot water loop. The solar thermal system is designed to produce the equivalent of 2,540,590 kWh annually.

Asset Management

As ASU's facilities age, the cost to maintain and sustain the assets becomes increasingly more challenging. ASU worked with Ameresco to identify immediate and long-term capital renewal needs and deferred maintenance backlog on a representative sample of their portfolio, utilizing Ameresco's Asset Planner™ software. The project team sorted through data discrepancies associated with multiple, separately managed data sources, resulting in a dynamic data set housed within a single source, Asset Planner. Ameresco conducted Asset Reviews with ASU Facilities Management staff to confirm building condition information and incorporate historical data, resulting in validated life cycle cost profiles comprised of almost 14,000 individual building elements. Outcomes of the project include:

- Decision Development Framework – designed to enhance decision making and business planning related to funding appropriation and capital investment priorities;
- Life Cycle needs with equipment replacement forecasts for each facility for a 30-year time horizon;
- Identified Unfunded Liability and deferred maintenance backlog for each facility and campus;
- Established Facility Condition Index (FCI) profile for each facility and campus;

SERVICES PROVIDED (cont.)

- Introduced an Asset Sustainability Target used to quantify funding appropriation targets and establish risk based parameters for capital investments;
- Established Capital Creation Strategies that reduce the Unfunded Liability gap and extend asset life; and
- Provided a dynamic database of Facility and Condition information that aligned numerous disparate data sources providing ASU with a comprehensive base of data to maintain and use for on-going reporting

Campus Metabolism®

In close partnership, ASU and Ameresco designed and implemented a real-time, interactive energy dashboard known as Campus Metabolism® to engage the campus community in energy conservation and waste minimization. The scope of the initial version of Campus Metabolism encompassed electrical, chilled water, hot water, and steam consumption, as well as renewable energy production, and is comprised of several different modules to communicate resource consumption data to different audience groups. This tool allows users to access live and historical energy usage and visualize the results in an easily understandable, non-technical manner. Additionally, the initial Campus Metabolism Interactive Virtual Room Module displays the financial and environmental impacts of 16 different electrical devices in a virtual office and dorm room on the monthly utility bill to show users the effect of wasteful behaviors.

Climate Neutrality

In the spring of 2013, Ameresco was selected by ASU as its Strategic Business Partner to achieve its goal of climate neutrality by 2025 (2035, including transportation) – defined as having no net climate impact resulting from carbon dioxide or other greenhouse gases. To complement our energy services solutions, Ameresco partnered with the Rocky Mountain Institute (RMI), an independent nonprofit working to transform global energy use, to help define and implement sustainability strategies that touch every part of campus life and operations.

CUSTOMER BENEFITS

As one of the largest universities in the United States located in a major metropolitan area, successfully implementing infrastructure modernization and renewable energy and efficiency projects has presented unique and often complex challenges. Through open and iterative dialogue between University staff, administration, and facility occupants; careful planning; and flexibility, ASU has never missed a class day for construction-related activities. Projects are completed safely and with minimal disruption to daily campus operations and to the living, learning, research, and working environments.

CUSTOMER BENEFITS (cont.)

Ameresco's southwest team partnered with ASU to complete multiple energy and renewable energy projects across its educational and research campuses. Representing multiple phases, projects range from comprehensive lighting and HVAC improvements, innovative laboratory ventilation upgrades, and a sophisticated energy information system, to a portfolio of distributed solar installations. As a result of Ameresco's work with ASU, the University saves 98.5 gigawatt hours of electricity, 1.4 million therms, and over $8 million annually. To date, CO2 emissions have been reduced by over 77,000 metric tons--equivalent to 23 percent of the University's total carbon footprint.[2] The environmental benefits from carbon reductions are roughly equal to 63,318 acres of pine forest absorbing carbon, 16,093 cars taken off the road for one year, or 3,859 households powered for one year.

1. The project originally was awarded to APS Energy Services, Inc., which Ameresco acquired in August 2011 and now operates as part of its southwest region. References to Ameresco in this case study includes APS Energy Services, Inc., as acquired and now operated by Ameresco.

2. Figures current as of May 2015.

ABOUT AMERESCO

Ameresco, Inc. (NYSE:AMRC) is one of the leading energy efficiency and renewable energy services providers. Our energy experts deliver long-term customer value, environmental stewardship, and sustainability through energy efficiency services, alternative energy, supply management, and innovative facility renewal all with practical financial solutions. Ameresco and its predecessors have constructed billions in projects throughout North America.

For more information about Ameresco and our full-range of energy efficiency and renewable energy solutions, please visit ameresco.com.

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