1. **Project / Program Title:** Automated Chiller Tube Cleaning Improves Chilled Water Plant Efficiency

2. **Name/Location of District Energy System/Project:** University of Virginia, Charlottesville VA

3. **Name of System Owner:** University of Virginia

4. **Contact Information of Person Submitting Application:**
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5. **Executive Summary: (700 words or less)**

The University of Virginia (UVA) is a leading public university located in Charlottesville, Virginia. UVA serves over 24,000 students and employs over 30,000 people. The brick-and-mortar infrastructure supporting these people is comprised of 560 facilities that range from buildings over 200 years old to new construction. District-level utility systems serve the more than 18M square feet and include 11 central cooling plants housing 39 chillers providing 45,000 tons of cooling capacity, 6.27 miles of utility tunnels, and 220 miles of underground distribution lines.

UVA continuously seeks to achieve energy savings and improve operational efficiencies within their campus utility operations and facilities. In 2014, UVA was presented a little-known technology to automate tube cleaning and tube fouling prevention in their chiller condensers and was interested in testing the overall impact to chilled water plant operations.

"I tend to believe success in innovative solutions is only limited by our appetite for risk," says Justin Callihan, Associate Director of Chiller Plants at UVA, "The trouble is, in the utility business, risk has to be mitigated. Find low risk ways to test new technology. In our case it was a trial run on a single chiller which was low cost and low operational risk."

A quantitative and qualitative test plan was set up to compare operational efficiency of a 2,000-ton chiller operating with an automatic tube cleaning system installed versus an identical chiller without the automated system. The trial was conducted for a full cooling season and the performance reviewed.

The automated system equipment is installed around heat exchangers and prevents tube fouling by periodically injecting specialized cleaning balls at programmed intervals into the cooling water flow, while the chiller is in operation. The balls rub the tubes clean and are then collected at the heat

exchanger outlet and returned to a side-stream staging vessel, where they are prepared for the next cleaning cycle.

The initial trial chiller operated 3,000 hours during the cooling season and performed 4-8% more efficiently than the control chiller, with no approach temperature rise and at cooling season's end required no manual tube cleaning. Financial return analysis indicated the project's simple payback would be approximately 5 years—making the system financially beneficial, especially on assets with a 20-year life cycle.

Additionally, as part of the program targeting improved chiller plant operational efficiency, UVA recognized the opportunity to leverage the reduced man-hrs for annual manual tube cleaning to enable highly skilled chilled plant maintenance personnel to tackle higher-level maintenance work (chiller teardowns, etc.).

Callihan explains, "We've learned from experience that, often when you try a new technology or program and you need to validate the performance metrics on your district cooling operation, it makes you evaluate your operations closely and maybe look at things differently than you have previously. Then you can start to tease out additional benefits and areas for improvement: Have we truly optimized our water flow schemes, our filtration systems? How can we leverage this to improve maintenance productivity or safety in our plants?"

UVA's decision to innovate has led to widespread technology adoption at UVA. The university now operates 20 water-cooled chillers with automated tube cleaning systems, delivering approximately 20,000 tons of cooling.

Since the first installation, energy savings of approximately 13 million kW-hrs have been realized, translating to energy cost savings of over $1 million. As the installation footprint has grown, cost savings are now above $350,000 annually.

In alignment with the university's sustainability goals, CO2 emissions have been reduced by almost 11,000 tons, with greenhouse gas emissions reduced by 1,500 tons per year—equivalent to removing more than 600 cars from the road annually.

With manual tube cleaning no longer required for chiller condensers, over 2,000 hours of labor are saved annually. This liberates skilled maintenance teams from manual chiller cleaning to higher value-added projects.

Finally, UVA continues to lead by example and share innovation successes in technical presentations and plant tours. Since the initial trial at UVA, IDEA member institutions have installed similar technology on 170,000 tons of cooling, saving more than 33 million kW-hrs and $3 million annually while reducing annual greenhouse gas emissions by over 27,000 tons.

6. Program Uniqueness (300 words or less)

Prior to implementation of automatic tube cleaning at UVA, the central plant chillers were operated in accordance with generally accepted industry best practice and status quo: Chemical water treatment programs were in place and chillers were opened and tubes were manually brushed at the end of each cooling season, with eddy current testing performed every five years.

Automatic tube cleaning system technology had been used in the power generation industry for years, and while UVA's facilities management personnel were familiar with the concept, the technology was not well-established or widely adopted in district cooling systems. UVA proposed a unique acquisition agreement and technology evaluation plan, in which Innovas would provide the automatic tube cleaning system equipment free of charge for the duration of a low-risk trial by the university. UVA was responsible for installing and operating the equipment for a full cooling season, and UVA then evaluated the energy savings and impact to chilled water plant operations. After reviewing the results, UVA purchased the automatic tube cleaning system equipment and proceeded with a phased approach to further technology adoption and integration into chilled water plant operations and maintenance.

7. Energy Efficiency Benefit (250 words or less)

Automating the chiller tube cleaning function as a continuous process occurring during chiller operation has improved chiller energy efficiency by approximately 4-8% across the central cooling plants at UVA. The annual and total energy savings since technology adoption are tabulated below.

Annual Cost Savings ($/yr)	Annual Energy Savings (kW-hrs/yr)	Annual GHG Emissions Reduction (tons/yr)	Equivalent Cars Removed from Road (Cars/yr)
$ 379,348	3,770,532	3,093	601

Total Cost Savings ($)	Total Energy Savings (kW-hrs)	Total GHG Emissions Reduction (tons)	Equivalent Cars Removed from Road
$ 1,624,203	16,449,438	13,495	601

According to the United States EPA, the annual energy savings are enough to provide electricity to 485 homes, and equivalent to the greenhouse gas emissions of driving a passenger vehicle 6.7 million miles—enough to circumnavigate the Earth 268 times!

8. Financial Advantages (250 words or less)

Since the first installation, energy savings of approximately 13 million kW-hrs have been realized, translating to energy cost savings of over $1 million. As the installation footprint has grown, cost savings are now above $350,000 annually.

Maintenance staff appreciate the elimination of manual tube cleaning. UVA estimates labor cost savings at more than 2,000 man-hours worth $150,000. Finally, the cost of operations for each system is approximately $.25 with the systems savings approximating $5.8 per operational hour. Also, UVA possesses exceptionally good makeup water, whereas the Universities who adopted UVA's approach benefit further due to more "normal" makeup water that translates to higher degrees of fouling.

9. Challenges? Plans? Community Reaction? (250 words or less)

Introducing a new way of conducting business is never without challenge. During the initial trial, and in the following cooling seasons of implementation, additional training of operations and maintenance personnel were required to ensure complete buy-in at all levels of the facilities management team. With the new systems now fully adopted as best practice, these systems are operational-as-standard on any chiller 1,000 tons or larger, and smaller chillers are evaluated on a case-by-case basis. The ripple effect of this project has translated to the adoption of this technology in many other organizations utilizing Central Cooling result in a total transformation of chiller operations. Elimination of fouling related maintenance, increased chiller capacity at no cost, reduced energy expenditures and significant sustainability benefits are becoming the new normal.

10. 3-5 attachments, images, diagrams, photographs in jpg format with captions

See attached jpgs to email

Automated tube cleaning system installed on 2,000 ton chiller

Close-up view of tube cleaning system components

University of Virginia Campus