

FINAL TECHNICAL REPORT

DOE EERE Award Number: **DE-EE0007720**
Name of Recipient: **SYRACUSE UNIVERSITY**
Project Title: **SYRACUSE UNIVERSITY INDUSTRIAL ASSESSMENT CENTER**
Project Period: **October 1, 2016 through February 28, 2022**
Principal Investigator/Technical Contact: **SURESH SANTANAM, Sc.D., P.E.**
SU-IAC Website: **iac.syr.edu**

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Executive Summary

Syracuse University Industrial Assessment Center (SU-IAC) project is focused on the two primary objectives: (i) educate undergraduate and graduate students in engineering and associated disciplines on the concepts of energy sustainability and to provide hands-on training by performing energy assessment at industrial facilities to become future energy efficiency experts, and (ii) offer energy assessments to small and mid-sized manufacturing companies in

the greater New York State region, perform analytical engineering work in support of assessment recommendations, and to report the results of those analyses to the client companies, to DOE, and to Field office personnel

Through this project period, SU-IAC successfully trained 77 engineering students who were undergraduate or graduate students at Syracuse University College of Engineering, or at SU-IAC's satellite center at Clarkson University. Each of these students received comprehensive 'in-class' technical training, safety training, and hands-on field training. The students performed various tasks related to energy assessment at the manufacturing facilities, including billing analysis, energy use reduction recommendations, and report preparation. Through this project period, a total of 34 students have completed all requirements of the SU-IAC program and have received the US DoE Certificate on Energy Efficiency, with the remaining students continuing at various stages of field work or training. During this project period, due to Covid-related measures in New York State, Syracuse University campus and most of the manufacturing facilities were completely closed or were under severe restrictions for access, for an extended period from March 2020 through April 2021. The closures affected our project execution, with the project Sponsor offering structured relief to carry-out a modified project during the affected budget periods.

During this project period, SU-IAC student teams, led by its Director, completed a total of 77 energy assessments at small- and medium-scale manufacturing facilities located in New York State. For these facilities, SU-IAC prepared and presented details for 569 assessment recommendations (ARs). The facilities implemented a total of 258 of these ARs, realizing annual average energy savings in the range of \$3,300 to \$55,000 per facility. Cumulatively, these facilities have reduced their "first year after implementation" energy use by a total of 4.37 million kwh, and fuel use by a total of 27.7 billion BTU.

SU-IAC project has successfully met the two primary objectives (and the associated sub objectives) and helped the manufacturing facilities in New York State achieve quantitative energy use reductions as a result of this project.

PROJECT OBJECTIVES

The overarching goal of SU-IAC, aligned with the vision of the U.S Department of Energy IAC program, is to educate and provide hands-on training for up to 15 engineering students to perform up to 20 assessments annually, focused on energy, cyber security and smart manufacturing aspects at small- and medium-sized manufacturing and water and wastewater facilities, and to enable these facilities to save energy and improve competitiveness. With the expanded mission of the DOE program, the SU-IAC is focused on the following specific objectives:

The SU-IAC focused on the following specific objectives:

1. Engage undergraduate students in engineering programs and courses specifically addressing energy issues, in addition to the traditional core engineering curriculum.
2. Provide internship and training for students on concepts and assessments at small- and medium-sized industrial facilities related to energy, cyber security assessments and at water and wastewater facilities.
3. Train students on the concepts of energy use, wasted energy, environmental energy burden, and methods to review and assess industrial processes for energy saving opportunities.
4. Provide hands-on training by participating and conducting energy assessments at small- and medium-sized manufacturing industries, and water and wastewater facilities.
5. Provide training in data review, estimations, development of recommendations related to energy savings, and the preparation of concise technical reports.
6. Provide energy assessments at small- and medium-sized manufacturing industries, and water and wastewater facilities (“client companies”) located within the geographical region of SU-IAC and to help them achieve energy savings and improve their competitive advantage.
7. Collaborate with regional entities affiliated with manufacturing facilities, including professional organizations, to facilitate recruitment and to enable broader participation of manufacturing facilities in the region with the SU-IAC program and to leverage the investments in SU-IAC.

STUDENT RECRUITMENT AND TRAINING

SU-IAC Director, working with Syracuse University engineering faculty identified potential student candidates for training under the IAC program. This effort was undertaken twice per year, during start of Fall and Spring academic semesters. A similar effort was undertaken by SU-IAC’s satellite center at Clarkson University. These efforts resulted in undergraduate and graduate students recruited for the project. This effort also provided students to SU-IAC project, to replace trained SU-IAC students graduating with their academic degrees each year. SU-IAC

successfully recruited students to maintain a total of 14 to 17 students active in the SU-IAC program at all times.

The recruited students were first trained on fundamentals of energy, energy use in manufacturing facilities, approaches to energy efficiency improvements, quantitative methods to analyze energy use data, site data collection methods, communications with client companies, technical report preparation and implementation follow-up. The students also received training on industrial safety. Additionally, the students were also trained at the SyracuseCoE facility for hands-on training on industrial-scale equipment installed at Syracuse University academic facilities. Upon completion of training, the students joined a team of SU-IAC students for a scheduled site visit for an energy assessment at a manufacturing facility.

Students were also trained to look for innovative solutions to reduce energy use, through group discussions and by attending technical presentations and webinars. As part of these activities, SU-IAC students participated in the annual SyracuseCoE Symposium held in 2017, 2018, 2019 and 2021 during this project period, and presented posters on topics related to energy efficiency improvements in industries, including on topics such as "Boiler Energy Efficiency Improvement Measures". SU-IAC students also participated and presented a team poster at the New York State Pollution Prevention Institute's (NYSP2I) annual student research poster competition held in April 2017 in Rochester, NY. SU-IAC student teams participated and presented two posters at the pre-eminent 7th International Building Physics Conference (IBPC) which was held in Syracuse, NY during September 23-26, 2018, with funding for student participation provided under a SyracuseCoE grant.

SU-IAC students were active in developing their work into research projects, with potential broad scale impact. These efforts resulted in an SU-IAC student team application for one of the US DoE Student Research Project award, IBPC2018 student participation award in 2013, and a application for student research project funding from New York State Pollution Prevention Institute (NYSP2I). SU-IAC has established tradition of performing assessment to reduce energy use at public and not-for-profit entities. SU-IAC students are also informed of the importance of contributing their knowledge and training in the communities where they live. In this project period, SU-IAC student teams led by its Director performed an energy assessments at the Buffalo Zoo. Participation in this project has also helped train SU-IAC students to develop keen interest in community participation and good citizenship.

The success and impact of this SU-IAC project is further illuminated by the placement of our graduating SU-IAC students. Students trained in the SU-IAC program are in high demand from

manufacturing companies, engineering firms, and graduate programs in energy engineering. SU-IAC students who completed training during this project period have secured coveted positions at firms or won scholarships, including a) Siemens Executive Development Program; b) Syracuse Research Center; c) National Grid Utility; d) Raytheon Corporation; e) Corning Corporation; f) Ramboll Engineers; g) Nine-mile Nuclear Power Plant; h) Cornell University; and i) City of Honolulu

ENERGY ASSESSMENTS AT MANUFACTURING FACILITIES

SU-IAC developed and deployed a multi-faceted outreach program to contact small- and medium-scale manufacturing facilities in our region, and to successfully provide energy assessments for these facilities. Our outreach activities included the following: a) information on SU-IAC activities and energy assessments maintained at the SU-IAC website (www.iac.syr.edu), which provided easy to use online forms for a facility to request an energy assessment; b) review of manufacturers' database and targeted invitation letters; c) contact and information sharing with facility representatives at conferences and webinars; d) contact and follow-up with manufacturers as result of strategic partnerships (MACNY; NYPA, local utilities); e) introductions from past/current SU-IAC client companies and follow-up; and f) direct mass mailing on SU-IAC activities.

SU-IAC successfully completed all the planned number of energy assessments in each of year of this budget period. A total of 77 energy assessment at individual manufacturing facilities during this project period. These facilities covered the entire manufacturing spectrum, such as automobile and machine parts, electronics, food and beverage, primary materials, plastics, chemicals, consumer goods, packaging materials. Individual year metrics are provided in the attached table. Each assessment was performed as a 'one assessment day'. SU-IAC prepared and presented details for 569 assessment recommendations (ARs). The facilities implemented a total of 258 of these ARs, resulting in more than 45% of the ARs being implemented. Annual energy savings at individual facilities varied, based on the magnitude of their respective annual energy bills, and energy intensity of their respective operations. Accordingly, annual average energy savings, from both electrical energy and fuels, was in the range of \$3,300 to \$55,000 per facility. Based on these implemented ARs, these facilities cumulatively have estimated to have reduced their energy use by a total of 4.37 million kWh, and fuel use by a total of 27.7 billion BTU.

SU-IAC completed all the scheduled site visits on schedule. SU-IAC prepared and submitted each Assessment report to the respective client company within 60 days of the site visits, after incorporating any review comments from the IAC Program Field Manager (Rutgers University). SU-IAC followed up with the client companies on their implementation of the ARs, within 180 to 360 days after the site visit. The attached Table also provides summary data from these implemented ARs.

COVID-RELATED IMPACTS ON THE PROGRAM

With the onset of Covid-19 pandemic in early March 2020, SU-IAC experienced immediate impacts on its operation, program execution and facility assessment site visits. With increasing Covid cases, State of New York closed all schools, institutions, manufacturing facilities, public venues and others starting in March 2020. Syracuse University also closed the campus and reverted to remote learning mode. Student gatherings were restricted and travel outside the campus area was also curtailed. In consultation with the Program Sponsor, SU-IAC implemented remote operations and continued with student training, client contact and all associated activities in remote mode. Upon widespread Covid vaccinations, Syracuse University reopened the campus in January 2021 (Spring 2021 semester), with stringent Covid protocols to minimize/eliminate spread. SU-IAC implemented the 'on-site/remote site visit protocol' advanced by the Sponsor and was able to re-start site assessment visits. SU-IAC was able to complete a reduced number of client assessments, with the agreement of the Sponsor, while maintaining a full complement of student training, and client follow-up activities remotely. Covid restriction continued into 2021, and many industrial facilities were reluctant to allow outside visitors (including vaccinated SU-IAC students) into their facilities. Concurrent economic impact on these facilities, during this 2020-21 period, also resulted in lack of resources at these facilities to implement the energy-saving recommendations made by SU-IAC in prior assessments. Syracuse University fully reopened the campus, for all vaccinated students, staff and faculty, starting May 1, 2021, with restrictive protocols in place. Subsequently SU-IAC was able to resume operations of the Center and continue with in-person activities as before the pandemic. SU-IAC continued to face difficulties in scheduling site visits due to reluctance of manufacturing facilities during the declining phase of the pandemic and also as a result of loss of business revenue and employment at these manufacturing facilities.

COLLABORATIONS

SU-IAC developed strategic collaborations with several organizations and entities to help disseminate information on the IAC program, and to seek client companies to provide energy assessments. These entities include: Corning Corporation, National Grid, New York Power Authority, NYSERDA, Western New York Sustainable Business Roundtable, and Manufacturers Association of Central New York. We also collaborated with SyracuseCoE, an energy and environmental center at Syracuse University. In 2020, SU-IAC worked with USDoE designated marketing and engagement consultant (ICF) and developed a formal “Stakeholder Engagement Plan” (Plan), capturing these ongoing SU-IAC collaborations. Subsequently and upon review/feedback from the consultant, SU-IAC and implemented the various aspects of the Plan, expanded on them and pursued additional collaborative activities and engagement with SU-IAC’s critical partners (such as NYPA, National Grid, etc.). These collaborations resulted in wider recognition of SU-IAC’s activities through our focused presentations, participation in events organized by these entities, and provided introductions to manufacturing facilities. We also continued our strategic collaboration agreement with CNYTDO, the local MEP.

SUMMARY

During this report period,

- SU-IAC successfully recruited and trained engineering students as envisioned at the onset of SU—IAC project;
- SU-IAC completed the number of scheduled energy assessments as per annual workplan of the SU-IAC program (with Covid-impacted modifications in 2020-21), and according to schedule;
- Client manufacturing Companies, based on SU-IAC energy assessments, were able to reduce energy expenditures by implementing the energy efficiency improvement recommendations provided by SU-IAC;
- SU-IAC has established significant collaborations to communicate the values of the IAC Program, and to enhance our outreach to manufacturing facilities;
- Work by SU-IAC is being well received – through highly productive job placements for SU-IAC trained students, and through presentations and publications of our work; and
- SU-IAC has operated a consistently safe and secure work environment for the students during training and site visits.
- Despite the impact of Covid-19, SU-IAC was able to maintain the program and its advancement through the period in 2020-21.

RECENT SU-IAC PUBLICATIONS/PRESENTATIONS

1. J. Gomez, G. Al-Sheik, S. Valitutti and S. Santanam. *Thermal Energy Savings in Boiler Systems*. Poster presented at the 2021 SyracuseCoE Annual Symposium, Syracuse, NY, August 2021
2. K. Driscoll, R. Brogley, H. Kim, A. Van DeWalker and S. Santanam. *Impact of Retrofit LED Lighting*. Poster presented at the 2021 SyracuseCoE Annual Symposium, Syracuse, NY, August 2021
3. J. D'Amaro and S. Santanam. *Industrial Assessment Center at Syracuse University*. Poster presented at the FuzeHub Emerging Technologies Show, Syracuse, NY, October 2018
4. S. Santanam. *Energy Efficiency and Sustainability*. Panel discussion presented at the FuzeHub Emerging Technologies Show, Syracuse, NY, October 2018
5. J. Kim, J. D'Amaro, A. Lincoln, S. Criscione and S. Santanam. *Evaluation of Efficient Lighting in Link Hall, Syracuse University*. Poster presented at the 7th International Building Physics Conference (IBPC)Syracuse, NY, September 2018
6. A. Lincoln, S. Ward, A. Hinchman, J. Guida, and S. Santanam. *Improving Energy Efficiency and Distribution of Conditioned Air from HVAC System in Link Hall, Phase 1 – Data Collection*. Poster presented at the 2018 International Building Physics Conference (IBPC2018), Syracuse, NY, September 2018
7. J. Hintz, E. Bartos and S. Santanam. Syracuse IAC Student Intern Training Program. Poster presented at the 2017 Annual SyracuseCoE Symposium, Syracuse, NY, October 2017
8. S. Santanam. *Energy Efficiency Improvement Opportunities for SME*. Invited presentation at WNYSBR Annual Stakeholder Meeting, Buffalo, NY, April 2017

SU-IAC Annual Energy Assessments Data

	Project Fiscal Year				
	2017	2018	2019	2020	2021
Number of Facilities Assessed	21	20	20	9	7
Total Number of ARs provided in Reports	158	162	148	66	41
Total Number of Implemented ARs	89	69	64	19	17
Implementation Rate (%)	56%	43%	43%	29%	41%
Average Savings per AR in Report (\$)	3,443	8,080	4,368	3,944	3,352
Average Electric use Savings per AR in Report (kwh)	33,975	52,215	27,547	33,098	26,359
Average Water use Savings per AR in Report (Gallons)	57,367	0	0	0	0
Average Fuel use Savings per AR in Report (MMBTU)	73	302	418	322	264
Average Recommended Cost savings per Facility (\$)	25,902	65,452	32,321	28,924	19,632
Average Implemented Cost savings per Facility (\$)	14,616	46,810	8,692	17,884	4,236