IAC INDUSTRIAL ASSESSMENT CENTERS

A Program of the U.S. Department of Energy

Beginning in 1976, the Industrial Assessment Centers (IACs) have provided small- and medium-sized manufacturers with site-specific recommendations for improving energy efficiency, reducing waste, and increasing productivity through changes in processes and equipment.

SUMMER NEWSLETTER **2020**

IN THIS ISSUE

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PROGRAM HIGHLIGHTS

TENNESSEE TECH'S AWARD-WINNING COOLING TOWER TOOL SUPPORTS INDUSTRIAL ENERGY EFFICIENCY AND STUDENT DEVELOPMENT

Tennessee Tech University Industrial Assessment Center (IAC) students and faculty continue to advance their "Cool Tool" Cooling Tower software, which received a Junior Faculty Research Award in 2015. This macro-enabled Excel-based tool aims to help facilities enhance the efficiency of their cooling towers through a series of simulations involving a range of variables.

Why Cooling Towers are Important in Industry

The purpose of a cooling tower is to cool down water that has been heated up due to industrial processes or air conditioning condensers. A cooling tower operates as a heat exchanger that allows water and air to come in to contact with each another to lower the temperature of the hot water (see Figure 1). This is achieved mostly through evaporation as the water circulates through the tower. Cooling towers allow industry to reuse cooling water supplied to their process for heat rejection efficiently and inexpensively.

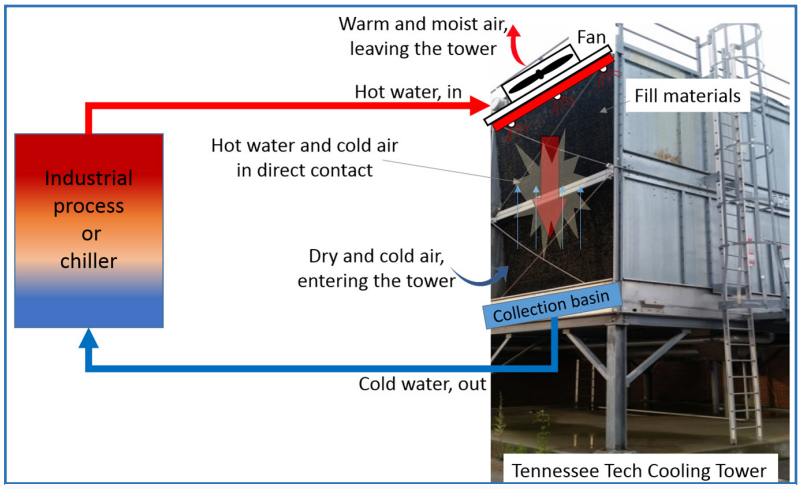
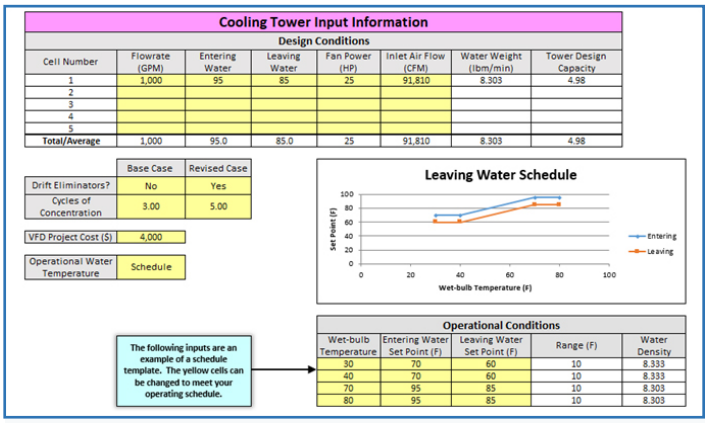


Figure 1. Schematic drawing of a cooling tower serving an industrial process or a chiller

The "Cool Tool" Model

"Cool Tool" is a macro-enabled Excel file that analyzes an annual base case compared to a revised case of a cooling tower operation. The tool simulates 8,760 hourly calculations for fan power for various fan controls, water consumption, and pumping energy consumption and demand based on the user's location and its corresponding Typical Meteorological Year 3 (TMY3) weather data. "Cool Tool" simulates up to five cooling tower cells as one tower utilizing one pump or parallel pumping. Through a partnership with Oak Ridge National Laboratory (ORNL), researchers incorporated ORNL's calculation algorithm in

analyzing various fan control technologies for cooling towers. The program provides a summary of the projected annual savings for fan power, water, and pumping results based on the user's inputs for their base and revised cases.



Cooling Tower Input Information

Design Conditions

Cell Number	Flowrate (GPM)	Entering Water	Leaving Water	Fan Power (HP)	Inlet Air Flow (CFM)	Water Weight (lbm/min)	Tower Design Capacity
1	1,000	95	85	25	91,810	8.303	4.98
2							
3							
4							
5							
Total/Average	1,000	95.0	85.0	25	91,810	8.303	4.98

	Base Case	Revised Case
Drift Eliminators?	No	Yes
Cycles of Concentration	3.00	5.00

VFD Project Cost ($)	4,000
Operational Water Temperature	Schedule

The following inputs are an example of a schedule template. The yellow cells can be changed to meet your operating schedule.

Operational Conditions

Wet-bulb Temperature	Entering Water Set Point (F)	Leaving Water Set Point (F)	Range (F)	Water Density
30	70	60	10	8.333
40	70	60	10	8.333
70	95	85	10	8.303
80	95	85	10	8.303

Figure 2: "Cool Tool" cooling tower input information

"Cool Tool" can help plants analyze ways to save energy and money at their facility through cooling tower modifications, whether they use it for process cooling or Heating Ventilation and Air Conditioning (HVAC) applications. Users will be able to input their entering/leaving water temperatures based on a monthly operating schedule or a wet-bulb temperature schedule. For the simulation, plants will be able to tell the program whether or not their base and revised case has a variable-frequency drive (VFD) on the fan/pump, drift eliminators, changes in cycles of concentration, reduced water flow rate, etc.

Impact on Teaching and Research

Dr. Ethan Languri, associate director of the Tennessee Tech IAC, supervised several lead students on the winning project, titled "Evaporative Cooling Tower Efficiency Enhancement."

The first student was Ms. Pallavi Patil, who completed her Master of Science in mechanical engineering based on this IAC funded research. She presented two conference papers and published her thesis titled "Dynamic Modeling and Experimental Analysis of an Induced Draft Cooling Tower" in 2017. The second student was Mr. Travis Howard who completed his degree in 2018 by publishing his thesis titled "Cooling Tower Optimization and Analysis Tool." His work was continued by Mr. Kade Howard, who performed field data collection and code development on the cooling tower project as a project for his master's degree in 2020.

The final graduate student was Mr. Joshua Hooper, who finalized the cooling tower modelling program (the "Cool Tool") utilizing the programming language Visual Basic, part of Excel. The "Cool Tool" has been presented to several experts in the field and verified in a number of cases before being presented to IAC team in late 2020.

SEVENTH ANNUAL STUDENT RESEARCH AWARDS

The U.S. Department of Energy's (DOE's) Advanced Manufacturing Office sponsors an annual applied research awards competition to honor exceptional students participating in the IAC program. The program provides students at IACs with hands-on training and real-world experience in energy engineering and management.

Each winning IAC student/faculty team receives $25,000 in program funds. The research awards are designed to create incentives for undergraduate and graduate students to pursue assessment-inspired research projects in the areas of manufacturing and industrial energy efficiency. The awards are intended to enhance traditional student-led research efforts and to recognize research proposals that stand out as being exceptional and particularly innovative.

Information about this year's six winning student projects is below:

- **University of Massachusetts:** Kedar Prashant, IAC Student; Dr. Beka Kosanovic, Advisor – Design of Latent Thermal Energy Storage Heat Exchangers for Combined Heat and Power Plants
- **University of Utah:** Anne Dougherty, Blake Billings and Nestor Camacho, IAC Students; Dr. Julie Sieving, Advisor – Improving the Economics of Industrial Battery Storage: A Proactive Policy and Management Approach
- **University of Wisconsin, Milwaukee:** Alaa Hasan, Abdel Rahman Salem and Ahmad Abdel Hadi, IAC Students; Dr. Ryo Amano, Advisor – The Power Reclamation of Utilizing Micro-hydro Turbines in the Aeration Basins of Wastewater Treatment Plants
- **Texas A&M University:** Rafael Dugarte, IAC Student; Dr. Bryan Rasmussen, Advisor – Peak Electrical Demand Reduction in Fluid Distribution Systems through Load-shifting using Model Predictive Control
- **University of Illinois, Chicago:** Xochitl Menchaca, IAC Student; Dr. Lin Li, Advisor – Framework for Net-Zero Wastewater Treatment Plant
- **Boise State University – University of Idaho:** Piyush Basnet and Anson Lunstrum, IAC Students; Dr. Dev Shrestha, Advisor – Improving Pump Efficiency through Combination of Impeller Redesign and Hydrophobic Coating

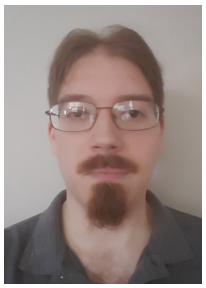
OUTSTANDING STUDENT & ALUMNI AWARDS

The Advanced Manufacturing Office also sponsors annual outstanding student and alumni awards competitions. The student awards honor exceptional students (undergraduate or graduate) for outstanding accomplishments in promoting the practices, principles, and procedures in energy efficiency, productivity improvement and smart manufacturing, waste reduction, water conservation, energy management, and cybersecurity. The alumni awards recognize outstanding accomplishments in promoting the practices, principles, and procedures of energy engineering in a professional or academic capacity after the IAC experience.

2020 Outstanding Students

Georgia Tech University: Saikamal Srinivas is a three-year veteran of the IAC program who has conducted 22 assessments. He is presently a graduate student in Georgia Tech's mechanical engineering program after graduating summa cum laude in his undergraduate studies. He is the Georgia Tech IAC Lead Student and has been with the program since January 2017.

West Virginia University (WVU): Josage Chathura Perera is a graduate student in the Industrial and Management Systems Engineering program at WVU who has conducted nearly two dozen assessments. His work experiences at the WVU IAC and Oak Ridge National Laboratory have helped him acquire intense knowledge on energy efficiency and sustainable manufacturing. He has a Bachelor of Science in Industrial Engineering from Pennsylvania State University.



Indiana University – Purdue University Indianapolis (IUPUI): Corey Miller is an undergraduate student in the Department of Mechanical and Energy Engineering at IUPUI. As a member of the IUPUI IAC, he has conducted an impressive 17 assessments in only a year and a half and has provided outstanding service to the manufacturing companies. In addition, Corey has played an influential role in energy related extracurricular activities. In one competition, Corey's team was among the finalist at National Renewable Energy Laboratory for 2019 Solar Decathlon Design Challenge Finals.

University of Wisconsin, Milwaukee (UWM): Farah Nazifa Nourin is a PhD candidate who joined the UWM-IAC team in 2017. She has performed 22 energy assessments since she joined the center, and she was the lead student for two of them. Moreover, based on her previous HVAC experience, she helped the center by giving technical presentations to show the center's outcomes in many conferences. In addition, she helped the other team members by giving two training sessions. Finally, she succeeded in publishing three papers in the field of renewables and energy efficiency, with two more under review. Her research is in the experimental gas turbine blade performance.

University of Wisconsin, Milwaukee: Mohammad Qandil has focused his research on increasing the efficiency and performance of water turbines by minimizing the formation of air pockets in low-pressure areas where the blades churn through the water. He is also working on a hybrid renewable energy system as an alternative to the electrical grid in remote areas. He is the lead student at the UWM IAC, which promotes energy efficiency and sustainability through energy assessments of manufacturing facilities.

2020 Outstanding Alumni

Oklahoma State University (OK State): Dr. Patrick Smith was the lead student of OK State IAC for more than two years. He currently works as the director of sustainability services for REM Risk Consultants, LLC. Patrick is a Certified Energy Manager (CEM). His job involves working as a consultant in industry, helping clients identify and make improvements in the areas of energy efficiency, energy management, productivity, waste reduction, as well as health and safety related areas all which are vital to sustainability.

University of Florida: Dr. Ahmad M. Mahmoud has led and managed multi-disciplinary engineering teams to design, develop and demonstrate cutting-edge high-efficiency thermal solutions for the HVAC and Refrigeration (HVAC&R) industry through commercialization channels within Carrier Corporation. As Advanced Systems Program Manager, Dr. Mahmoud manages and oversees the technical and programmatic execution of technology R&D in the areas of residential, commercial, transportation and applied HVAC&R.

University of Utah: Brie Thompson is the associate general manager of field operations for Washington County Water Conservancy District. In this capacity, she manages the operations at the district's water treatment plant, reservoirs, hydropower plants, pipelines, dams, and wells. Thompson joined the district in 2006. She's a licensed professional engineer and certified grade IV water treatment operator in the State of Utah and a member of the American Water Works Association, Utah Water Quality Alliance, and Rural Water Association. She has a MBA from Southern Utah University and a Bachelor of Science in chemical engineering from the University of Utah.

Boise State University: Stephanie Johnson joined Pacific Northwest National Laboratory's Building & Connected Systems (BAS) team in 2013 and has been primarily involved in energy and water evaluations and BAS retuning, both onsite and remote, for various types of federal facilities. Her current work is focused on increasing the efficiency of data collection and analysis so energy managers can quickly understand their facilities to optimize the energy reduction and resiliency potential of their buildings. She is currently attending Seattle University to complete her Master of Science in mechanical engineering.

West Virginia University (WVU): Anne Mallow is a graduate of the WVU IAC program. She earned a Bachelor of Science in industrial engineering from WVU in 2010 and PhD in Mechanical Engineering from Georgia Tech in 2016. Anne is currently an R&D Mechanical Engineer at Sandia National Laboratories.

West Virginia University: Amir Abolhassani is a data scientist at Ford Motor Company. As a member of the advanced manufacturing and Industrial Internet of Things team, he develops real-time process monitoring and prognostic methods to enhance productivity. He also has collaborated with Duke University to define the strategies and techniques to improve energy efficiency by using North American plants data and developing advanced and robust hybrid statistical models.

CLIENT TESTIMONIALS

University of Missouri

"Thank you for the work you and your team performed for Melton Machine & Control Company (MMCC). The assessment report for our facility was very comprehensive and outlined very specific and practical ways to save energy. Our personnel that worked with you and your team learned a lot from the process and the assessment report. Following your visit, MMCC made the decision to build a new facility and relocate. This was a large undertaking and was recently completed this year. Many of the recommendations in the assessment were incorporated into the design of the new building."

– **Stacy Lindsey, president of Melton Machine & Control, 10/26/2020**

Arizona State University (ASU)

"Thank you so much to the ASU IAC team. From the beginning we were all impressed with how well prepared, professional, and knowledgeable the whole team was. They were attentive to our needs, and well informed on the energy usage and engineering principles involved in our specific manufacturing process. They were able to identify energy savings and efficiency improvements that would have otherwise gone unnoticed. With their recommendations, we hope to greatly decrease our energy usage and waste. I would strongly recommend the team and their services to anybody that is lucky enough to have the opportunity."

– **Brad Gilkison, process engineer, Service Wire Co., 07/17/2020**

IAC Program Quarterly Results

Between January and March of 2020, IACs conducted 106 assessments (Table 1). As a result, IACs made 736 recommendations that identified nearly $17.6 million in potential cost savings.

IDENTIFIED SAVINGS

Table 1. January - March 2020

Total Assessments	106	
Total Recommendations	736	
	Total Recommended Annual Savings	**YTD**
Energy Savings	15.1 M Therms	27.0 M Therms
Electricity Savings	107,656,814 kWh	219,052,078 kWh
Generation Reduction (approx.)	12.29 MegaWatts	25.01 MegaWatts
Natural Gas Savings	4.0 M Therms	4.4 M Therms
CO_2 Reduction	0.09 Tons	0.16 Tons
TOTAL Cost Savings	$17.61 Million	$30.86 Million
- Energy Related Savings	$10.87 Million	$20.35 Million
- Productivity Savings	$6.01 Million	$9.45 Million
- Waste & Water Savings	$0.73 Million	$1.05 Million

LOCATIONS

Plants assessed were located in 33 states (Figure 1). The plants represent a broad range of industries, with food, fabricated metals and plastics and rubber products being the most common (Table 2).

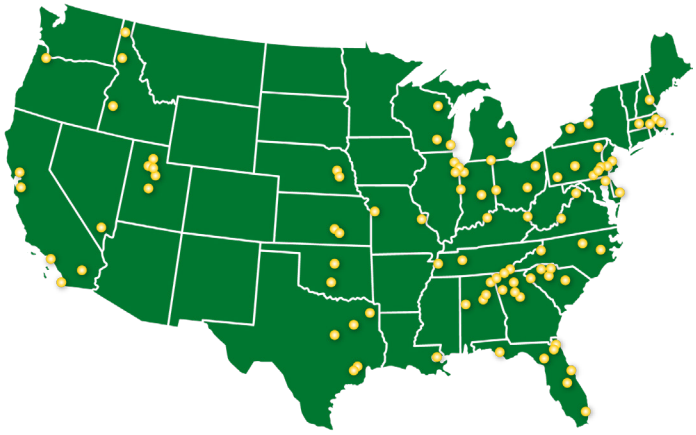


Figure 1. IAC Assessments Nationwide, January – March 2020

INDUSTRIES

Table 2. January – March 2020 Assessments by NAICS Industrial Category

Industrial Category (NAICS #)	Assessments
Food Manufacturing (311)	17
Fabricated Metal Product Manufacturing (332)	16
Plastics and Rubber Products Manufacturing (326)	16
Transportation Equipment Manufacturing (336)	8
Machinery Manufacturing (333)	7
Chemical Manufacturing (325)	5
Electrical Equipment, Appliance and Component Manufacturing (335)	5
Wood Product Manufacturing (321)	3
Primary Metal Manufacturing (331)	2
Beverage and Tobacco Product Manufacturing (312)	2
Furniture and Related Product Manufacturing (337)	2
Computer and Electronic Manufacturing (334)	2
Nonmetallic Mineral Product Manufactuirng (327)	2
All Other Manufacturing	8
Others	11

PARTICIPATION

A total of 332 engineering students were active during the quarter in the IAC program across the 31 centers; and more than one-fourth of these were new to the program.

For more information contact:
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