WESTERN COOLING CONNECTION

INNOVATIVE NEW MULTI-NOZZLE INJECTOR

Sealing building envelopes may have just gotten much faster pg. 7

LATEST PROJECTS & UPDATES

Get a sneak peak into WCEC's new laboratory and read about some of the currently running projects!

THE CHALLENGE EXPANDS

The Western Cooling Challenge is testing new equipment pg. 3

UC DAVIS UNIVERSITY OF CALIFORNIA

2013 | Q1

WCEC WESTERN COOLING EFFICIENCY CENTER

LETTER FROM THE DIRECTOR

To our readers,
WCEC has officially moved into our new offices in West Village! The West Village move grants WCEC with greater resources for research, collaboration and a greater public presence. We would like to welcome any of our newsletter subscribers to stop by and take a tour of our new facility. Our laboratory facility, the prime factor in our move, is in the final stages of completion and should be fully operational in the coming weeks.

Western Cooling Challenge: Expanding Scope

The Western Cooling Challenge has increased its scope to include a variety of climate appropriate products, not just limiting the competition to unitary RTUs. The first is a dedicated outdoor air system by Munters called the EPX 5000 which is currently being field and laboratory tested. Other potential challenge entrants include air precoolers by Coolerado and Seeley.

Aerosolized Envelope Sealing: New Injection System and New Sealant

We just finished our first field test of a new, multi-nozzle injection system and tested a new, custom tailored sealant. The findings from this research are promising. Ultimately leading us that much closer to a commercialized solution.

In This Issue

WCEC has some exciting updates to our current projects and some new additions. Please note, we cannot cover every project in each Newsletter:

> Featured articles: Western Cooling Challenge and Aerosolized Envelope Sealing
> WCEC's Laboratory: 4 Projects up-and-running
> WCEC Outreach efforts time line and notable visitors

Mark Modera, Director
mpmodera@ucdavis.edu

"WCEC is expanding our scope of research to meet the needs of our stakeholders and the demands of California's Strategic Energy Plan. We are beginning to explore research not just in cooling and envelopes, but in heating and gas-based applications."

—Mark Modera, Director

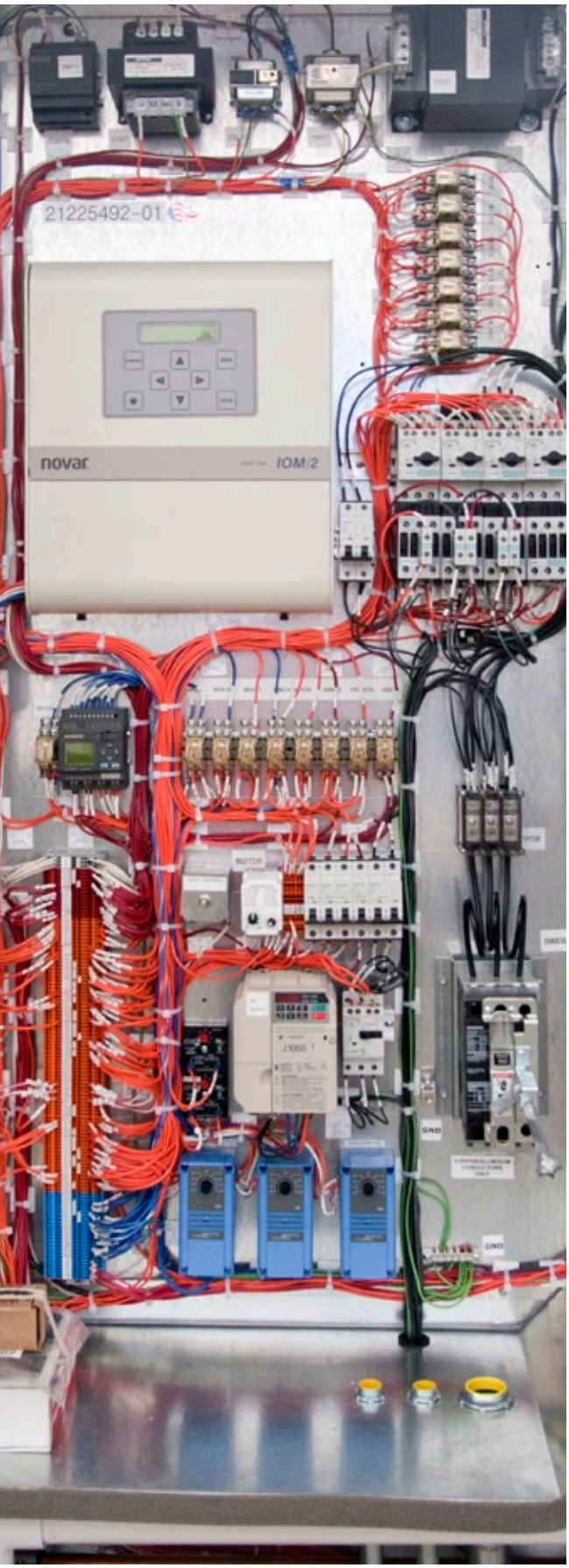
WCEC is an element of the Energy Efficiency Center at the University of California, Davis, with a mission to "partner with stakeholders to identify technologies, conduct research and development, disseminate information, and facilitate programs that reduce cooling system electrical demand and energy consumption in the Western United States."

THE WESTERN COOLING CHALLENGE EXPANDS

Broadening the scope of the Challenge, maintaining the mission to advocate for climate appropriate technologies.

Few RTUs can meet the rigorous standards that the Western Cooling Challenge (WCC) requires. One hybrid unit, the Speakman Air$_2$0 didn't meet the requirements. But over the last few years the WCC has seen 2 success stories, one from the Coolerado H80 and another from Trane's Voyager DC. Advocating for other manufacturers to create future-WCC Certified RTUs is an important part of the Cooling Challenge, but it is no longer the only way to become Cooling Challenge Certified.

By expanding the range of products, WCC equipment can cover more ground, offering a wider variety of solutions that meet both new construction and retrofit markets, increasing the potential market penetration of these climate appropriate technologies.



New Product Solution, Same Climate Appropriate Technology: Munters EPX 5000 Dedicated Outdoor Air System (DOAS)

Dedicated outdoor air units are definitely a departure from a standard, do-it-all hybrid-RTU that the Challenge typically tests. These systems are focused on meeting the majority of the ventilation requirements within a building, relieving the RTUs or other cooling systems of ventilation duties.

Typically, RTUs bring in roughly 15% of outside air continuously to supply enough fresh air for a building. Unfortunately, most RTU's just serve the ventilation requirement without conditioning the air first, regardless of the outside air temperature. A DOAS unit, especially one like the Munters EPX 5000, acts like a suped-up energy-recovery-ventilation system and conditions the ventilation air to more reasonable temperatures before it enters the building. Ventilation air is brought from outside into the system which is first cooled by a highly efficient indirect evaporative heat exchanger (IDEX). If the ventilation air is sufficiently conditioned, it will be delivered to the space. If the ventilation air requires more cooling, the system will turn on the vapor compression system to lower the temperatures further.

Changing the Protocol of the Challenge while maintaining the same, rigorous efficiency requirements

Woolley explained the impetus for broadening the scope of the challenge, "... climate appropriate equipment is making some in-roads with major customers, and UC Davis' testing is showing pronounced energy and demand reductions. It's key to think about the implications that commercial air conditioning has for grid scale electrical demand in the summertime." Woolley continued, "California reserves roughly 10,000 MW of generating capacity to operate for less than 2% of the year. Efficiency for cooling at peak is the only way to tackle this problem. California really needs to think about Western Cooling Challenge equipment as an alternative to expanding generation."

> *"California reserves roughly 10,000 MW of generating capacity to operate for less than 2% of the year. Efficiency for cooling at peak is the only way to tackle this problem."*
>
> ***—Jonathan Woolley, Associate Engineer***

Laboratory Testing of the Munters EPX5000

Laboratory testing of the Munters EPX 5000 is already underway at PG&E's Applied Technology Services laboratory facility. Data analysis is currently ongoing and will be reported on within the coming months.

Larry Klekar giving the audience at the PG&E laboratory a brief technology tour of the Munters EPX 5000

Robert Davis running the test protocols on the Munters EPX 5000 in San Ramon, CA

The Future of the Challenge

Since the life-cycle of RTUs is between 15-20 years the potential for savings in the retrofit market, as opposed to new purchases, is quite substantial. Because of this, WCEC is evaluating the possible addition of indirect evaporative pre-coolers for the Western Cooling Challenge, though the protocol for benchmarking such systems has yet to be determined. We are, at this moment, field testing the performance of 12 total units from 2 different indirect evaporative pre-cooler manufacturers on a commercial building in California. Results from these tests will determine the feasibility of this technology for the Challenge and help develop proper protocols for benchmarking them against other products in their class, and the broader Challenge participant technologies.

ETCC Public Meeting

May 16th | SMUD's Rubicon Room | 6301 S St. Sacramento, CA

Climate Optimized HVAC

From desiccant evaporative systems to fault detection and diagnostics, this meeting will focus on technologies and systems that are poised to revolutionize the HVAC field. Whether your interest lies in residential, commercial, electric or natural gas—this event is for you! And if you're curious about emerging technologies outside of the realm of HVAC, stick around for the afternoon sessions when California's utilities and state agencies will share findings from their latest emerging technology efforts.

SMUD™

Time	Topic	Presenter
8:30 am	Continental Breakfast	
9:00 am	Welcome, Safety, and Introductions	Bruce Baccei or Vicki
9:15 am	ETCC: Updates & Calendar of Events	Bruce Baccei or Vicki
9:20 am	Western Cooling Efficiency Center: Setting the stage for Climate Optimized HVAC	Mark Modera
9:50 am	PG&E: Advanced RTU retrofit devices—game changers?!	Marshall Hunt
10:20 am	Break	
10:35 am	AHRI DR Sub-Committee: Defining and enabling DR-ready AC and heat pump systems	Robert Wilkins
11:00 am	NREL: DEVAP—Broadening the climatic conditions for evaporative cooling	Jason Woods
11:30 am	Speed Networking	
11:45 am	Lunch	
12:30 pm	CEC Updates	Virginia Lew
12:45 pm	CPUC Updates	Paula Gruendling
1:00 pm	SMUD Updates	Bruce Baccei, Dave Bisbee and Connie, TBA
1:15 pm	SDG&E Updates	Kate Zeng / Nate Taylor
1:30 pm	SoCal Gas Updates	Abdullah Ahmed / Aline Dew
1:45 pm	SCE Updates	Edwin Hornquist
2:00 pm	PG&E Updates	Aaron Panzer
2:15 pm	Adjourn	

Join us in person or call in through our web conference number:

Call-in Number: 1-415-655-0001

Meeting Number: 800 997 228

Access code: 800 997 228

WCEC's own Mark Modera will be presenting at this year's ETCC Public Meeting on Setting the Stage for Climate Optimized HVAC

AEROSOL-BASED AUTOMATED SEALING FOR BUILDING ENVELOPES

The steady progress towards commercialization through design iteration

Sealing leaks in building envelopes is a proven solution to reducing energy used from HVAC. The problem with conventional envelope sealing is that it is an entirely manual process--requiring numerous contractors and labor hours to seal many of the leaks--and even then, a substantial number of leaks are difficult to reach and even more difficult to spot. WCEC's-own technology uses an aerosol-based automated process to seal building envelopes, offering a comprehensive solution that has the potential to seal the vast majority of leaks without the guesswork... all while providing instantaneous and verifiable results.

WCEC has already demonstrated the efficacy of the technology by sealing 4 homes at rough-in stage and 1 home as a retrofit. The results are promising, with the sealant effectively sealing over 50% of the available leaks within each of these homes. At this time, WCEC is working to refine the technology to make it easier to install, seal faster and minimize clean-up time.

Crafting a Better Sealant

The original sealant used for sealing building envelopes worked effectively at sealing building leaks, and could be used to seal leaks in a new build situation. The problem with the original sealant was that it would remain sticky almost indefinitely, making it quite difficult to clean up in a retrofit situation where the sealant could end up on carpets or furniture. Since the retrofit market makes up a significant portion of potential energy savings, WCEC has been working with a sealant manufacturer to craft a better sealant that will effectively seal leaks and dry more proficiently--allowing for easier clean up in a retrofit situation.

On February 14th, in Stockton California, WCEC tested the new adhesive in another rough-in home provided by Habitat for Humanity.

Nelson Dichter, one of WCEC's field engineers confirmed some positive findings, "During the sealing process, I often enter the house to move the injector," Dichter said. "What I noticed most was that the new adhesive could be easily wiped off my hair and body. Yet in larger clumps where it sealed leaks, the sealant hardened nicely to create a strong seal. The previous sealant was more problematic when moving the injector nozzle because it always remained sticky, and was difficult to clean off of any surface, including me." Dichter concluded, "This new sealant shows great promise."

"There was one drawback to the new sealant," said WCEC's engineer Curtis Harrington, "it took longer to form seals at leak points compared to the previous adhesive." Harrington continued, "The new sealant definitely took longer to get the house sealed up and required much more of it to fully seal a house. For this test, since we did not have another canister of the new sealant, we decided to finish up the house with the previous sealant." Harrington concluded, "We are confident that this particular sealant will only require some minor adjustments to find that balance between tackiness and hardness, to get the best overall seal with the least amount of clean-up time."

One of WCEC's solutions for the new sealant is to inject more of it into the space in the same amount of time. To do this, WCEC had to go back to the design stages of the sealant injector and redesign it from the ground up.

> *"We are confident that this particular sealant will only require some minor adjustments to find that balance between tackiness and hardness, to get the best overall seal with the least amount of clean-up time."*
>
> ***—Curtis Harrington, Associate Engineer***

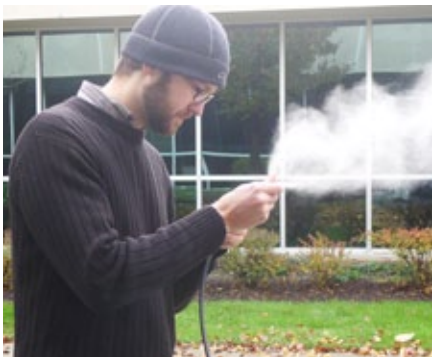


IMAGE CAPTIONS

WCEC Director Mark Modera, Nelson Dichter and Mari Thomsensolis at a demonstration house in Stockton, CA.

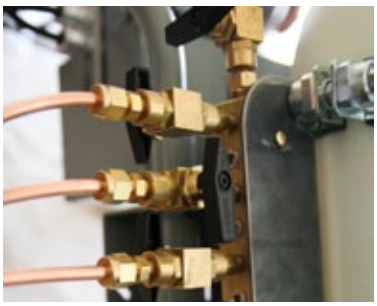
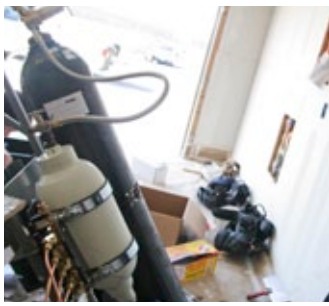
Test panel showing new sealant's ability to seal leaks.

Nelson Dichter testing the spray pattern on a new nozzle design.

> *"We need to add more injection points that seal simultaneously. This will allow us to not have to enter the space until the sealing is completed and should also increase the speed at which the space gets sealed."*
>
> ***—Curtis Harrington, Associate Engineer***

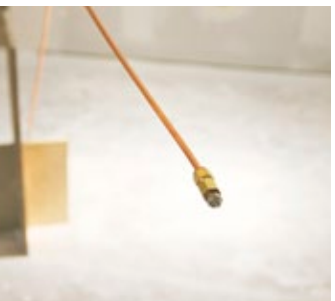
Redesigning the Sealant Injector with Multiple, Simultaneous Nozzles

To create a multi-nozzle injector, WCEC had to re-think many of the important parts of the injection system:

1. **The pressurized air system:** An air compressor can only handle the duty for one nozzle. Since it would be largely impractical to require contractors to carry multiple air compressors, WCEC had to come up with a new, more compact system that could serve at least 5 different nozzles.

   The solution is a pressurized tank of nitrogen that feeds into a smaller tank that pressurizes the sealant. This system is much more manageable than carting around multiple air compressors, is virtually silent and can properly push 5 sealant injectors simultaneously.



2. **The nozzle:** Though the original nozzle for this system works quite well, its specific design makes for a very expensive initial capital investment. Since WCEC wants to utilize many nozzles at once, using the original nozzle would make the system much more cost prohibitive, and thus less attractive to potential contractors who may want to purchase a system in the future. WCEC's new nozzles cost a fraction of what the original nozzles cost and work just as effectively.

Testing the New System, Improving the Design Through Iteration

Stockton, CA: Automated envelope sealing, 4th demonstration

The first test of the new, multi-nozzle injector system showed significant improvements over the single nozzle system with the new sealant. The system sealed the leaks faster than the first test with the new sealant, but it wasn't without some caveats. Since the new system used sealant at a higher rate, WCEC had to introduce more sealant into the system constantly, at about a rate of once every 12-15 minutes.

"The peristaltic pump used to push sealant into the pressurizing chamber took a long time to fill up the sealant tank," admits Harrington. "While the system can pump out sealant faster, and spread it more evenly throughout a space, the pump that introduces the sealant to the pressure chamber would take between 20-30 minutes to fill up. This increased the time it took to seal the envelope effectively and is a bottleneck to the entire system," said Harrington.

He continued, "We have designed a new system to introduce sealant into the pressurized chamber that should fill it in under 2 minutes. We will test this in the field within the coming weeks".

WCEC will continue to test and iterate on this promising technology in the near future with plans to begin demonstrations of aerosol-based automated sealing in multi-family homes and apartments.

UCEC

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A. COOLERADO® C60 IDEC TO COOL THE LAB

B. HOT SIDE TEST CHAMBER

C. MUNTERS® HCD-4500 DESSICANT DEHUMIDIFIER

PROCESS HOT WATER BUFFER TANK

PROCESS CHILLED WATER BUFFER TANK

GENERAL LABORATORY EXHAUST (NOT PICTURED)

OUTDOOR AIR INTAKE FOR TEST STATIONS

TEST STATION EXHAUST

TEST STATIONS

FLOW NOZZLE AIRFLOW MEASUREMENT

COLD SIDE TEST CHAMBER

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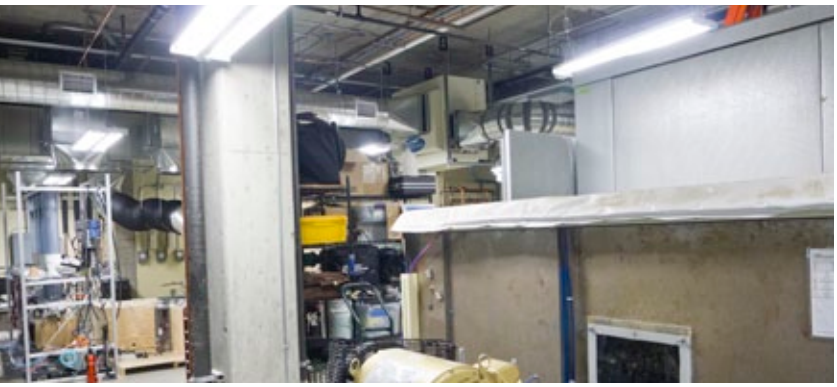
WCEC LABORATORY PROJECT UPDATES



Our new laboratory facility is designed to test up to 5-ton RTUs and retrofit pre-coolers in a variety of environments. One major feature that makes this laboratory unique is our ability to control humidity levels even at high temperatures.

In the test stations, WCEC currently has 4 projects that are up and running, with many more beginning in the coming months.

1. OPTIMIZATION OF HYBRID EVAPORATIVE COOLING EQUIPMENT

The first is dedicated to creating a successful protocol to model indirect evaporative coolers (IDEC). At this stage, the IDEC project is completing fluid testing over a base-case, smooth material to determine the effect of pin geometry and spacing will have on the pressure drop over the heat exchanger. UC Davis College of Engineering PhD candidate Zhijun Liu is heading this effort and has caught the attention of many established industry stakeholders including Munters and Coolerado.

The test apparatus and sensors to determine pressure drop changes via pin distribution.

2. Phase Change Materials for Hydronic Systems

The second project now running in WCEC's new laboratory looks to add microscopic phase-change beads to water thermal systems. Just like how ice acts as a cooling energy storage for a glass of water, these Phase Change Materials (PCMs) can store more thermal energy, significantly reducing the rate at which a hydronic system needs to be circulated. This should translate into a large energy savings in pumping power for these systems.

The PCMs project is headed by WCEC's William Allen and UC Davis' College of Engineering Master's student, Myra Vega. The current laboratory portion is in full swing, Allen and Vega are studying the mechanical effects of PCMs as they are pumped through a closed loop experiment. The team is looking to determine what effect will the pump have on these PCMs and what potential effects the PCMs could have on the pump.

Mayra Vega, UC Davis College of Engineering student, standing with the PCM apparatus.

HTIL laboratory testing apparatus with outdoor air environment chamber

3. HVAC Technician Instrument Lab (HTIL)

The third project is an extension of the Fault Detection & Diagnostics research that helped change California policy to require fault detection on all new commercial rooftop units with economizers. The HTIL project posits the question: What if HVAC technicians mis-diagnose or overlook certain faults (especially proper refrigerant charge) because their HVAC measurement tools or procedures may not be accurate? Simply knowing there is a problem but not being able to accurately diagnose or treat it can lead to decreased efficiency and longevity in the HVAC equipment and can have the negative effect on customer trust in the HVAC contractor industry.

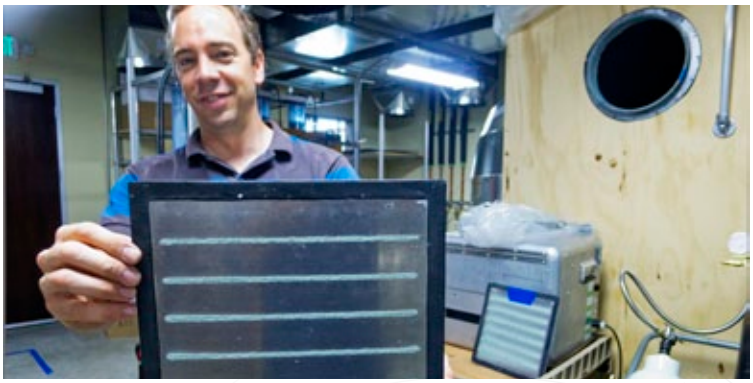
The HTIL laboratory apparatus will allow WCEC to test a large variety of these HVAC tools to determine if they are properly diagnosing faults such as proper refrigerant charge. Another portion of this research includes the human behavioral aspect of HVAC diagnosis and will study the common procedures of many different contractors to determine the efficacy of their training.

WCEC will also be mentoring students from the College of Engineering at UC Davis on the development of a more effective temperature sensor tool for technician field work.

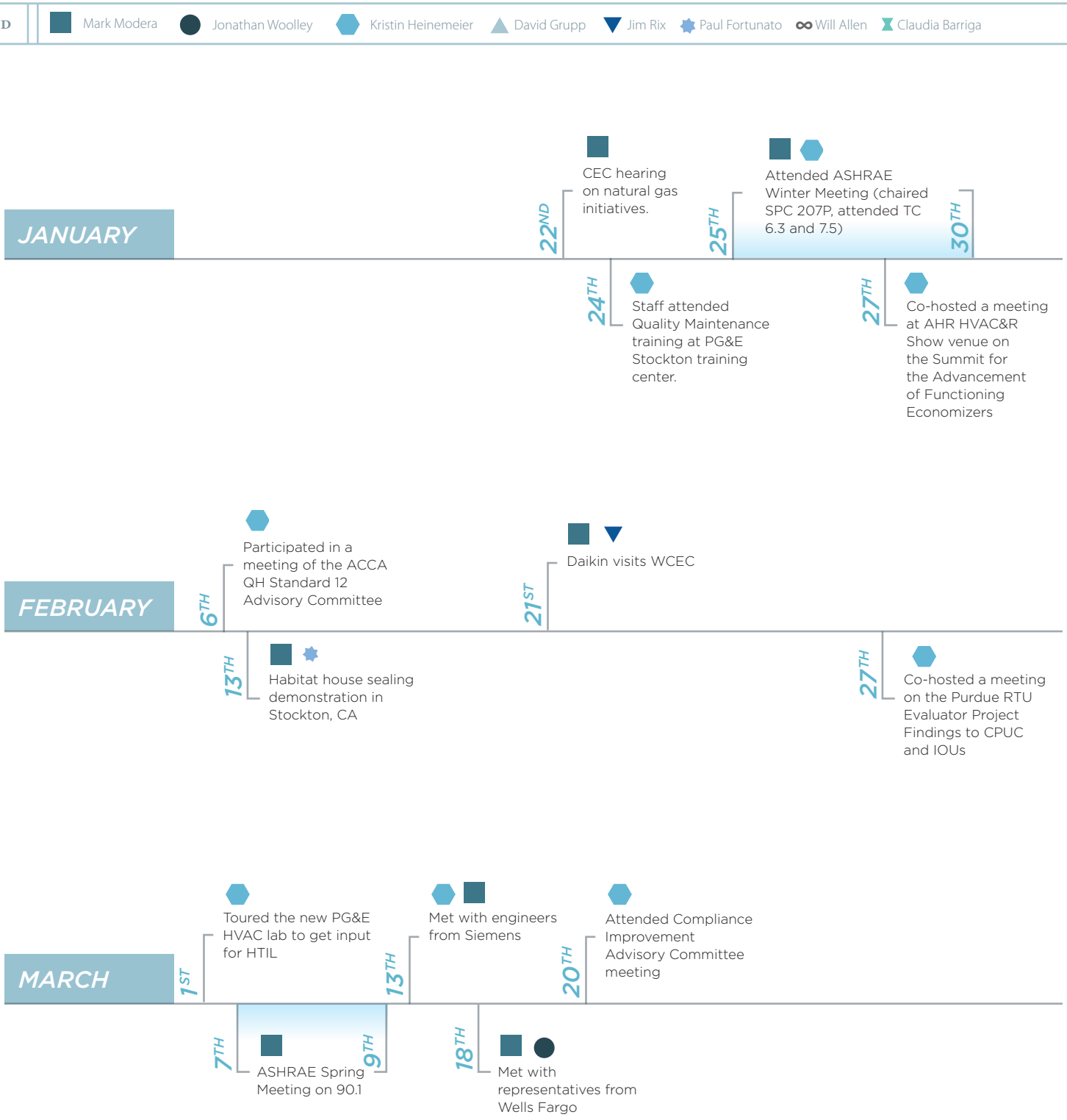
4. aerosolized adhesives for building envelopes

The fourth project that is up and running is the small scale, box testing for the automated sealing of building envelopes using aerosolized adhesives. This box test was the original proof-of-concept testing ground to see if aerosolized adhesives could work in a largely quiescent space. Since the success of the first tests, WCEC has effectively used this new technology in 6 different applications including 5 different single-family homes at various stages of construction and 1 apartment.

This box is currently used to test different sealant mixtures by controlling these main variables: speed at which the sealant dries, how tacky it is, and how quickly it seals. Another important use for the box is to test other injector nozzles and pressures to determine the effect particle size plays in sealing effectiveness while reducing clean-up.



WCEC NOTABLE OUTREACH EVENTS TIMELINE



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