

## THE COVID-19 ISSUE

### Engineers Collaborate on Breakthrough Technique to Expand Ventilator Capacity

**EDITOR'S NOTE:** All of us are now familiar with the many consequences of the COVID-19 pandemic. This May issue of the Wiliki O Hawaii showcases three articles regarding engineering and the virus. The two front page articles describe how the UHM College of Engineering is helping in the fight against the virus. The article on page x discusses contingencies for dealing with disasters like this.

An innovative technique to treat up to four COVID-19 patients with a single ventilator has the potential to save lives in Hawai'i and around the world.

The team working on the new method includes: University of Hawai'i at Mānoa Mechanical Engineering Associate Professors A Zachary Trimble and Scott Miller, Brennan Yamamoto, a 2019 UH Mānoa mechanical engineering PhD graduate and researcher for the University of Hawai'i Applied Research Laboratory, Russell Woo, MD, Kapi'olani Medical Center for Women and Children pediatric surgeon and John A. Burns School of Medicine (JABSOM) associate professor of surgery, and the project's founder, Donald Gaucher, MD, an anesthesiologist at Straub Medical Center.

"The quad-split ventilator system allows four patients to be ventilated off one ventilator, each with their own different minute ventilation," Gaucher said.

Hawai'i Lt. Gov. Josh Green, who is also a medical doctor, said there are about 535 ventilators in the state and about 15 percent are currently in use. This new technique would be implemented only in an emergency if all ventilation capacity has been used. If needed, it would enable four times the number of patients to be treated. "That's a huge difference. Often, intensive care units are clustered so that you can get beds near one another. We have our Army Corp of Engineers also looking at some additional facilities, and those facilities will be designed with this kind of technology in mind so that if we did have to couple people onto a ventilator or bring people into close contact, this of course

in a crisis circumstance, we could do it," Green said.

"Currently with the coronavirus, we predict there will not be enough ventilators available in the United States," Gaucher said.

Researchers said doctors worldwide are already working on ways to treat more than one patient with a single ventilator. However, this advancement allows patients to receive more individualized care than simply just sharing the

*Continued on page 5*



### UH Mānoa Students Create Mask Sewing Kits Aimed at Saving Lives in College of Engineering's FabLab

A group of volunteers led by two University of Hawai'i at Mānoa PhD students are creating sewing kits for cloth masks designed for people to wear as a preemptive measure against possible asymptomatic transmission of COVID-19.

Sergey Negrashov and Chris Ketter established Aloha Mask to create double-ply fabric mask kits through the College of Engineering's FabLab, a self-sustaining space designed for students to fabricate their designs. Each kit contains the materials needed to produce one mask, and it takes an individual about 15 minutes to sew the mask with a sewing machine. Negrashov, a computer science student who recently passed his dissertation defense, works full-time as an applied physicist at Oceanit. Ketter is a physics student.

"The universal shortage of personal protective equipment across the world has driven a lot of people to do what they can to help people on the front line fighting this disease," Negrashov said. "I tried my hand sewing the masks from available patterns and found that most of my time was spent cutting the patterns.

Our innovation is using the FabLab laser cutter to mass produce mask kits for volunteers with sewing machines to assemble and donate to any organization that needs them."

Negrashov's goal is to make 400 masks per day for all types of frontline workers, as long as they can continue to secure materials. The current version of the mask is designed to contain the virus and protect others if the wearer is ill. He eventually hopes to design a mask to protect healthy individuals from getting sick.

"Current research suggests that the best material for masks is cotton," Negrashov said. "We will be pivoting our production towards a new mask design with a pocket for a filter commonly used in hospitals. Those will go

directly to healthcare workers."

Negrashov and Ketter are working with Oceanit and are planning to collaborate with researchers in the UH Mānoa oceanography department to test the effectiveness of their filter designs. Once team members identify the best filter material, they will retool their manufacturing process.





Published monthly by:

HAWAII COUNCIL OF ENGINEERING SOCIETIES

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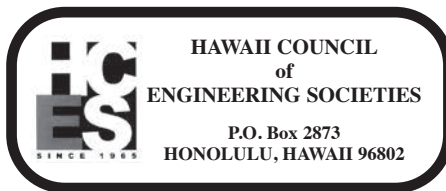
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## COVID-19 Highlights the Need for Resilient Island Nano-Grid Power 24/7 at Hospitals, Medical & Healthcare Facilities

Today's panic over shortages for the critical medical lifesaving equipment "ventilators" during the COVID-19 pandemic is widespread across the United States. These ventilator life-supporting medical equipment require electrical power 24/7 though some have 2-6 hours of battery backup, any prolonged power interruption to Hospitals, Medical & Healthcare facilities as well as Nursing/Retirement Homes would be fatal. Currently New York City is using thousands of ventilators. Luckily we are in a calm weather period for the month of April, but COVID-19 is expected to last through early summer in the United States when severe weather events such as Hurricanes, Tornados, and wildfires are typical causes of localized and widespread electrical grid power outages. In California and Hawaii, we also have Earthquakes that disrupt grid power.

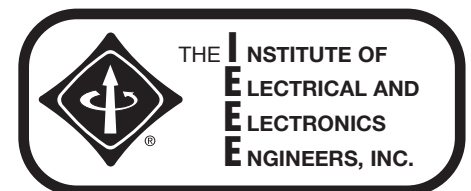
Lessons learned from hurricane Maria in Puerto Rico (September 2017) is that centralized grid with above ground power lines are not resilient and failure isolated many communities and homes for days, weeks and even months without electrical power. The prolonged electrical power outages lasted months costing nearly 3,000 lives [1]. Puerto Rico also learned that back-up emergency generators powered by fossil fuel are also not resilient, running out of fuel after a few hours while structures (homes/buildings) using solar-PV power during daytime coupled with battery storage discharge power at night were resilient having electrical power 24/7 in Island Nano-Grid mode of operation. The New England Journal of Medicine article "Mortality in Puerto Rico after Hurricane Maria" published July 12, 2018, detailed the high mortality rates were caused by "interruption of medical care" [2]. Many individuals in Puerto Rico were dependent on life-sustaining equipment requiring electricity 24/7, healthcare disruption was a major "contributor to both morbidity and mortality". During the November 2018 Northern California wildfires, many people described not being able to see at night to escape their homes due to the power outage highlighting safety issues with 85 lives lost and the importance of resiliency with Island Nano-Grid to save lives. The September 2018 Hokkaido Island Japan earthquake caused an island-wide power outage to all 2.9M customers for 2 days [3]. "Hospitals were forced to function on emergency backup power due to the blackout. Many hospitals had to turn away emergency patients because of the outages". Therefore, home and building resiliency requires Island Nano-Grid for power 24/7 ensuring safety, security and to save lives [4].

All homes/buildings in the State of Hawaii that have critical life-supporting medical equipment from simple oxygen generators to complex ventilators requiring electrical power 24/7 must be made resilient. Most ventilator power rating is between 100-200W or 2.4-5kWh/day; this is equivalent to 1 or 2 refrigerator daily power usage. Overnight usage would require battery discharge of 1.2-2.5kWh/night per ventilator so a single 10kWh battery can back-up 4-8 ventilators. A side benefit of achieving resilient Island Nano-Grid for electrical power 24/7 is also achieving the state of Hawaii 100% Renewable Clean Energy goal today with 100% electrification for Carbon-Free emissions [5].

Today the cost for single crystal silicon rooftop solar-PV modules is as low as 28¢/W with module/panel power between 400-500W. Add the cost of inverter, installation and soft costs (marketing & advertising), the total cost of a system as low as \$3/W in Hawaii while as low as \$2/W in California using polysilicon modules. Hawaii state rebate and Federal tax credit reduces the cost of the total rooftop solar-PV system to ~\$1.40/W in Hawaii. The average daily sun radiance for Oahu is 5.5hours/day making the daytime solar-PV electricity generation costs 3.6¢/kWh for a 7kW size PV system over 25 years. Adding a Li-ion battery electrical storage systems sized between 10-20kWh with hybrid-inverter costs <71¢/W on the low price side and after State and Federal credits ~14.8¢/kWh over 10 years depending on the battery manufacturer.

- 1] John Borland and Takahiro Tanaka, "Solar Plus Multi-Storage Restores Power to Families in Puerto Rico", *Renewable Energy World*, May 1, 2018.
- 2] N. Kishore et al., "Mortality in Puerto Rico after Hurricane Maria", *New England Journal of Medicine* 2018; 379:162-170.
- 3][https://en.wikipedia.org/wiki/2018\\_Hokkaido\\_Eastern\\_Iburi\\_earthquake](https://en.wikipedia.org/wiki/2018_Hokkaido_Eastern_Iburi_earthquake).
- 4] John Borland, "Fight Climate Change and Decline of Rooftop Solar-PV in Hawaii with Resilient Island Nano-Grid 2nd Solar Wave and Zero Grid-Buy Equivalence", *Wiliki-o-Hawaii*, vol.55, no.2, April 2019, p.1.
- 5] John Borland, "Be Proactive Not Reactive to the Next Island Blackout: A Case Study for Achieving 100% Renewable Energy From The Sun + Multiple Storage For Hawaii Residences With <3Years Payback & Off-Grid Operation", *Wiliki-o-Hawaii*, vol.53, no.10, December 2017, p.1.

**Bio:** John O. Borland is President of J.O.B. Technologies and published over 160 technical and conference papers in the areas of advanced semiconductor device manufacturing, high efficiency c-Si solar cells, and resilient Island Nano-Grid using Solar + Multi-Storage. He has also been awarded 6 patents. He is a senior member of IEEE, the IEEE Region 6 Central Area chair, the IEEE Hawaii section past-chair and the IEEE Hawaii Chapter chair for both the Power & Energy Society and Electron Device Society.



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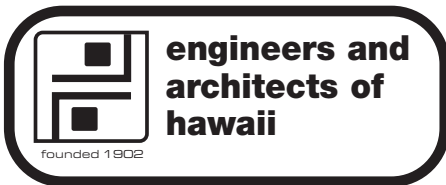
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The local section, AAACE Hawaii, was originally established in 1973. It achieved both the Platinum and Gold Award for six consecutive years 2014-2019. Our local area continues to achieve CCP, CEP, CST and PSP certifications. For more information, please visit <http://web.aacei.org/certification> and our local website [www.aacehawaii.com](http://www.aacehawaii.com).

The AAACE Hawaii Section Board of Directors is seeking candidates for the 2020-2021 elections. Please contact [aacehawaii@section@gmail.com](mailto:aacehawaii@section@gmail.com) for description of positions. The term will be June 2020 to May 2021. Nominations will be accepted through May 15, 2020. Elections will be conducted from May 16 to May 25, 2020.



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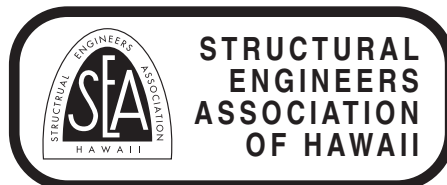
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EAH's meeting location is Room 301 in the Topa Tower downtown Honolulu 745 Fort Street. Validated parking is available (enter from Nimitz). Visit [eahawaii.org](http://eahawaii.org) for directions and a map and any Program schedule or meeting location updates.

Meetings are held 2 times per month on Fridays. Meetings start at NOON and have ended PROMPTLY at 1:00 pm for over 110 years.

All are Welcome. Lunch is \$10.00 for Members, \$12.00 for guests and \$5.00 for students. Drinks and refreshments are complimentary. Brown baggers welcome. \$2.00 donation is gratefully appreciated if not having lunch.



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**SEAOH Annual Convention**

- The 2020 SEAOH Convention and Japan trip have been postponed due to Covid-19.
- Membership
- Noemaikalohaiku'ulei Lum and Leah Miyasato have been approved as Associate members.
- Michelle Goo of Wiss, Janney, Elstner Associates, Inc. has applied for Associate membership. Please contact any SEAOH Board Member by June 1, 2020 with comments regarding the application.

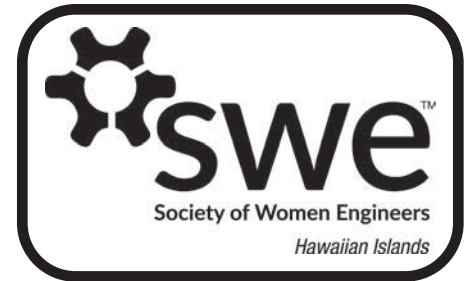
**Next Meeting** on May 6, 2020. For information, contact SEAOH President Danny Fujioka.



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Last held: April 7, 2020  
 Next meeting: May 5, 2020

**ASCE HAWAII SECTION DINNER MEETING Program: T.B.D**

The continued health and safety of our membership is our top priority and we will continue to monitor the COVID-19 pandemic. Future ASCE Hawaii events, including our section dinner meetings, are still temporarily on hold. We will keep you informed via e-blasts and/or notices posted on our website at [ascehawaii.org](http://ascehawaii.org) when they will be scheduled. Please continue to stay safe, watch out for each other, especially our kupuna, and continue to be vigilant about best health practices.

**Speakers: T.B.A**

Date: T.B.A  
 Location: T.B.A.  
 Time: T.B.A  
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 Cost: T.B.D

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ASCE Hawaii is looking for volunteers to fill the following committee positions: Two (2) Student Practitioner Advisors. If you are interested or have questions on any of these positions, please contact President Jason Kage, [jkage@ascehawaii.org](mailto:jkage@ascehawaii.org).

**MEMBERSHIP**

If you haven't already done so, please renew your ASCE membership. You can renew your membership at [www.asce.org](http://www.asce.org).

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- **Booz Allen Hamilton** (Senior Civil Engineer and Wastewater Specialist)
- **City and County of Honolulu** (Civil Engineer III, IV, V, Mechanical Engineer V, & Electrical Engineer V)
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For further information, please visit <http://www.ascehawaii.org/job-listings.html>.



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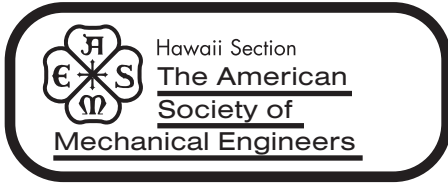
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**NEXT ASME-HAWAII GENERAL MEMBERSHIP MEETING**

Date: Date yet to be determined depending on COVID-19 status and State Social Distancing proclamation relaxation and depending if remote-virtual meeting conducted.

Time: usually from 5:30 pm to 6:45 pm

Place: Pre-COVID-19: at Johnson Controls, 550 Paiea Street (map and parking instructions found on the Hawaii Section website)

Agenda: A copy of the agenda will be on the Section website.

As usual, all members, students and guests are invited and encouraged to attend our meetings. There are always lots of complimentary refreshments. Please contact Chairman Froilan Garma for directions and for more information, such as parking.

**2020 FRANCIS RHODES MONTGOMERY DESIGN COMPETITION (FRMDC)**

Pre-COVID-19, the FRMDC was scheduled for May 8th from 12-6 p.m. at the UHM Campus. With current COVID-19 guidelines, it has been decided that the virtual version be held essentially the same. There will be nine teams represented. The competition time is now planned from 11 a.m. to 4:00 p.m., since it is virtual and since there will not really be any "hardware" to show.

**FRMDC format:**

**1) Presentation:** This will be essentially the same as always - just remote. There will be three Hawaiian Electric Company judges. Each team will have a set time to present and will do so via Zoom or HECO's WebEx account. However,

since the students have been using Zoom for their courses and familiar with it, it will most likely be via Zoom.

**2) Poster Presentation:** Each team will prepare a print ready poster in pdf format. The poster will be pre-distributed to the judges. After all the formal presentations are completed, each team will reconnect with the judges remotely for ten minutes for the judges to ask questions about the poster. This format mimics the live version of the FRMDC as much as possible.

**3) Hardware demonstration:** This part is cancelled altogether due to the following reasoning. Some teams will have limited hardware, and some teams will have none. Teams that figured out how to make some hardware in the current situation will look more impressive. However, we need to remember some projects are conducive to working from home. Some are not. For instance a team that is making small 3D printed parts or small arduino electronics can continue to make some hardware progress. A team making a formula race car or other large project cannot make that hardware at their home. Additionally, some students have access to a shop or garage to continue working on hardware from home. Some students live in an apartment and cannot. Per the current UH COVID guidelines, we cannot expect students to build any hardware since as a public school cannot guarantee their ability to do so from home. Thus, under the equal opportunity guidelines at the university we need to eliminate hardware demonstration via video or other means.

Judges are engineers from Hawaiian Electric Company (HECO) due to Francis R. Montgomery's affiliation retiring as Vice President of Engineering in 1979. In addition, HECO engineers are very willing and able to volunteer.

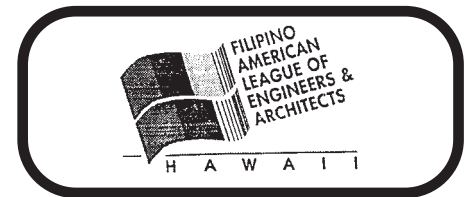
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ventilator. "This system works by using a series of flow and one-way valves, as well as some 3D-printed materials to individually regulate the flow and thereby the volume and pressures to each of the patients sharing the ventilator," Woo said. "It allows for individualizing multiple elements of the respiratory care, which we feel will make this more safe and more feasible."

One of the challenges researchers needed to overcome was to institute safety measures to prevent cross-contamination between patients. "There are medical grade biofilters (a filter designed to remove 99.97 percent of airborne

particles, including biomaterials like bacteria and viruses, measuring 0.3 micrometers or greater in diameter passing through it) in every patient limb in both the inspiration and expiration sides, and there are anti-backflow valves in both inspiration and expiration sides which limit the flow between patients. Thus, what limited flow that may be shared between patients is filtered," Trimble said.

"This solution, as any sharing solution, is only in an absolute emergency situation when all ventilation capacity has been used up, there's no more ventilation capacity. So, if we need the ability to ventilate people, this would be an emergency solution," Trimble said. The team added that its technique allows doctors worldwide to make modifications because the shared ventilator system is sourced by parts they can find at local hardware stores. The group is conducting additional testing to improve the system before the need becomes critical in Hawai'i.



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