MEMORANDUM

Pacific Northwest NATIONAL LABORATORY

Date:	**11/11/2022**		
To:	**Howard Wiig and Gail Suzuki, Hawai'i State Energy Office**	Information Release #	**PNNL-179680**
From:	**Vrushali Mendon, Rob Salcido, and YuLong Xie**		
Subject:	**Excerpt from Cost-Effectiveness Analysis of the 2021 IECC for Hawai'i; Ceiling Fan Analysis**		

The State Energy Office of Hawai'i requested an energy analysis of the code provisions pertaining to tropical semi-conditioned single-family buildings compared to a naturally ventilated scenario with ceiling fans. To assess these impacts, PNNL analyzed the energy and cost-effectiveness of adopting the 2021 IECC compared to the amended 2015 IECC adopted by Hawai'i using the DOE Residential Building Prototype models and DOE's Residential Cost-Effectiveness Methodology.

Table 2. Fuel Prices used in the Analysis

Electricity ($/kWh)	Gas ($/Therm)	Oil ($/MBtu)
0.30	4.45	2.52

Analysis of the Tropical Semi-Conditioned Prototype

The State Energy Office of Hawai'i additionally requested an energy analysis comparing the annual energy use of cooling a 900 sq.ft. space using a split air-conditioning system, compared to one that uses four ENERGY STAR ceiling fans. In lieu of building a new single-family prototype building with 900 sq.ft. of conditioned space, the State Energy Office experts agreed to using the tropical semi-conditioned prototype with 1188 sq.ft. of conditioned floor area as a reasonably comparable case.

For the ceiling fans scenario, the 1188 sq.ft. area is assumed to be served by four ceiling fans. Thus, each ceiling fan serves an area of 297 sq.ft. ENERGY STAR guidance[1] suggests a fan size of 50-54" for an area of 225-400 sq.ft. This analysis assumes four fans of 52" for the energy calculation. ENERGY STAR requires a minimum efficiency of 110 cfm/W for ceiling fans

1. https://www.energystar.gov/products/lighting_fans/ceiling_fans/ceiling_fans_key_product_criteria

between 36” and 72” in diameter.[2] Most fans in the ENERGY STAR database have an efficiency rating of 110-340 cfm/W. These fans consume between 14-27 W at high speeds, depending on the model. Assuming a conservative high-speed fan energy consumption of 27 W and that the fans run at high-speed for 3,000 hours annually, the energy consumed by the fans is estimated to be 80.4 kWh per fan. This works out to $97 for the four fans at $0.30/kWh.

Table 9 summarizes the annual energy costs of cooling the tropical semi-conditioned prototype built to the requirements of the 2021 IECC with an air-conditioning system with SEER 14, compared to the energy consumed by four ENERGY STAR fans as calculated above. If a higher efficiency air-conditioning system such as a SEER 18 system were utilized instead, the costs of air-conditioning would reduce to approximately $1,092 annually.

Table 9. Energy Consumption for the Tropical Semi-Conditioned Prototype with an Air-Conditioning System Compared to ENERGY STAR Ceiling Fans

Tropical Semi-Conditioned Prototype House Energy Costs ($/year)	
Split Air-Conditioner (SEER 14)	**ENERGY STAR Ceiling Fans**
$1,404	$97

2. https://www.energystar.gov/products/lighting_fans/ceiling_fans/ceiling_fans_key_product_criteria