

# Digitized Home & Solar Energy Audit To ID Root Causes Of High Electric Bill

John O. Borland, J.O.B. Technologies, Aiea, Hawaii  
JohnOBorland@aol.com



Today, many families are experiencing high home electricity bills and high Energy Burden due to the high costs for oil paid by Hawaiian Electric, high home energy usage and/or degradation in home solar system performance. Most families have no idea how much energy their various home appliances use day to day, week to week and month to month nor any seasonal energy use pattern changes which can be significant due to climate change. On Oahu, the electricity rates peaked at 44.1¢/kWh in 2022 while on Molokai it reached 57¢/kWh. Today (July 2023) electricity rates have dropped to 36.5¢/kWh on Oahu and 41.0¢/kWh on Molokai. To ID which household appliances are “Energy Hogs” we digitized the home energy ecosystem with smart IoT devices to monitor and control energy usage on both the wall plug and circuit breaker level. This allows analysis and ranking every second, minute, hour, day and month. Heating and cooling household appliances account for 80-90% of the daily home energy usage during summer months as shown in **Fig.1** for July 16, 2023. Air Conditioning (AC) for space cooling was 40% (8.4kWh/day) and electric hot water heating was 49% (10.3kWh/day) of daily home energy usage. **Fig.2** shows the hourly AC energy usage and how changing the room temperature setpoint, changes the duty cycle from 100% at 70°F to 69% at 75°F. Overnight AC-on duty cycle between 2-6AM drops to 28.5% as shown in **Fig.3** using second and minute energy data analysis (2 minutes AC-on at 630W, 5 minutes AC-off at 81W). The duty cycle is 89% at 4:30PM (17 minutes AC-on, 2 minutes AC-off).

Digitized daily solar energy production monitoring from 2015 to 2023 (8 years) is shown in **Fig.4**. The yearly Solar-PV production dropped 42% from 14.4MWh in 2019 to 8.4MWh in 2022 resulting in climbing monthly electric bill. Detailed daily solar production analysis/audit detected a 28% drop on 5/14/21 and the next 2 years it continued to drop another 21%. Root cause was solar cell coating failure and panels will be replaced under warranty.

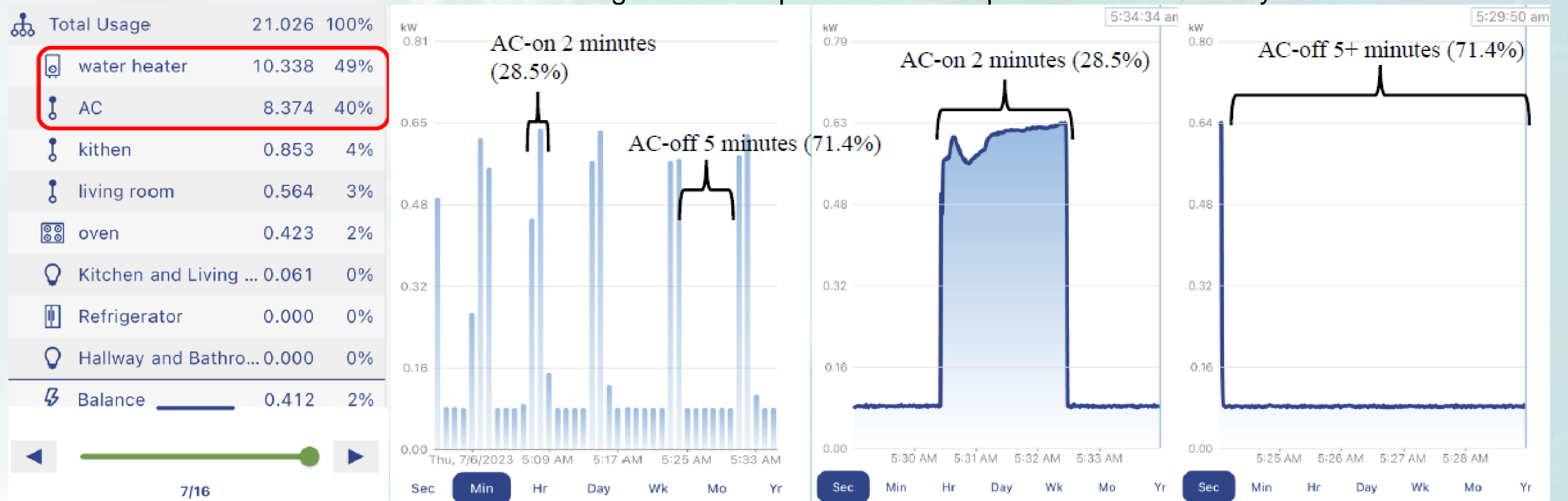


Fig.1: Daily home energy usage.

Fig.3: AC-on duty cycle of 28.5% (2 minutes on, 5 minutes off) from minute and second data analysis.

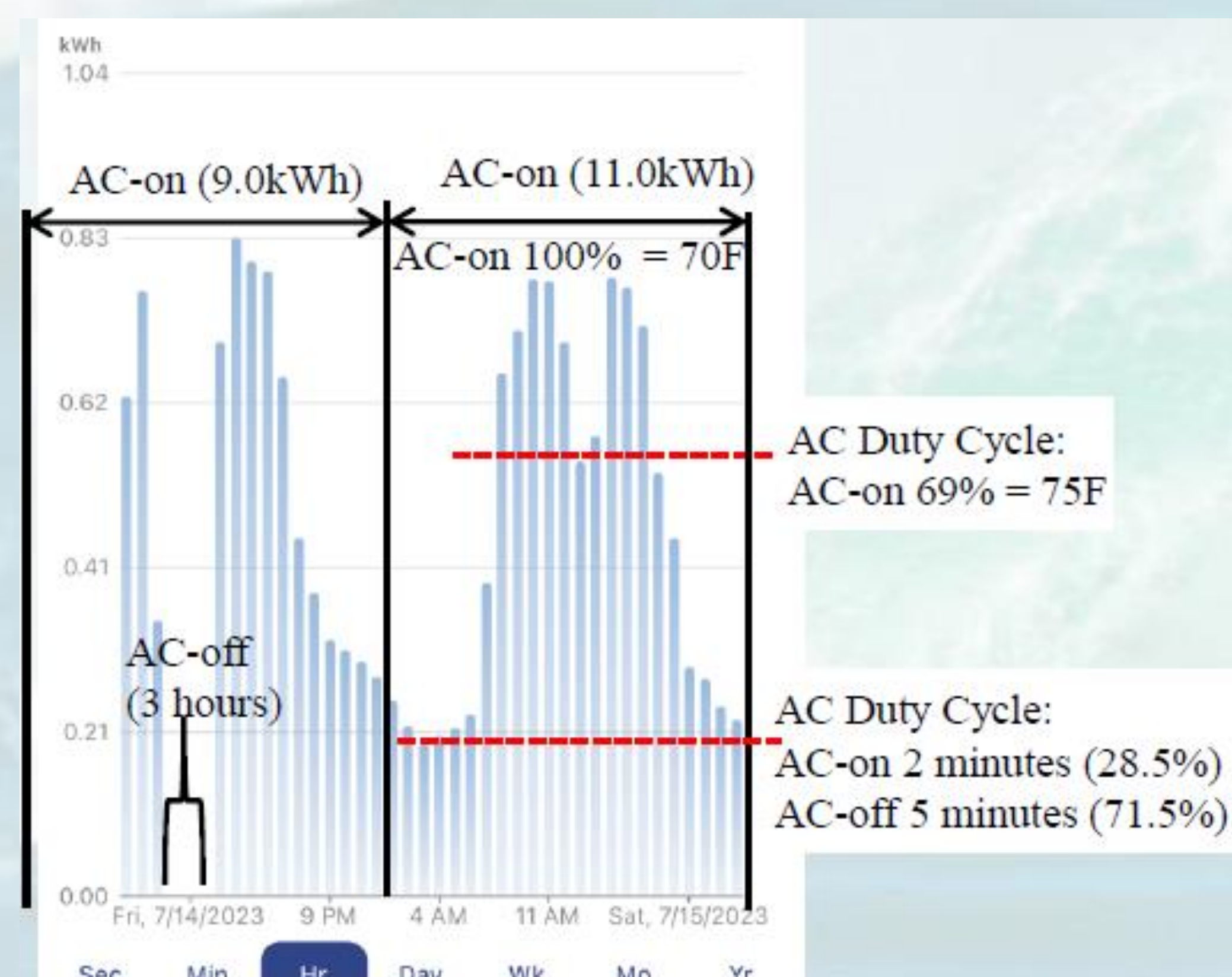


Fig.2: AC-on hourly energy analysis.

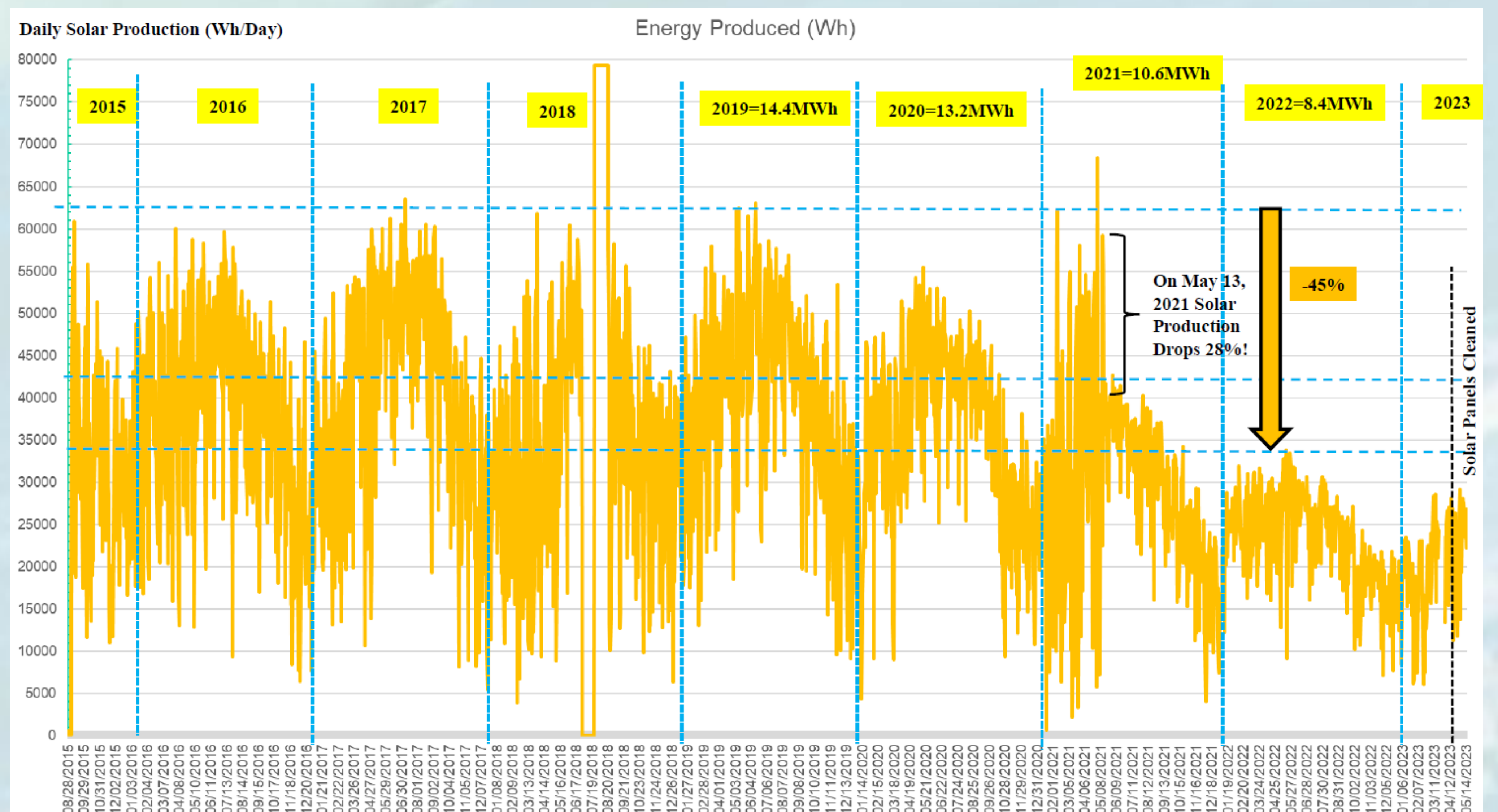


Fig.4: Daily Solar production performance from 2015 to 2023 showing a 28% drop on 5/13/21.