Filing Receipt

Received - 2021-11-22 06:21:16 PM
Control Number - 52373
ItemNumber - 257

Energy Efficiency will help Grid Resiliency and Affordability in Texas

William Hetherington, CEO of Bandera Electric Cooperative, Inc

For the

Public Utility Commission of Texas

Submitted November 22, 2021

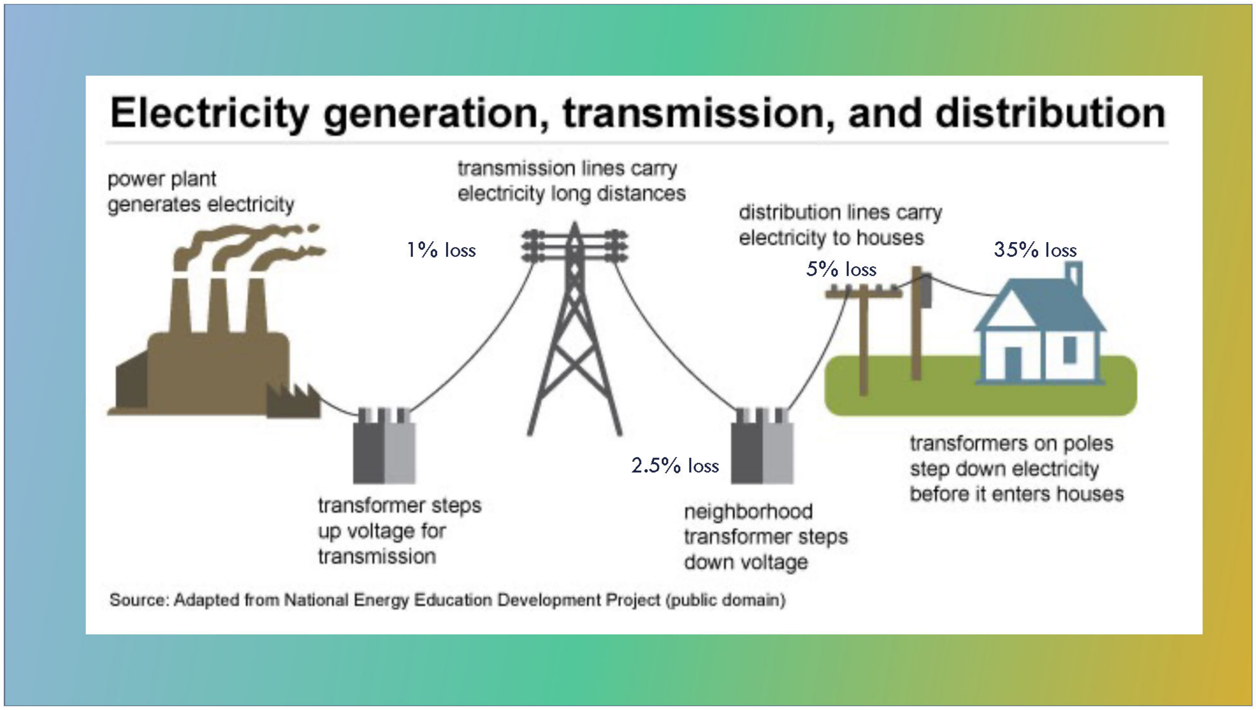
Docket 52373

As a Distribution Electric Cooperative, we saw first-hand the impacts the winter storm Uri had on our electric members and we concur with comments offered by Alison Silverstein Consulting that the PUCT and ERCOT need to improve energy efficiency and demand response programs more effectively to ensure grid **affordability and resiliency**.

As you are probably aware electric cooperatives are not-for-profit entities owned by the people we serve. Likewise, we are very sensitive and responsive to meet their needs and expectations, especially costs of energy. We would like to provide evidence that shows by improving energy efficiency and a developing a market priced, statewide demand response program, the potential of future blackouts could be greatly reduced.

As Texas's electric demand continues to grow, we must be realistic that we cannot just build our way out of this problem, the resulting costs to consumers would be significant. I believe that the electric utilities (ourselves included) have done a remarkable job planning and installing the necessary infrastructure to deliver reliable and affordable energy. However, transmission costs have grown over 100% in 5 years and future transmission plans will only add to higher costs to the customer.

In order for Texas to maintain its cost competitive business environment we must look to all of the potential solutions. One critical piece that is missing is the emphasis on energy efficiency. Electric Utilities have made the grid energy efficient but energy losses behind the meter have been excluded in the discussion and that is where most of the energy loss is occurring.



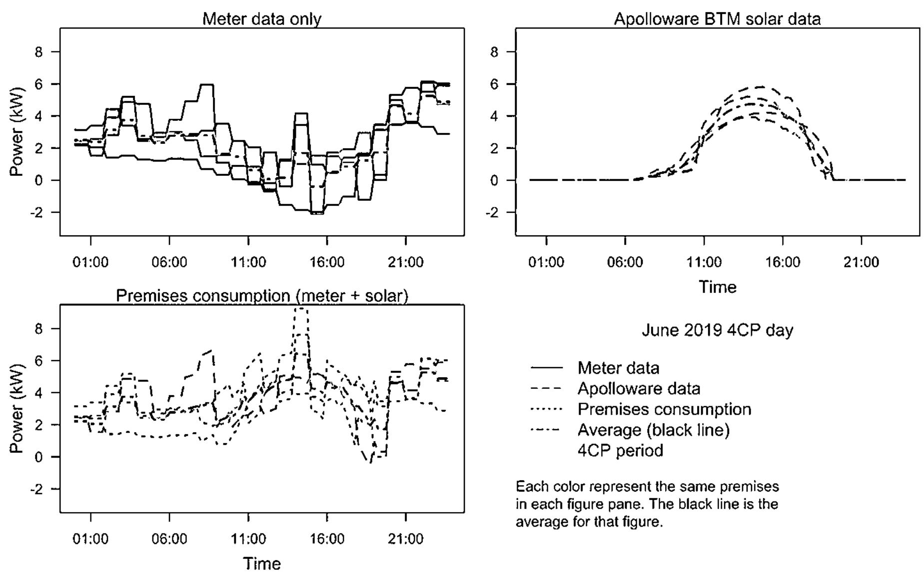
Today there are more than 125,000[1] unregistered rooftop and ground mount PV installations in Texas, amounting to over 1,000 MW of unregistered renewable capacity[2]. In 2016, Bandera Electric Cooperative recognized that the increasing level of Distributed Energy Resources being installed on rooftops and energy losses behind the electric meter were growing substantial and yet there was no way to capture and display this information in real time. The dynamics between energy use, distributed generation, and energy storage behind the meter are complex and there are many contributing factors, including weather that further complicates the issue and the existing metering technology does not provide a timely or granular enough data to utilize energy analytical tools.

---

[1] Source: https;//www.seia.org/state-solar-policy/texas-solar

[2] Source: http://Ercot.com/content/wcm/key_documents_lists/213962/13_2021_Q2_UnregDG_WMS_Update

The following is graphical a comparison between traditional AMI data, compared to AMI with a local inverter to finally the real time Apolloware data[3]



Without understanding and identifying the energy losses behind the meter, there is no way to correct this situation, hence we developed Apolloware.

Apolloware is a cloud based energy management platform which monitors real time energy use at the appliance level, including energy resources such as solar and energy storage devices. It is cloud based, secure and provides energy data every second. Recently we added the capability to control and aggregate, at the appliance level, these resources for the benefit on both the ERCOT grid and the individual

[3] Source : Using Real Time DER data to Improve Utility Operations by Thilo Janssen(BEC),Joshua D. Rhodes and Charles R Upshaw (IdeaSmiths LLC) September 2020

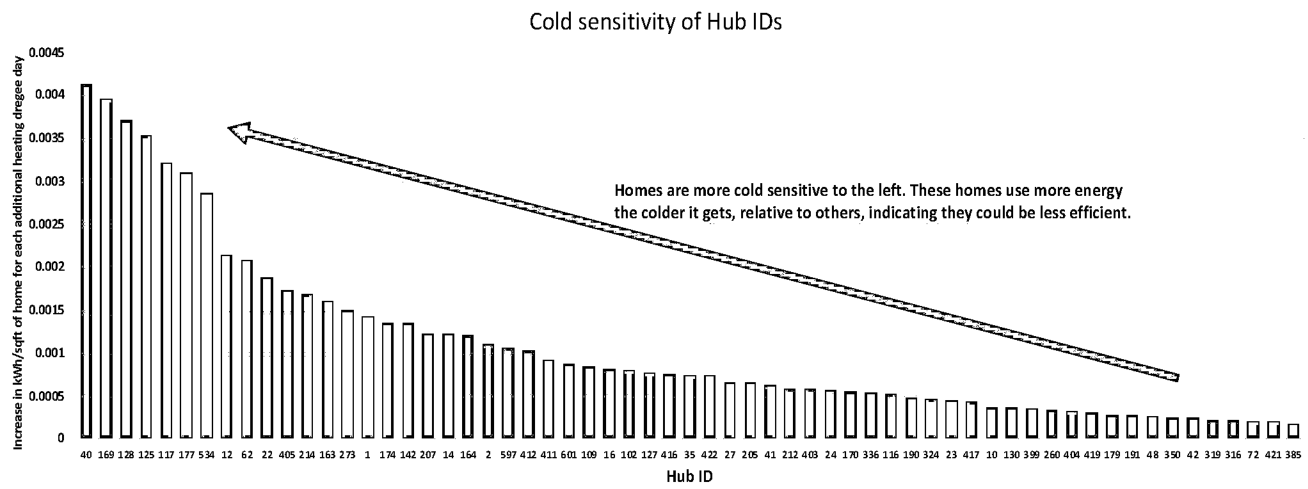
user. Since the appliances as well as any solar or storage are tied to the meter, it is part of the electric grid.

In 2020, BEC implemented a rate tariff requiring that all distribution generation resources interconnecting with BEC to install Apolloware. BEC services about 38,000 electric meters, 10,000 broadband customers, 1,600 phone customers, 434 solar customers and 232 Apolloware customers. We started deploying this technology and now all interconnected DER resources have Apolloware and we believe this technology could provide ERCOT and the PUCT better understanding of the grid and enable better energy efficiency in Texas.

Thanks to Apolloware, we have saved our members more than $251,000 in reduced demand during 4CP and during winter storm Uri we were able to achieve the required load reductions in a surgical and efficient manner.

During winter Storm Uri, we were able to capture some very interesting data about energy consumption, particularly the variation of homes susceptible to cold weather. The variation of homes energy efficiency was 21X as displayed below. This means energy efficient homes were 21 times more energy efficient than inefficient homes.

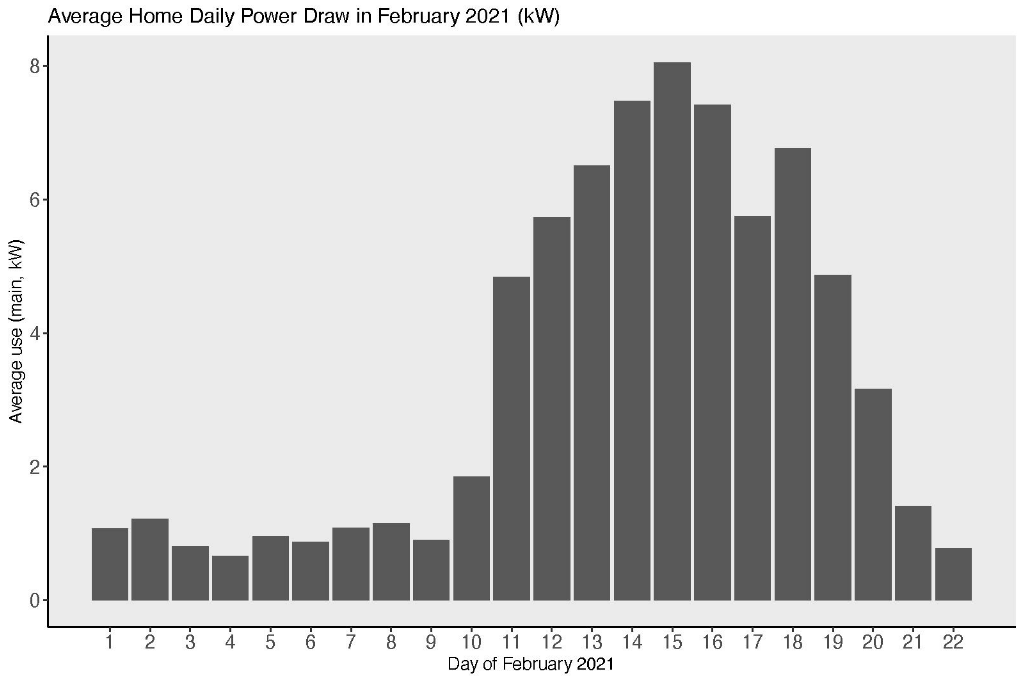
The following graphs [4] show the dramatic impact of extreme cold on energy use in the home.



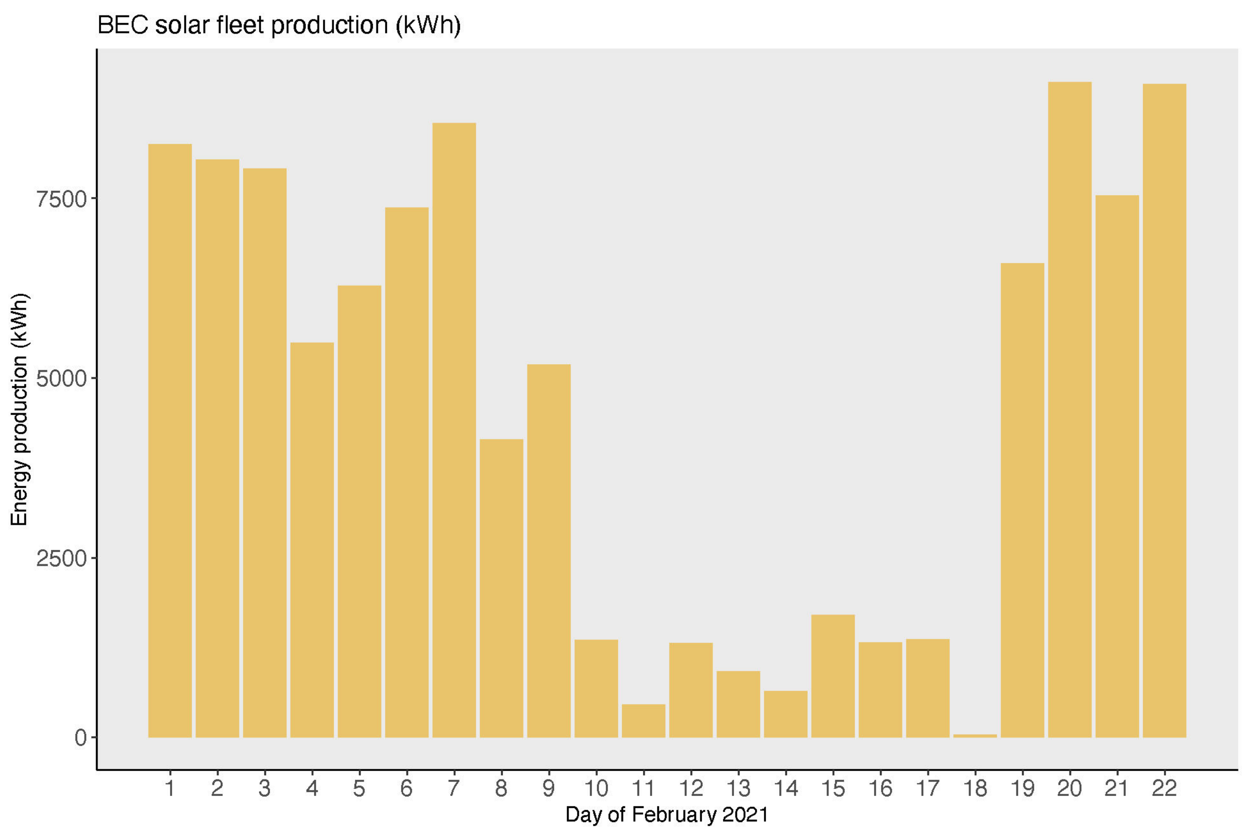
This data clearly demonstrates the importance of energy efficiency. The USDA recently approved the installation of Apolloware as an authorized energy efficiency improvement and we are now using Apolloware to improve energy efficiency throughout our service territory.

[4] Impacts of Winter Storm Uri using Apolloware by Joshua D. Rhodes and Charles R Upshaw (Ideasmiths LLC) March 2021

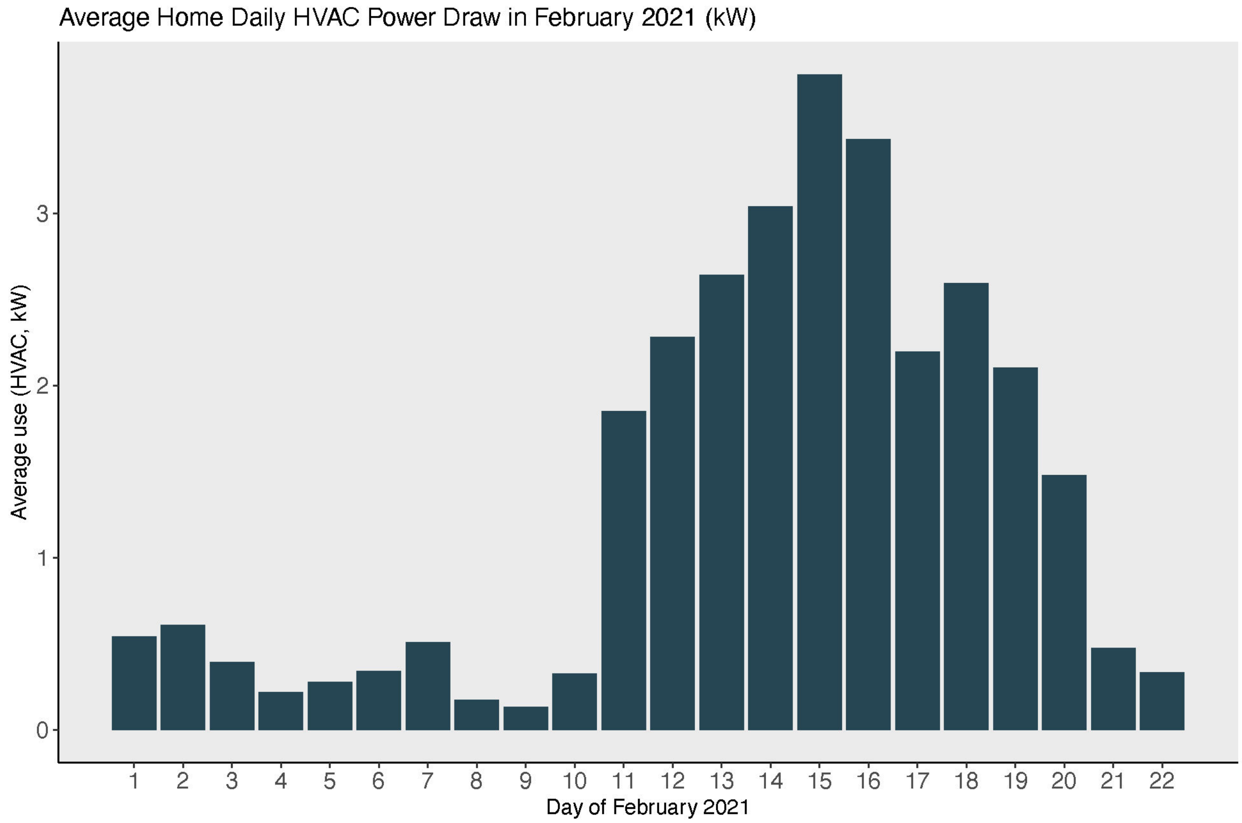
Average home power draw was almost 500% higher Feb 11-20 vs. Feb 1



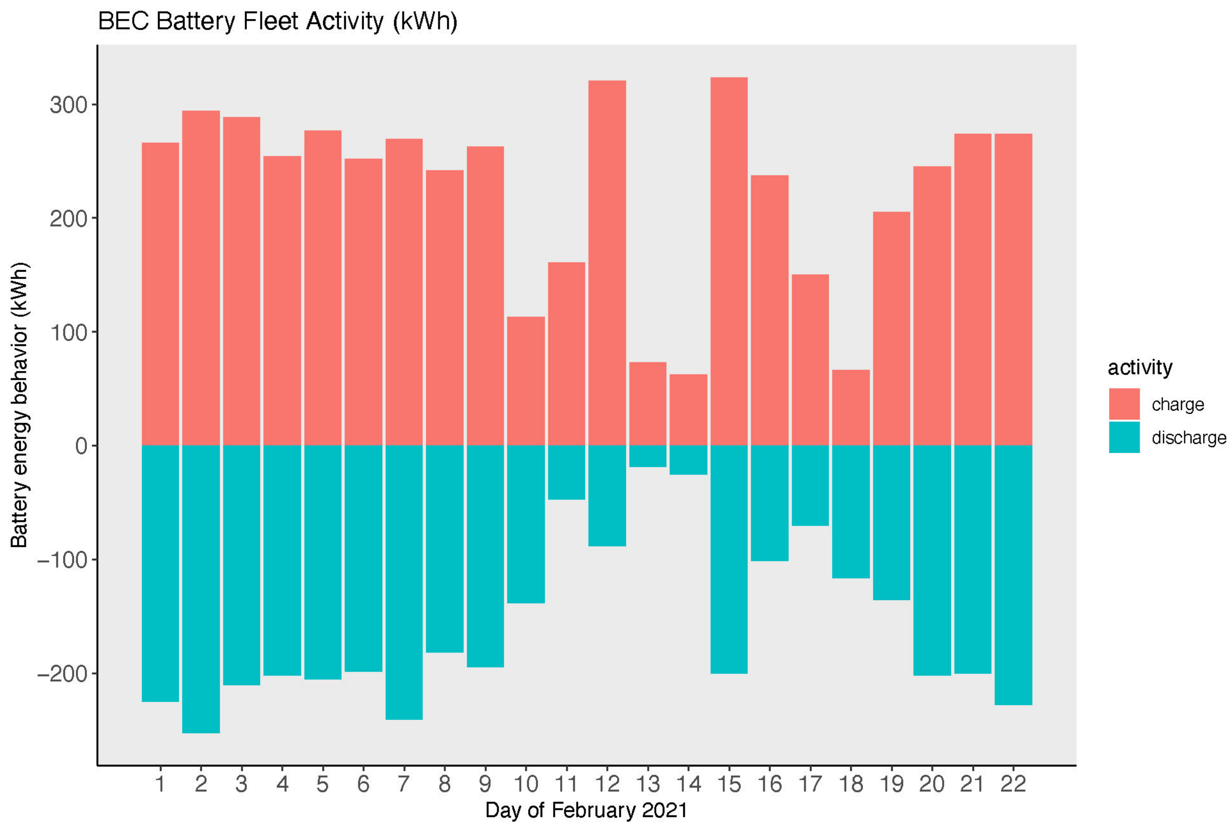
Fleet-wide solar production was down about 63% Feb. 11-20 vs. Feb 1-10



Average HVAC power demand was up over 620%



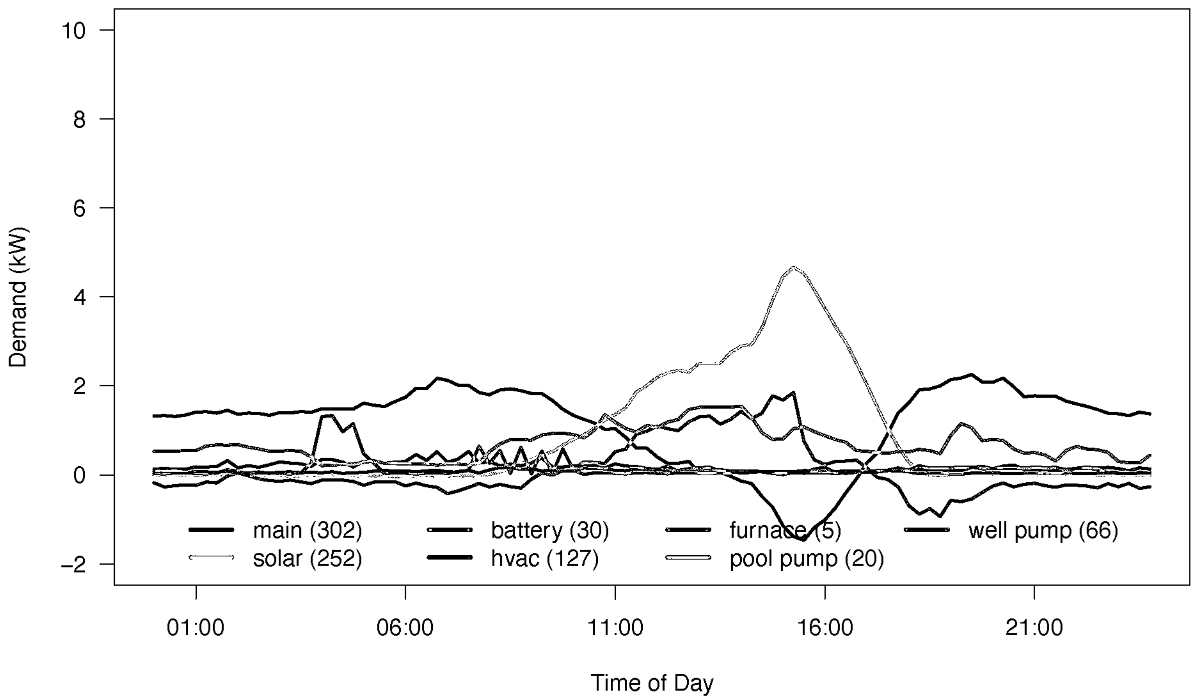
The graph below shows that we were charging batteries during these extreme weather event. With the necessary automation in place we had to notify the members to voluntarily stop charging batteries.



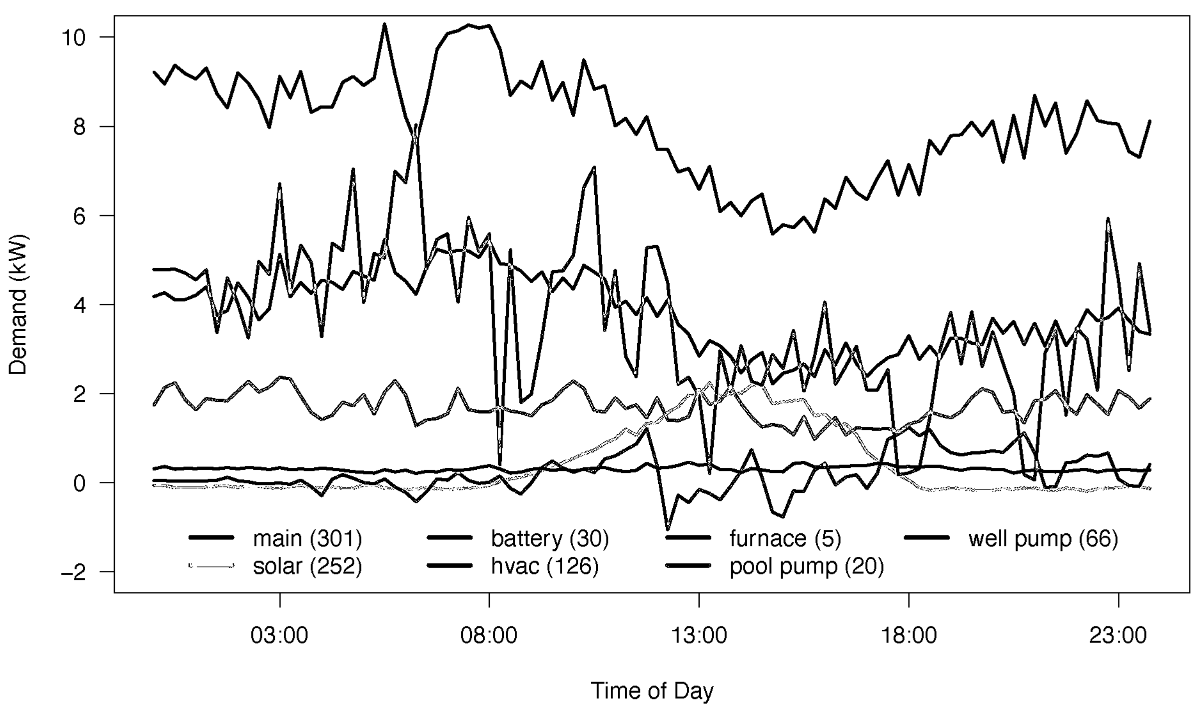
The next two slides[5] show the dramatic effect of Winter Storm Uri. The first slide is a graph of average energy usage the week before the Winter storm the second slide shows the average energy usage during the winter storm.

[5] Impacts of Winter Storm Uri Joshua D Rhodes and Charles R Upshaw (Ideasmiths LLC) March 2021

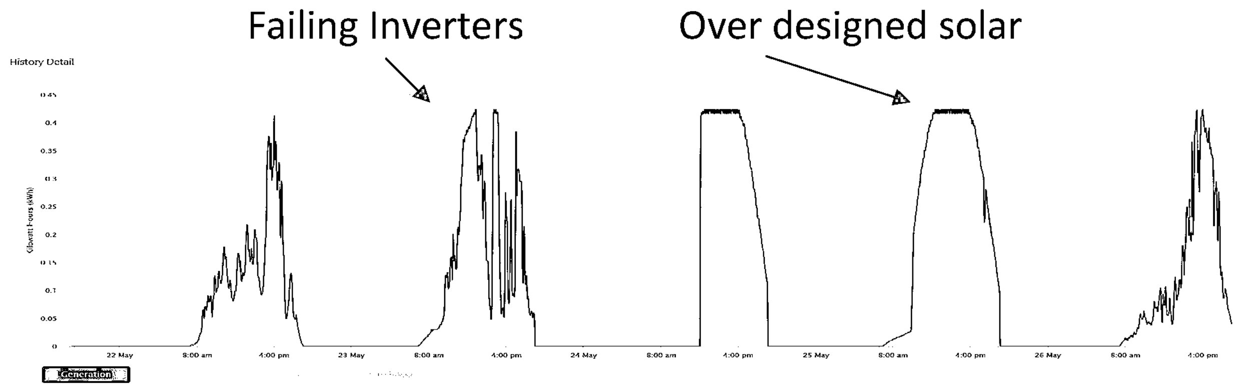
Average demand on 2−08−2021, by major end use



Average demand on 2−15−2021, by major end use



Having granular individual data tied to substation, feeder and phase is an important aspect of understanding energy use tied to weather. Insights into individualized rooftop solar indicates almost 20% are not performing as designed which contributes to inefficiency.



Having behind the meter visibility and transparency would help ERCOT with better grid planning and more importantly better understanding of how to minimize black-outs through the development of an intelligent demand response program based on fleet wide monitoring and control of HVAC, Water Heaters and Pool pump devices ties to wholesale market prices.

If this type of program had been in place during Winter Storm Uri the impacts would have been minimal. With the right pricing signals TDSP could incentivize voluntary load reductions thereby avoiding MANDATORY rolling blackouts.

The structure of the wholesale electric market (aka the ERCOT market) works well when adequate generation supply is available. Although when electric load (demand) exceeds available generation (supply), the ERCOT market fails. ERCOT solves the shortfall by utilizing **voluntary** load reduction. If you've ever been in the grocery store in the summer when every other light is off – this is load reduction. ERCOT considers this type of service “ancillary”, essentially a basket of reserve energy. Entities that voluntarily participate in ERCOT’s ancillary service programs are compensated albeit at a nominally modest amount.

When generation capacity collapsed by almost 50% overnight in the early hours of February 15, 2021, distribution utilities were “forced” to initiate rolling outages. Voluntary load reduction was incapable of solving the problem because of the rapid breakdown in generation. The involuntary action resulted in distribution utilities and their retail customers essentially becoming “electric generators” to prevent grid failure. However, instead of generating electricity, the distribution utilities generated negative electric load, also known as “negawatts”, a service just as necessary to keeping the system, at least in part, running.

This involuntary load reduction was in the thousands of megawatts, at a time when the average price for energy was over $6,000/MWh (vs. mid-30s normally) and the pricing for ancillary services hit almost $25,000/MWh (vs. just a few dollars normally).

We have the technology to operate an intelligent grid down to the appliance level, but we need energy efficiency programs and individualized demand response programs that tie directly to market pricing to keep the loss of power voluntary. If these programs had been in place last February, I believe that Voluntary load reductions would have been adequate to keep the grid for rolling blackouts on a statewide basis.

What was happening inside Texas homes during the February 2021 freeze?

Bill Hetherington, John Padalino, and Justin McKenzie
Bandera Electric Cooperative
Bandera, TX, USA
j.mckenzie@banderaelectric.com

Joshua D. Rhodes, PhD and Charles R. Upshaw, PhD
IdeaSmiths LLC
Austin, TX, USA
rhodes@ideasmiths.net

***Abstract*— Winter Storm Uri resulted in one of the largest grid disasters in recent times. In the ERCOT system, multiple days of blackouts resulted in millions without power and hundreds of deaths. The duration of the extreme (for Texas) cold caused simultaneous high levels of generation failures and record levels of electricity demand. The largest component of the increase in winter peak demand can be attributed to the residential sector. This paper analyzes appliance level data from about 400 homes in the Bandera Electric COOP territory that were equipped with the appliance-level energy monitoring Apolloware system. Data from the systems indicated that average home power demand rose almost 500% during the storm, as compared to the more average days before, largely driven by increased HVAC loads, while solar production fell. Other monitored circuits, such as pool and well pumps increased as well as pools and residents sought to protect their pipes from freezing. It was also observed that the default settings of energy storage systems took them offline for many of the COOP's members.**

Index Terms—Data, electricity, power grids, residential, resilience

I. INTRODUCTION *(HEADING 1)*

In early-mid February 2021, Winter storm Uri brought multiple days of freezing temperatures and snow to the southern part of the US [1-3]. While many parts of the south were hit hard, Texas was hit especially so. For the first time in recorded history, all 254 counties of Texas were under a winter storm warning at the same time. The extreme levels of cold resulted in very high levels of electricity demand as many homes and businesses utilize electric heating. If the Electric Reliability Council of Texas (ERCOT), the grid that serves about 90% of Texas [4] had been able to meet the 76,819 MW estimated peak demand during the storm, it would have surpassed its all-time summer peak, which is usually the highest demand season.

Instead, the ERCOT grid lost about 50% of its power plant capacity to a variety of weather-related, fuel supply, and other issues, which resulted in ERCOT having to call up to 20,000 MW of firm load shed that lasted from February 15 to February 19. The ERCOT grid experienced a frequency drop below 59.4 Hz for about 4 minutes and 23 seconds that, had it persisted for nine total minutes, would have likely resulted in a system-wide blackout that, depending on the level of damage caused, might have taken weeks, if not months, to fully recover from [2].

While the public was initially told that the blackouts would roll, so that no one would be left without power for long, the levels of cuts were so severe that many transmission and distribution utilities (TDUs), many of those charged with rationing the available power could not do so because they had no "non-critical" circuits that they could turn off to then turn others on. Thus, some customers lost power for multiple days in a row, while others that were on critical circuits, such as those with hospitals and fire services, stayed on the entire time. Many Texans were not able to relocate to locations with power and heat because Texas cities and counties generally do not have snowplows and most Texas vehicles do not install seasonal snow tires.

And, while smart meters, which are installed across most of the state, technically have remote connect/disconnect abilities to turn off and on individual customers, the communications backend across the ERCOT grid is only able to handle a few thousand switches per day, whereas millions of switches per day would have been required to more equitably spread out the required power rationing.

The power crisis snowballed into a $50+ billion-dollar financial crisis with multiple market participants going bankrupt, a water crisis with millions of Texans told to boil water even if they didn't have power, a housing crisis with frozen pipes leaking and destroying homes after the thaw, and a humanitarian crisis with official numbers indicating that over 200 people died as a direct impact from the storm [5]. New state legislation and regulatory leadership were ushered in to "fix" the grid, but their effectiveness has yet to be tested.

While much has been made over the impacts of the winter storm itself, relatively little work has been performed to look at the main drivers of that energy demand, namely the residential sector. The residential sector drives peak demand in both summer and winter [6]. However, the underlying factors of that electricity use is not fully known. This analysis seeks to fill that knowledge gap using appliance level data from homes located in Bandera Electric Cooperative's (BEC) territory that were outfitted with BEC's Apolloware subcircuit data collection system.

Apolloware is a cloud-based platform that empowers intelligent energy performance by providing real-time information on distribution system interconnected energy resources delivering value in distribution planning. It also aggregates appliance level devices such as solar generation, battery storage, HVACs, and other high energy In February 2021, there were over 400 service locations with Apolloware. As of fall 2021, there are plans to have an additional 200 Apolloware units deployed by the end of 2021.

II. APPLIANCE LEVEL DATA

Texas is well-versed in preparing for hot summers with high amounts of air-conditioning load but is less familiar with periods of extended cold periods. Figure 1 shows how the average power draw of homes in the BEC territory changed as Winter Storm Uri rolled into Texas.

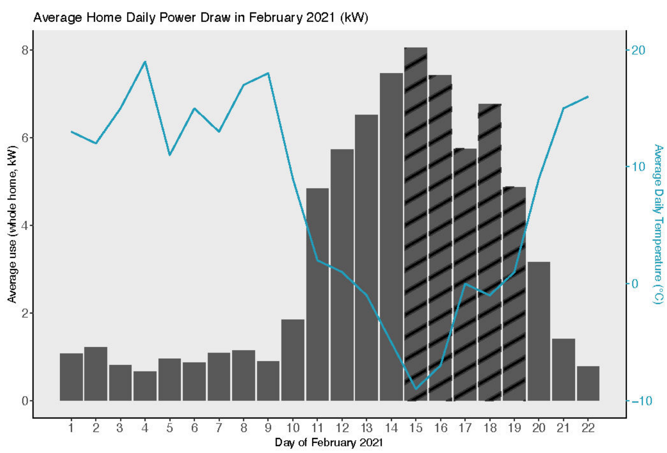


Figure 1: Figure showing the average whole-home power draw for 300 homes for the first 22 days in February 2021. The striped bars indicate days that experienced load shed in the ERCOT region. The line indicates the average daily temperature (°C) and corresponds to the right vertical axis.

While the blackouts began on February 15, the average home's energy use began increasing on February 11 when the temperatures began to drop. The average February temperature for Bandera County is about 11.3 °C [7]. The average daily temperature for the first 10 days in February 2021 was about 14.2 °C, but the average of the next ten days was -1 °C. Comparing the same time periods (February 1-10 & 11-20), the average power draw for each home increased by about 470% from 1.06 kW to about 5.73 kW.

A large part of this average increase could be found from the heating, ventilation, and air-conditioning (HVAC) equipment utilized to maintain the customers desired comfort settings. From the first 10 days (1-10) of February 2021 to the second 10 days (11-20), the average HVAC load increased from about 0.35 kW to 2.54 kW, or about a 620% increase

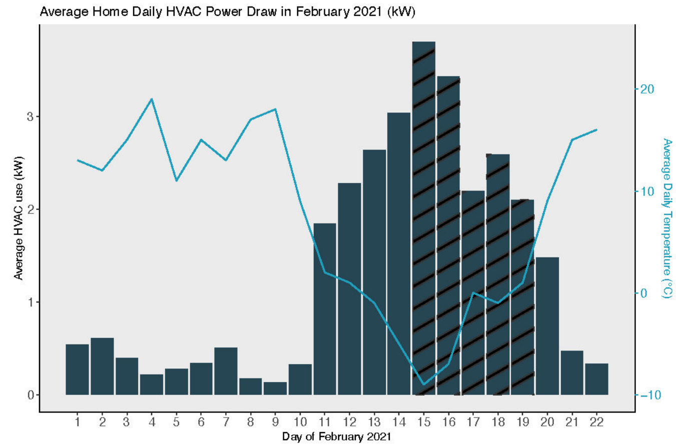


Figure 2: Figure showing the average HVAC power draw for 126 homes for the first 22 days in February 2021. The striped bars indicate days that experienced load shed in the ERCOT region. The line indicates the average daily temperature (°C) and corresponds to the right vertical axis.

While homes were demanding more energy use, solar production was declining. Figure 3 shows the total solar production across the entire BEC fleet (252 arrays) at the time.

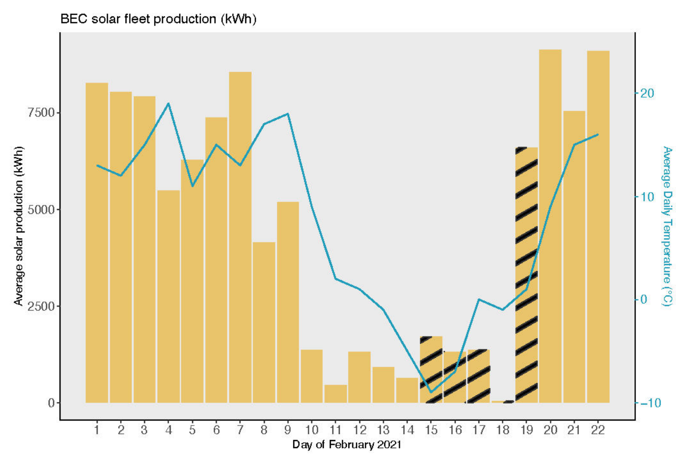


Figure 3: Figure showing the BEC solar fleet production for the first 22 days in February 2021 (252 arrays). The striped bars indicate days that experienced load shed in the ERCOT region. The line indicates the average daily temperature (°C) and corresponds to the right vertical axis.

The average daily BEC solar fleet production fell from 6,258 kWh/day from February 1-10 to about 2,345 kWh from February 11-20, falling by about 62%. Cloudy skies and show covered solar panels contributed to the decline in solar production, which was also observed in nearby Austin, TX via the Pecan Street Project [8].

Figure 4 shows how the average daily residential pool pump changed consumption patterns over the same time period, increasing from an average of 0.68 kW to about 1.58 kW, a 131% increase.

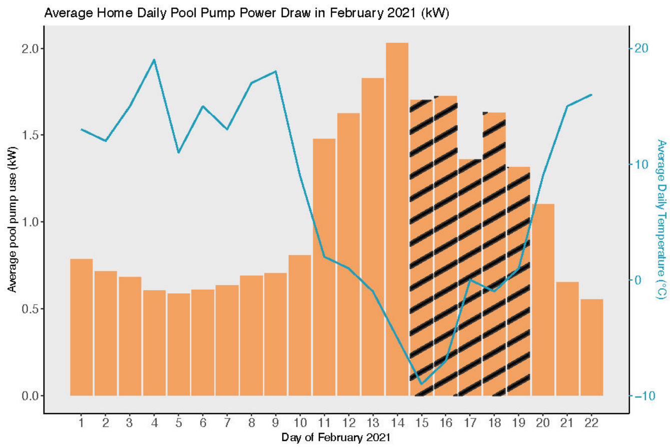


Figure 4: Figure showing the average pool pump power draw for 20 homes for the first 22 days in February 2021. The striped bars indicate days that experienced load shed in the ERCOT region. The line indicates the average daily temperature (°C) and corresponds to the right vertical axis.

Upon seeing the subcircuit pool pump data, BEC subsequently learned that all their pool pumps have a minimum temperature "on switch" (~3.3°C, 38°F) that will force the pool pump to run continuously below a certain temperature, usually around freezing, thus contributing to demand during times of system-wide firm load shed. Many customers were also concerned about their pipes freezing and elected to continuously run or drip their faucets. Figure 5 shows how customers that were on well water systems increased their well pump energy consumption over the time period of interest.

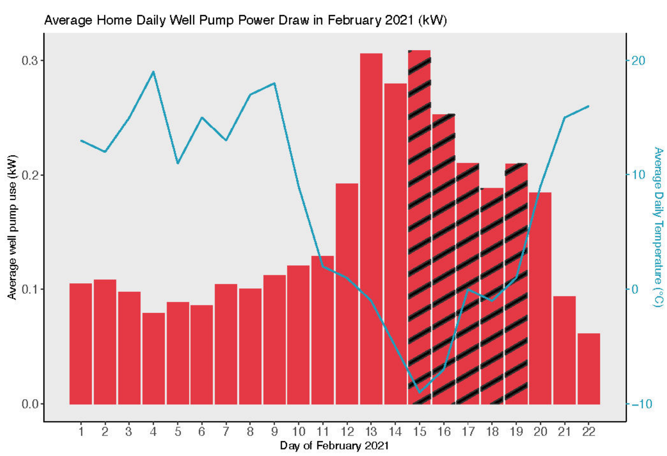


Figure 5: Figure showing the average well pump power draw for 66 homes for the first 22 days in February 2021. The striped bars indicate days that experienced load shed in the ERCOT region. The line indicates the average daily temperature (°C) and corresponds to the right vertical axis.

For the 66 homes within the Apolloware dataset that were on wells, the average power draw for well pumps increased from an average of 0.1 kW to 0.22 kW from February 1-10 to February 11-20, a 125% increase. While we do not have data for the municipal water system, it is likely that similar behavior for homes on municipal water systems also used more water and increased the electricity demands for those systems too. In February 2021, there were about 30 homes that were also equipped with battery energy storage systems. Figure 6 shows the fleet total charging and discharging behavior during the first 22 days in February.

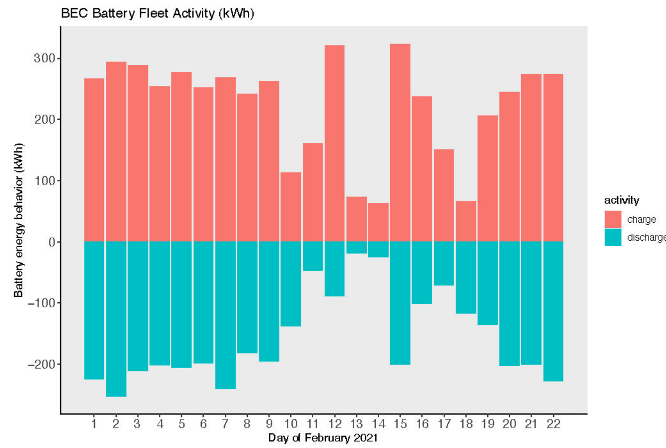


Figure 6: Figure showing the total daily charge and discharge behavior of the 30 battery storage systems for the first 22 days in February 2021.

In general, the batteries followed the same pattern during the first 9-10 days in February. However, as the storm approached, many of the batteries, mostly Tesla Powerwalls, went into a "storm mode" over the weekend of the February 13-14. On the morning of the first day of the blackouts (Monday, February 15) BEC noticed that the batteries were not discharging. Some BEC Members also reported that their backup systems were not working and helped them override the setting. In general, the battery behavior did not return to normal until the winter storm passed and temperatures returned to more normal conditions.

Figure 7 and Figure 8 show the average hourly consumption and generation of the main subcircuits that are monitored by the Apolloware system for February 8 and February 15, respectfully.

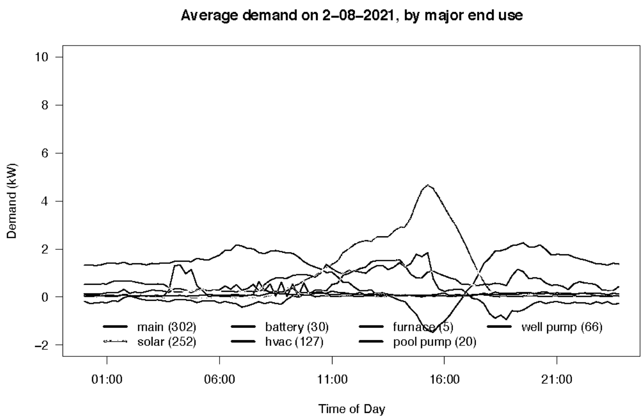


Figure 7: Figure showing the average hourly demand of Apolloware subcircuits on February 8, 2021, before the ERCOT system-wide blackouts began.

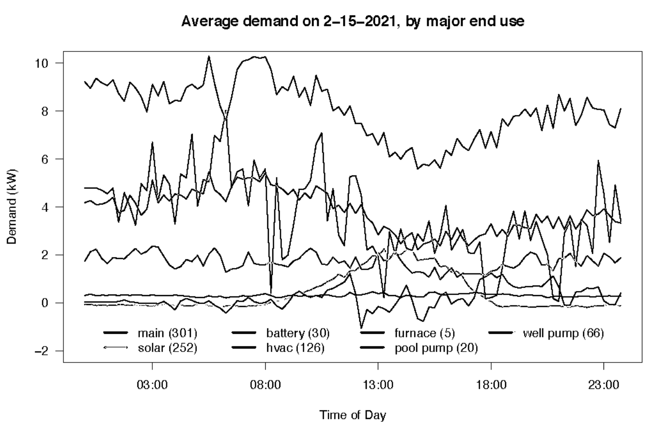


Figure 8: Figure showing the average hourly demand of Apolloware subcircuits on February 15, 2021, the first day of the ERCOT system-wide blackouts.

The average temperature on February 8 was 17 °C (62 °F), whereas the average temperature on February 15 was -9 °C (15 °F). The figures for a much higher level of consumption on February 15 vs. February 8 for all hours of the day. A large portion of this increase in demand was driven by increased HVAC loads and pool pump loads, as well as a reduction in the level of solar generation.

III. DISCUSSION AND CONCLUSIONS

Extreme events, such as Winter Storm Uri that impact locations that are not used to such temperatures, will have an outsized impact on the grid. It is likely that many expected heating loads to increase during such a storm, but this analysis has indicated that that is not the only residential demand portion to increase. Multiple other uses, such as pool and well pumps also increased their energy demands double or more those during a normal period. It was also seen in the data that home energy storage systems were not, by default, setup to provide support to the grid during times of scarcity.

Future extreme grid events could be better handled by being able to control individual devices rather than turn off entire feeders of homes. HVAC systems were responsible for the majority of home's elevated energy use in the Apolloware dataset during the winter storm. Being better able to control/cycle these loads, along with others in home, could lead to a more equitable rationing and faster rolling of power, such that customers are less likely to be left in the dark for days at a time. However, insight into how energy is being consumed is key to making this possibility a reality.

REFERENCES

[1] FERC & NERC, "The February 2021 Cold Weather Outages in Texas and the South Central United States" FERC, NERC and Regional Entity Staff Report, Nov. 2021

[2] C. W. King, J. D. Rhodes, and J. Zarnikau, "The Timeline and Events of the February 2021 Texas Electric Grid Blackouts" The University of Texas at Austin Energy Institute, July 2021

[3] J. W. Busby, K. Baker, M. D. Bazilian, A. Q. Gilbert, E. Grubert, V. Rai, J. D. Rhodes, S. Shidore, C. A. Smith, and M. E. Webber, "Cascading risks: Understanding the 2021 winter blackout in Texas", *Energy Research & Social Science*, Volume 77, 2021, 102106

[4] The Electric Reliability Council of Texas, "Fact Sheet October 2021" https://www.ercot.com/files/docs/2021/10/13/ERCOT_Fact_Sheet_10.13.21.pdf

[5] A. Webber, "Texas Winter Storm Death Toll Goes Up To 210, Including 43 Deaths In Harris County" Houston Public Media, July 14, 2021 https://www.houstonpublicmedia.org/articles/news/energy-environment/2021/07/14/403191/texas-winter-storm-death-toll-goes-up-to-210-including-43-deaths-in-harris-county/

[6] P. White and J. D. Rhodes, "Electrification of Heating in the Texas Residential Sector" 2019 https://www.ideasmiths.net/wp-content/uploads/2019/09/IdeaSmiths-Final-Report-2019.pdf

[7] National Oceanic and Atmospheric Administration, "Climate at a Glance" https://www.ncdc.noaa.gov/cag/county/rankings/TX-019/tavg/201902

[8] S. Hinson, "How Did Texas Solar Perform in a Snowstorm?" Pecan Street Inc., https://www.pecanstreet.org/2021/02/solarstorm/