SOUND FUTURE

Renewable Energy at Willie Nelson's Luck Reunion
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Executive Summary

Live events rank among humanity's greatest connectors. Ongoing efforts by musicians, athletes, designers, and artists to reduce the dependence of their live events on fossil fuels represent a powerful signal that they are willing to do their part in creating a more climate-conscious future.

Music festivals are particularly interesting opportunities to explore climate innovation, including the use of renewable energy. Often held in remote settings with limited access to grid power, research shows that a multi-day festival can consume the same amount of energy as a small city.

This case study focused on reducing the use of diesel generators at the 11th Annual Luck Reunion, a music, art, and food festival held at Willie Nelson's Luck Ranch outside of Austin, Texas. Coordinated and funded by REVERB, and in partnership with Luck Presents, the activation took place in March of 2023 and focused on the main stage which hosted 11 hours of live performances featuring over 30 artists. Power for these performances, including the legendary Willie Nelson, was provided entirely by solar batteries and inverters, resulting in the largest 100% renewably powered festival stage in the United States.

Outcomes for this case study were measured on Sound Future's three metrics of value: good for the environment, good for the bottom line, and good for talent. In sum, the use of renewable solar power provided by Overdrive Energy Solutions prevented carbon dioxide emissions equivalent to a car driving ~900 miles, roughly from Austin to Atlanta. The cost of the activation was approximately $1,000 more than the estimated budget for diesel generator rental and fuel, proving the model that climate-conscious festivals can be economically advantageous but for the externalities and redundancies that will be eliminated with scale. The experience of talent was also reported as positive, with the founder of Luck Reunion stating: "Outside of knowing we are making steps to lower our carbon footprint, hearing the silence between sets and not having wafts of diesel exhaust blowing onto stage was a welcomed change on its own."

Sound Future aims to reduce the perceived reputational, operational, and financial risk to talent, management, and production of deploying climate innovation at festivals and live events. The success of an activation at this size and scale is intended to further normalize the adoption of climate technology and operations, and illustrate that: *if it's good enough for Willie, then it's good enough for you.*

Introduction

Live events serve as humanity's great connector; shared experience translates to shared culture, bringing people together regardless of their divisions. Shared cultural leaders have often played a key role in igniting social change, and the climate crisis is in desperate need of such leadership. Reducing the dependence of live events on fossil fuels is an effective and powerful signal that musicians, athletes, designers, and artists are contributing to a future that reduces their impact on the climate. This kind of change requires rethinking the operations and technologies that power live events, creating room for new innovations in renewable energy. This case study, and others like it, are a powerful demand signal that culture leaders are ready for a fossil-free future for live events.

Sound Future, a 501(c)(3) nonprofit leveraging the power of live events as a catalyst for climate innovation, is built on the knowledge that live events can create a positive pull toward climate action. Sound Future and its partners REVERB and Overdrive Energy Solutions (collectively, "the team") share an urgent call to invest in culture as a mechanism to shift attitudes and behaviors around the climate crisis. More on each of these organizations can be found in Appendix A. These three organizations have partnered to bring renewable energy innovation to select live events as part of REVERB's Music Decarbonization Project, starting with the 2023 Luck Reunion.

Background

The 11th Annual Luck Reunion, an experience-based collective held by Willie Nelson outside of Spicewood, Texas in March 2023, was host to the next level of environmentally-focused live music production.[1] Nelson, a legend of Outlaw Country, and Luck Presents partnered with the team to bring remote renewable solar energy to Nelson's property, called Luck Ranch, in an effort to break the event's dependence on diesel-powered generators.

The scope of the 2023 activation included supporting a week-long program at Luck Ranch from 3/15-3/19, which included a fundraising dinner and performance by Nelson called Potluck on 3/15, the Luck Reunion on 3/17, a New Orleans Takeover on 3/18, and a Revival Brunch on 3/19 celebrating Sister Rosetta Tharpe. Each event hosted an audience of varying sizes, with the largest audience, ~5,000, in attendance for Luck Reunion. This report will focus on the Luck Reunion main stage, called the World Headquarters (WHQ) Stage, and the performances of 3/17. Information on the additional programming can be found in Appendix B.

The Legend

As a cultural icon, Willie Nelson is no stranger to using his platform to support environmental activism. In 2020 he worked with Paul Simon to fight against the Texas Permian Highway pipeline, which contaminated the Blanco River during construction.[2] Nelson is also a co-founder of Farm Aid. Along with Neil Young and John Mellencamp, Nelson organized the first benefit concert in 1985 with the goal of raising funds to help family farmers stay on their land. The Farm Aid Board now includes Dave Matthews and Margo Price and has raised more than $70 million.[3] Nelson has also been a champion for climate innovation. A vocal advocate for biodiesel, Nelson supported the Sustainable Biodiesel Alliance, a defunct multi-stakeholder organization founded in 2006 by his wife Annie, actress Daryl Hannah, and Kelly King, co-founder of Pacific BioDiesel.[4]

Luck Ranch & Luck Reunion

Originally constructed as the backdrop for the movie "Red Headed Stranger," Luck Ranch was built in 1985 for the film interpretation of Willie Nelson's album of the same name.[5] Conceived by Nelson, and partner Bill Wittliff, the screenplay called for the set to be burned to the ground in the last scene but Nelson instead kept the set and built his own home nearby, calling the property "Luck, TX". Luck has been a site for gatherings of musical legends over the last several decades. As these memories began to fade, some with ties to the property proposed revitalizing the space and its legacy with a concept called Luck Reunion.

Luck Reunion, now in its 11th year, represents its creators' vision for a new kind of live event, an annual gathering aimed at welcoming modern-day self-proclaimed outliers. Invitations to participate are offered to those who honor the cross-section of culture that has been motivated by creative American traditions in music, food, and craft. Led by the team at Luck Presents, Luck Reunion is only one facet of how this community honors both the artistic legacy and the creative origins of the ranch.

Image 1 - 2022 Luck Reunion
Photo credit[5]

Luck Reunion, like most festivals, is held in a remote setting with limited access to grid power. Research shows that a multi-day festival can consume up to 30,000 Megawatts (MW) of electricity, which is equivalent to that of a small city.[6] Thousands of festivals, sports, and themed remote events happen annually, and most rely on gas generators as a primary source of power.

The Opportunity & Team

To honor the ethos of Luck Reunion, the Luck Presents team and REVERB spent several years brainstorming an activation that would reduce the environmental impact of the festival and demonstrate cutting-edge climate innovation for live events. Ultimately, Luck Presents and REVERB chose a first-of-its-kind case study to reduce the need for diesel generators by using remote solar-powered batteries and inverters.

The activation focused on using solar-powered inverters and batteries to serve the main stage, dubbed the World Headquarters (WHQ) Stage, which does not have access to grid power. Two other off-grid stages as well as temporary artist and guest services, all traditionally powered by diesel generators, were also supplied with renewable solar energy. These additional clean energy services are considered outside the scope of this paper but are outlined briefly in Appendix B.

The team selected to execute the case study included REVERB, which brought funding from its Music Decarbonization Project and a long-standing relationship with Willie Nelson and his team; Overdrive Energy Solutions and subcontractor The Footprint Project as the hardware and operations providers; and Sound Future in a facilitation and Impact Analysis role. This paper, a product of Sound Future, is scoped to evaluate the outcomes based on its three metrics of value: environmental impact, financial impact, and impact on talent.

Theory of Change

The theory of change (TOC), Figure 1, for this activation centered around the idea that success at a high-visibility, remote festival would further normalize the adoption of climate-conscious solutions for music festivals and outdoor events worldwide. Widespread adoption of climate-conscious behavior at live events generates a stronger market demand signal, which creates competition among – and generates new – providers, resulting in more purpose-built or tailored solutions that ultimately scale to lower the cost of climate-conscious behavior at live events.

The collective goal of all participants in this case study was to ignite this process toward change by leveraging the Luck Reunion brand. Specifically, for talent and their teams, the intent was to reduce the perceived reputational, operational, and financial risk of deploying climate-conscious innovation at festivals and remote gatherings. At its core, a slightly cheeky TOC can be summed up by the following*: if it's good enough for Willie, then it's good enough for you.*

Image 2 - Willie Nelson Headlining the 2023 Luck Reunion on 3/17
Photo credit: Sound Future

The Case Study

As a testament to the culture of the Luck Presents, and the beliefs of the organization's founders and host, REVERB and Sound Future joined forces with the renewable energy experts at Overdrive to propose a solution to eliminate the use of many of the gas generators for the 11th Annual Luck Reunion. The event, originally scheduled for 3/16, was held on 3/17, in Spicewood, TX.

Luck Ranch sits on 700 acres and is located approximately 30 miles from Austin, TX. In total, the team provided power for three stages, the food truck court, artist check-in, vendors, signage, and artist catering. Supplemental funds for hardware rental and operations were paid by REVERB through the Music Decarbonization Project, including a small donation to Sound Future for event analysis. Clean energy for this activation via solar-powered batteries included the entire Ranch for the duration of the 2023 Luck programming, with a stretch goal of achieving an overall reduction in fossil fuel use by 75% over previous years. This report will focus on the WHQ Stage on 3/17.

The Tech

The sun is one of the greatest sources of renewable, clean energy. Thanks to a new generation of batteries that store solar energy, solar has become mobile and available for use on demand. Operators can now leverage solar energy, whether or not an event happens in a sunny location or on a sunny day, and distribute power when and where it is needed.

Solar-charged batteries power inverters, a technology that switches a battery's current from Direct Current (DC)-to-Alternating Current (AC), in order to generate power.[7] In addition to the environmental benefits of this technology, solar-powered inverters also offer

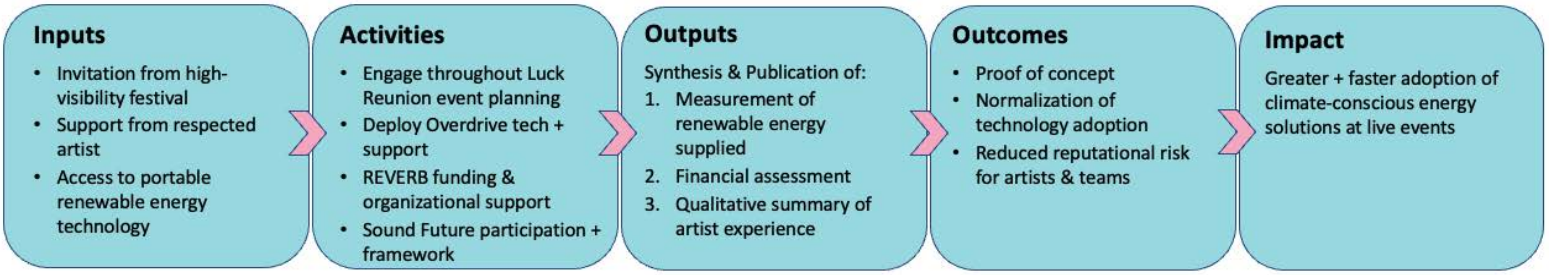

Figure 1 – 2023 Luck Reunion Activation Theory of Change

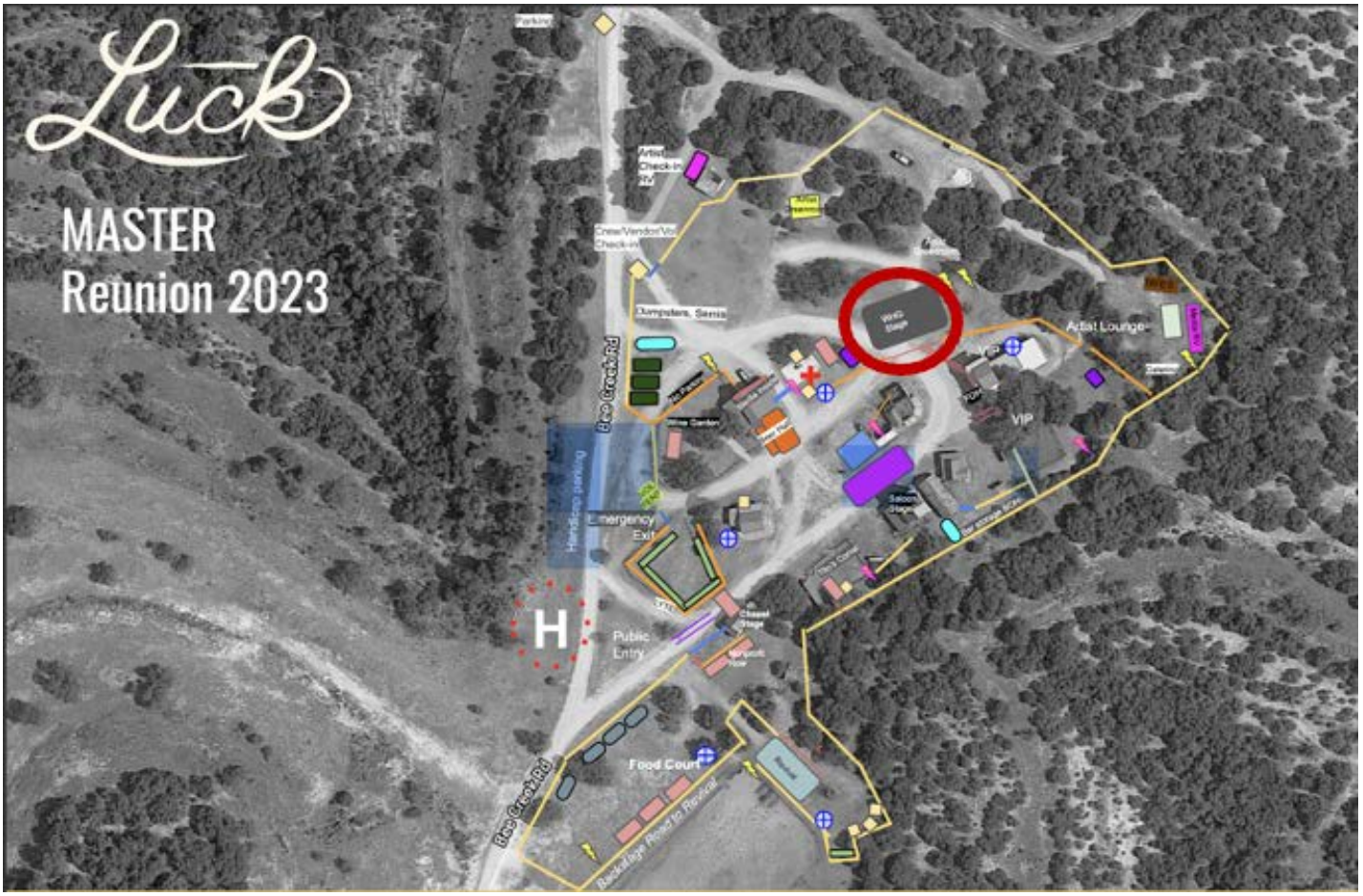

Figure 2 – Luck Reunion 2023 Festival Layout Map, WHQ Stage Circled in Red

reduce noise, eliminate exhaust, and do not require the need for hazardous fueling operations. This allows the power units to be more thoughtfully distributed to optimize site design and reduce cabling and ramps.

Battery technology for storing solar energy has traditionally been the domain of Lithium Ion (Li-ion) batteries. However, Lithium Iron Phosphate (LiFePO4) batteries were selected for this case study due to enhanced efficiency and safety features based, in part, on a more stable chemistry and reduced risk of thermal overload. In addition, LiFePO4 batteries don't contain any cobalt or nickel and have a 5-6 times longer life than Li-ion. At the end of rated life (80%), LiFePO4 batteries can be repurposed for utility-scale storage or recycled, which greatly reduces e-waste.[8]

To power the largest inverters onsite at Luck Ranch, the Overdrive team chose to build a solar farm in the form of a ground-mount array to minimize wind-loading. The ground-mount array required four people to assemble and the 15 kilowatt (kW) array was sized at 15 feet by ~60 feet.

Image 3 - Ground Mount Solar Array
Image Credit: REVERB

Additional solar innovation deployed at Luck Reunion included the use of 4 millimeter (mm) photovoltaic (PV) Merlin flexible solar panels to charge the smaller inverter systems.

Essentially a mono-crystalline silicon solar panel in flexible resin, the Overdrive system used a peel-and-stick version that offered on-site flexibility for deployment and placement. These panels also allow for seamless operations, as they are designed to be walked on, folded up for transport, and can be deployed and stowed by a single person. In preparation for the festival, an approximately 15kW solar farm was active from 3/13-3/14, and broken up into three separate farms during the event days.

Image 4 - Flexible PV Solar Panels
Photo credit: REVERB

The solar power inverter solution set offers additional safety features over diesel generators for operators and event attendees. The solar systems at Luck Reunion operated between 200-250 volts (V), allowing for lightweight 10 gauge wire. Combined with the ability to decentralize the power sources, this enhancement decreases the overall weight and volume of required gear, while reducing the tripping hazard for crew and festival guests. In some instances, it is possible to pre-charge the solar batteries with enough

energy to power the entire event, preventing the need for solar farms and recharging operations.

Image 5 - 10 Gauge DC Power Cables
Photo credit: Sound Future

See Appendix C for a detailed Equipment List.

The Activation

The scope of the case study was to maximize the use of solar renewable energy for the duration of the festival, 3/15-3/19. The Luck Reunion, originally scheduled for 3/16, was held on 3/17. For clarity, the dates throughout this paper have been changed to align with the Luck Reunion date of 3/17.

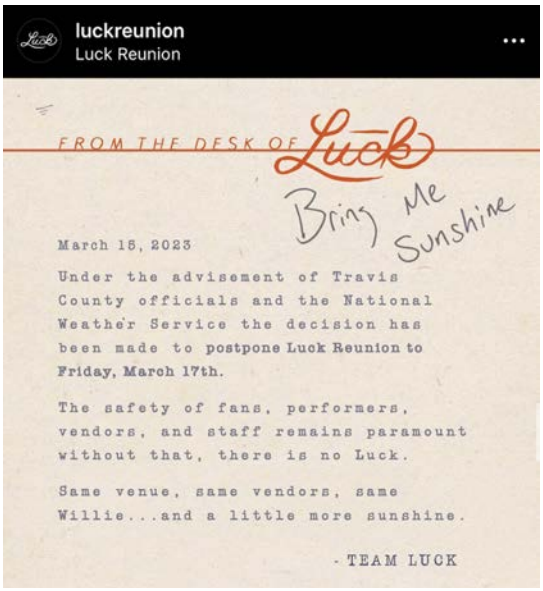

Image 6 - Luck Reunion Instagram Post Announcing Schedule Change
Image Credit: Luck Reunion Instagram

The overall Luck programming success criteria focused on the reduction of fossil fuel use and were identified as follows:

- **Level 0** – Replace the main stage lighting rig with LED lights to reduce the overall power consumption.
- **Level 1** – Power Willie Nelson's performance on the World Headquarters (WHQ) Stage the evening of 3/15 with renewable energy.
- **Level 2** – Power Willie Nelson's performance on the WHQ Stage the evening of 3/17 with renewable energy.
- **Level 3** – Power the WHQ Stage for the entire day of 3/17 with renewable energy.
- **Level 4** – Power all 3 off-grid stages (WHQ, Revival Stage, & Beer Hall Stage) with renewable energy for the entire day on 3/17.
- **Level 5** – Reduce the estimated diesel consumption for the entire event, 3/15-3/19, by 75%.
- **Stretch Goal** – Power all 3 off-grid stages with renewable energy for the entire event, 3/15-3/19.

For reporting purposes, this paper addresses only the WHQ Stage for 3/17, running from 8:47am on 3/17 - 12:52am on 3/18 with several performances throughout the day and an, always-on, full curtain backdrop of LED lights.

Therefore, the success criteria reviewed as part of this post-event analysis are as follows:

- **Level 0** – Replace the main stage lighting rig with LED lights to reduce the overall power consumption.
- ~~**Level 1** – Power Willie Nelson's performance on the World Headquarters (WHQ) Stage the evening of 3/15 with renewable energy.~~
- **Level 2** – Power Willie Nelson's performance on the WHQ Stage the evening of 3/17 with renewable energy.
- **Level 3** – Power the WHQ Stage for the entire day of 3/17 with renewable energy.
- ~~**Level 4** – Power all 3 off grid stages (WHQ, Revival Stage, & Beer Hall) with renewable energy for the entire day on 3/17.~~
- ~~**Level 5** – Reduce the estimated diesel consumption for the entire event, 3/15-3/19, by 75%.~~
- ~~**Stretch Goal** – Power all 3 off grad stages with renewable energy for the entire event, 3/15-3/19.~~

Information on the success criteria associated with the additional programming can be found in Appendix B.

For the WHQ Stage activation, the Overdrive team focused on ensuring sustained solar power for the full day of performances on 3/17. The WHQ Stage was a mobile stage supplied by Stageline. The SL320/360 mobile stage has a 40 foot by 40 foot floor and is capable of being assembled by four people in 2.5 hours. This size is recommended for crowds between 2,000 and 10,000 people.[9] In previous years, the WHQ Stage has been run entirely off of diesel generator power.

To completely eliminate the need for generator power on WHQ, the team selected two POWR2 XPRO 60.120-208 units. Reference data on each of these units is as follows: 60 kilovolt-amperes (kVA), 120 kilowatt-hours (kWh) (108 nominal), 208V three-phase power output. These were sourced from the supplier Aggreko. Each POWR2 unit has a max rated power of 48kW and 166 Amps for constant draw.[10]

The final system set-up included two additional Overdrive-supplied Victron Solar Controllers added to the primary unit to provide an additional 10kW of charge capacity. The two POWR2 units were in a series with one supplying the energy to the stage and the other as an energy holding tank serving as both an energy pass-thru and as a backup in case of emergency. A single unit was estimated to have enough energy redundancy to supply the WHQ Stage while allowing the backup unit to be relocated to the solar farm to recharge with solar power at any point during the festival. Together, the two power banks offered 216kWh and an estimated 92kW of power for WHQ. Further redundancy was built into the system to cover the contingency scenarios such as the weather not allowing for solar charging and the need for additional energy for peak shaving. In these circumstances, the units were also capable of grid charging and, in a worst-case scenario, charging via a diesel generator.

Image 7 - One of Two POWR2 Units at the WHQ Stage
Photo Credit: REVERB

Due to the lack of ground area backstage for WHQ, the team was only able to deploy a small 5kW solar array next to the unit. When not in use, the team used a forklift to relocate the secondary unit to the festival entrance to be charged by the larger ground-mount solar farm and returned for operation.

Measurements & Outcomes

In order to evaluate the success of the WHQ Stage activation, it is important to note the assumptions versus actuals, as well as the estimates and calculations as follows:

<u>Assumptions vs Actuals</u>

- Assumption: Events would occur on the dates scheduled.
    - Actual: The primary Luck Reunion event was delayed from 3/16 to 3/17 due to inclement weather.
- Assumption: March in Texas would offer adequate sunlight for solar panels and battery charging throughout the duration of the event.
    - Actual: The storm brought clouds, high winds, and lightning to the area, reducing the capacity to charge the batteries and requiring additional logistics to secure the hardware.

<u>Estimates</u>

- In 2022, the week-long Luck events were powered by 4 generators with one generator as a cold backup, conservatively estimated to have used ~350 gallons of diesel, which is estimated at 4 tons (3.6 metric tonnes) of carbon dioxide equivalent (CO_2e).
    - In 2022, for the duration of the festival the WHQ Stage operated off of two generators.
- Diesel generators are 28% efficient.[11]
- POWR2 units arrived with an estimated 91% charge for the primary unit (Unit 5), and 74% charge for the secondary/pass-thru unit (Unit 6).
    - Given that the source of this charge was unknown, estimates on the amount of renewable energy used were calculated by:

Renewable Energy Consumed for WHQ on 3/17
=
Solar input for the week
+
Charge from the units that Overdrive brought (which are confirmed to have been charged with solar)
-
Overall power used by the WHQ Stage

- WHQ power needs were estimated by the Luck Presents team, and calculated at 100 amps.
    - WHQ power needs were confirmed at sound check, but not all performers and instruments were accounted for at that time.

During the scope of this evaluation on 3/17, the WHQ Stage hosted 11 hours of live performances, spanning 8 acts, and featuring over 30 artists. A full list of performers can be found in Appendix B. Power for these performances was provided by entirely renewable sources, meaning that no diesel generators were used in the scope of this case study. In order to derive an independent calculation of the amount of energy used for the 3/17 show day, Sound Future turned to partner Pilio Group for its assessment. Further details on Pilio Group can be found in Appendix A.

The primary unit (called Unit 5) came in with 91% state of charge (SOC), assuming a 108kWh battery, which equals approximately 98kWh. The secondary unit (Unit 6) came in with 74% SOC, estimated at 83.16kWh. A script was written to integrate the total power out of these devices during the run time in kWh. Pilio Group also calculated the solar energy collected by subtracting the delta (change) of the two units. The three phases of the unit powering the stages were calculated to be 48 kWh, 49 kWh, and 40 kWh, for a total consumption of 138 kWh of power. As this would traditionally have been powered by a diesel generator, assumed to run at 28% efficiency, it would therefore have required 494 kWh of diesel to run the WHQ Stage on 3/17.

As the WHQ Stage used no diesel generators and ran solely on renewable energy for the entire day of 3/17, the amount of CO2e prevented from being released into the atmosphere was also calculated. With mineral diesel having a CO2e emissions factor of 0.27 kgCO2e/kWh (or 2.7 kg per liter of diesel), using renewable energy for the WHQ Stage on 3/17 prevented the release of 133 kgCO2e (392 pounds of carbon dioxide equivalent) into the atmosphere.

Outside the scope of this paper, but relevant to overall reporting, it is estimated that the week-long, event-wide support for clean energy exceeded the Level 5 success criteria. It is estimated that the team achieved a reduction in diesel consumption of over 90% from the amount consumed in 2022.

Discussion

The Luck Reunion outcomes were evaluated on the three primary metrics of success as determined by Sound Future: environmental impact, financial impact, and impact on talent. The combination of these metrics is unique to the live events space as all three are necessarily evaluated in order to determine better practices for optimized hybrid touring and events, where hybrid is defined as a mix of renewable and traditional operations and technologies.

Good for the Environment

After running on 100% renewable energy for the entire day of 3/17 at Luck Reunion, the WHQ Stage is now considered the largest renewably powered festival stage in the United States.

In order to bring context to the 494 kWh of diesel avoided, the following references were pulled from the Environmental Protection Agency's (EPA) Greenhouse Gas (GHG) Equivalencies Calculator for Table 1 and Table 2.[12]

Table 1: WHQ 3/17/23
Equivalent CO2 Emissions Avoided

	Equivalencies of 494 kWh Avoided
Miles Driven by a Gasoline-Powered Car	897 miles
Propane Cylinders Used for Home Barbeques	16.1 cylinders
Number of Smartphones Charged	42,586 phones

Prevention is the preferred method of protecting the future of the planet. Avoided emissions are far more valuable than offsets, which are intended to "make up" for the damage already done to the atmosphere.

Given that festivals are, by and large, multi-day and multi-stage events, this data can be extrapolated for a 5-day, 3-stage festival (stages only) as follows:

Table 2: Extrapolated 5-Day, 3-Stage Festival Equivalent CO2 Emissions Avoided

	Equivalencies of 7,410 kWh Avoided
Miles Driven by a Gasoline-Powered Car	13,462 miles
Propane Cylinders Used for Home Barbeques	241 cylinders
Number of Smartphones Charged	638,787 phones

In revisiting the success criteria for the 3/17 operations at the WHQ Stage, this event achieved all of the following success criteria:

- **Level 0** – Replaced the main stage lighting with LED lights to reduce the overall power consumption.
    - Verified by Phil Arciniega of Midnight Lighting on 1/30/23
- **Level 2** – Power Willie Nelson's performance on the WHQ Stage the evening of 3/17 with renewable energy.
    - Verified in the reported data.
- **Level 3** – Power the WHQ Stage for the entire day of 3/17 with renewable energy.
    - Verified in the reported data.

Good for Business

Luck Presents reported an ~$23,000 diesel generator budget for the 2023 Luck Ranch events for 3/15-3/19. The estimated cost of running a majority of the event on renewable energy was slightly higher and included hardware rental, consumables, freight, labor, and the rental of diesel generators to supplement and serve as a backup. The increased cost, estimated at ~$17,000, was paid by REVERB as part of its Music Decarbonization Project. The fund also supported a $5,000 donation to Sound Future for event analysis.

The cost of the renewable energy activation for the entire 5-day Luck Ranch programming is as follows:

Table 3: Actual Cost for Renewable Energy + Generator Rental for Luck Ranch 3/15/23-3/19/23

	Cost (USD)
Renewable Hardware Rental	$19,962
Consumables[+]	$576
Diesel Generator Rental[++]	$5,300
Total	**$25,838**[+++]

[+]This figure does not include the cost of carbon, detailed below. The total amount of diesel used for the 2023 activation is unknown but estimated at less than 10% of what was used in 2022 and considered negligible.
[++]It is important to note that the entire festival was not run entirely on renewable energy and required supplementation by diesel generators. The total cost for the 2023 generator rental is estimated based on input from the Luck Presents and REVERB teams.
[+++]An additional $15,701 was invoiced by Overdrive for freight and labor. These lines were removed from the financial summary as the equivalent data for the diesel-only estimate was not provided.

As a counterpoint, below is the estimated equivalent cost for the festival if it had been run entirely on gas generators.

Table 4: Estimated Costs for Diesel-Only Power for Luck Ranch 3/15/23-3/19/23

	Cost (USD)
Diesel Generator Rental Budget[+]	$23,000
Consumables	$1,355*
Total	$24,355

*Consumables were assumed as equivalent to the 350 gallons estimated for the 2022 festival. The average cost of diesel in Texas is, as of the published date of this paper, $3.87/gallon.[13]

When considering overall cost, it is important to acknowledge that there is a calculable environmental cost to the estimated CO2e that was avoided during the 2023 renewable power activation. By looking at the cost to offset the carbon that would have been

emitted with the diesel generators (350 gallons of diesel = 3.6 tCO2e)[12], the true cost of carbon can be calculated using the suggested minimum carbon price of $100/tCO2e, as recommended by the Intergovernmental Panel on Climate Change.[14] The result would have added approximately $360 to the overall cost of the diesel-powered activation, bringing that total to $24,715.

Based on the data above, the renewable energy activation out-of-pocket costs for the 2023 week-long activation at Luck Ranch are $1,123 over the estimated cost of powering the events with diesel generators. While the goal of Sound Future is to present solutions that are better for business than traditional operations, there are several caveats to extrapolating these findings for future activations. First, future activations are not likely to require rented diesel generator backup power. Second, it is important to note that, like all climate innovation, the cost of portable renewable energy will be reduced through economies of scale. Third, costs will be further reduced as even more advanced innovations enter the market. Finally, near-term savings are likely as providers learn more about the planning and operations required to execute live events with renewable energy, thereby reducing the need for specialized staff and refining predictions around the quantity and capacity of the hardware necessary to create fail-safe operations.

Good for Talent

Sound Future evaluates climate innovations, which can take the form of technologies or operations, through the unique lens of talent. Common sense and experience indicate that talent will not use their platforms to call for change that makes their jobs, or lives, more difficult. Therefore, the notion of "good" is a subjective value and can take two forms: no impact on the talent experience or improved talent experience. The following qualitative feedback is a direct quote from Matt Bizer, Founder and CEO of Luck Reunion:

"Luck was proud to partner with REVERB to reduce our event's overall carbon emissions. This is an effort that Luck's team not only takes seriously but we believe it is a necessary path forward for events in this changing world. We were incredibly excited this year when the team at REVERB approached us with a strategy to integrate solar farms and intelligent battery systems into the event's electrical and power plans helping us to eliminate a vast majority of our carbon emitting diesel generator use. Along with their Music Decarbonization Project and partners like Sound Future and Overdrive Energy Solutions, REVERB assisted Luck in not only sourcing the technology and resources necessary for this undertaking, but they consulted with our vendors and led the team through the process to help us tackle the change and put to rest any insecurities our vendors had with a new technology in a festival setting. We were grateful to work beside the team to eliminate 90% of our overall fuel consumption. Outside of knowing we are making steps to lower our carbon footprint, hearing the silence between sets and not having wafts of diesel exhaust blowing onto stage was a welcomed change on its own. We are proud to have been a leader in testing these new technologies in a live and practical setting and look forward to furthering our mission to decarbonize Luck. We hope to work with REVERB to assist other festivals in the transition away from Carbon energy."

The value of this type of feedback is that it helps in normalizing the adoption of climate-conscious innovation at live events. The use of renewable energy for Luck Reunion allowed the team to take a step forward toward its TOC Outcomes and Impacts. The viability of this solution was validated, and the

experience served to de-risk the use of renewable energy on a high-visibility stage, with world-class performers in Willie Nelson and his guests.

Additional information on lessons learned from the activation and forward work can be found in Appendix D.

Conclusion

The 11th Annual Luck Reunion, an experience-based collective held by Willie Nelson and Luck Presents outside of Spicewood, Texas, played host to a new level in environmentally-focused live event production. In partnership with Luck Presents and REVERB, Sound Future and Overdrive Energy Solutions successfully reduced the 2023 Luck Reunion's dependence on diesel generators. Solar-powered batteries and inverters were provided as an alternative and the team made history with the largest 100% renewably powered festival stage in the United States on March 17, 2023.

Revisiting the case study's TOC, as outlined in Figure 1, puts the elements and outcomes of this activation into perspective. It also helps to qualify the success of the program and point toward future opportunities.

Input: All three conditions were satisfied as the first set of elements necessary for the case study.

Activities: Initial planning and team development were completed weeks in advance of the activation.

Outputs: As detailed in this paper, the quantification of the renewable energy supplied was used as a basis for comparison to previously quantified elements of the event: the number of generators, the amount of diesel used, and the estimated budget for gas generators. These pieces of data were compared to the calculations on the measurements that were collected during the case study. The data provided as output includes the amount of CO2e avoided by the use of renewable energy on 3/17 at 133 kgCO2e**.** From a financial perspective, the activation had a total cost outlay of approximately $1,123 more than the estimated budget for diesel generator rental and fuel. Given that the solar-powered inverter equipment selected for this activation is not yet widely available, and a portion of the budget overrun was dedicated to renting backup diesel generators, this cost is expected to drop over time as the market for this hardware grows. A final, qualitative, element of the outputs category was the artist experience. Feedback from the organizers was provided via email on April 24, 2023. In sum, the Founder and CEO of Luck Reunion commented that "Outside of knowing we are making steps to lower our carbon footprint, hearing the silence between sets and not having wafts of diesel exhaust blowing onto stage was a welcomed change on its own."

Outcomes: The success of this activation at this size and scale has, to date, widely been considered the first proof of concept in the United States that quantifies and qualifies this operational mode. In looking forward, the normalization of technology adoption will accelerate as others choose to become first-movers in clean energy solutions for festivals and live events. As the data accumulates to become more accurate and precise (further informing a direct comparison of standard equipment versus renewable systems), and adoption begins to scale, a reduction of reputational and financial risk will be enjoyed by talent and their teams.

Impact: Finally, as more activations of this genre are successful, the faster adoption will scale. Greater adoption generally leads to

reduced cost and refined operations, which makes this alternative to standard practice not only more attractive but the right decision by environmental, talent, and business metrics and the impact on the planet, fans, and the bottom line.

In Sum

This case study illustrates the benefits and value of renewable energy for remote outdoor events. Music festivals operate much like other off-grid power applications. While this activation represents a relatively small use case for solar power, live events are a highly visible sector and one that is likely to help build trust in renewable energy solutions and normalize its use. In doing so, the aim is to generate a competitive market and drive innovation in portable, scalable renewable energy solutions and encourage uptake for uses ranging from birthday parties to the Olympics to large-scale disaster relief.

The activation at the 2023 Luck Reunion set a new precedent in the United States for the use of renewable energy in remote live events. By using solar-powered inverters and batteries to serve the WHQ Stage, the main stage that did not have access to grid power, the team was successful in providing the Luck Reunion and Willie Nelson with the largest 100% renewably powered festival stage in the United States. This case study, and others like it, are a powerful demand signal that culture leaders are ready for a fossil-free future for live events.

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Appendix A

The Team

Sound Future: Sound Future is a 501c3 nonprofit that exists to create a world where gathering does good. Sound Future leverages the power of data and science to turn live events into a catalyst for climate innovation. With minds from NASA, Harvard, and years of experience in entertainment, we make the business case for measurable, scalable, change. Additional information is available at: asoundfuture.org

REVERB: Uniting around the music we love, tackling the environmental and social issues we face, REVERB is a 501c3 nonprofit dedicated to empowering millions of individuals to take action toward a better future for people and the planet. Additional information on the Music Decarbonization Project is available at: reverb.org/campaign/music-decarbonization-project

Overdrive Energy Solutions: Offers smart battery power stations as the easiest way to bring renewables to any site. Its solar, battery, and data products are built for the demands of concerts and touring, with the intelligence to match. Additional information is available at: www.overdrive.rocks

Pilio Group: An energy and environmental innovation company born out of the University of Oxford in 2011, Pilio's team has years of experience in bringing the best cutting-edge expertise and approach to environmental and energy management. Pilio traditionally works with businesses across the UK to give them the intelligence, tools, and expertise to successfully transition into and spur the green economy. Additional information is available at: www.piliogroup.com

Appendix B

Week-Long (3/15-3/19) 2023 Activation Outcomes

The scope of the activation included supporting the entire Ranch for the duration of the 2023 Luck programming with a stretch goal of achieving an overall reduction in fossil fuel use by 75% over previous years. As reported in the body of the paper, the Level 5 success criteria was achieved with an event reduction in diesel consumption greater than 90% from the amount estimated to have been consumed in 2022. The success criteria eliminated from consideration due to the scope of this paper are addressed as follows:

- **Level 1** – Power Willie Nelson's performance on the World Headquarters (WHQ) Stage the evening of 3/15 with renewable energy.
    - The entire evening of performances was powered by 100% renewable energy.
- **Level 4** – Power all 3 off-grid stages (WHQ, Revival Stage & Beer Hall) with renewable energy for the entire day on 3/17.
    - There were issues with providing sufficient power for food activations and, due to improper equipment sizing, the Revival Stage was switched to generator power halfway through the first day and ran on diesel for roughly 6 hours.
    - This outcome fed many of the lessons learned but also illustrated the value of the hybrid system with renewable energy as a primary power source and traditional diesel generators for backup during this study phase for climate-conscious technology and operations.

- **Level 5** – Reduce the estimated diesel consumption for the entire event, 3/15-3/19, by 75%.
    - Achieved, see above.
- **Stretch Goal** – Power all 3 off-grad stages with renewable energy for the entire event, 3/15-3/19.
    - This was not achieved. In addition to the Level 4 notation, due to extended inclement weather, the POWR2 units for the WHQ Stage were topped off on the morning of 3/18 with 10 gallons of diesel to ensure maximum charge in the WHQ units prior to any acts stepping onto the stage.

Neel Vasavada of Overdrive submitted the following quote to Live Design Magazine when discussing this case study: "Overall, an over 90% reduction in use of fossil fuels was achieved onsite, while powering a Stageline SL320 with a full festival tech package, backline and 14 hour daily run times. Featuring sounds from Willie Nelson's classic guitar standards to the subwoofer pounding vibes of Big Freedia, this system provided 200A, pure sine-wave 3-phase service with unparalleled stability. This system is expandable to provide over 450A peak, and 480V + transformers are unnecessary since feeder runs can be kept short - there's no noise or exhaust."

Week-Long Activation Power Scope

Stages
- Grid Powered Stages
    - Saloon Stage
    - Chapel Stage
- Hybrid Powered Stage (Renewable + Diesel Powered)
    - Revival Stage
- Renewably Powered Stages
    - World Headquarters (WHQ) Stage
    - Beer Hall Stage

Food & Beverage (Hybrid Powered)
- Artists Lounge + Catering
- Food Trucks
    - Food Trucks ran for a total of 35 hours and were supplemented with diesel generator power for 11 hours.
- Wine Garden
- Beer Hall Bars
- VIP Area Food Trucks
- Margarita Machine
- Kombucha Machine

Miscellaneous (Hybrid Powered)
- Screen Printing Tent
- Artist Check-In
- Artist Dressing Rooms
- VIP Restroom Trailer
- Media Artist Lounge
- Cowboy Pools (2)

3/17 WHQ Performances + Run Times

A full schedule of performers for the WHQ Stage on 3/17, reported by Luck Presents, is as follows:

12:20-1pm - Angel White
1:40-2:20pm - Devon Gilfilian
3:00-3:40pm - Terry Allen & the Panhandle Mystery Band
4:20-5:00pm - Sierra Ferrell
5:40-6:40pm - Leon Russell Tribute featuring: Beau Bedford, Robert Ellis, The War & Treaty, Margo Price, Devon Gilfillian, Charlie Sexton, Marc Benno, Zella Day, Jesse Woods, Sierra Ferrell, Taylor Hanson, Kelsey Wilson
7:20-8:00pm **-** Margo Price + The Band of Heathens
8:40-9:20pm - Spoon
10:00-11:00pm - Willie Nelson & Family

Appendix C

Equipment List

Main Stage Power
- 2 x POWR2 60kVA/108kWh systems from Aggreko

Revival Stage Power
- 1 x 4.6kW/5kWh Overdrive DiskoBox Pro 46 system
- 1 x 2kVA/5kWh Overdrive DiskoBox Pro 20 system
- 2 x 2kW/6kWh DiskoBox Mega - *Shared with Artist Check-In*

Beer Hall Stage Power
- 1 x 3kVA/6kWh Overdrive DiskoBox 30 system

Food Court Power
- 1 x 30kVA/60kWh Overdrive DiskoBox Pro 100 system

Artist Catering
- 1 x 5kVA/5kWh Overdrive DiskoBox Pro 50 system

Entrance Signage
- 2 x 1kW/.6kWh DiskoBox mini

Cowboy Pools & Spare
- 2 x 2kW/2kWh DiskoBox Mojo II
- 2 x 1.5kW/2kWh DiskoBox Mojo

Batteries
- 15 x EG4LL 5.2kW LiFePO4 batteries
- 2 x SOK 5.2kW LiFePO4 batteries

Solar Panels
- 2 x 1kW Merlin Mat
- 1 x 210W Merlin Mat
- 1 x 320W Merlin Mat
- 36 x 335W Solar Panels (various manufacturers)

Controllers
- 3 x Orion-TRI solar charge controllers

Appendix D

Lessons Learned & Forward Work

In addition to fully addressing the TOC, this case study provided many valuable lessons learned for future activations:

<u>Overall</u>

1. Change often doesn't happen unless someone makes a case for it.
2. Hybridization is an effective operating model for reducing risk. For renewable energy, having the grid power charging option and gas generators as a backup helped ease the anxiety over operating with new hardware and reduced overall risk to the performance.
3. Prepare for all weather conditions in advance by pre-charging batteries with renewable energy and use on-site solar charging for ongoing operations.
4. It is likely that there will be more artists and more equipment on stage than estimated by organizers.
5. For festival stages, lighted backdrops are likely to be on all day.
6. There was more available grid power than organizers were aware of; re-assessing assumptions and schematics can lead to valuable information that may have been previously overlooked or undocumented.
7. Understanding the source of energy for the grid power and the state of charge by the rental equipment is important to calculate the true quantity of renewable energy used.

Preparation

8. Secure power needs in writing in advance; do not add additional power services on-site.
9. Standby draw is meaningful, ensure they are included in pre-event estimates.
10. Traditional equipment specs overestimated power needs, further research is necessary for an accurate estimation of continuous and peak power draws.
11. Ask questions during Sound Check: Who is missing? What equipment is missing? Are you planning for special or surprise guests? How long is the set?
12. Older equipment pulls more amps than newer equipment.
13. Prioritize the location of the solar farm during the festival layout to ensure convenient and ongoing charging during operations.

Operation

14. Properly train an adequate number of staff to set up, identify, and respond to issues at all sites and constantly monitor all data recorders.
15. Data loggers fail frequently; models to back-calculate the source of power are important for accurate energy accounting.
16. Innovation can take the form of hardware, but it can also take the form of changes to operations.
17. Safety features can create unforeseen failure modes, including the low-voltage cut-off.
18. Backup power, grid, or gas generators need to be tested, on standby, and ready for quick change-over.

Forward Work

- Dig into the lessons learned with a team-wide post-mortem to ask: how would we do it next year to minimize overhead and cost while maximizing success?
- Scope the opportunity to renewably power the entire 5-day festival in the future.
- Identify press and external communications mechanisms that would allow these ideas more visibility and scale.
- The live events industry needs to feel confident in the power specs and reduce over-spec for equipment.
- As data capture can be inconsistent between hardware, pre-format data for expedited reporting. Invest in tools to standardize estimation, recording, and calculation for live events.