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Research Article

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Sustainability Plan for Amusement Parks – A Case Study

Vibhu Sharma

Energy Engineer, Energy Group Grumman Butkus Associates Evanston IL, USA
Email: vsharma@grummanbutkus.com

Abstract This report presents findings from an environmental assessment of multiple amusement parks across North America. The assessment aimed to identify opportunities to reduce greenhouse gas emissions, energy consumption, and water usage. Key findings include: two-thirds of total emissions come from off-site energy generation, significant energy savings potential during off-season periods, variation in energy intensity across locations, and a strong correlation between cooling degree days and energy consumption at one location. Recommendations include reducing electrical consumption, purchasing green energy, installing on-site renewable energy, replacing fossil fuel equipment with cleaner alternatives, and implementing water conservation measures. These insights inform decarbonization, energy conservation, and sustainable operations across the company's portfolio

Keywords Environmental assessment, Amusement parks, Energy consumption, Greenhouse gas emissions, Water usage, Decarbonization, Energy reduction measures, Water conservation, Energy intensity, Climate data, Sustainable operations

1. Introduction

Amusement parks play a significant role in the tourism industry, attracting millions of visitors each year. Amusement parks serve as popular destinations for tourists, offering a variety of entertainment and recreational activities. They contribute to local economies, create employment opportunities, and enhance the overall tourism experience. However, the intensive energy consumption and resource usage associated with amusement parks raise concerns about their environmental impact. To mitigate these concerns and ensure the long-term sustainability of amusement parks, it is essential to develop comprehensive sustainability plans. Energy consumption in Amusement Park Industry is a significant contributor to greenhouse gas emissions and overall environmental impact. Therefore, conducting environmental assessments and implementing measures to reduce emissions and resource usage are crucial steps towards achieving sustainable operations in the amusement park industry. The findings of the environmental assessment highlight the need for a comprehensive approach to reduce greenhouse gas emissions, energy consumption, and water usage in amusement parks. These findings underscore the importance of adopting decarbonization strategies, implementing energy reduction measures, and promoting water conservation practices within the industry. These actions will not only help mitigate the environmental impact of amusement parks but also result in cost savings and improved operational efficiency. Implementing sustainable practices in the amusement park industry is crucial for both environmental and business reasons. [1][2][3]

A prominent entertainment company owns and operates multiple amusement parks, water parks, sports centers, and hotels across North America. As part of its Environmental, Social, and Governance (ESG) initiatives, the company engaged a consulting firm to assess energy, water, and carbon emissions from its theme parks and facilities. The assessment includes energy and water usage totals and breaks down greenhouse gas (GHG) emissions into Scope 1 direct emissions, Scope 2 indirect emissions from energy provided by other parties, and excludes Scope 3 emissions. Further details on the scope are provided later in the report.

2. Findings

In general, the ESG documentation and analysis identified opportunities to reduce emissions. This report studied the impact of different energy sources, mobile fuels, and refrigerants. The report may be used to identify the current state of greenhouse gas emissions and prioritize future investigations. Data was acquired for normal operations during 2018 and 2019, as well as atypical operations in 2020 and 2021 resulting from the pandemic. It was found that during normal operations, approximately two-thirds of the total greenhouse gas emissions were associated with off-site generation. The company may reduce this environmental impact by reducing electrical consumption, purchasing green energy, and installing on-site renewable energy. The other third of greenhouse gas emissions come from a combination of natural gas used for heating, cooking, and hot water, as well as mobile fuels. Additional contributions to the total emission rates are from fugitive refrigerants. The reduction of these emissions requires a close analysis of each facility. Emissions in this category may be reduced through the replacement of fossil fuel equipment with electric or clean energy counterparts, phasing out of high GHG emissions factor refrigerants in AC units, and additional controls on HVAC equipment.

3. Greenhouse Gases Emissions

The assessment conducted by the consulting firm revealed that the theme parks and facilities have significant greenhouse gas emissions. The analysis showed that the majority of the emissions were associated with off-site energy generation, indicating a potential for reducing environmental impact through measures such as decreasing electrical consumption, transitioning to green energy sources, and implementing on-site renewable energy solutions. Additionally, the report highlighted that a significant portion of the greenhouse gas emissions came from natural gas usage for heating, cooking, and hot water, as well as mobile fuels and fugitive refrigerants. To address these emissions, the report recommended strategies such as replacing fossil fuel equipment with cleaner alternatives, phasing out high GHG emissions refrigerants in AC units, and implementing enhanced controls on HVAC equipment.

As part of the investigation, all sites submitted utility, refrigerant, and mobile fuel data. This data, collected in late 2021, was analyzed for greenhouse gas (GHG) emissions. The data was grouped into categories based on the United States Environmental Protection Agency (EPA) Center for Corporate Climate Leadership and is summarized below.

A.Scope 1 Emissions

Scope 1 emissions refer to direct greenhouse gas (GHG) emissions that occur from sources owned or controlled by an organization, such as fuel combustion in boilers, furnaces, and vehicles, as well as fugitive emissions from equipment and processes, including leaked refrigerants.[4] These emissions need to be closely monitored and managed to reduce their impact on the environment. To address Scope 1 emissions, it is crucial for organizations to focus on reducing fuel combustion in boilers, furnaces, and vehicles, as well as implementing measures to prevent and address fugitive emissions from equipment and processes. To effectively reduce greenhouse gas emissions in the theme parks and facilities industry, organizations should prioritize strategies such as decreasing electrical consumption, transitioning to green energy sources, implementing on-site renewable energy solutions, replacing fossil fuel equipment with cleaner alternatives, phasing out high GHG emissions refrigerants in AC units, and implementing enhanced controls on HVAC equipment

Examples of Scope 1 emissions at these amusement parks facilities include domestic hot water heaters, service vehicles, fuel oil furnaces, diesel generators, and refrigerants used in air conditioning systems. To quantify Scope 1 emissions, data was collected from facility operators, including documentation from HVAC service contractors, mobile fuel vendors, and HVAC supply vendors. The data was analyzed, with natural gas data input into Energy Star Portfolio Manager to compute the total greenhouse gas CO2 equivalent based on the heating content of natural gas. Mobile fuel data was compiled and converted to GHG equivalents using standard methodologies, while refrigerants were analyzed based on their Global Warming Potential (GWP) and converted to an equivalent CO2 quantity for inclusion in the Scope 1 emissions figures

B.Scope 2 Emissions

According to the Environmental Protection Agency (EPA), Scope 2 emissions are indirect greenhouse gas (GHG) emissions associated with the purchase of electricity, steam, heat, or cooling. To accurately measure and manage Scope 2 emissions, organizations should focus on tracking and reducing their electricity consumption.[4] To effectively address Scope 2 emissions, organizations should prioritize strategies such as improving energy efficiency, investing in renewable energy sources for electricity supply, and participating in carbon offset programs. By implementing measures to reduce fuel combustion and address fugitive emissions, organizations in the theme parks and facilities industry can make significant strides in reducing their greenhouse gas emissions.

In the case of these amusement parks, Scope 2 emissions resulted solely from purchased electricity. Electrical utility data was collected from all parks in various forms, including spreadsheets, utility bills, online portals, and emails. The data was compiled and uploaded to Portfolio Manager, which utilized the EPA's Emissions and Generation Resource Integrated Database (eGRID) to calculate GHG equivalents. The figure below illustrates how the same unit of electrical energy has a different environmental impact across various US eGRID regions.

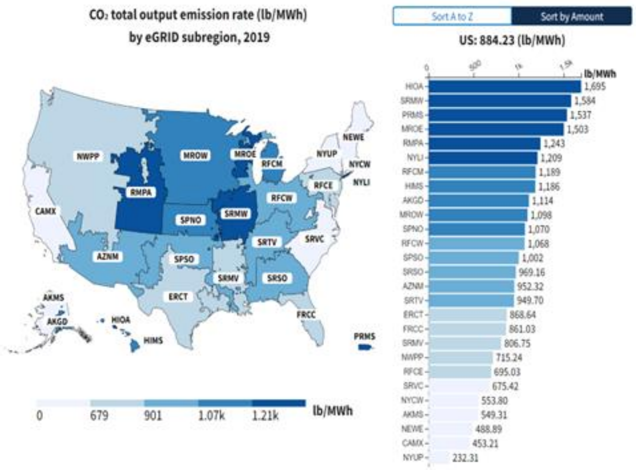

Figure 1: eGrid Regions and Emissions Rates from US EPA [8]

4. GHG Reduction Prioritization

To accurately manage their emissions, organizations should focus on tracking and reducing their electricity consumption. One key strategy for reducing greenhouse gas emissions in the theme parks and facilities industry is to prioritize addressing Scope 2 emissions. [5]

To effectively reduce greenhouse gas (GHG) emissions, a comprehensive approach is recommended, involving investigation, identification, analysis, and investment in energy reduction measures at each facility. While opportunities for reduction exist at every facility, leadership may prioritize efforts at facilities with the highest emissions. A summary of emissions for 2018 and 2019 reveals the top three facilities with the greatest emissions, which are prime targets for emissions reduction strategies. This data also highlights the significance of addressing energy usage at two facilities in particular, which are the most energy-intense locations and offer the greatest potential for emissions reduction. A multifaceted program has been initiated by the amusement park company to identify and reduce greenhouse gas (GHG) emissions across all facilities over several years. This report represents the first phase of the program, aiming to assess the current GHG emissions and serve as a starting point for future efforts. Through collaboration with the company and analysis of utility data, high-level recommendations have been developed for consideration in a broader emissions reduction program. To assess the energy savings potential during off-season periods, analysis was done for energy consumption in 2020 as a ratio of the preceding two years. This metric indicates whether operations can be modified to reduce energy consumption when closed. Two facilities successfully reduced overall energy costs during 2020, suggesting potential best practices.

To quantify the opportunity for off-season optimization, the ratio of winter to summer energy consumption was analyzed. Facilities with a larger off-season to in-season energy consumption ratio may indicate opportunities for additional optimization. Specific improvements to off-season turn-down may include:

- Additional occupancy control and programmable thermostats
- Additional lighting controls and occupancy sensors
- Inventory management to identify idle equipment
- Reducing space setpoints for unused areas
- Remote temperature monitoring to prevent equipment damage

These findings suggest potential energy savings during off-season periods and highlight the importance of targeted improvements.

5. Water Consumption Optimization

Addressing water consumption is an important part of ESG analysis as it can significantly contribute to the sustainability efforts of the organization. By implementing water conservation measures, amusement park operators can effectively reduce water consumption and enhance sustainability. To promote water conservation and enhance sustainability, amusement park operators should consider implementing various measures such as installing low-flow fixtures, conducting regular leak detection and repairs.@

The water utility data provided was summarized and sorted by total usage, revealing insights into water consumption patterns. Notably, one facility has a significant well water usage, which was included based on monitoring data. An off-season analysis compared January water consumption to July water consumption, revealing that some facilities maintain a large portion of summer water consumption during winter. This data offers a framework for prioritizing water conservation efforts. Field visits are necessary to identify specific opportunities, which may include

- Toilet flush valve and flapper repairs
- Pool level controls optimization
- Quarterly water monitoring programs
- Net metering evaluations
- Rainwater harvesting implementations

These findings suggest potential water savings and highlight the importance of site-specific evaluations to identify and implement water conservation measures.

6. GHG Sources

An inventory of GHG emissions sources revealed that direct emissions account for roughly one-third of overall emissions, while indirect emissions from electricity generation account for two-thirds. Analysis of emissions data from 2018 to 2021 showed consistency in emissions patterns. To reduce emissions, the organization may consider:

- Onsite electricity generation to offset purchased electricity and reduce transmission losses
- Implementing high efficiency appliances to reduce energy consumption
- Replacing appliances with lower emissions technologies
- Implementing a new construction policy prioritizing lower GHG potential refrigerants
- Transitioning fleet vehicles to lower emissions technologies

These findings suggest opportunities for the organization to invest in decarbonization efforts for greatest impact. A multifaceted plan composed of smaller projects can help achieve the goal of decarbonization.

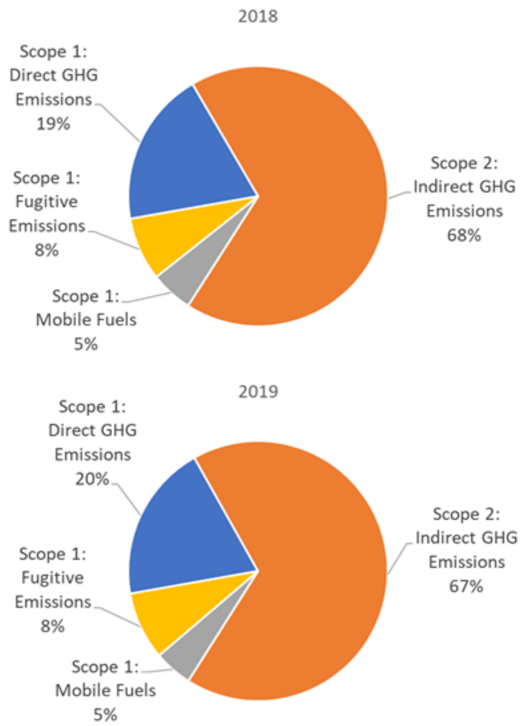

Figure 2: Summary GHG Emission Sources for 2018 and 2019

7. Fuel Purchases

To further reduce greenhouse gas emissions, the organization can also consider optimizing fuel purchases. This can be done by:• Seeking out suppliers that offer alternative fuels with lower carbon emissions • Implementing fuel efficiency measures in transportation fleet vehicles • Exploring the use of electric or hybrid vehicles for transportation needs These strategies not only contribute to reducing greenhouse gas emissions but also promote sustainability and environmental responsibility. These strategies not only contribute to reducing greenhouse gas emissions but also promote sustainability and environmental responsibility. Implementing these strategies can lead to significant reductions in carbon emissions and contribute to the organization's overall goal of decarbonization. Implementing these strategies can lead to significant reductions in carbon emissions and contribute to the organization's overall goal of decarbonization, ultimately helping to mitigate climate change.[6][7]

A deeper dive into fuel purchases revealed interesting results. All fuel data was compiled into a single category, adding gallons of diesel and gasoline for each location. While gasoline and diesel have different heating values, for this analysis, the focus was on demonstrating the scope of mobile fuels at the locations

The chart shows significant fuel purchases at all locations, used for various applications:

- Fleet operations
- Portable generators
- Temporary lighting
- Permanent generators
- Landscaping equipment

While mobile fuel emissions are a small portion of annual emissions, maintaining fuel vessels requires regulatory filings and special provisions for safe storage. The organization can use this data to consider operational changes:

- Evaluate alternative fuel sources for backup generators
- Transition landscaping equipment to electric alternatives
- Explore electric or lower-emissions options for fleets
- Assess alternatives for portable generation

No single solution can eliminate gasoline and diesel fuel use, but understanding fuel usage and investing in electrical infrastructure and alternative energy assets can reduce environmental risks, regulatory requirements, and fuel delivery logistics.

8. Park Energy Intensity

The energy use intensity for each location was calculated by dividing total kBTU by developed acre. This analysis revealed that certain locations had a relatively higher energy use per acre compared to others, highlighting the energy requirements of operating these facilities.

This insight suggests potential energy conservation measures, such as:

- Improving volume control systems
- Optimizing equipment scheduling

Investigating these measures could help the organization significantly reduce overall emissions.

9. Energy use and Park Attendance

To assess the impact of attendance on energy consumption, energy data and attendance information provided by a theme park company were analyzed. A notable benchmark was established: total energy used per attendee for the whole year. Energy use per guest on an annual basis was calculated.

This data revealed a significant energy premium for water parks. Energy use per guest ranged from approximately 30 kBTU to 110 kBTU. Assuming national energy cost averages and a typical energy mix (one-third gas, two-thirds electricity), estimated energy costs per guest in 2019 were calculated.

Many of the company's energy costs are fixed and would not significantly fluctuate based on attendance.

10. Energy Use And Climate Data

The analysis of energy use and climate data allowed for a deeper understanding of the impact of energy consumption on greenhouse gas emissions. Investing in electrical infrastructure and alternative energy assets can play a crucial role in reducing environmental risks, meeting regulatory requirements, and improving fuel delivery logistics to ensure sustainable and responsible energy practices. Investing in energy conservation measures and optimizing equipment scheduling can help the organization significantly reduce overall emissions.

The energy consumption at each location consists of two components: process loads (attractions, pumps, compressors, lighting) and HVAC loads (air handlers, split systems, fans, heaters). By analyzing local weather data and monthly energy use, it was found that HVAC usage constitutes a small portion of total location energy.

The correlation analysis showed relationship between weather data and energy consumption. One location showed a strong correlation (0.7977) between cooling degree days and energy consumption, likely due to its year-round operation. In contrast, the other locations had poor correlations, indicating that seasonality affects energy consumption. The analysis also revealed that natural gas consumption has a poor correlation with heating degree days, suggesting that more natural gas is used for cooking than heating at one location. This trend was typical of other locations. These findings offer insights into potential improvements:

- Electrical correlations were stronger than natural gas correlations, indicating that locations spend more energy on cooling than heating.
- Weak HVAC correlations suggest opportunities for kitchen appliance upgrades and demand control ventilation.
- Weak correlations may also indicate a need for additional controls, such as advanced controllers and remote monitoring.
- The lack of weather dependency suggests that process loads (attractions, pumping) consume a larger percentage of energy, highlighting the potential impact of energy conservation measures on larger loads like water pumping.
- These insights can inform location-specific energy and infrastructure projects.

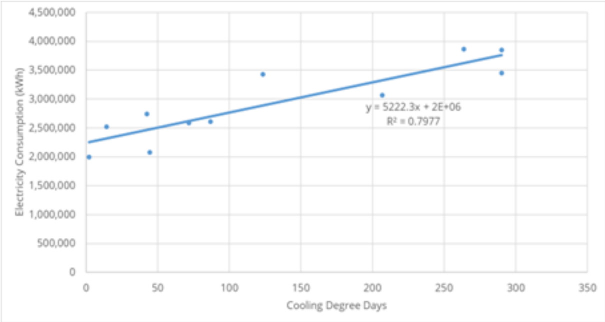

Figure 3: kWh Vs Cooling Degree Days

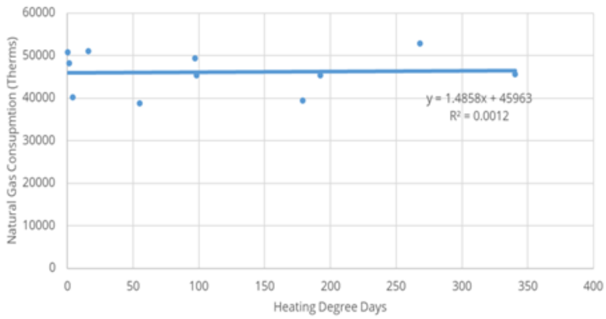

Figure 4: Therms Vs Heating Degree Days

11. Future Insights

A.Energy Costs Across the Portfolio

Our research revealed a wide variety of energy procurement methods at each facility, including third-party providers and local utility rate structures. It is recommended augmenting utility data with financial data to analyze energy costs monthly and identify opportunities to reduce energy costs by selecting different providers. Calculating current unit costs of electricity will help inform decarbonization efforts, as purchasing from carbon-free generation providers can reduce Scope 2 emissions.

B. Energy Analysis with Greater Resolution

Reviewing monthly data for all facilities revealed big-picture trends, but greater utility detail can drive business decisions. An example from one facility shows 15-minute power readings revealing baseline power draw, off-hours operations, and scheduled events. Comparing data from closed and open days provides insights into operations' impact on energy use.

C. Water Analysis with Greater Resolution

Hourly water consumption data, available from some utility providers, can optimize operations and reduce excess water consumption. A smart meter example demonstrates the potential for identifying leaks and providing timely notifications. The company may benefit from investing in similar meters to gather additional data and resolve problems.

These insights can inform the company's energy and water management strategies, supporting more sustainable operations across their portfolio.

References

[1]. G. Eason, B. Noble, and I. N. Sneddon, "On certain integrals of Lipschitz-Hankel type involving products of Bessel functions," Phil. Trans. Roy. Soc. London, vol. A247, pp. 529–551, April 1955.

[2]. J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.

[3]. S. Jacobs and C. P. Bean, "Fine particles, thin films and exchange anisotropy," in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.

[4]. K. Elissa, "Title of paper if known," unpublished.

[5]. R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.
[6]. Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].
[7]. M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.
[8]. O. US EPA, "Data Explorer," US EPA, Mar. 02, 2020. https://www.epa.gov/egrid/data-explorer