

Case Study: C3.ai

A Project Report Submitted by

Mukul Bhele (B20MT028)



॥ त्वं ज्ञानमयो विज्ञानमयोऽसि ॥

Indian Institute of Technology Jodhpur
Data Visualisation (MSL7320)

08/10/2023

1 Introduction

In an era marked by increasing global energy consumption and growing environmental concerns, the effective management of energy resources has become paramount. Leveraging cutting-edge technology and data-driven insights, organizations strive to optimize their energy utilization, reduce operational costs, and contribute to sustainability goals. This project explores the vital role of data analytics in achieving these objectives within the context of the energy management domain.

Objectives and Scope

The primary objective of this project is to delve into the practical applications of data analytics in energy management, focusing on the industry leader, C3.ai. C3.ai is a renowned organization at the forefront of harnessing data analytics and artificial intelligence (AI) to transform energy management practices. This case study aims to shed light on the various data analytics use cases adopted by C3.ai, their methodologies, and the impact they have on the energy landscape.

C3.ai: A Beacon in Energy Management

C3.ai stands as a beacon of innovation and excellence in the realm of energy management. With a rich portfolio of solutions rooted in data analytics, machine learning, and AI, C3.ai empowers organizations to unlock the full potential of their energy assets, optimize operations, and navigate the complexities of the modern energy landscape.

In this case study, we will delve into C3.ai's contributions to the energy management domain, showcasing real-world examples of how their data analytics solutions are addressing critical challenges, improving operational efficiency, and paving the way for a more sustainable future.

By dissecting the methodologies and outcomes of select use cases, we aim to provide a comprehensive understanding of the transformative power of data analytics when harnessed by visionary organizations like C3.ai. Through this exploration, we hope to inspire and inform energy stakeholders, decision-makers, and enthusiasts about the possibilities and opportunities that data-driven energy management presents.

2 Application Domain and Rationale

Defining the Energy Management Domain

Energy management represents the dynamic and multidisciplinary field responsible for the effective planning, monitoring, and optimization of energy resources across various sectors, including industrial, commercial, and residential. It encompasses the full spectrum of activities, from energy generation and distribution to consumption and efficiency improvements. The energy management domain is of paramount importance due to the ever-increasing global demand for energy, coupled with the need to mitigate environmental impacts and reduce operational costs. Organizations across industries are faced with the challenge of balancing energy supply and demand, ensuring grid stability, adopting renewable energy sources, and adhering to stringent sustainability goals.

Rationale for Choosing C3.ai

The rationale behind selecting C3.ai as the subject of this case study stems from its outstanding reputation as a trailblazer in applying data analytics and AI to revolutionize energy management practices. C3.ai's expertise and track record in developing innovative solutions that address critical challenges within the energy domain make it a compelling focus for analysis. With a portfolio of data analytics use cases tailored to the energy sector, C3.ai has demonstrated its commitment to optimizing energy resources, improving operational efficiency, and promoting sustainability. By examining the methodologies and outcomes of select use cases, this case study seeks to elucidate the profound impact of C3.ai's data analytics solutions on the energy landscape, offering valuable insights and inspiration for stakeholders and decision-makers within the industry.

3 Data Analytics Use Cases by C3.ai

1. Predictive Maintenance for Energy Assets

Objective

The primary objective of predictive maintenance is to proactively manage and maintain critical energy assets, such as power generation equipment or HVAC systems, to minimize unplanned downtime and reduce maintenance costs. By predicting when equipment is likely to fail, organizations can schedule maintenance activities in advance, ensuring optimal asset performance.

Analytics Techniques

- Predictive Analytics: C3 AI Energy Management employs predictive analytics and machine learning algorithms to analyze sensor data, historical maintenance records, and real-time operational parameters of energy assets. These models predict equipment failures based on patterns and anomalies in the data.

Benefits

- Downtime Reduction: Predictive maintenance minimizes unplanned downtime by addressing potential issues before they lead to failures.
- Cost Savings: Proactive maintenance reduces emergency repair costs and extends the lifespan of equipment.
- Improved Reliability: Equipment reliability and availability are enhanced, ensuring consistent energy supply.

2. Demand Response Optimization

Objective

Demand response optimization focuses on managing peak electricity demand efficiently and cost-effectively. The goal is to reduce operational costs during high-demand periods by adjusting energy consumption patterns in response to market conditions or grid constraints.

Analytics Techniques

- Predictive Analytics: Predictive analytics is used to forecast demand spikes, helping organizations anticipate when peak demand is likely to occur.
- Prescriptive Analytics: Prescriptive analytics recommends actions, such as load shifting, curtailing non-essential operations, or utilizing on-site generation sources during peak hours.

Benefits

- Cost Reduction: By shifting energy consumption away from peak hours, organizations can reduce energy costs and avoid peak-demand charges.
- Grid Stability: Demand response actions contribute to grid stability by preventing overloads during peak periods.
- Efficient Resource Utilization: Energy resources are optimized, ensuring they are used effectively and efficiently.

3. Renewable Energy Integration

Objective

The objective of renewable energy integration is to seamlessly incorporate intermittent renewable energy sources, such as solar and wind, into the power grid. This use case aims to maximize the use of clean energy while ensuring grid stability.

Analytics Techniques

- Optimization Models: C3 AI Energy Management uses optimization models to balance energy supply and demand, accounting for the variability of renewable energy production.

- **Predictive Analytics:** Predictive analytics helps forecast renewable energy generation patterns, allowing grid operators to plan for fluctuations.

Benefits

- **Clean Energy Adoption:** Maximizing the use of renewable energy sources reduces reliance on fossil fuels and contributes to sustainability goals.
- **Grid Stability:** By managing the variability of renewable energy, grid stability is maintained, preventing disruptions.
- **Environmental Impact:** Reduced carbon emissions and environmental impact are achieved by using more renewable energy.

4. Grid Reliability Analysis

Objective

Grid reliability analysis is focused on ensuring the reliability and stability of the electric grid. This use case involves continuous monitoring and analysis of grid data to identify potential issues and prevent disruptions.

Analytics Techniques

- **Descriptive Analytics:** Descriptive analytics is used to monitor grid health and provide real-time information about grid status.
- **Predictive Analytics:** Predictive analytics identifies potential grid issues by analyzing historical data and predicting future trends.

Benefits

- **Continuous Power Supply:** Enhanced grid reliability ensures continuous power supply to customers, reducing the likelihood of blackouts.
- **Customer Satisfaction:** Reliable grids lead to improved customer satisfaction and trust in energy providers.
- **Proactive Issue Resolution:** Predictive analytics allows organizations to address potential issues proactively, preventing disruptions.

5. Energy Efficiency Benchmarking

Objective

Energy efficiency benchmarking involves comparing the energy consumption of different facilities or assets to identify areas for improvement. The objective is to enhance energy performance and reduce operational costs.

Analytics Techniques

- **Descriptive Analytics:** Descriptive analytics is used to compare energy consumption data across facilities.
- **Predictive Analytics:** Predictive analytics helps identify areas with potential for efficiency improvements by analyzing historical data.

Benefits

- **Cost Reduction:** Energy efficiency improvements lead to reduced energy costs and operational expenses.
- **Sustainability:** Lower energy consumption contributes to environmental sustainability goals.
- **Asset Optimization:** Identification of underperforming assets allows for targeted improvements and resource allocation.

6. Product Carbon Footprint Analysis

Objective

Product carbon footprint analysis focuses on assessing the environmental impact of products throughout their lifecycle. The goal is to quantify and reduce the carbon emissions associated with manufacturing and product use.

Analytics Techniques

- Life Cycle Assessment (LCA): LCA is used to evaluate the environmental impact of a product from raw material extraction to disposal.
- Environmental Modeling: Environmental models estimate carbon emissions and assess the impact of various production and transportation methods.

Benefits

- Sustainability Reporting: Product carbon footprint analysis supports sustainability reporting and eco-labeling.
- Consumer Awareness: Transparency about carbon emissions informs consumer choices and preferences.
- Regulatory Compliance: Compliance with environmental regulations and reduction of carbon tax liabilities.

7. Energy Consumption Forecasting

Objective

Energy consumption forecasting involves predicting future energy demand patterns to optimize energy generation, distribution, and pricing. The objective is to ensure reliable energy supply while minimizing operational costs.

Analytics Techniques

- Time Series Analysis: Time series models analyze historical consumption data to predict future demand patterns.
- Machine Learning: Machine learning algorithms are used to incorporate various factors influencing energy consumption, such as weather and economic indicators.

Benefits

- Efficient Resource Allocation: Accurate forecasting allows for the optimal allocation of energy resources, reducing waste.
- Cost Savings: Efficient energy distribution and pricing strategies lead to cost savings for both providers and consumers.
- Grid Stability: Stable and well-planned energy distribution contributes to grid stability and reliability.

8. Energy Consumption Analytics for Smart Buildings

Objective

Energy consumption analytics for smart buildings focuses on optimizing energy usage within commercial and residential structures equipped with smart technologies. The objective is to enhance energy efficiency and user comfort.

Analytics Techniques

- Real-time Monitoring: Smart sensors and meters continuously monitor energy consumption and provide real-time data.
- Prescriptive Analytics: Prescriptive analytics recommends energy-saving actions, such as adjusting temperature settings or optimizing lighting.

Benefits

- Energy Efficiency: Smart building analytics lead to energy-efficient operations, reducing waste and costs.
- User Comfort: Optimized settings enhance user comfort and productivity within smart buildings.
- Sustainability: Reduced energy consumption contributes to environmental sustainability goals.

4 Data Source

Predictive maintenance relies on various data sources to make accurate predictions. These sources include sensor data, historical maintenance records, and real-time operational parameters of energy assets. Sensor data provides real-time information on equipment performance, while historical maintenance records offer insights into past issues and repairs. These data sources are essential for training predictive models. In terms of data types, predictive maintenance deals with both structured and unstructured data. Structured data includes numerical values such as sensor readings and maintenance timestamps, while unstructured data might encompass text-based maintenance reports or images from equipment inspections. Both data types are significant as structured data aids in quantitative analysis, while unstructured data provides valuable qualitative information that can enhance predictive accuracy.

5 Insights Derived

C3.ai's Predictive Maintenance analytics provide valuable insights that contribute to minimizing downtime, reducing costs, and improving equipment reliability. These insights include early warnings of potential equipment failures, enabling organizations to take proactive measures. By addressing issues before they escalate, organizations can avoid unplanned downtime, resulting in cost savings and improved equipment reliability. Additionally, historical analysis of maintenance records can reveal trends, helping organizations make data-driven decisions about equipment replacement or upgrades.

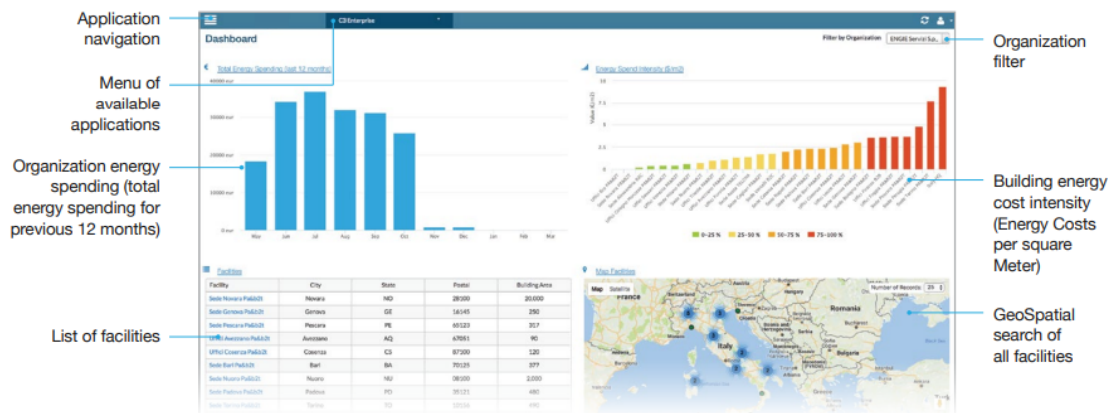
6 Benefits

- **Energy Efficiency:** C3.ai's solution enables a 15-35% reduction in energy consumption through predictive analytics, optimization, and benchmarking, resulting in cost savings and sustainability alignment.
- **Emissions Reduction:** The platform streamlines GHG emissions monitoring and facilitates a 10-25% reduction in emissions through AI recommendations, contributing to environmental sustainability.
- **Optimized Investment:** By prioritizing high-value repairs and upgrades in alignment with sustainability goals, organizations achieve a better CapEx ROI.
- **Enhanced Reliability:** C3.ai's solution improves energy infrastructure reliability by integrating on-site power, predicting peak demand and outages, and optimizing energy demand across buildings, reducing downtime.
- **Cross-Enterprise Alignment:** The platform fosters alignment across the organization and with external stakeholders, enabling collaboration between operations and corporate sustainability teams, enhancing transparency, and accountability in sustainability efforts.

7 Visualisations

In the context of Predictive Maintenance, visualizations serve as crucial tools for conveying complex information in a comprehensible manner. C3.ai utilizes various visualizations such as time-series plots, scatter plots, and heatmaps. Time-series plots show trends in equipment performance, scatter plots help identify correlations between variables, and heatmaps highlight areas of concern.

The rationale for using specific visualizations lies in their ability to simplify complex data, making it easier for decision-makers to understand and act upon. Time-series plots, for example, allow for the visualization of equipment degradation over time, aiding in scheduling maintenance. Scatter plots can reveal relationships between factors that contribute to failures, helping organizations prioritize preventive actions. Overall, these visualizations support informed decision-making and facilitate timely interventions.



C3 Energy Management Dashboard for Clara Domus



Analyze Energy tool in C3.ai Energy Management configured for ENGIE Clara Domus

Figure 1: Dashboard Analysis

Total Energy Consumption plot, typically represented as a line chart or bar graph, offers insights into energy consumption trends over time. By visualizing variations and patterns, it allows for the identification of seasonal fluctuations or long-term trends. This plot offers valuable insights into energy usage patterns, enabling organizations to identify peak consumption periods and adjust their operations accordingly and the **Graph of Selected Assets and Metrics** often depicted as a scatter plot or line chart, is designed for comparing relationships between selected assets and key metrics like temperature changes (Delta Temp) or pressure. This visualization helps in pinpointing assets that may require maintenance or optimization based on their correlation with important metrics. "Building Energy Cost Intensity," often presented as a stacked bar chart or heatmap, provides a spatial view of how energy costs are distributed across different buildings or areas. It helps organizations identify areas with high energy cost intensity, ultimately leading to cost-saving opportunities and efficient resource allocation.

Organization Energy Spending visualization, usually displayed as a bar chart or treemap, allows for the comparison of energy spending across different organizations. It offers insights into how various organizations allocate their energy spending over a year, highlighting variations and patterns. This plot is invaluable for understanding spending patterns and identifying opportunities for cost management and efficiency improvements and **Geospatial Facilities Search** presented as maps or geographical plots, offers a spatial view of facility locations. This visualization assists organizations in assessing the physical distribution of facilities, which is crucial for optimizing energy distribution, logistics, and resource allocation.

Energy ROI (Return on Investment) visualizations, often in the form of time series line charts or scatter plots, provide an assessment of the effectiveness of energy-related investments. By visualizing ROI over time, organizations can evaluate the success of energy projects and their contribution to financial goal and **Energy Cost, Carbon Reduction, and Benchmarking** visualizations, usually as separate bar charts or stacked bar charts, enable organizations to assess energy costs, carbon reduction achievements, and benchmarks compared to peers. These plots are instrumental in evaluating performance, tracking sustainability goals, and making informed decisions within the energy management domain.

Potential layers in these plots could include additional dimensions or attributes that provide deeper insights. For example, the map visualization might have layers for facility types or energy sources, pie-charts for energy source breakdown, time series plots for time variations, heat maps to visualise high energy and low energy usage clusters. Utilizing the grammar of graphics principles allows for flexible layering to convey richer information.

Conclusion

In conclusion, C3.ai's Predictive Maintenance solution represents a transformative approach to energy management. Its impact on operations is undeniable, with multifaceted benefits that resonate across various facets of the organization. By significantly reducing energy consumption and emissions, organizations not only achieve substantial cost savings but also advance their sustainability goals, contributing to a cleaner and more responsible energy future. Moreover, the platform's ability to foster cross-enterprise alignment empowers organizations to synchronize their energy management initiatives with broader sustainability objectives, promoting transparency and accountability. As the energy management sector continues to evolve, C3.ai remains at the forefront, adapting to emerging trends and driving innovation. The future promises even greater efficiency gains, sustainability achievements, and a more resilient energy infrastructure.

This case study underscores the pivotal role of data analytics in revolutionizing energy management. C3.ai stands as an industry leader, guiding organizations toward a future of efficient, sustainable, and reliable energy management.

8 References

1. C3.ai : Energy Management <https://c3.ai/products/c3-ai-energy-management/>
2. Resource Data Sheet <https://c3.ai/resources/data-sheet/c3-energy-management-data-sheet/>
3. BHC3 Energy Management https://azuremarketplace.microsoft.com/en-us/marketplace/apps/c3iotinc.bhc3_energy_management?tab=overview/
4. Analytical Problem Statement <https://c3.ai/customers/fortune-100-technology/>