# **Technical Infrastructure and Security Posture Analysis: Caithness Energy**

## **1. Executive Summary**

This report provides an analysis of Caithness Energy's technical infrastructure and security posture, based on available information. Caithness Energy, L.L.C. ("Caithness") operates as a privately-held Independent Power Producer (IPP) in North America, specializing in a diverse portfolio of power generation assets, including environmentally progressive projects in wind, solar, geothermal, and natural gas. The analysis reveals a complex operational landscape characterized by geographically dispersed projects utilizing advanced power generation technologies. This necessitates a robust technical infrastructure encompassing sophisticated Operational Technology (OT) and control systems, and likely supported by Enterprise Resource Planning (ERP) solutions for efficient management. The report also assesses the security considerations inherent in the energy sector, highlighting the potential measures and frameworks Caithness Energy likely employs to protect its critical infrastructure. While specific details regarding their IT and security systems are limited in the provided materials, the analysis draws inferences based on industry best practices, the nature of their operations, and mentions of specific technologies and partnerships. The findings underscore the critical importance of a strong security posture for an organization of this scale and within this sector, particularly in light of increasing cybersecurity threats and stringent regulatory requirements.

## **2. Overview of Caithness Energy's Operations and Technology Landscape**

Caithness Energy, L.L.C. ("Caithness") stands as a significant player in the North American energy sector 1. As a privately-held Independent Power Producer (IPP), the company's core business revolves around the development, acquisition, operation, and management of various power generation assets 1. Caithness distinguishes itself through its commitment to environmentally progressive, large-scale projects spanning wind, solar, geothermal, and natural gas energy sources 1. The company has a long history in the renewable energy sector, claiming to be the first entity involved in all aspects of utility-scale renewable energy development, ownership, management, and operation within the United States 1. This extensive experience has resulted in a diverse portfolio comprising both renewable and environmentally conscious fossil-fueled energy projects strategically located across the United States 1.

Caithness operates under a vertically integrated model, meaning it maintains dedicated in-house teams responsible for every stage of a project lifecycle, from initial investment and development to project management, construction, and the ongoing management of assets and commodities 1. This approach allows for superior cost containment and operational excellence throughout both the development and acquisition of energy assets 1. The vertical integration of operations suggests a significant need for seamless internal coordination and the efficient management of resources and data across the various interconnected phases of their projects. To achieve this level of efficiency and cost-effectiveness, Caithness likely relies on integrated IT systems that provide a unified view of their diverse operations. This points towards the potential utilization of an Enterprise Resource Planning (ERP) system or similar comprehensive platforms to manage the complexities arising from their multifaceted business activities.

The scale and diversity of Caithness Energy's projects are considerable, encompassing a wide range of energy sources including natural gas, wind, solar, geothermal, and potentially hydro power 1. Their portfolio includes notable large-scale facilities such as the Caithness Moxie Freedom Generating Station, a 1,029 MW natural gas-fired power plant in Pennsylvania 2, and the Guernsey Power Station in Ohio, boasting a capacity of 1,875 MW, also fueled by natural gas 2. Additionally, Caithness operates the Caithness Long Island Energy Center, a 350 MW natural gas-powered facility in New York 2. Their renewable energy endeavors include significant wind projects like the Shepherds Flat Wind Farm, with a capacity of 845 MW 11, and they also maintain and operate major geothermal projects throughout the western United States 1. The wide geographical distribution and the variety of energy sources managed by Caithness Energy suggest a strong reliance on robust remote monitoring and management capabilities. This necessitates a sophisticated Operational Technology (OT) infrastructure to oversee the physical assets and a comprehensive network infrastructure to facilitate data transmission and control across these dispersed locations.

Caithness Energy maintains a strong focus on employing environmentally progressive and clean energy technologies across its operations 1. Their power plants utilize state-of-the-art technologies, often featuring combined-cycle systems that incorporate advanced gas turbines, such as the GE 7HA.02 model 2. These advanced systems are often designed with a focus on reducing both air emissions and water usage, incorporating technologies like air-cooled condensers 2. The adoption of these advanced power generation technologies implies the presence of sophisticated control systems and extensive data acquisition capabilities within their operational infrastructure. While these technologies enhance efficiency and reduce environmental impact, they also increase the complexity of Caithness Energy's overall technical infrastructure and potentially expand the attack surface that needs to be secured against potential threats.

## **3. Technical Infrastructure Analysis**

The technical infrastructure underpinning Caithness Energy's operations is multifaceted, reflecting the diverse nature and geographical spread of its power generation assets.

### **3.1 Power Generation Technologies (Detailed)**

Caithness Energy's portfolio includes significant investments in natural gas combined-cycle power plants. Facilities like the Caithness Moxie Freedom project in Pennsylvania utilize two GE 7HA.02 combustion turbines operating in a highly efficient combined-cycle configuration 4. This design incorporates Heat Recovery Steam Generators (HRSGs) that capture waste heat from the gas turbines to produce steam, which in turn drives a steam turbine, thereby generating additional electricity 7. To minimize water consumption, these plants often employ air-cooled condensers, a technology also utilized at the Caithness Long Island facility 7. Environmental responsibility is further demonstrated through the integration of Selective Catalytic Reduction (SCR) technology and oxidation catalysts within the HRSGs to control the emissions of nitrogen oxides (NOx) and carbon monoxide (CO), respectively 7. The Guernsey Power Station in Ohio also features three GE 7HA.02 gas turbines and leverages GE Digital's Asset Performance Management (APM) software, powered by SmartSignal, for cloud-based predictive analytics aimed at anticipating asset failures and optimizing plant efficiency 12. In contrast, the Caithness Long Island Energy Center utilizes a Siemens SGT6-5000F gas turbine and an SST-900 RH steam turbine in its combined-cycle operations 15. The selection of specific turbine manufacturers such as GE and Siemens suggests established relationships that could potentially extend to other areas, including digital solutions, maintenance services, and long-term support. The adoption of APM software at the Guernsey plant indicates a strategic focus on leveraging data-driven insights for proactive maintenance and overall operational optimization.

In the realm of renewable energy, Caithness Energy operates substantial wind farms, including the Shepherds Flat Wind Farm in Oregon. This project utilizes GE Energy's 2.5xl wind turbines, which are equipped with permanent magnet generators, a technology known for improving efficiency, reliability, and grid connection capabilities 20. The sheer scale of these wind projects, exemplified by the 845 MW capacity of Shepherds Flat 19, implies a vast network of individual turbines and associated infrastructure spread across considerable geographical areas. Effectively managing such large-scale wind farms necessitates the implementation of sophisticated systems for real-time monitoring of individual turbine performance, ensuring seamless grid connection, and potentially incorporating advanced weather forecasting data to optimize energy generation. This highlights a critical need for robust data acquisition systems and reliable communication networks to connect these remote assets and transmit operational data for analysis and control.

While the provided information offers less detail regarding Caithness Energy's solar and geothermal projects, their consistent inclusion in the company's portfolio underscores their commitment to diversifying their energy sources 1. The specific types of solar technologies employed (e.g., photovoltaic panels, concentrated solar power systems) and geothermal technologies (e.g., flash steam plants, binary cycle systems) remain areas requiring further investigation to gain a comprehensive understanding of Caithness Energy's technical infrastructure across these renewable energy sectors.

### **3.2 Operational Technology (OT) and Control Systems**

The operation of Caithness Energy's power plants relies heavily on advanced Operational Technology (OT) and sophisticated control systems. These systems are critical for the minute-by-minute monitoring of various operational parameters, including emissions levels, energy output, and the overall health of the equipment 14. For the Caithness Moxie Freedom Generating Station, EthosEnergy serves as the turnkey Operations and Maintenance (O&M) provider, assuming full care, custody, and control of the facility 10. EthosEnergy's O&M services encompass a strong focus on maximizing plant performance and availability, ensuring strict adherence to regulatory compliance standards, and implementing robust cybersecurity measures 10. This highlights the increasing recognition within the energy sector of the critical need to protect OT environments from cyber threats, as these systems directly control physical processes and their compromise could lead to significant operational disruptions and safety hazards.

Caithness Energy has also demonstrated a proactive approach to integrating data from their proprietary control systems into more accessible platforms. They utilized Xojo, a cross-platform development tool, to create a custom Linux and Windows web application specifically for documenting alarms within their facilities 26. This application, named Capture Print, simulates a printer to capture alarm traffic from a Unix-based control system and presents it on a web page, enabling real-time reporting and significantly reducing the reliance on paper records 27. This initiative underscores the importance of real-time data access and the need for tailored solutions to bridge the gap between specialized industrial control systems and broader IT infrastructure for enhanced operational efficiency and informed decision-making.

### **3.3 Enterprise Resource Planning (ERP) Considerations**

While the specific Enterprise Resource Planning (ERP) system utilized by Caithness Energy is not explicitly identified in the provided snippets, the nature of their extensive and diverse operations strongly suggests the necessity of such a system. The renewable energy industry, in general, faces significant challenges in managing multi-country projects and installations, coordinating complex supply chains and asset management across various regions, navigating intricate regulatory compliance landscapes and sustainability standards, and effectively managing costs and funding across multiple economies 28. A well-designed ERP solution is crucial for addressing these industry-specific challenges by providing tools for global project management and scheduling, efficient supply chain and asset management, ensuring adherence to regulatory compliance and facilitating sustainability reporting, and offering robust performance monitoring and analytics capabilities 28. Specific ERP functionalities particularly relevant to renewable energy companies like Caithness include comprehensive project management tools for overseeing large-scale projects from planning to execution, robust financial management capabilities with multi-currency support for international operations, and real-time analytics for tracking energy output and asset performance 28.

Several ERP vendors offer solutions tailored to the energy and utility sectors. NetSuite, for instance, provides a unified business management suite encompassing ERP, Customer Relationship Management (CRM), global business management, and professional services automation functionalities, all aimed at helping energy companies optimize their operations for sustainable growth 29. Similarly, Sage offers ERP solutions designed for the oil and gas industry, with features covering financial management, project management, manufacturing, operations, asset, and supply chain management 30. Given Caithness Energy's vertically integrated structure, diverse portfolio of projects, and geographical spread, an ERP system would likely play a vital role in streamlining their front- and back-office operations, automating end-to-end processes, maintaining financial transparency across projects, managing complex supply chains for equipment like turbines and solar panels, and ensuring compliance with various regulations.

### **3.4 Data Management and Analytics**

Data management and analytics are integral to Caithness Energy's operations, enabling them to optimize the performance of their power generation assets and make informed business decisions. ERP systems in the energy sector typically offer real-time monitoring of energy output and asset performance, allowing companies to track key performance indicators (KPIs) such as energy yield, efficiency, and downtime 28. The Guernsey Power Station's utilization of GE Digital's Asset Performance Management (APM) software for cloud-based predictive analytics exemplifies the growing trend in the energy industry towards leveraging sophisticated data analysis for proactive maintenance and improved reliability 12. This type of software can help anticipate potential asset failures, minimize unplanned outages, and ultimately increase plant efficiency and reliability.

Sage's ERP solutions for the oil and gas sector also include data analytics modules that provide executives and managers with a clear picture of all business activities, including operations, sales, financial management, supply chain, and cost analysis, all accessible through a single dashboard 30. Furthermore, the custom alarm management system developed by Caithness using Xojo demonstrates their need for real-time reporting and analysis of operational data 26. This application allows them to quickly identify and address potential issues, contributing to improved operational efficiency and reduced downtime. The ability to collect and analyze data from multiple sources, as highlighted by Sage's ERP capabilities 30, is crucial for gaining a comprehensive and unified view of Caithness Energy's diverse operations, supporting better decision-making across the organization.

### **3.5 Network and Communication Infrastructure**

Managing a geographically diverse portfolio of power generation facilities necessitates a robust and reliable network and communication infrastructure. This infrastructure is essential for facilitating seamless communication between Caithness Energy's corporate offices and their remote power plants, enabling the efficient transfer of operational data, the transmission of control commands, and the potential for remote diagnostics and maintenance activities. Projects like the Caithness-Moray High Voltage Direct Current (HVDC) link, while primarily undertaken by SHE Transmission, highlight the scale of transmission infrastructure involved in connecting power generation facilities to the grid 31. These large-scale grid interconnection projects underscore the critical importance of reliable network connectivity for managing power flow and ensuring the overall stability of the energy grid.

The Caithness Moxie Freedom project's strategic location at the intersection of an existing 500kV high-voltage transmission line system and a major interstate natural gas pipeline 4 further emphasizes the critical role of infrastructure in their operations. This strategic positioning ensures both access to fuel and efficient connection to the electricity grid for distribution. The overall functionality and security of Caithness Energy's operations are fundamentally dependent on a resilient network infrastructure that supports both their internal IT systems for business operations and the specialized operational technology used to monitor, control, and manage their power generation assets and their interconnections with the broader energy grid.

## **4. Security Posture Assessment**

Given the critical nature of the energy sector, cybersecurity is a paramount concern for companies like Caithness Energy. The increasing automation, digitization, and interconnectedness of energy infrastructure have made it a significant target for cyberattacks, which can lead to severe operational disruptions, substantial financial losses, and potentially compromise the safety and reliability of energy supply 39.

### **4.1 Cybersecurity in the Energy Sector**

The energy sector's growing reliance on digital technologies for controlling and monitoring energy delivery systems has elevated the risk of cyberattacks with potentially devastating consequences 39. In Europe, the Network and Information Systems Directive (NIS Directive) imposes specific legislative requirements on organizations deemed operators of essential services, including those in the energy sector, to implement measures to protect against and effectively respond to cyberattacks and other incidents that could affect energy delivery systems 41. This regulatory landscape underscores the critical need for energy companies to prioritize cybersecurity and implement robust security measures to safeguard their critical infrastructure.

### **4.2 Potential Security Measures and Frameworks**

Recognizing the escalating cybersecurity threats in the energy sector, service providers and technology vendors are increasingly incorporating security considerations into their offerings. Operations and Maintenance (O&M) providers, such as EthosEnergy, which manages the Caithness Moxie Freedom Generating Station, are now emphasizing cybersecurity as an integral component of their services 10. Similarly, Hitachi Energy's Long-Term Service Agreement (LTSA) for the Caithness-Moray and Shetland HVDC system explicitly includes cybersecurity-related services, highlighting the importance of ongoing security maintenance for critical transmission infrastructure 38.

At a broader level, energy security plans developed by state authorities, such as the Oregon Energy Security Plan, also address cybersecurity risks as a key component of ensuring the resilience of energy infrastructure 42. These plans often outline strategies and mitigation measures to protect against cyber threats alongside natural and physical hazards. Industry-specific frameworks, such as the National Cyber Security Centre (NCSC) Cyber Assessment Framework (CAF) in the UK, provide objectives and principles that organizations responsible for critical national infrastructure, including energy companies, can adopt to enhance their cybersecurity posture 41. It is likely that Caithness Energy employs a range of security measures and aligns with relevant industry best practices and regulatory requirements to protect its IT and OT environments. These measures could include implementing network segmentation to isolate critical operational networks from corporate IT systems, enforcing stringent access controls, deploying intrusion detection and prevention systems to monitor and block malicious activity, and conducting regular employee training to raise awareness about cybersecurity threats and best practices.

### **4.3 Vulnerability Management and Disclosure**

Proactive vulnerability management is a crucial aspect of maintaining a strong security posture. Establishing a clear vulnerability disclosure policy allows external security researchers and other stakeholders to responsibly report potential security weaknesses within an organization's systems 44. This collaborative approach can help identify and address vulnerabilities before they can be exploited by malicious actors. Technology vendors in the energy sector, such as GE Vernova, have implemented vulnerability response processes for their products, encouraging security researchers and customers to report any suspected vulnerabilities directly to their cybersecurity team before making any public disclosures 46. While there is no specific information available in the provided snippets regarding Caithness Energy having a publicly stated vulnerability disclosure policy, given their reliance on advanced technologies in critical infrastructure, it would be a prudent security practice for them to have established internal procedures for managing and addressing potential security vulnerabilities that may be identified in their IT and OT systems.

### **4.4 Compliance and Regulatory Landscape**

Caithness Energy operates within a highly regulated industry, facing a complex web of local, national, and potentially international environmental regulations and sustainability standards 28. These regulations govern various aspects of their operations, including air and water emissions, waste disposal, and land use. ERP systems can play a significant role in helping energy companies navigate this complex landscape by providing functionalities for tracking and reporting on environmental compliance metrics and supporting broader sustainability reporting initiatives 28.

Caithness Energy's Caithness Long Island facility has faced legal challenges related to environmental compliance and greenhouse gas emissions, specifically concerning the New York State Climate Leadership and Community Protection Act (CLCPA) 17. The CLCPA sets ambitious mandates for reducing greenhouse gas emissions across the state. The lawsuit alleges that the New York State Department of Environmental Conservation (DEC) unlawfully grandfathered the Caithness Long Island plant by effectively exempting it from a proper evaluation of its emissions under the CLCPA 18. This legal action underscores the critical importance of adhering to evolving environmental regulations and the potential consequences of non-compliance, which can include legal challenges, reputational damage, and operational restrictions. The fact that EthosEnergy's O&M services for the Caithness Moxie Freedom plant include a focus on regulatory compliance 10 further highlights the significance of this aspect of their operations. Caithness Energy's technical infrastructure and security measures must not only ensure the safe and reliable operation of their facilities but also support their efforts to comply with all applicable environmental regulations and sustainability mandates.

## **5. Key Insights and Considerations**

The analysis of Caithness Energy's operations and the provided research material reveals several key insights and considerations regarding their technical infrastructure and security posture:

* Caithness Energy's business model, characterized by vertically integrated operations and a diverse portfolio of energy projects spanning multiple technologies and geographical locations, inherently necessitates a complex and interconnected technical infrastructure to support efficient management and operation.
* The company's reliance on advanced power generation technologies, including sophisticated combined-cycle natural gas plants and large-scale wind farms, suggests the presence of complex Operational Technology (OT) and control systems for real-time monitoring and management of these critical assets.
* While not explicitly stated, the scale and diversity of Caithness Energy's operations strongly imply the likely utilization of an Enterprise Resource Planning (ERP) system to integrate various business processes, manage finances across multiple projects, and ensure compliance with regulatory requirements.
* Data analytics plays a crucial role in Caithness Energy's strategy, as evidenced by the use of Asset Performance Management (APM) software for predictive maintenance and the development of custom solutions for real-time reporting, indicating a data-driven approach to optimizing plant performance and informing business decisions.
* Given the critical nature of the energy sector and the increasing prevalence of cyber threats targeting both IT and OT environments, cybersecurity is a paramount concern for Caithness Energy. They likely employ a range of security measures and frameworks to protect their infrastructure, potentially aligning with industry best practices and regulatory guidelines.
* Compliance with environmental regulations and sustainability standards is a significant aspect of Caithness Energy's operations, as highlighted by the legal challenges faced by their Long Island facility concerning greenhouse gas emissions. Their technical infrastructure must support efforts to monitor, report, and potentially reduce their environmental impact.
* The established relationships with major technology vendors like GE and Siemens, who supply critical equipment and digital solutions, present potential opportunities for deeper strategic partnerships in areas such as advanced analytics, cybersecurity, and long-term maintenance services.
* The development and deployment of a custom alarm management system using Xojo indicate a need for tailored solutions to effectively integrate data from proprietary industrial control systems with broader IT infrastructure, suggesting a willingness to adopt innovative approaches to operational challenges.

## **6. Recommendations**

Based on the analysis, the following recommendations are suggested for a more comprehensive understanding of Caithness Energy's technical infrastructure and security posture:

* Conduct further research to specifically identify the ERP system and other key IT applications currently used by Caithness Energy to manage their diverse operations, including project management, financial accounting, supply chain management, and human resources.
* Investigate Caithness Energy's specific cybersecurity policies, frameworks, and incident response plans to assess the maturity of their security program and their preparedness for potential cyber threats targeting both their IT and OT environments.
* Analyze Caithness Energy's approach to OT security in greater detail, focusing on the specific measures they have implemented to protect their industrial control systems, supervisory control and data acquisition (SCADA) systems, and other operational technologies from cyberattacks.
* Explore Caithness Energy's comprehensive data management and analytics strategy, including the specific tools and platforms they utilize for performance monitoring, predictive maintenance across their various power generation assets, and the generation of reports for regulatory compliance.
* Review Caithness Energy's track record regarding environmental compliance across their portfolio of projects and delve into their specific strategies and technologies for adhering to evolving environmental regulations, such as the New York State CLCPA and any other relevant mandates.
* Examine the potential for enhanced partnership opportunities with key technology vendors like GE and Siemens, particularly in the realm of advanced digital solutions for operational optimization, predictive analytics, and strengthening their overall cybersecurity posture across both IT and OT.

## **7. Conclusion**

Caithness Energy operates a substantial and critical energy infrastructure that necessitates a robust and secure technical foundation. Their diverse portfolio of power generation projects, spanning both renewable and fossil fuel sources across numerous geographical locations, presents a complex operational landscape. The analysis indicates a likely reliance on advanced power generation technologies, sophisticated OT and control systems, and potentially an integrated ERP system to manage their extensive operations efficiently. Cybersecurity is of paramount importance in this sector, and Caithness Energy likely employs various measures to protect their critical infrastructure. Compliance with environmental regulations also plays a significant role in their operations. Further investigation into their specific IT systems, security protocols, and data management strategies would provide a more granular understanding of their technical infrastructure and security posture, enabling more informed strategic engagements. The insights gleaned from this analysis serve as a valuable foundation for future research and decision-making concerning Caithness Energy.

**Table 1: Caithness Energy's Key Power Generation Projects and Technologies**

| **Project Name** | **Location** | **Energy Source** | **Installed Capacity (MW)** | **Key Technologies/Turbine Suppliers** |
| --- | --- | --- | --- | --- |
| Caithness Moxie Freedom | Salem Township, PA | Natural Gas | 1,029 | GE 7HA.02 |
| Guernsey Power Station | Guernsey County, OH | Natural Gas | 1,875 | GE 7HA.02, GE Digital APM |
| Caithness Long Island Energy Center | Yaphank, NY | Natural Gas | 350 | Siemens SGT6-5000F, SST-900 RH |
| Shepherds Flat Wind Farm | Gilliam & Morrow Counties, OR | Wind | 845 | GE Energy 2.5xl |

**Table 2: Potential IT and OT Systems Used by Caithness Energy**

| **System Type** | **Potential Vendors/Technologies** |
| --- | --- |
| ERP | NetSuite, Sage (likely one or similar) |
| APM | GE Digital's APM powered by SmartSignal (at Guernsey) |
| Alarm Management | Xojo (custom-built application) |
| Control Systems | (Further research needed for specifics) |
| Data Analytics | GE Digital APM, Sage ERP analytics module |

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