CASE STUDY : EXELON

DRIVING GRID EFFICIENCY AND REVENUE PROTECTION EFFORTS

BGE
An Exelon Company

In 2014, Baltimore Gas and Electric Company (BGE), a subsidiary of Exelon Corporation, launched C3 Energy's smart grid applications across all two million meters in its service territory. BGE is leveraging C3 AMI Operations™ to optimize the deployment and ongoing health of its advanced metering infrastructure (AMI) network and C3 Revenue Protection™ to identify and reduce unbilled energy usage. BGE expects these applications to deliver an annual economic benefit of $20 million to BGE and its customers.

C3 Energy delivered the solutions on schedule, in six months from project kick-off to launch. Deployment involved developing 42 integrations to 12 source systems. C3 Energy loaded two years of historical BGE data in a 10 terabyte federated cloud image and configured more than 140 complex analytics and predictive algorithms to match BGE's requirements and available data. Since deployment, the solutions have met or exceeded all business performance targets. In the first six months, C3 Revenue Protection identified over 15,000 non-technical loss cases, generating $2.8 million in economic benefit from verified fraud cases. During the same timeframe, C3 AMI Operations identified 400,000 meter health issues with a 99% accuracy rate.

PROJECT SCOPE

- **2 million** smart meter deployment
- **3 C3 Energy Smart Grid Applications**
  C3 AMI Operations™
  C3 Revenue Protection™
  C3 Energy Intelligence™
- **$20 million** per year estimated economic benefit to BGE and its customers
- **28 weeks** from project kickoff to launch
- **12 weeks** to complete planning, integration, and configuration; remainder allocated to testing

DATA REQUIREMENTS

- **12 unique** enterprise source systems provide data to C3 Energy
- **42 distinct extracts**, both as daily batch files and message integrations
- **10 TB** federated cloud image of data
- **35 billion** rows of data aggregated, federated, and analyzed
- **8 GB / 220 million** rows of new data delivered each day to the C3 Energy Analytics Engine
- **140 complex analytics** in use across C3 AMI Operations and C3 Revenue Protection
- **650 rules** contribute to the complex analytic results reported to the end user

6 MONTH RESULTS

- **400,000 meter** health issues identified
- **99% accuracy** on investigated cases of meter malfunction
- **90% yield** in the field confirming fraud using advanced machine learning
- **$2.8 million+** in identified economic benefit from verified fraud cases alone
- **15,000+** non-technical loss leads identified

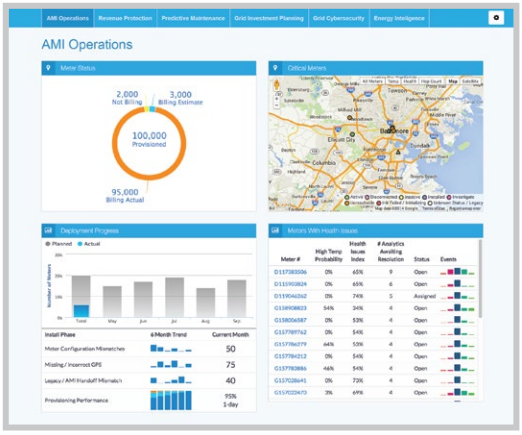
APPLICATIONS TO DELIVER UP TO $20 MILLION IN ANNUAL ECONOMIC BENEFIT

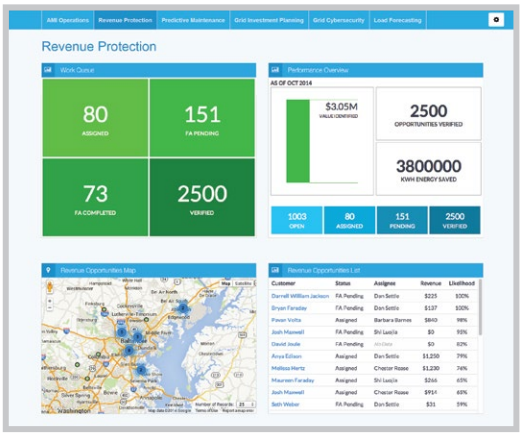
C3 AMI Operations safeguards revenues, reduces operational costs, and improves customer satisfaction by ensuring the operational effectiveness of smart meter systems during both AMI meter deployment and the ongoing lifespan of AMI network operation.

C3 Revenue Protection detects unbilled energy usage, quantifies the amount of revenue and energy loss at stake, and prioritizes service points for investigation, so that utilities can address energy loss, rectify malfunctions or unsafe conditions, and capture additional revenue.

The two applications together are expected to deliver up to $20 million in recurring annual economic benefit to BGE and its customers. The primary economic benefit comes from identifying and resolving unbilled energy usage, which reduces the cost of non-technical energy losses—a cost typically passed on to customers. Additional benefit derives from detecting problems with meters or with the communication network. This reduces the amount of missing usage data and increases billing accuracy and the overall effectiveness of the AMI meter deployment. These benefits represent a significant improvement over the benefits of smart grid infrastructure alone.

Additional benefits come from the streamlining of existing BGE business processes across smart grid operations, revenue management, and field operations, saving time and effort. The solutions also provide safety benefits. C3 AMI Operations and C3 Revenue Protection reduce risks to customers and utility employees in the field by alerting users to potentially hazardous meter conditions, such as unsafe meter temperature or potential meter tampering.





C3 AMI Operations and C3 Revenue Protection present complex analytics and predictive analysis in an intuitive, interactive format to simplify and accelerate business processes.

IMPLEMENTATION COMPLETED IN 28 WEEKS, ON SCHEDULE AND ON BUDGET

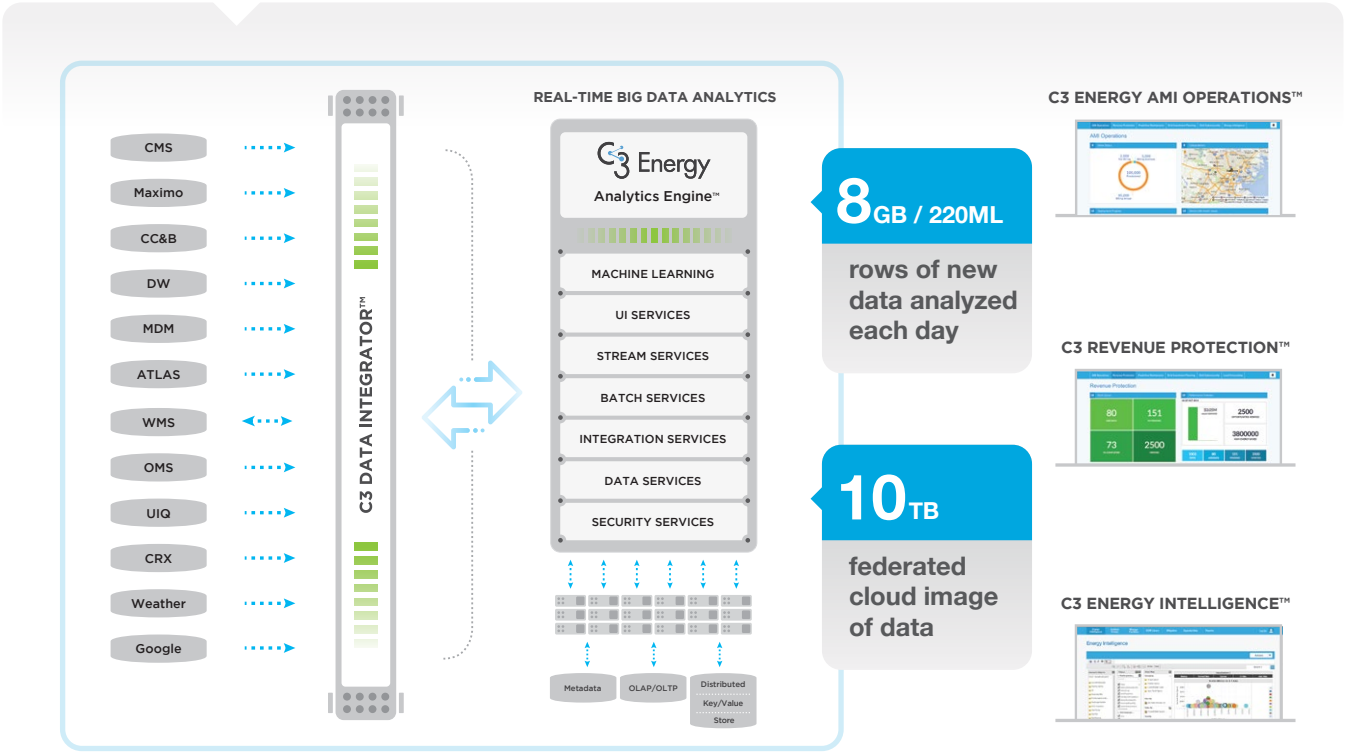
The first three implementation phases – project planning, scope analysis, and data integration and product configuration design – were completed in 12 weeks. In this timeframe, C3 Energy and BGE defined the scope of the source system data requirements, mapped BGE data to C3 Energy's canonical data model, designed the integration architecture, and established secure file and message transfer channels. C3 Energy worked with experts from across BGE to configure the analytics and user interface to ensure that C3 Energy's out-of-the-box functionality addressed key business needs.

In the following 16 weeks, BGE conducted rigorous testing of the application over two test phases. Unit testing covered data validation, analytic algorithm unit tests, and user interface testing. End-to-end performance tests replicated the 'day-in-the-life' for each application environment and proved that the application could handle the frequency and volume of data being loaded.

DATA INTEGRATIONS SPAN 12 SOURCE SYSTEMS, 220M DATA ROWS DAILY

Data integrations to the C3 Energy Data Integrator span 12 source systems with 42 separate integrations, including head end, MDMS, CIS, work management, EAM, OMS, GIS, CMS, and meter installation vendor systems. C3 Energy processes data from BGE both as daily batch files and as messages delivered to C3 Energy, arriving at near real time.

C3 Energy and BGE extracted, transformed, and loaded two years of history from source systems into a 10 TB federated cloud image during the initial data load. Every day, BGE sends an additional eight gigabytes (220 million rows) of data from source systems. Two years of data from AMI meters represents 35 billion rows of data. The peak speed for processing raw data is benchmarked at 6.5 billion rows per hour.



LIBRARY OF COMPLEX ANALYTICS AND PREDICTIVE MODELS INCORPORATES LEADING MACHINE-LEARNING TECHNIQUES

C3 Energy configured over 140 complex analytics to identify specific modes of meter malfunction or unusual activity. This library of complex analytics is based on more than 650 simple rules that interrogate and compare AMI interval data and other data sources.

The results of the 140 complex analytics are fed into advanced, at-scale machine learning algorithms that prioritize meters for investigation. In C3 Revenue Protection, the machine learning algorithms are trained on historical, confirmed examples of unbilled energy. The machine learning algorithms then prioritize new leads for investigation. C3 Revenue Protection is configured to automatically track and report the outcome of future investigations. These outcomes automatically refine the machine learning algorithms, so that C3 Revenue Protection's predictive capability continuously improves.

In C3 AMI Operations, machine learning models are applied both to prioritize general meter health issues by severity and to highlight potentially hazardous meter conditions. For example, the machine learning algorithms are trained on historical, hazardous meter conditions to provide advanced warning of meters that are likely to quickly reach a hazardous state.

RESULTS ON METER HEALTH AND NON-TECHNICAL ENERGY LOSSES SUBSTANTIALLY EXCEED TARGETS

Both C3 Revenue Protection and C3 AMI Operations have met or exceeded key performance targets. After six months of full operation, C3 Revenue Protection identified over 15,000 non-technical loss leads, many times higher than BGE's goal, with an accuracy approaching 90% in the field. The application generated $2.8 million in economic benefit for BGE from the reduction of energy theft, consumption on inactive meters, and service point configuration errors. This amount is 120% of the target value originally defined in the business case. C3 Revenue Protection identified so many non-technical loss events that BGE has begun a new back-billing process to handle the large volume of identified non-technical loss cases.

During the same period, C3 AMI Operations identified 400,000 meter health issues with 99% accuracy. The application prioritized data for all meters to identify actionable health issues contributing to meter failure: 55% of health issues were attributed to meter/network communication issues, 24% to abnormal usage, 18% to meter hardware failure, and 3% to location/misplaced meters. The application's high accuracy and reliability enabled BGE to streamline critical maintenance.

In addition, the scalability of the platform has been proven by the deployment of a new set of analytics to support BGE's continuous gas service initiative. With the help of the new analytics, BGE can safely provide continuous gas at vacant premises right up to the state limit and avoid technician visits to shut off service when residents vacate a premise. The new business process is expected to yield significant reduction in operational costs and improve the safety of the gas service network across the BGE service territory.

The C3 Energy Smart Grid Analytics solutions have also been well received by BGE employees, with 100% of trained users agreeing that they are enthusiastic about the solutions' abilities to bring value to their jobs.

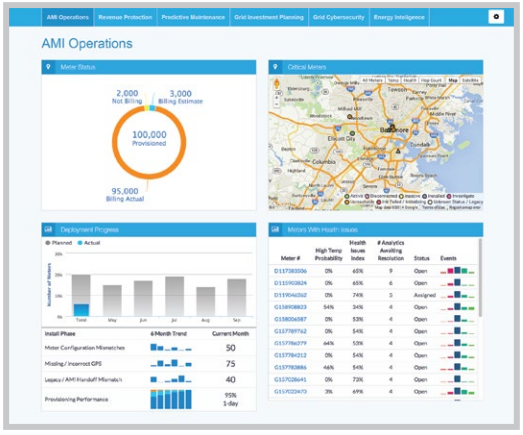
The success of these two implementations now serves as a foundation for deploying additional C3 Energy smart grid applications. The C3 Energy Smart Grid Analytics platform already deployed and integrated to BGE's operational systems ensures that deploying successive C3 Energy applications can be done quickly and at minimal additional cost.

> *"BGE team members are enthusiastic about the efficiencies they are already seeing from C3 Energy solutions, meaning greater value to BGE customers in terms of improved service reliability at affordable rates."*
>
> ***– A. Christopher Burton** VP, Smart Grid & Technology, BGE*

ACTIONABLE INSIGHTS WITH DASHBOARDS AND AD-HOC REPORTS

Along with C3 AMI Operations and C3 Revenue Protection, BGE deployed C3 Energy Intelligence™, which provides BGE operators and application developers with virtually unlimited ad-hoc reporting and analytics flexibility. C3 Energy Intelligence is explicitly designed for utility personnel and business analysts to discover and share actionable insights through robust predictive data analysis and compelling, intuitive data presentment.

C3 Energy Intelligence empowers BGE operators to discover insights from their data using compelling visualizations and an intuitive interface. BGE personnel and business analysts can quickly explore any data integrated into the C3 Energy Analytics Engine and analyze them by defining new metric calculations, zooming into details with filters, and setting thresholds for these results.



C3 Energy Intelligence enables BGE to discover insights from their data with pre-built dashboards.