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Data Science Case Study

Reducing Greenhouse Gas Emissions with Data Science

Mosaic developed an innovative optimization app for a leading energy company, helping them recommend suites of renewable energy products to meet corporate carbon footprint reduction goals within budgetary constraints.

Industry

Utilities

Use Case

Recommending Greener Energy Portfolios

Techniques

Mathematical Optimization

Outcome

Reduction in Corporate Greenhouse Gas Emissions

CLIMATE CHANGE, CORPORATE RESPONSIBILITY AND REDUCING GREENHOUSE GAS EMISSIONS

As the world becomes increasingly exposed to climate change impacts, the corporations that produce and distribute just about everything the population buys, uses, and throws away are searching for ways to reduce their carbon footprints. For example, according to this report, the top 15 U.S. food and beverage companies generate nearly 630 million metric tons of greenhouse gases every year[1], making them a larger emitter than Australia, the world's 15th largest annual source of greenhouse gases. A large share of these and other companies' carbon footprints comes from the emissions associated with generating the electricity that drives their manufacturing lines, powers their electronics and IT infrastructure, and heats and cools their office buildings. Companies must account for and address these emissions in order make a meaningful reduction in their contribution to climate change.

US utility players have stepped up their efforts to provide environmental, social, and governance reports (ESG) with clear emissions reduction goals and to actively support their corporate customers in achieving their own emission reduction goals. Recent initiatives by leaders across all industries have brought numerous new commitments to zero carbon emission goals and an accompanying surge in construction of wind and solar generation over the next few decades. Not surprisingly, machine learning & advanced analytics can play a large role in assisting utilities and their customers with insights and recommendations on meeting these targets.

REDUCING GREENHOUSE GAS EMISSIONS INTRODUCTION

Mosaic's customer is a leading power conglomerate, owning & operating multiple energy generation companies, regional utilities, and supporting businesses. One of their subsidiaries is a retail power company providing energy portfolios and related services to corporate customers to meet their comprehensive energy needs.

Companies that have made greenhouse gas (GHG) reduction or green energy commitments can work with the sales team at the retail power company to incorporate a range of energy efficiency initiatives, renewably sourced energy, carbon offset credits, and investment in renewable energy construction projects into their power portfolios in order to achieve these goals. The sales team works with prospective customers to compare various candidate portfolios of GHG reducing and offsetting products and to explore the costs and tradeoffs of potential offerings. In the past, this has been a manual and time-consuming effort as sales personnel had to piece together a portfolio to cover energy usage across tens of thousands of service locations for a customer over a multi-decade window. This slow process was error prone and made it impossible for the sales team to explore the range of options that they often sought. Automating the process would be a massive win for the company and its customers.

Mosaic, a premier data science consulting company, was tasked to develop an optimization model to act as the engine behind a new strategic portfolio planning tool. Mosaic leaned on our deep experience designing & deploying analytics-driven algorithms to critical operational and strategic decisions.

REDUCING GREENHOUSE GAS EMISSIONS APPROACH

Mosaic laid out an iterative project plan to dynamically meet the energy firm's needs at every point of the analytics development lifecycle. Mosaic's data scientists collaborated with key stakeholders to lay out requirements for an interactive dashboard and the algorithms driving the portfolio recommendations. The operating concept was that a sales rep could load customer usage forecasts for thousands of physical locations across North America, define intermediate and long-term GHG reduction goals, click a button, and receive a cost-efficient portfolio of products that would meet the customer's GHG targets. Reps could then adjust customer preferences within the application based on real-time feedback during the sales process and quickly get back a revised offering.

Mosaic decided to develop a custom mathematical optimization algorithm to select the products to eliminate or offset the emissions required to reach the GHG targets. The algorithm needed to be highly scalable. A typical planning scenario comprises over 50,000 customer locations, up to 15 possible GHG reduction/offset products for each location, and a planning horizon of 20+ years. These conditions translate to upwards of 15 million individual product selections. Adding to the complexity, forecast energy usage, emissions estimates, and product and energy costs vary over the planning horizon, and the portfolio recommendations must account for these shifts. Numerous constraints also need to be satisfied by any recommended portfolio, including:

- Some products are only available in certain geographical areas;
- Products may have multi-year contract requirements, which need to be aligned with corporate policies;
- New build products, such as dedicated solar installations, require multi-year wait times before they can begin providing power;
- Some products require bundled contracts covering multiple locations that together exceed a minimum annual energy usage threshold;
- Selections at any single location are restricted in how they can vary over time.

Mosaic needed to develop the algorithm to handle a very complex problem while also being fast enough to update recommendations in real time during sales calls.

REDUCING GREENHOUSE GAS EMISSIONS EXECUTION

Throughout the project's duration, Mosaic's data science team worked in close collaboration with client stakeholders and sales reps to ensure that the algorithm developed fully solved the problem at hand. Additionally, Mosaic worked closely with the client's software development team, who was tasked with building the front-end interface, to make sure that the algorithm and front-end interactivity were tightly coupled. Working cohesively with these teams allowed Mosaic to deliver a custom algorithm under a tight delivery schedule.

The development process began as far away from the code as possible. Mosaic led several brainstorming sessions focused on fully defining the problem and understanding the many nuances that sales reps had to account for in a portfolio. Mosaic brought ideas to the table for new ways to think about portfolio tradeoffs and ways that users might interact with portfolio recommendations inspired by the Mosaic team's extensive experience designing similar decision support tools. In between these meetings, Mosaic deliberated internally on the best algorithmic approaches to use to solve the problem at hand. There are almost always multiple ways to solve the same problem. Taking adequate time to decide whether, for example, a formal mathematical optimization model that can be solved by a commercial or open-source optimization solver or manually implemented custom heuristics were going to be most appropriate, proved to save a significant amount of time off the back end of the project and resulted in the most effective possible solution.

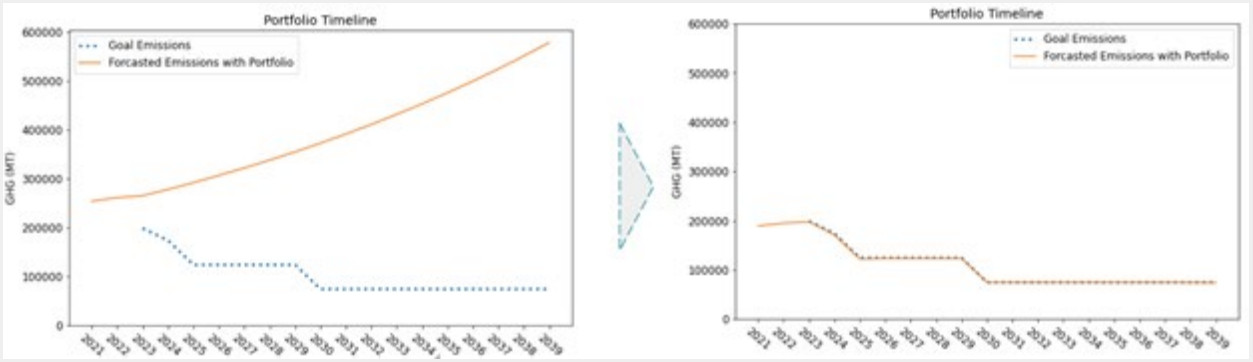
The team ultimately decided on a blended approach with business rules, such as fixed product hierarchies, directly encoded and mathematical optimization given freedom to make the most efficient or desirable selections within the bounds of those business rules. This allowed the team to streamline pieces of the problem significantly and to develop an explainable algorithm that could run more quickly than a naïve mathematical optimization model might have otherwise. This also ensured that the final recommendations would meet the preferences and expectations of the energy company's customers.

Implementation of the algorithm was an iterative process. Mosaic regularly demonstrated intermediate portfolio recommendations to customer sales personnel to solicit feedback that was incorporated back into the next version. For example, sales personnel preferred portfolios that steadily built over time toward final long-term GHG reduction goals even if this meant

a higher cost portfolio than one that purely optimized year-over-year, so Mosaic adjusted the logic to first optimize the portfolio for the final goal years and then iteratively work backwards through time to ensure steady progress toward the long-term portfolio. The result of this process was a more effective algorithm and a deeper trust from the sales team in the recommendations. Similarly, the development of the algorithm and user interface was a collaborative and iterative process, allowing ideas for improved functionality to flow back and forth.

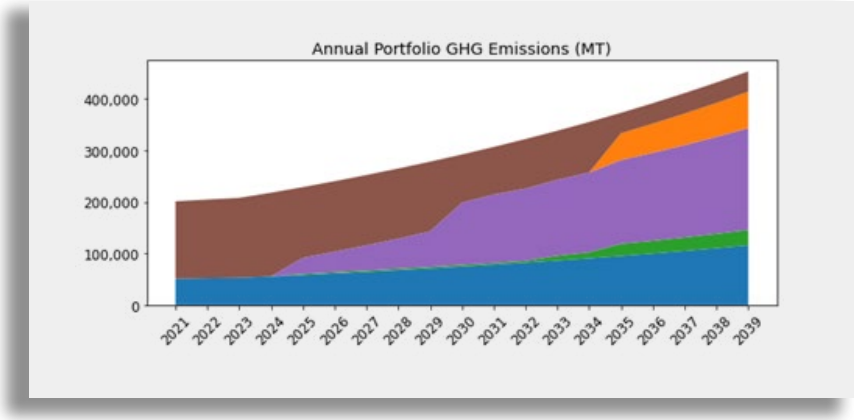
REDUCING GREENHOUSE GAS EMISSIONS RESULTS

The visual below shows a before and after depiction of a customer's annual forecasted GHG emissions (orange line) and yearly GHG targets. The optimization builds a cost-efficient portfolio that collapses the predicted emissions onto the target emissions by moving backward in time.

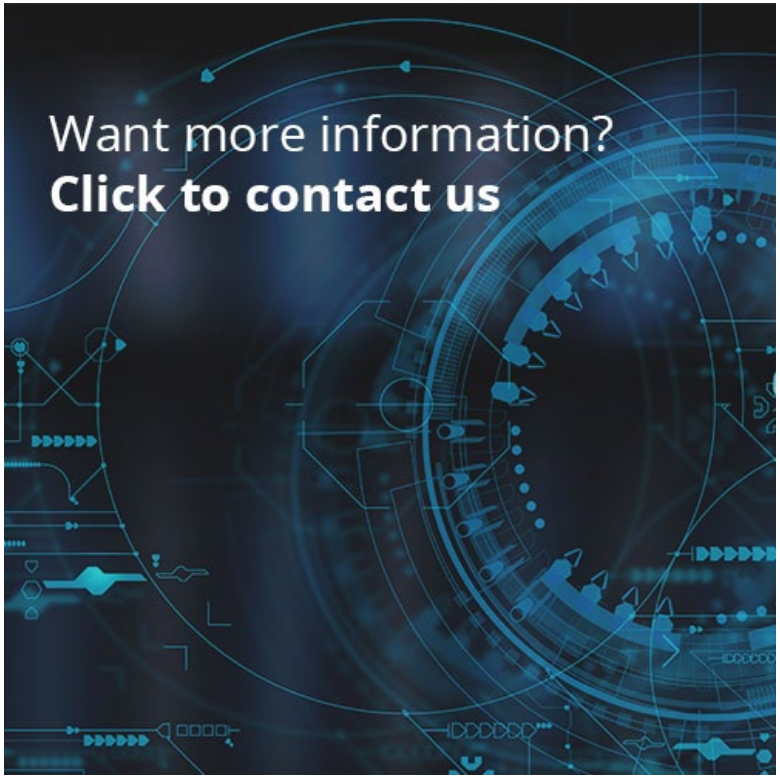


greenhouse gas reduction bar comparison chart

Sales reps and customers can see how the source of their electricity will break down over time under the recommended portfolio. In the below chart, the different colors represent different products in the recommended portfolio and the share of emissions that are accounted for by each product category over time. This includes GHG elimination products (efficiency measures to reduce energy usage, new solar power installations, etc.) and GHG offset products (such as renewable energy credits tied to existing solar and wind power). The brown area shows the decreasing share over time of non-offset "brown" power sourced directly from the power grid, which represents the ultimate carbon footprint of the customer.



This custom optimization tool helps Mosaic's utility customer save human sales time that can be better directed toward exploring a wider variety of portfolio options and helping more customers reduce their carbon footprints. It improves the accuracy of calculations and boosts the firm's commitment to helping its customers do their part to combat climate change. Custom analytics solutions like the one developed in this case study can not only assist utility operators in being upstanding corporate citizens but can also boost their customers' brand equity while driving to meet lofty reduction goals.



Endnotes

1. https://engagethechain.org/top-us-food-and-beverage-companies-scope-3-emissions-disclosure-and-reductions