Three Step AI Journey Cuts $330,000 in Annual Energy Costs, 9 Million CO_2 Emissions for Ingredient Manufacturer.

Whitepaper

Canvass AI

CANVASS

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INTRODUCTION

Creating a roadmap for AI can be daunting for some manufacturers. Questions about data, Return on Investment (ROI), digital skills, and technology requirements often put the brakes on AI before it has a chance to prove its value. This whitepaper shares the key learnings and insights from a global food ingredient manufacturer as they embarked on their first deployment of AI. The three-step AI journey:

- Preparing for AI
- Applying AI
- Automating with AI

saw the company fully automate the optimization of their gas turbines, resulting in annual energy savings of $333,000 and 9.39 million pounds reduction of CO_2 emissions.

About the company

A leading global ingredients solution company that has a firm focus on identifying opportunities to grow its business in an environmentally sustainable manner, while increasing profitability by pursuing new operational efficiencies. Key corporate goals include:

- $100M+ in cumulative savings by 2021 through operational efficiencies
- 10% reduction in carbon emission intensity by the end of 2020.

AI in Action

By implementing Canvass AI, the manufacturer:

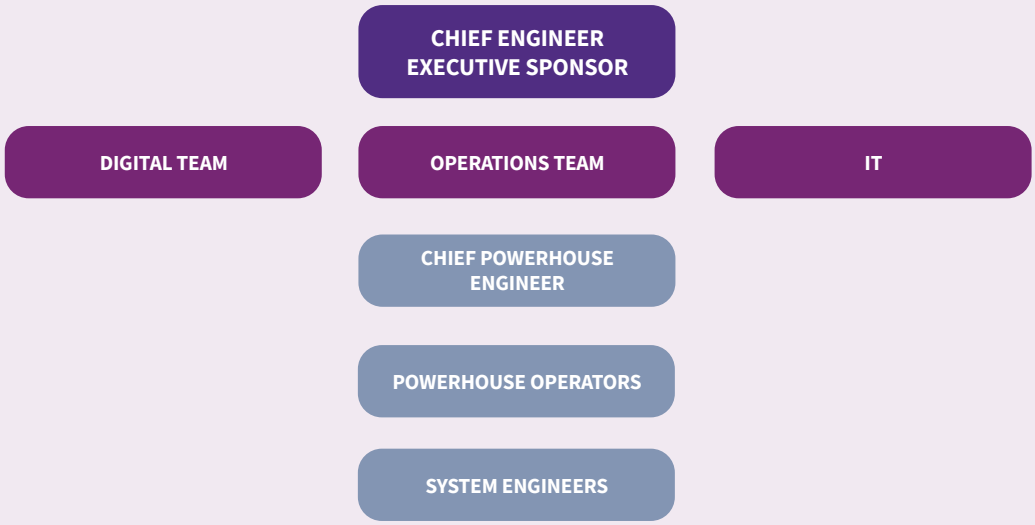
- Cut annual energy costs by $333,000
- Reduced carbon emissions by 9M+ pounds
- Improved OEE of their gas turbines

STEP 1: PREPARING FOR AI

COMMITTING THE PEOPLE, PROCESSES AND TECHNOLOGY

Critical to implementing AI is not how to make an AI project successful, but how to set up the organization to be AI successful. This requires the organizational structure: the people, processes, assets, and everything around it, to be focused on how it can foster a successful AI organization that then breeds further success and value. AI ushers in a data-driven decision-making environment. Therefore, operations teams must adopt a mindset that AI and the insights it can derive will help them to enhance their capabilities, optimize their operations, and will empower them to create new kinds of workflows and processes, unlike the ones that they have been running before. In addition to an executive sponsor, the buy-in by the operations team at the beginning of your AI journey is critical to success because they have the in-depth knowledge of your operational challenges and therefore will provide the insights to select the right use case and ensure that AI applications do not jeopardize your process or create other unintended risks.

Manufacturer's AI Team



At the manufacturer, the AI team was sponsored by the chief engineer and also included members of the digital and operations teams, such as:

- Chief Powerhouse Engineer
- Powerhouse Operators
- Systems Engineers

In addition, the IT organization provided connectivity support to set up a secure data protocol and Microsoft Azure data pipelines to send real-time streaming data to Canvass's cloud and receive Canvass's AI predictions.

SELECTING AN AI USE CASE

Getting started on the right foot when it comes to AI can be daunting. Particularly, when we see some confronting statistics:

IDC found for one in four companies, **50%** of their AI projects will fail

Gartner estimated that **85%** of AI projects will fail to deliver

MITSloan found that just **ONE OUT OF 10** companies obtained significant financial benefits

In the case of the IDC survey, respondents stated that their AI projects failed due to unrealistic expectations. These 'unrealistic expectations' can arise when there is a misconception of what AI is, what it can do for a company, and where and how they should implement it.

To be successful with AI, Canvass recommends identifying a use case that can meet the following criteria:

1. A process that has high operational expenses (OPEX) where there are opportunities to generate revenue or create savings
2. Assets are already instrumented; therefore, a lot of data is being collected
3. Benefits and ROI are measurable
4. Does not jeopardize plant safety
5. The AI use case can be scaled to similar processes and plants

> The involvement of the operations team brings key operational insights into how AI can be applied to processes.

At Canvass, we believe AI initiatives should be approached as a journey rather than an endpoint. A good analogy of how you should approach AI is by comparing it to the advancement of how we drive cars – using manual gear shift, cruise control, and to the ultimate in AI in motion, autonomous/self-driving cars. Therefore, ensure you select an initial use case that has the opportunity to prove value and can be scaled so that you don't end up in a state of pilot purgatory.

> "Much like Google Maps provides the fastest route, we wanted to use AI to provide us the least cost route to meeting the plant's steam requirements,"
>
> Manager, Digital Center of Excellence, Fortune 1000 Manufacturer

Following this advice, the manufacturer identified their boiler operations as a process use case to apply AI. The plant uses gas turbines and boilers to supply energy and steam. In this process, multiple natural gas turbines are used to generate electricity. The excess heat supply is fed into three boiler units to produce pressurized steam used for the evaporation process. Under the rules-based process control approach, the plant operator would place a static bias to each boiler to control their fuel intake. Once they were set up, the operator would not change the bias again until a major process change was required. Therefore, when plant demand increased, the turbines were treated equally, and the same rate of fuel was increased to each boiler. However, the thermal efficiency of each boiler can fluctuate due to different setups and piping,

environmental conditions, and varying wear and tear, meaning that they were consuming the same rate of natural gas but not necessarily producing the same output. The manufacturer's operations team wanted to utilize AI to predict the thermal efficiency of each boiler so that the loading could be optimized according to efficiency.

The objective for AI: to exploit the real-time difference in thermal efficiency of the three turbines to optimize the natural gas load; thereby reducing energy use, operating costs, degradation across the group of turbines, and carbon emissions.

	AI USE CASE CRITERIA	MANUFACTURER'S BOILER OPERATIONS
1	A process that has high operational expenses (OPEX) where there are opportunities to generate revenue or create savings	More than $10M was spent on natural gas per annum - the second-largest expense at the plant.
2	Assets are already instrumented, and therefore a lot of data is being collected	The three gas turbines, which are connected to one boiler, have been instrumented and collecting data for 2+ years.
3	Benefits and ROI are measurable	• 5.09% gain in thermal efficiency • $330,000 yearly reduction of natural gas costs • 9.39 Million pounds of CO_2 reduction • The application of AI aligns with the company's energy management program, which focuses on reducing greenhouse gases and utility costs.
4	Does not jeopardize plant safety	AI models will only automate the changes to setpoints; the control system provides overarching safety protocols and alarms will be activated if thresholds are exceeded.
5	The AI use case can be scaled to similar processes and plants	The manufacturer has multiple plants and processes that rely on gas turbine and boiler systems.

DATA PREPARATION AND CONTEXTUALIZATION

Having enough of the right data is more important than having volumes of data in its own right. Just because you have a lot of it, does not mean it is useful.

And there are many ways that data can fail this test. For example, the data might not be representative of your everyday operations. You might leave the sensor on a manufacturing asset running when the machine is off, and thus the data collected creates more noise for ML to extract meaningful patterns. In addition, the data needs to be multifaceted enough that ML can detect meaningful patterns in it. If you are looking to predict/prevent failures, you also need to include data that represents multiple instances of those failures so that the Machine Learning algorithms can recognize them.

Recommended Data Requirements for AI

Machine Learning can be trained using between 3-24 months of time-series data, provided it includes:

- All feature types that affect the process or target
- For predictive maintenance, ensure 5-10 failures are available
- Missing data does not exceed 10%

What is often underestimated is the complexity of the data and therefore the time spent preparing the data for AI applications. It has been suggested that data scientists can spend about 40% of their time gathering and cleaning data, rather than enriching it to derive additional value. However, using Canvass's automated data preparation, contextualization, and AI model building capabilities enabled the manufacturer's operations team to cut the time from data preparation to model training by nearly 60%.

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EXPEDITED DATA PREPARATION

Utilizing Canvass' AI platform, the operations team uploaded 18 months of time-series data that was generated by the gas turbines and boilers. Using Canvass AI's visual data analysis tools, the operations team was able to detect missing data, determine feature importance and relationship correlation, and identify outliers in the process. The operating log was important to cross-reference outliers, such as scheduled downtime or maintenance. By doing so, the operations team were able to clean their dataset and identify the features that represented:

- The performance of each asset to predict fuel usage and cost
- The variables that affected steam generation (e.g., steam flow)
- The environmental variables that affected thermal efficiency (e.g., ambient temperature)

By empowering the operations team to conduct the data preparation themselves ensures that important context to the data was provided ahead of training the models.

STEP 2: APPLYING AI

APPLYING CANVASS AI TO FORECAST AND OPTIMIZE BOILER EFFICIENCY

To predict the optimal biases in fuel intake between the boilers, three AI models were configured:

1. **Boiler simulator model**: to predict expected fuel usage
2. **Optimal control parameters model**: to identify the optimal control parameters that would minimize the total fuel consumption of all boilers
3. **Fuel consumption model**: to predict how the different parameters affect fuel consumption.

Canvass AI automation capabilities:

- Selects the best performing model
- Accelerates model training by 60%
- Continuously trains models with new data.

Using the Simulation application, the Canvass AI platform trained the AI models with the clean offline historical data. The Canvass Platform automatically selects the best model by cross-validating the historical data. As shown in Figure 1, Canvass AI was used to configure a simulator model for each boiler to predict the expected fuel usage given the plant steam demand, as well as the operating conditions of the turbine and boiler. An optimizer model was then configured on top of these boiler simulator models to identify the optimal control parameters that would minimize the total fuel consumption of all boilers while respecting the physical and safety constraints of each boiler (ref Figure 2). The operations team configured an additional simulation model to predict how different parameters affect fuel consumption. Canvass AI's automated model training infrastructure ensure that the AI models continuously improve with new data.

> Canvass's no-code platform requires no IT resources to build and train AI models.

FIGURE 1

14-Day Boiler Fuel Flow and Steam Flow

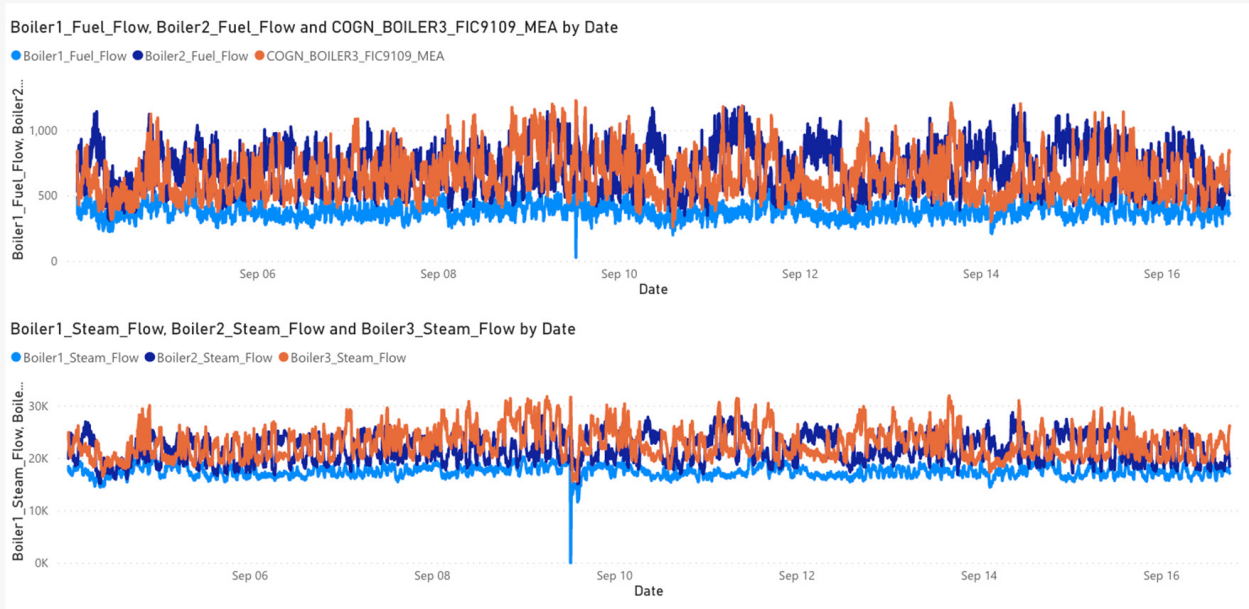
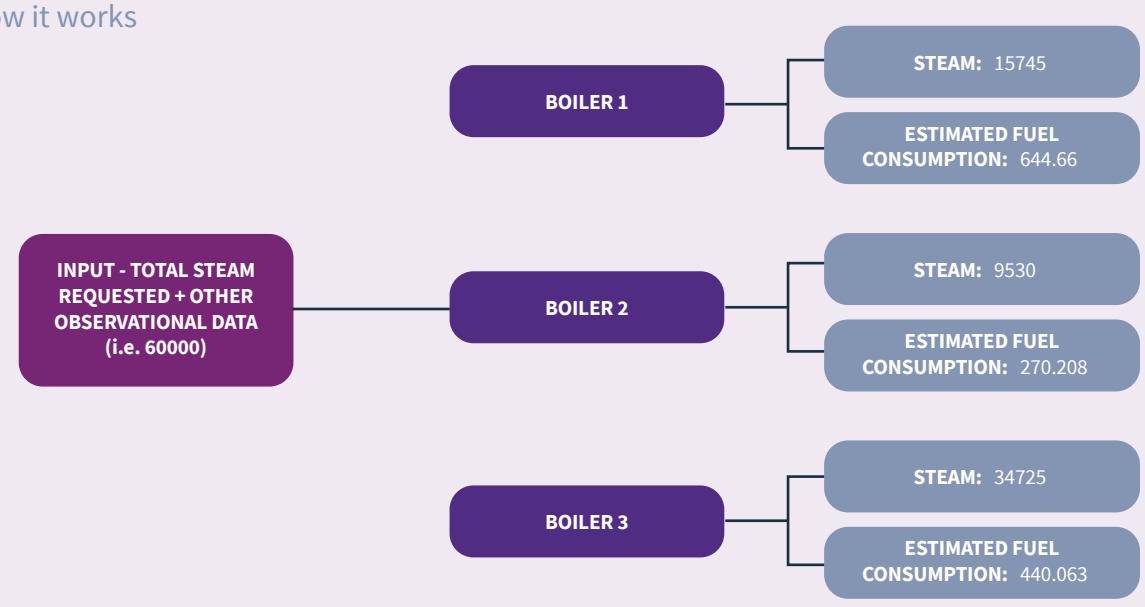


FIGURE 2

How it works



Based on the thermal efficiency of each boiler, Canvass's platform estimates the optimum fuel required for each boiler while ensuring overall steam production meets demand.

STEP 3: ATTAINING AI-DRIVEN AUTOMATION

If we refer back to the driving analogy we mentioned earlier, the ingredient manufacturer's journey to automation was taken in three steps:

AI ADOPTION JOURNEY

AI in Manufacturing	AI in Auto
AI with human supervision	Manual shift gear
Applied AI	Cruise control
Automation	Autonomous driving

1. AI with human supervision

A native data pipeline was set up by the manufacturer to stream data to the Canvass platform. Per the specified prediction schedule, every four hours, the operator manually inputs the setpoint change recommendations based on the prediction from Canvass AI to adjust the biases in fuel intake.

A 2.5% improvement in thermal efficiency was observed when compared to historical reports. Impressed by the gains achieved, the continuous improvement team and operations team were convinced that further gains can be made if the model generated predictions in shorter time intervals.

2. Applied AI

Once the AI models are productionized, it is important to refine the protocols and apply rules to your specific operating environment. In the case of this manufacturer, the operations team asked questions, such as:

- Is the prediction schedule appropriate for the process?
  - i.e., can an operator respond to setpoint changes based on predictions that are received every 1 minute or is a 15-minute average more useful?
- What business and operating constraints need to be applied to the model?
  - i.e., the boiler with the highest load should not exceed 70% in order to manage the remaining use of life
- What safety protocols need to be applied?
  - i.e., fuel input must not exceed a specified range

3. Automation

Live data streaming between the instrumented process, Canvass AI, and the control system is required to achieve automation without human intervention. The plant set up a secure data protocol and Microsoft Azure data pipelines that send data to Canvass's cloud and receive predictions from Canvass AI. The predictions are displayed as part of the HMI control screen that the operator tracks. When the operator turns on auto-mode, the control system directly takes Canvass's prediction as a set point to adjust fuel biases every 15 minutes, enabling the plant to automate the optimization of their boilers with no intervention from the plant operators.

Operators are assured that there are no safety risks to automating this process. This is because only the changes in fuel setpoints are being automated and the control system still maintains its safe operating window, with alarms being activated if thresholds are breached due to predictions deviating outside of the expected operating conditions.

RESULTS

PROVEN SAVINGS IN FUEL USAGE, UTILITY COSTS, AND REDUCTION IN CO_2 EMISSIONS

The AI application aimed to exploit the difference in thermal efficiencies of its boilers to minimize total fuel usage. Since the deployment of the Canvass AI platform to this process, the natural gas input is now being managed according to the turbine's individual efficiency performance. To date, the plant has achieved a **5.09% gain in thermal efficiency, which translates to $333,000 in annual savings and 9.39 million pounds reduction of CO_2 emissions produced by the three turbines.**

This application of AI has proven the value of AI to the manufacturer's operations team in their day-to-day operations. With the overwhelming confidence in the predictions, the automation of boiler optimization has become embedded as business-as-usual. "At any time that we need to take the Canvass platform offline for maintenance, the operations teams are eager to get it back online as soon as possible." The operations team is now actively looking for opportunities to expand the use of AI to other processes and plants.

Since implementing Canvass AI, the manufacturer has:

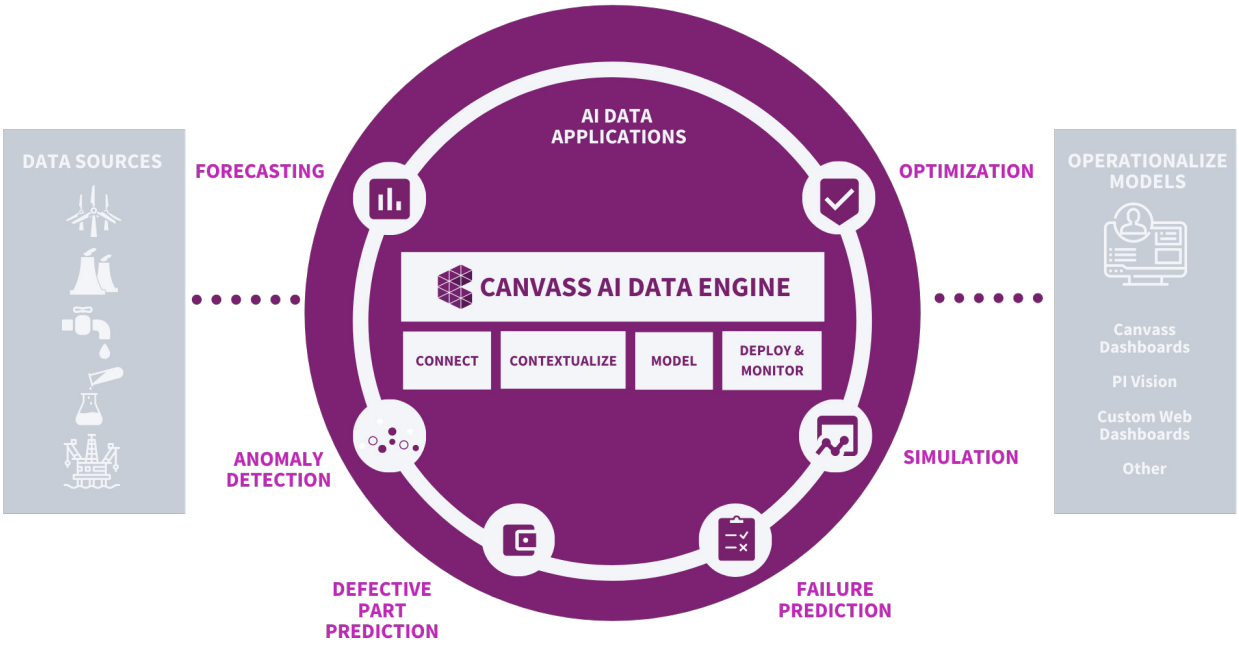
- Increased thermal efficiency by 5.09%
- Cut annual energy costs by $330,000
- Reduced CO_2 emissions by 9 Million Pounds

ABOUT CANVASS AI

Adoption of AI in manufacturing has stalled because tools have typically been designed for developers and data scientists, leaving the domain experts on the sidelines. At Canvass, we're addressing this challenge by making AI accessible and easy for industrial engineers to participate in each part of the AI journey.

Canvass's patent-pending industrial AI platform breaks down the barriers that have made AI slow, hard, and expensive for manufacturers to implement into their day-to-day operations. By putting AI in the hands of plant operators with pre-developed AI templates, Canvass's platform empowers them with data-driven insights to improve operational processes and optimize assets. This enables process engineers the ability to control their processes by giving them the tools to visualize and contextualize data, derive predictive insights, and make preemptive operational adjustments - without requiring any coding experience.

Canvass is a no-code, machine learning-based platform that simplifies the process of building, applying, and scaling applied industrial AI in day-to-day operations.



The Canvass AI platform automates the entire data science process, eliminating the need for lengthy consulting data science projects. This platform approach has accelerated the time to insights 12x faster than other solutions and approaches. Developed specifically for the industrial sector, Canvass AI platform continuously adapts to changing operational variables, spearheading industrial operators to increase yield, improve quality, reduce costs, and lower energy consumption.

Canvass is one of the only AI platforms, identified by IDC, that acts in near real-time, whereby its AI predicts process performance, optimizes, and can create closed-looped operations on the plant floor.

The platform ingests streaming operational data from disparate data sources and provides a visual view of different variables, such as ambient conditions, asset flow, fuel input, pressure, other process parameters. The Canvass platform applies industrial artificial intelligence (AI) to automate the entire data science process allowing process engineers to focus on contextualizing the data and refining the predictive models.

As a purpose-built Industrial AI platform for scale, Canvass AI empowers industrial engineers to improve OEE by equipping them with pre-coded AI applications that address industrial manufacturing's most common use cases, such as:

- Forecasting
- Asset and process optimization
- Anomaly detection
- Model what-if scenarios
- Asset failure prediction
- Defect part detection

> IDC has identified Canvass as one of the only analytics companies that acts in near real-time, whereby its AI predicts process performance and initiates automated physical action on the operations floor in a closed-loop fashion.

ABOUT CANVASS AI

Canvass AI is a leading provider of industrial data software. Its patent-pending technology enables intelligent industrial operations by putting AI directly in the hands of plant operators - empowering them with data-driven insights to improve production processes and optimize assets. A purpose-built platform for AI at scale, Fortune 5000 companies use Canvass AI to improve OEE, optimize production processes, and reduce energy and operating costs. Funded by Alphabet's Gradient Ventures and Yamaha Motor Ventures, Canvass' customers include leading manufacturing and energy companies globally.

For more information about Canvass and to get started on implementing AI into your operations, please contact us:

Canvass AI | info@canvass.io | www.canvass.io