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The Role of AI in Achieving Net Zero Emissions: Opportunities and Challenges

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AVEVA

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By

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Agenda

- Introduction
- Sustainability Framework
- Surveillance to Insight (AI Driven Transformation)
- Opportunities
- Challenges
- Key Shifts
- Case Studies/Examples
- Q&A

Introduction

❖ The McKinsey Global Institute estimates that achieving net zero emissions worldwide could cost around $275 Trillion[1]

❖ Artificial Intelligence (AI) can enhance efficiency within companies by optimizing energy consumption and accurately forecasting energy demand and generation

❖ AI can analyze historical data, trends, and patterns to predict future climate conditions and the effectiveness of various strategies for reducing emissions

❖ AI can be utilized to foresee potential equipment failures, thereby preventing wastage of energy and contributing to a reduction in emissions.
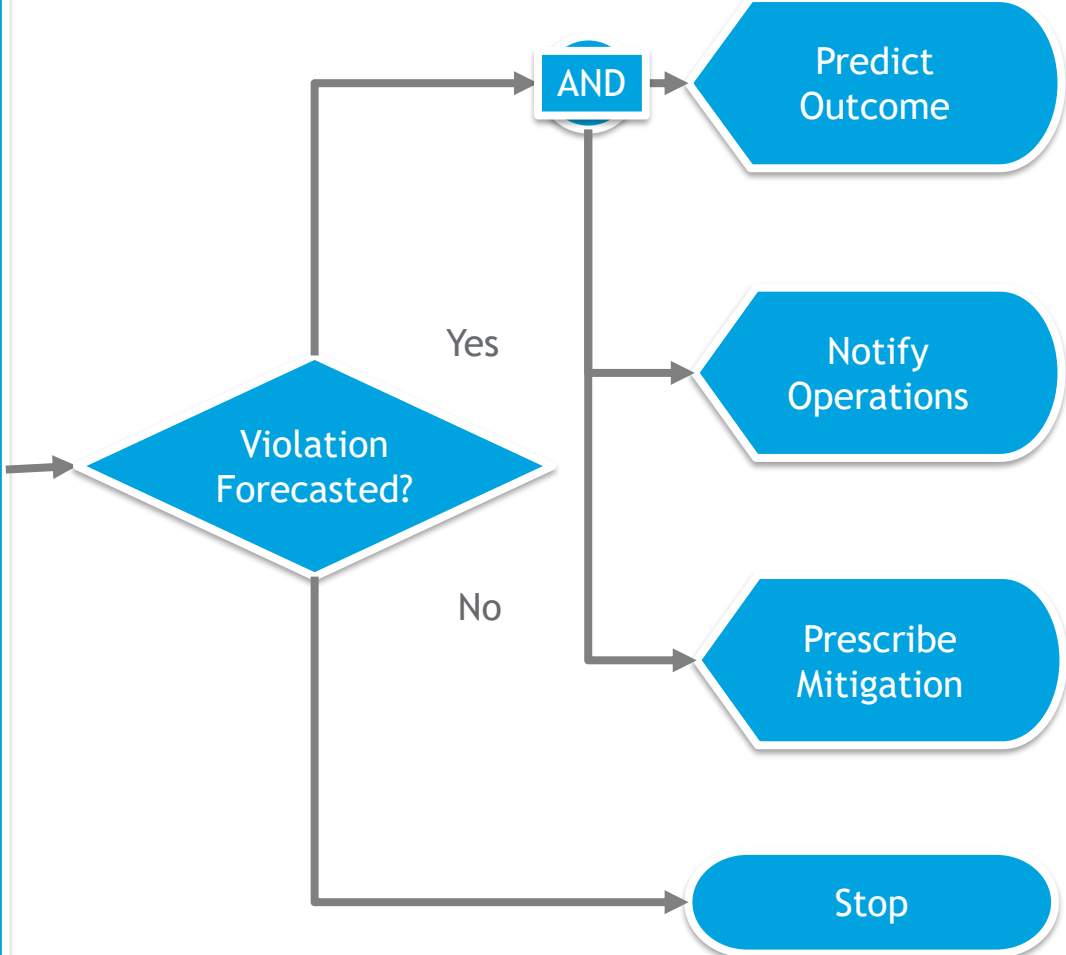

1) https://www.mckinsey.com/featured-insights/sustainable-inclusive-growth/chart-of-the-day/the-cost-will-not-be-net-zero
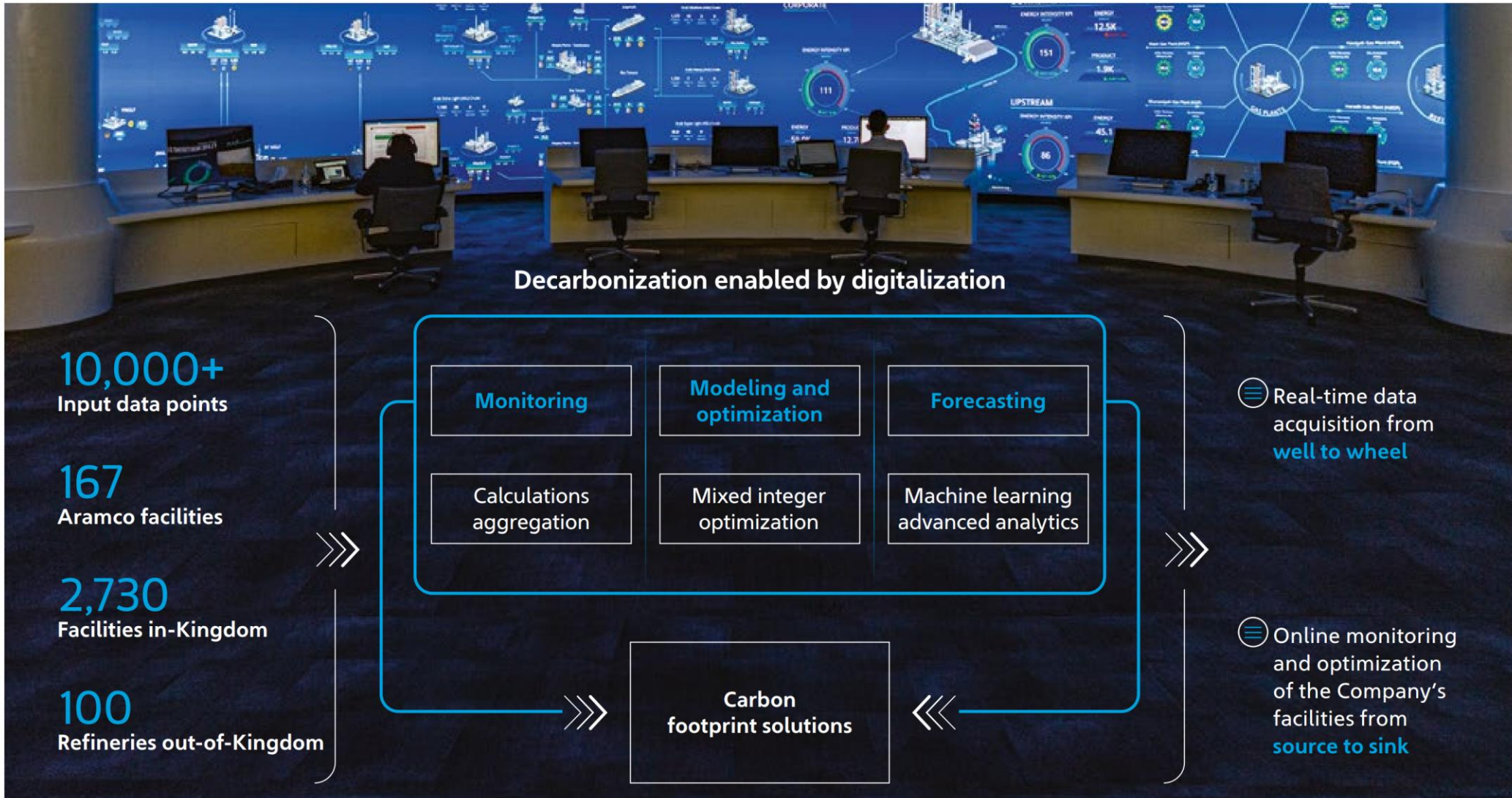
Surveillance to Insight (The AI Driven Transformation)

Decarbonization Enabled by Digitalization

Decarbonization enabled by digitalization

10,000+
Input data points

167
Aramco facilities

2,730
Facilities in-Kingdom

100
Refineries out-of-Kingdom

Monitoring	Modeling and optimization	Forecasting
Calculations aggregation	Mixed integer optimization	Machine learning advanced analytics

Carbon footprint solutions

Real-time data acquisition from **well to wheel**

Online monitoring and optimization of the Company's facilities from **source to sink**

1) https://www.aramco.com/en/sustainability/sustainability-report
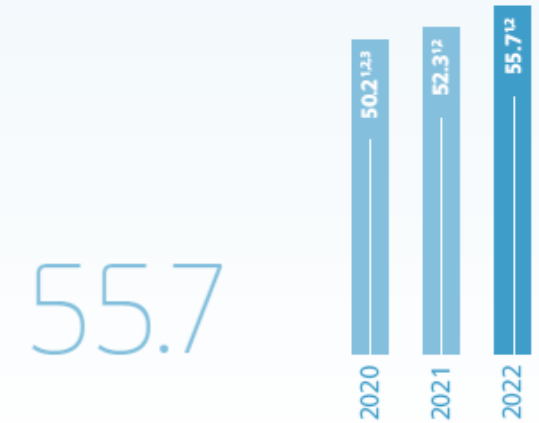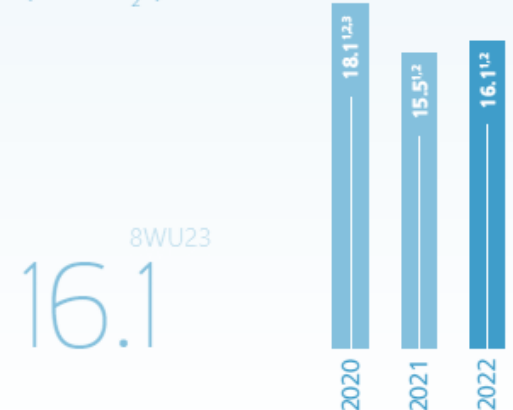
GHG Emissions

❖ Saudi Aramco Ventures has established a $1.5 billion Sustainability Fund to invest in technologies that address the balance of energy security and sustainability[1]

❖ The company is committed to the global goal of reducing GHG emissions, with a plan to decrease net annual Scope 1 and Scope 2 GHG emissions from both upstream and downstream businesses by 43% (from 119 to 67 MMtCO2e) by 2035[1]

❖ In 2022, even with a 10% increase in hydrocarbon production, the total emissions (Scope 1 and Scope 2) from Saudi ARAMCO and its operationally controlled entities only increased by 6% (71.8 MMtCO2e in 2022 vs. 67.8 MMtCO2e in 2021) compared to the previous year[1]

Scope 1 emissions
(MMtCO$_2$e)

55.7

2020	2021	2022
50.2[1,2,3]	52.3[1,2]	55.7[1,2]

Scope 2 emissions
(MMtCO$_2$e)

8WU23

16.1

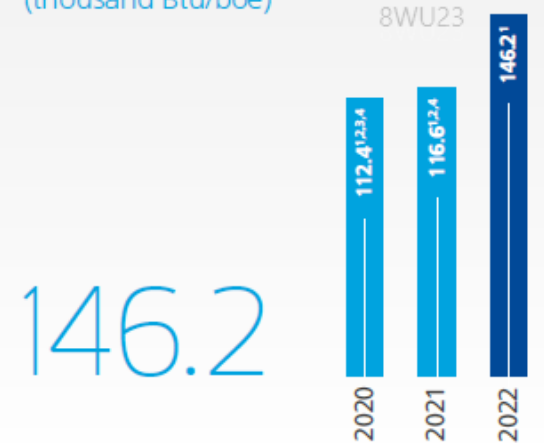| 2020	2021	2022
18.1[1,2,3]	15.5[1,2]	16.1[1,2]

Energy Intensity & Flare Emissions

❖Saudi ARAMCO has aligned its operations with sustainability goals, focusing on optimizing energy intensity.

❖Improved Energy Production Efficiency, resulting in a thermal efficiency of 70.7% in 2022 at integrated co-generation facilities[1]

❖Advanced digital solutions are being implemented to enhance energy efficiency performance. One of these digital solutions, Energy Demand Forecasting won an innovation award from AEE (US) in 2022[1]

❖The company aims to reduce flaring to 0 by 2030. In 2022, flaring intensity was reduced by 17% due to a digital approach to optimize the flaring of facilities[1]

Energy intensity
(thousand Btu/boe)

8WU23

2020	2021	2022
112.4[1,2,4]	116.6[1,4]	146.2[1]

146.2

Flaring intensity
(scf/boe)

2020	2021	2022
5.97[1,3]	5.51[2]	4.60[1,2]

4.60

1) https://www.aramco.com/en/sustainability/sustainability-report

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Saudi Aramco: Public

Integrated Energy & Economic Modeling System

❖ Saudi Aramco has created a computer-based solution that integrates global economic and energy models, including various sub-models for economics, energy demand, climate, and supply chain components such as oil, gas, coal, refining, and petrochemicals

❖ The use of AI-powered processes in Saudi Aramco has enabled continuous, proactive digital adjustment of the oil stabilization process

❖ This has led to a 4.5% increase in energy efficiency since 2019 and a reduction in CO2 emissions[1]

1) https://www.aramco.com/en/sustainability/sustainability-report
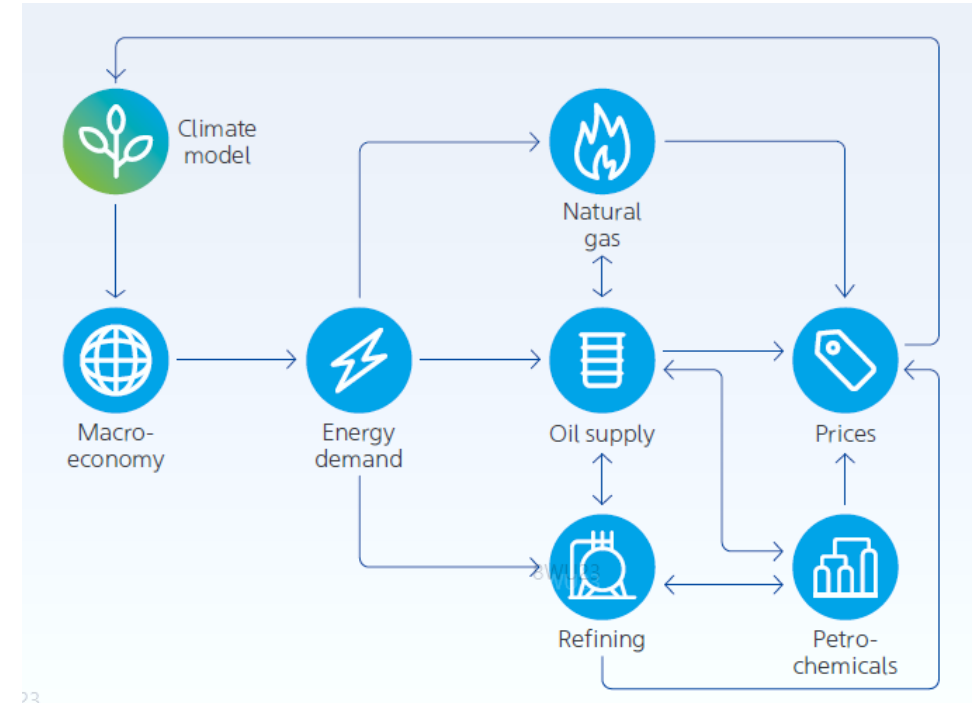
Opportunities

❖**Monitoring and Predicting Carbon Emissions:** Utilize AI to track and forecast carbon emission trends

❖**Environmental Monitoring:** Apply AI for monitoring environmental changes, including shifts in air pollutant concentrations

❖**Air Quality Assessment and Monitoring:** Employ AI for assessing and monitoring air quality

❖**Climate Technologies for a Sustainable Environment:** Leverage AI in:
- ✓ Designing more energy-efficient buildings
- ✓ Monitoring deforestation
- ✓ Optimizing renewable energy deployment

❖**Identifying Key Variables that Cause Emissions:** Use AI to pinpoint the crucial variables contributing to emissions

❖**Process Optimization Strategies:** Enhance process optimization strategies with the help of AI

Challenges

❖ **Data Collection and Precision:** One of the major challenges is ensuring that the data collected for measuring carbon emissions is both accurate and comprehensive

❖ **Trust in AI Systems:** The 'black box' nature of some AI systems can lead to trust issues, particularly when the sources and biases are not clear

❖ **Technological Advancements:** By 2050, many technologies that are currently in the prototype stage will need to become widespread

❖ **Meeting Targets:** A considerable number of companies may not meet their own targets, with a projected 22% failing to achieve net zero by 2050

❖ **Global Cooperation:** Achieving net-zero emissions by 2050 necessitates cooperation from all countries. This can be challenging due to differences in economic development, resources, and political systems

Key Shifts

❖ **Embrace True Technology Transformation**: Energy companies are increasingly recognizing the importance of digital and AI technologies for sustainability and profitability, leading to rapid transformations in their operations

❖ **Recalibration from Energy Provider to Software Provider:** The industry is shifting focus towards building technology that capitalizes on abundant, zero-marginal-cost energy sources like solar and wind

❖ **Importance of Sharing Data Across the Ecosystem:** There's a growing emphasis on the need for new, clear, agreed-upon data structures that uniformly represent information to all users

❖ **Potential Impact of Greater Public-Sector Support:** The public sector is seen as playing a significant role in supporting the transition to net-zero emissions through policy support, research and development funding, and incentives for businesses to adopt sustainable practices

Case Studies/Examples

- Energy Demand Forecasting
- Flare Prediction, Prescription & Mitigation
- CO2e Monitoring, Prediction & Mitigation

Data Architecture Landscape for AI/ML

14
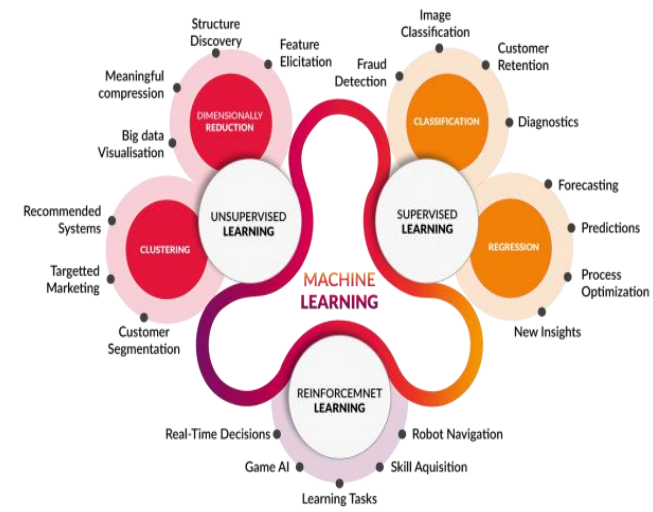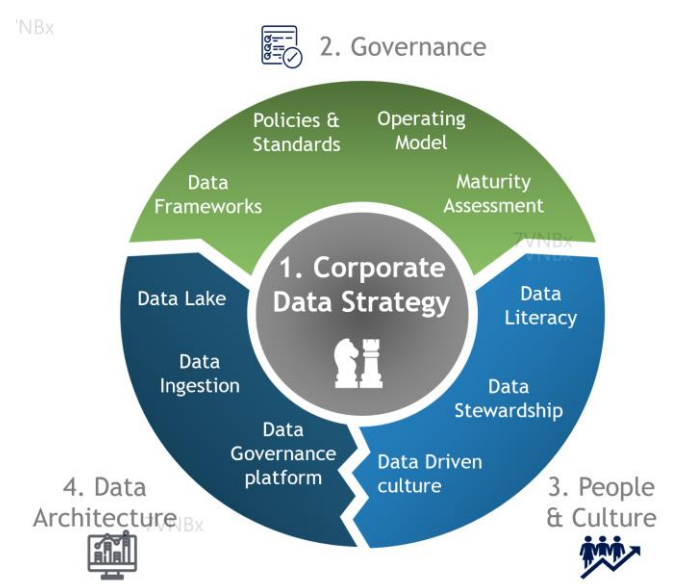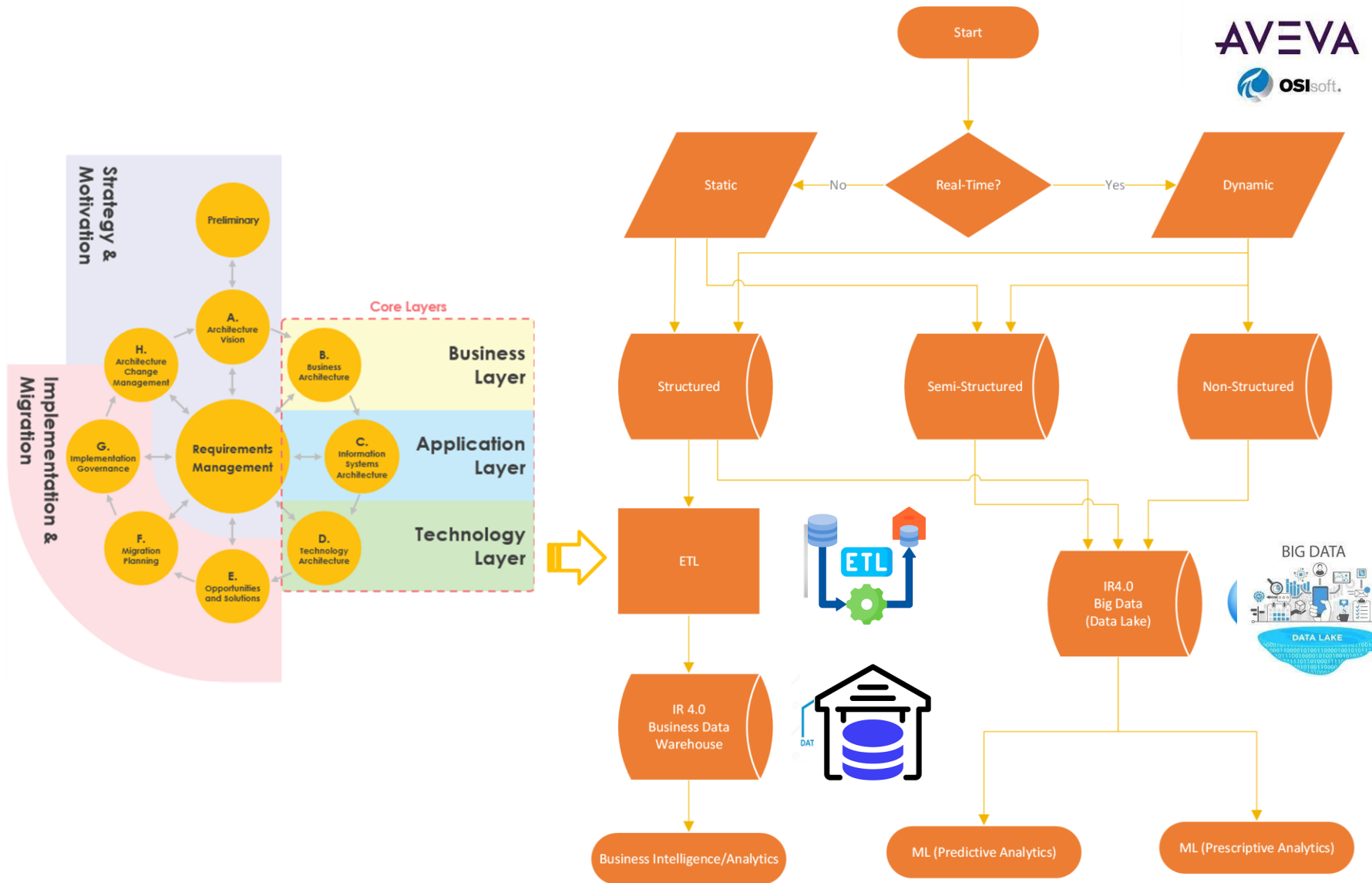
Energy Demand Forecasting Solution - Architecture

Inputs
(Energy & Production streams)

AVEVA
OSIsoft.

> Steam Consumption
> Power Consumption
> Power Generation
> Steam Generation
> Fuel Gas Consumption
> Shutdown schedule
> Ambient Temperature
> Equipment efficiency

> Production A
> Production B
> Production C
> Feed A
> Feed B

Pre-processing

Actual process measurements

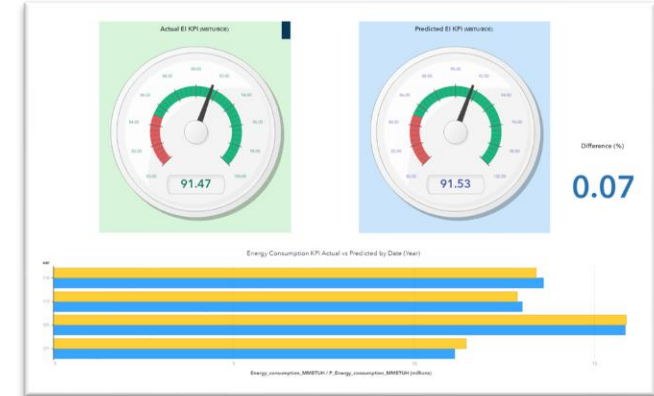*Production & Energy KPI*

ML Models (300)

Predictions

Production & Energy KPI

Machine Learning Platform

Manual "target" inputs

Daily Monitoring
(Actual vs. Predictions)

Target Setting
(Periodic)

Energy Demand Forecasting Solution - Results

Energy Intensity – Actual vs. Predicted

- Actual
- Predcited

Q1: 94.89% / 94.92%
Q2: 95.69% / 94.34%
Q3: 97.32% / 96.93%

Emissions (Scope 1 & 2) – Actual vs. Predicted

- Actual
- Predcited

Q1: 94.50% / 94.98%
Q2: 94.16% / 93.99%
Q3: 94.5% / 94.20%
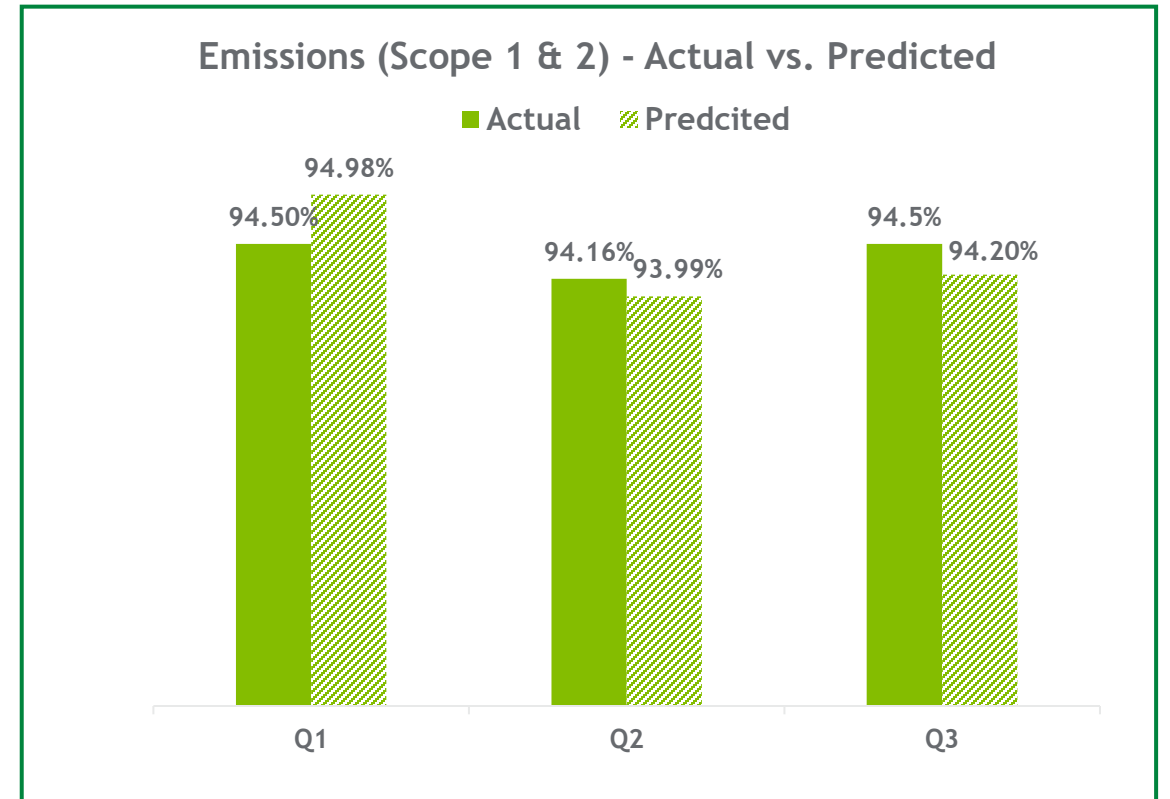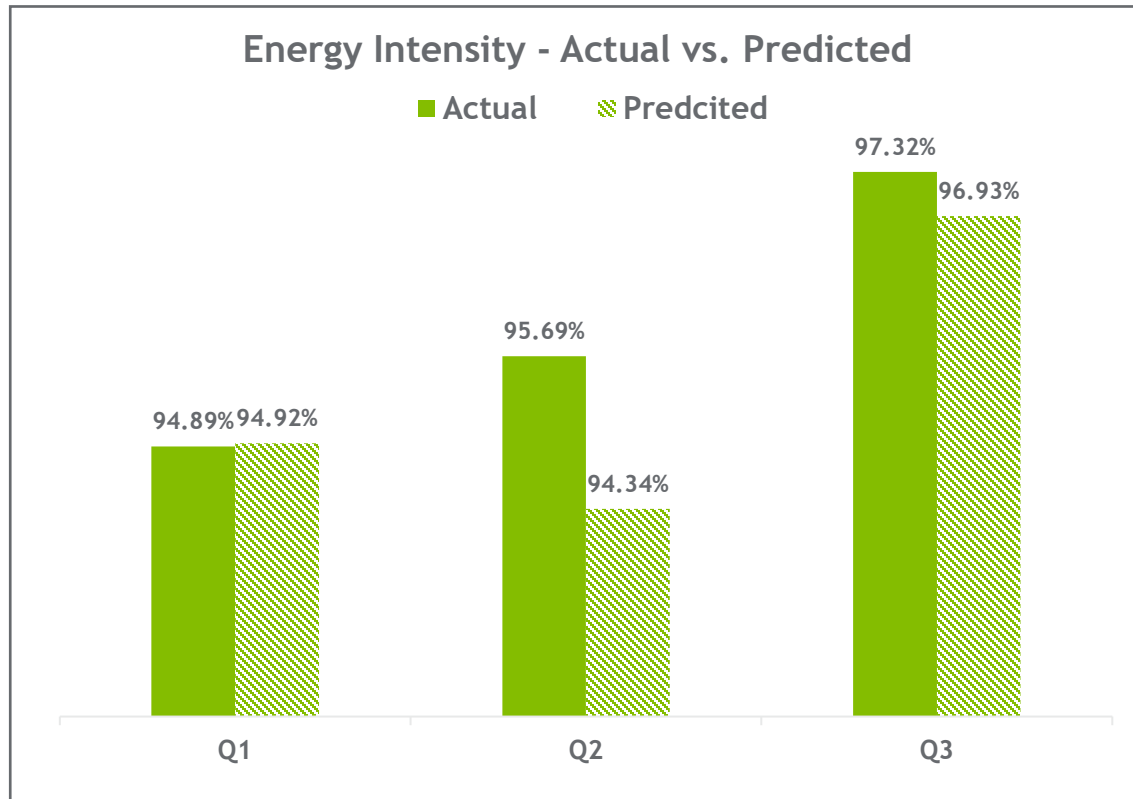
The values are scaled

Flare Monitoring Solution - Predictions

Actual Vs. Predicted Flare (MMSCFD)

86.99 (46.15%) — Original Flare (MMSCFD)
101.51 (53.85%) — Predicted Flare (MMSCFD)

Flare (MMSCFD) Forecasting

Ambient Temperature | Overhead Pressure | Overhead Temperature | Crude API | Crude Federate

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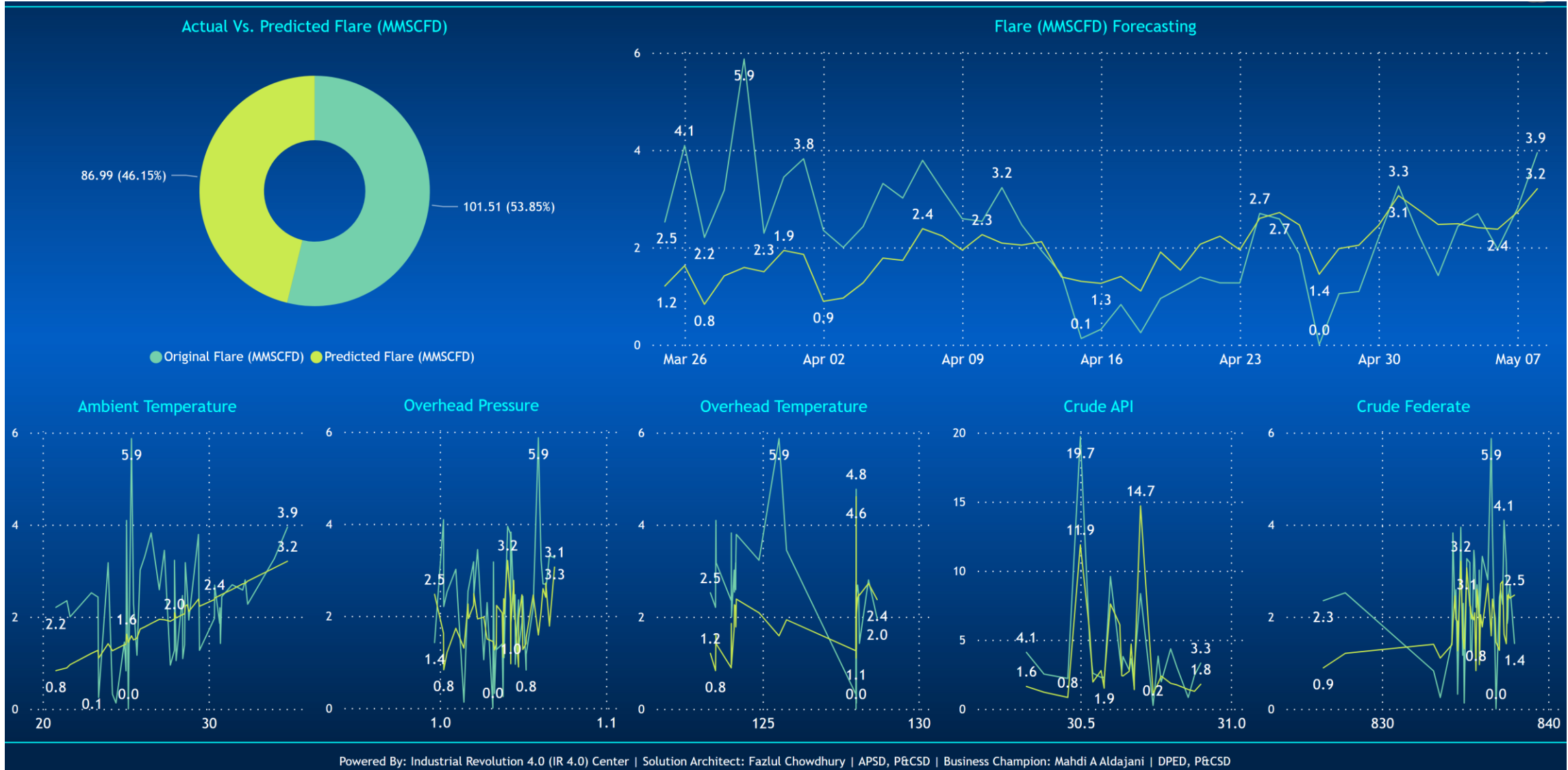
Flare Monitoring Solution - Notifications

Mon 8/28/2023 1:00 PM

IS

IR4 SERVICE ADMINISTRATOR

[INTITIAL ALERT] Flare Monitoring System (FMS) Notification

To ⊞ ***HGP environmental team**;

ⓘ If there are problems with how this message is displayed, click here to view it in a web browser.

SAUDI ARAMCO

IR 4.0 CENTER NOTIFICATION PLATFORM

Dear Customer.

This is to inform you that, based on Flaring Predictions Algorithm, this department may exceed the flaring target for this Quarter.

You are advised to investigate the reason of high flaring and conduct reduction measures in order to meet the quarterly target.

Please contact Flare & Emissions Administrators for additional clarifications.

Company	Business Line	Admin Area	Department	Process Date	Target	Actual
				27-08-2023	791.70	1014.40

Please look into: Report and Update Notification Log accordingly.

****This is an automated e-mail. Please **DO NOT** reply to this message.

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Emission Monitoring Solution - Predictions

Actual Vs. Predicted CO2e (TONNES)

351.83K (49.99%)
351.94K (50.01%)

CO2e (TONNES) AI/ML Model for Fuel Gas (MMSCFD)

- CO2e (Predicted)
- CO2e (Original)

Fuel Gas

CO2e (TONNES) Forecasting based on Fuel Gas (MMSCFD)

- CO2e (Original)
- CO2e (Predicted)
- Fuel Gas
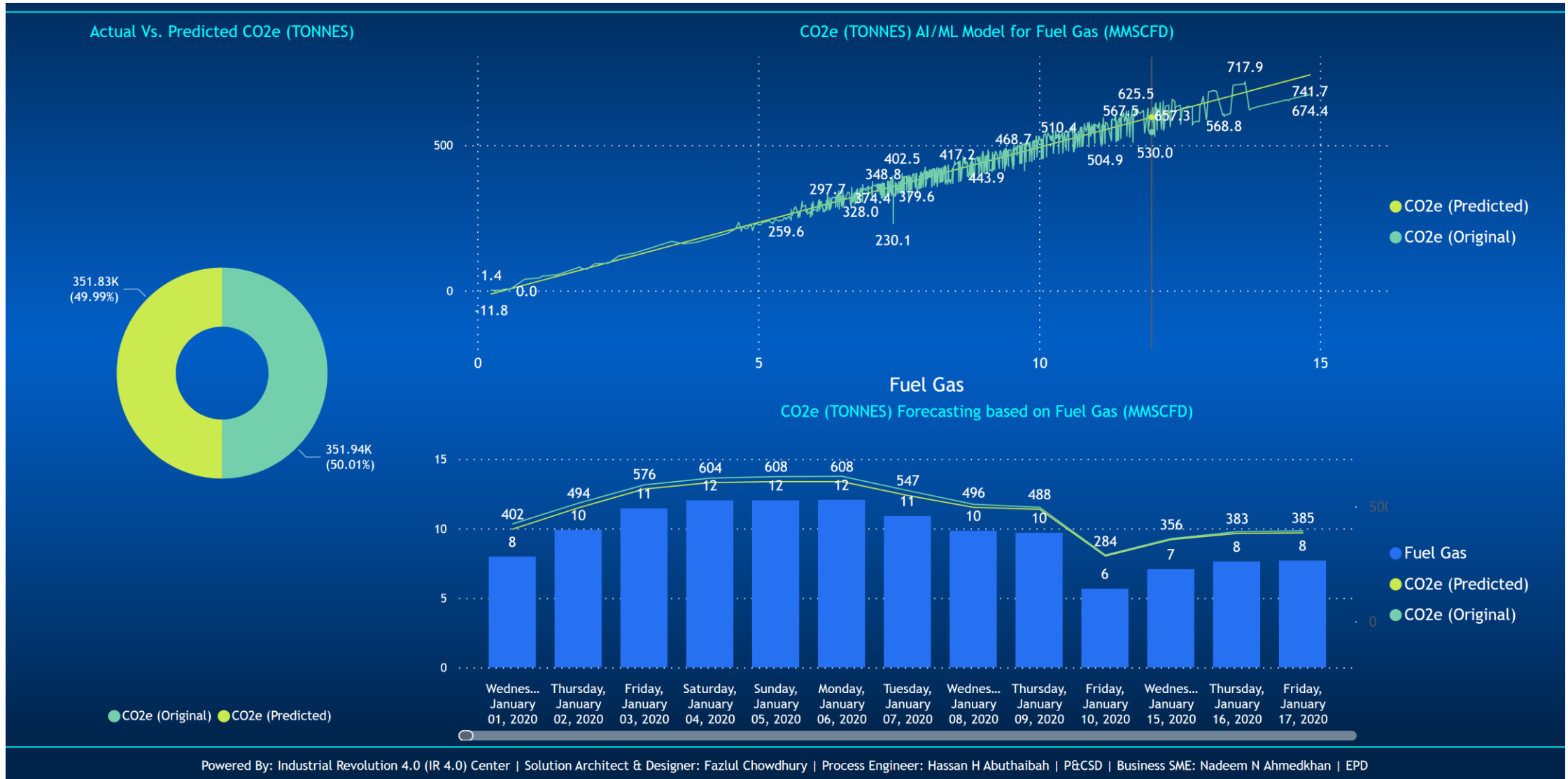
Powered By: Industrial Revolution 4.0 (IR 4.0) Center | Solution Architect & Designer: Fazlul Chowdhury | Process Engineer: Hassan H Abuthaibah | P&CSD | Business SME: Nadeem N Ahmedkhan | EPD

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Emission Monitoring Solution - Notifications

Mon 9/4/2023 1:10 PM

IS

IR4 SERVICE ADMINISTRATOR

[INTITIAL ALERT] Emission Monitoring Solution (EMS) Notification

To   ⊞ **EMS Administrators Group**

ℹ️ If there are problems with how this message is displayed, click here to view it in a web browser.

SAUDI ARAMCO
IR 4.0 CENTER NOTIFICATION PLATFORM

Dear Customer.

This is to inform you that, this department may exceed yearly CO2e target.

You are advised to investigate the reason of exceedances and take necessary actions to address this issue.

Please contact ARAMCO EMS Administrators for additional clarifications.

Company	Business Line	Admin Area	Department	Process Date	Target	Actual
				02-09-2023	3762679.42	4090216.16

Please look into: Report and Update Notification Log accordingly.

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Thank You

References

- [Our 2022 sustainability report | Aramco](#)
- [https://www.mckinsey.com/capabilities/quantumblack/our-insights/using-digital-and-ai-to-meet-the-energy-sectors-net-zero-challenge](#)
- [https://www.forbes.com/sites/markminevich/2021/10/08/11-examples-of-ai-climate-change-solutions-for-zero-carbon/](#)
- [https://www.bcg.com/publications/2021/ai-to-reduce-carbon-emissions](#)
- [https://www.bcg.com/publications/2022/how-ai-can-help-climate-change](#)
- [https://www.weforum.org/press/2021/09/artificial-intelligence-energy-transition](#)
- [Towards a Framework for Enterprise Architecture Analytics](#)