# Optimisation of Operational and Sustainability Practices For Aramco

**Seminar Group 4 Team 3**
Ayesha U2220739H
Jian Bo U2110567D
Sailesh U2221329C
Xinyi U2221219H
Liyi U2220985F

# Table of contents

01

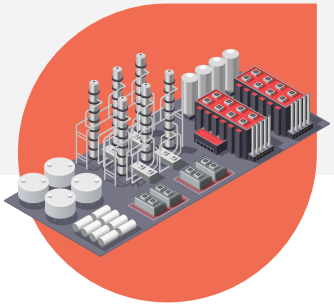
# Introduction

Opportunity Statement

# About Aramco


**Largest daily oil production**

**US$ 535b earned in 2022**



**2nd largest public company**

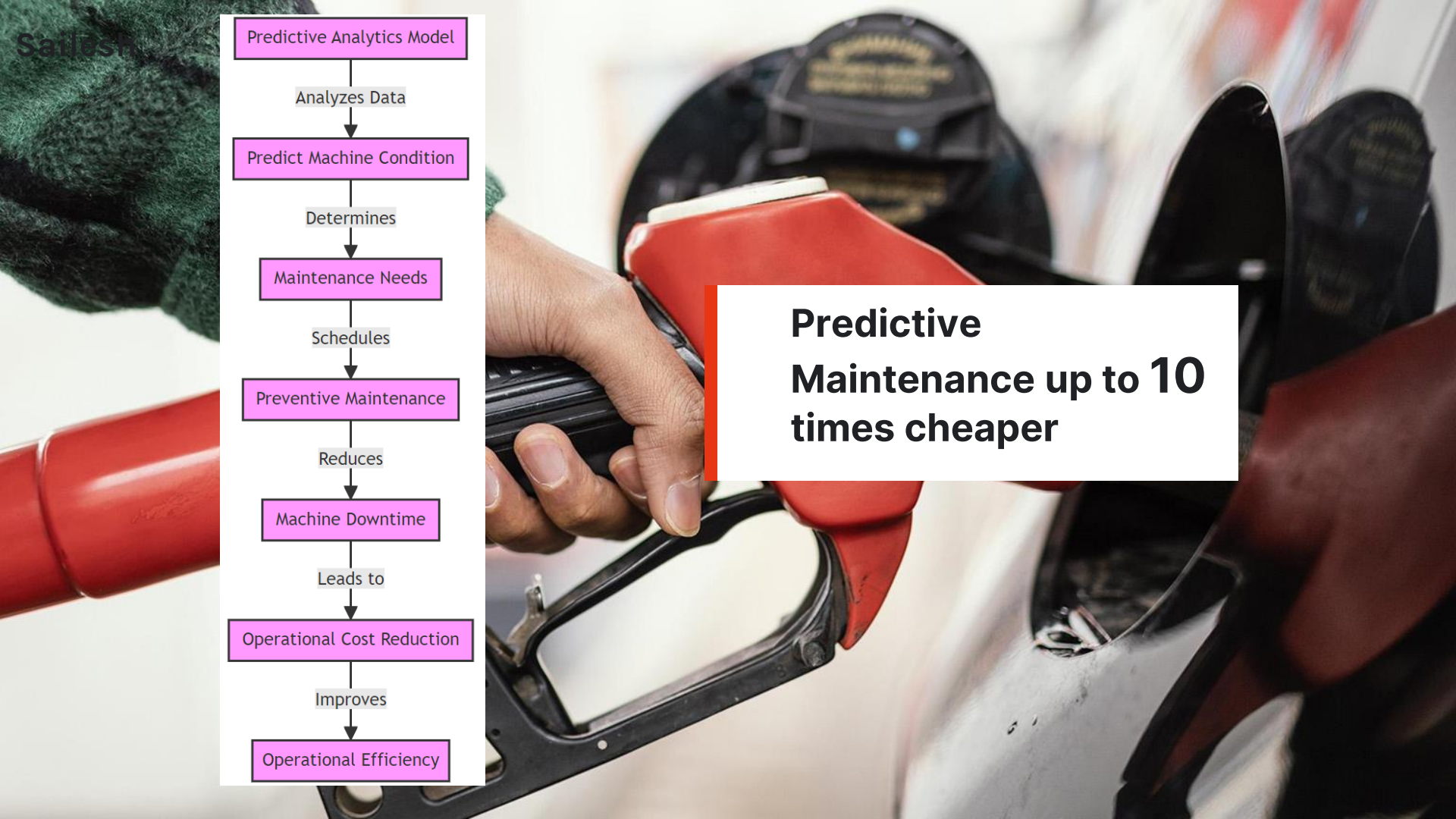
# Opportunity for Aramco


## Operational Efficiency

## Alternative Energy

Sailesh

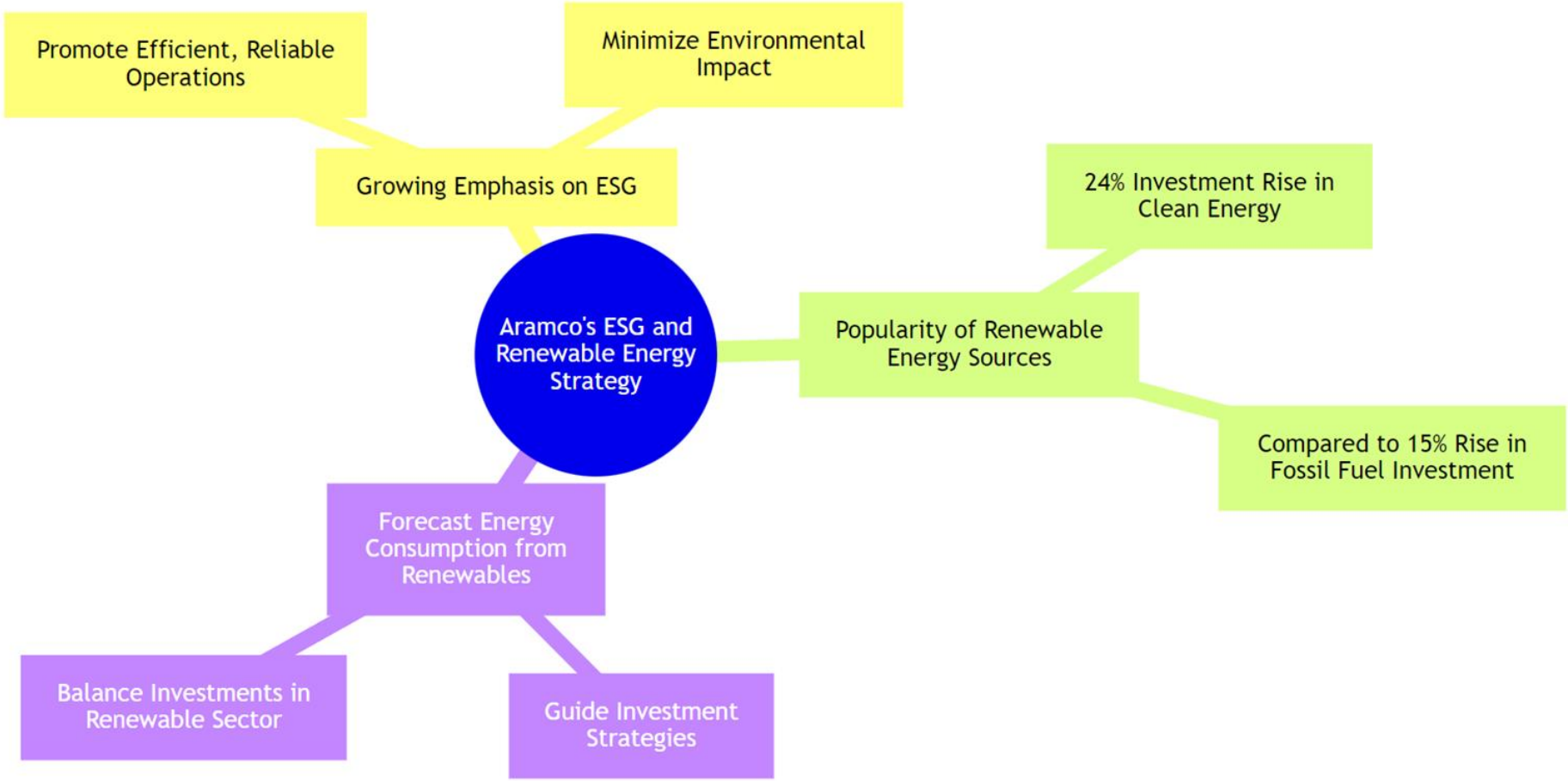
# Enhancing Operational Efficiences

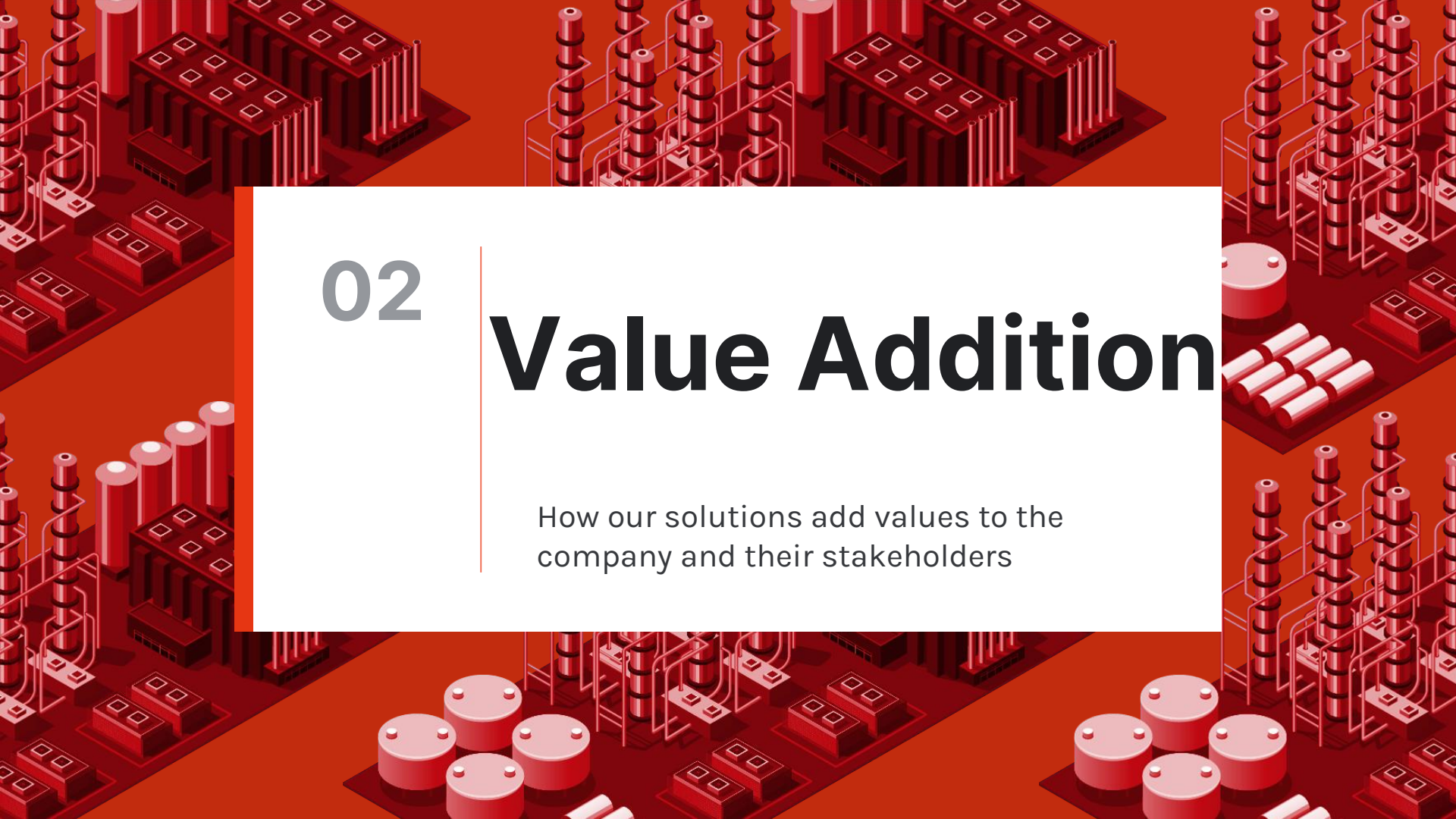

Predictive Analytics Model
Analyzes Data
Predict Machine Condition
Determines
Maintenance Needs
Schedules
Preventive Maintenance
Reduces
Machine Downtime
Leads to
Operational Cost Reduction
Improves
Operational Efficiency
Predictive
Maintenance up to 10
times cheaper

Sailesh

# Forecasting Demand for Renewable Energy

Sailesh


Promote Efficient, Reliable Operations
Minimize Environmental Impact
Growing Emphasis on ESG
Aramco's ESG and Renewable Energy Strategy
24% Investment Rise in Clean Energy
Popularity of Renewable Energy Sources
Compared to 15% Rise in Fossil Fuel Investment
Forecast Energy Consumption from Renewables
Balance Investments in Renewable Sector
Guide Investment Strategies



02

# Value Addition

How our solutions add values to the company and their stakeholders

Xinyi

# Value Addition to Aramco

## Operational Efficiency Enhancement

- Accurate prediction of machine conditions and maintenance needs.
- Proactive maintenance to reduce downtime and costly machine failures.

Xinyi

# Value Addition to Aramco

## Resource Allocation Optimization

- Predictive analysis of future renewable energy share.
- Guideline for oil production aligned with market demand.

Xinyi

# Value Addition to Aramco

## Diversification into Renewable Energy

- Exploring opportunities in the renewable energy sector.
- Focusing on solar panels for small to medium-sized firms.
- Expanding revenue streams while aligning with ESG goals.

# Value Addition to Aramco's Stakeholders

## Investors

01

- Empowered with knowledge of renewable energy trends.
- Able to capitalize on promising opportunities.
- Enhanced confidence in Aramco's stability and reliability.

## Governmen t

02

- Positive alignment with ESG policies.
- Utilizing predictions for infrastructure and incentives.
- Boosting economic efficiency and responsible resource management.

## Businesses

03

- Refining business strategy with industry trends.
- Leveraging our proposal for partnerships.
- Enhancing supply chain reliability.

03

# Methodology

How we made use of our data for analysis

# Data selection

## 01 Volume

Large volumes of data will be easier to analyse for the discovery of any patterns, correlations, and clustering for deeper insights

## 02 Accuracy

Having data that align closely with the actual characteristics of events being recorded which can allow for more reliable analysis

## 03 Timeliness

Having up to date data is also very important as it allows us to perform more timely predictions for the coming year.

# Datasets used

## Machine failure

- Identify significant factors that predict when machine failure will occur.

## Renewable energy demand

- Identify key factors to reliably predict future renewable energy demand.

# Linear Regression

| | |
|---|---|
| **01 Assumptions** | The independent variables and dependent variable are linearly related |
| **02 Application** | Through application of a linear approach to model the relationship between the variables, we will then be able to determine the significance of the independent variables when predicting the dependent variable. |
| **03 Potential Problems** | Large number of independent variables could result in multicollinearity, which our team overcame through calculating the variance inflation factor (VIF) through the ratio of overall model variance of each specific variable |
| **04 Backward Elimination** | To simplify the process, we made use of the step function which would remove independent variables that resulted in the highest impact on the equation until the optimal model is reached. |
| **05 Interpreting data** | To interpret the optimal model that is generated, we will have to look at the coefficients of the model where it shows the relationship between the individual variables with the dependent variable. |

# Classification and Regression Tree

| | |
|---|---|
| **01 Assumptions** | No assumptions are needed when using the CART model |
| **02 Application** | Decision Tree is grown to the maximal using the Gini Index through testing independent variables to determine the best split, splitting continues until the largest tree is achieved. |
| **03 Potential Problems** | A decision tree that is grown to the maximum is very likely to be overfitted and there will be too many decision nodes for any meaningful analysis. Hence , we will find optimal model between the max and min tree. |
| **04 Pruning** | To achieve the optimal tree, we will do pruning through using the prune function which will automatically determine the first node where the mean error is lower than the sum of squared errors (SSE) |
| **05 Interpreting data** | To interpret the optimal model that is generated, we will have to look at the decision nodes to determine which variables are significant for obtaining the terminal nodes that are optimal to us |

# Comparison between both models

## Linear Regression

- Assumes a linear relationship between independent and dependent variables.
- Independent variables are normally distributed
- Data has to be cleaned as linear regression will skip through NA values

## CART

- Comprehensive model that is capable of dealing with data regardless of linearity
- Able to deal with missing value through replacing them with surrogates
- More difficult to interpret than Linear Regression

## Similarities

We will make use of the 70 - 30 train - test split to prevent overfitting of the models as we can make use of the test set to test the predictive capabilities of the model.

04

# Results & Analysis

The interpretation of our results and model comparison

Ayesha

# Key Predictor Variables

Predicting Machine Failure

## Logistic Regression

- Rotational speed
- Torque
- Tool wear
- Air temperature
- Process temperature

## CART

- Rotational speed
- Torque
- Tool wear
- Air temperature
- Process temperature

Ayesha

# Model Comparison

Predicting Machine Failure

## Logistic Regression

| Prediction | Reference: no failure | Reference: failure |
|---|---|---|
| no failure | 2503 | 24 |
| failure | 395 | 78 |

## CART

| Prediction | Reference: no failure | Reference: failure |
|---|---|---|
| no failure | 2608 | 9 |
| failure | 290 | 93 |

Positive class: ‘no failure’, Negative class: ‘failure’

Ayesha

# Model Comparison

Predicting Machine Failure

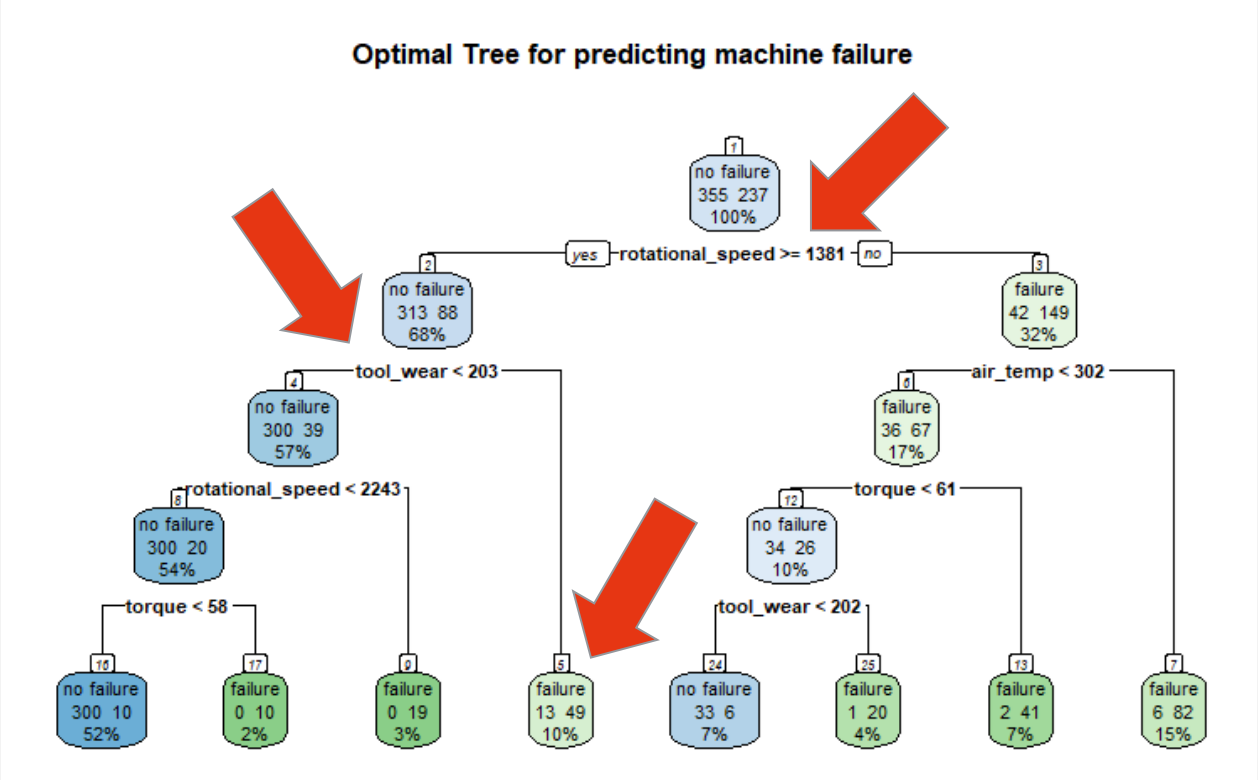
| | Logistic Regression | CART |
|---|---|---|
| Misclassification Error | 14 % | 10 % |
| True Negative Rate | 76 % | 91 % |
| False Positive Rate | 24 % | 9 % |

Positive class: ‘no failure’, Negative class: ‘failure’

Ayesha

# CART Model

## Predicting Machine Failure



Ayesha

# Key Predictor Variables

Predicting Renewable Energy Share

## Linear Regression

- C02 Emission
- Energy intensity

## CART

- C02 Emission
- Energy intensity

# Model Comparison

Predicting Renewable Energy Share

| | Linear Regression | CART |
|---|---|---|
| RMSE (train set) | 24 | 20 |
| RMSE (test set) | 24 | 25 |

RMSE: the average difference between the actual and predicted values

Ayesha

# Linear Regression Model

## Predicting Renewable Energy Share

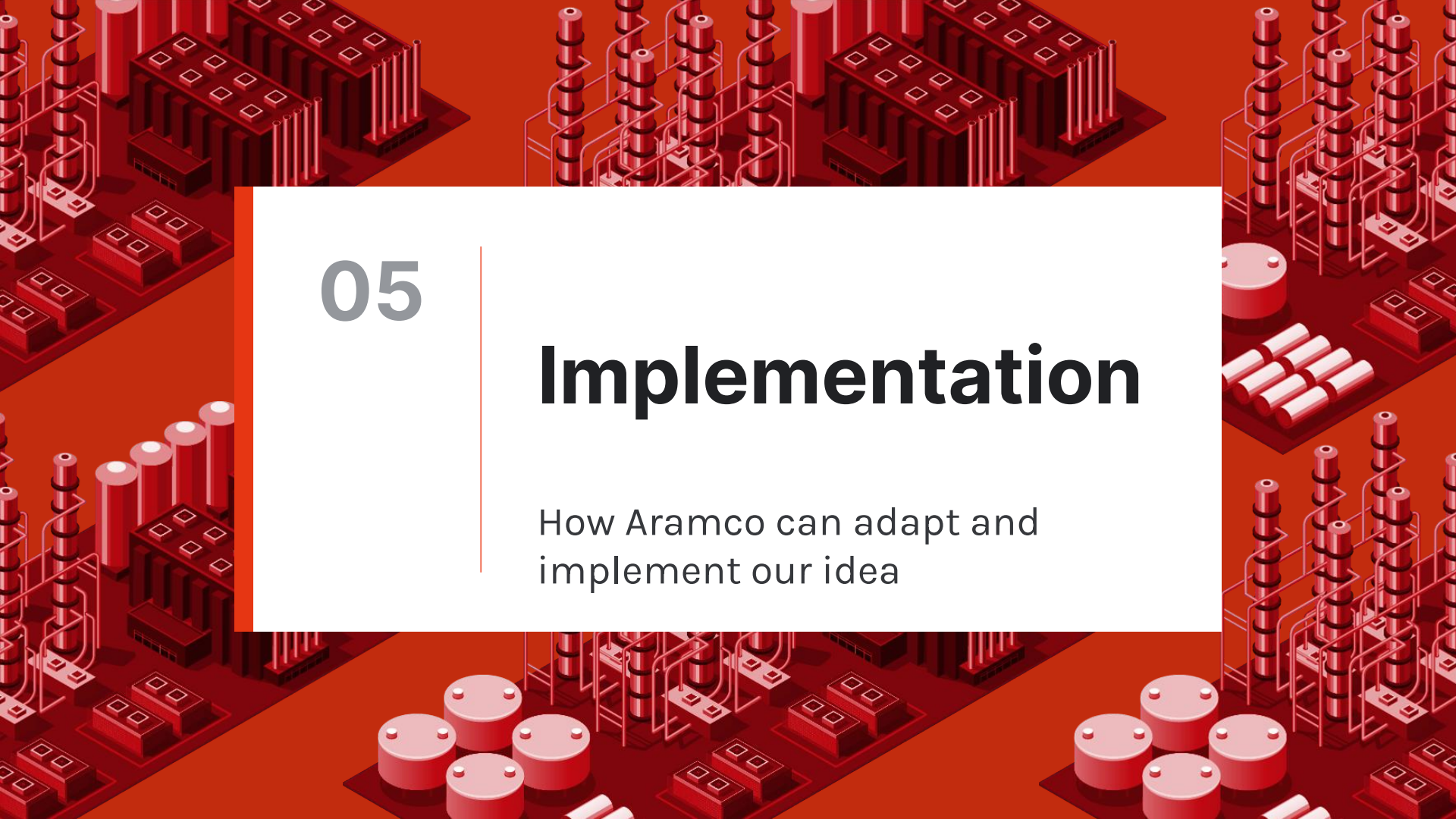
Renewable energy share = **40** + **22** *Energy Intensity* - **4** *C02 Emissions*

C02 Emissions have a negative correlation with renewable energy share

# Limitations

Incomprehensive Predictor Variables

Vulnerability to Unforeseen Circumstances

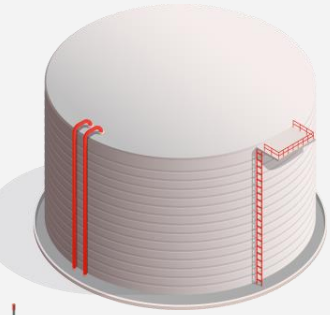


05

# Implementation

How Aramco can adapt and implement our idea

Liyi



+

Less than 4 days of unplanned downtime will cost

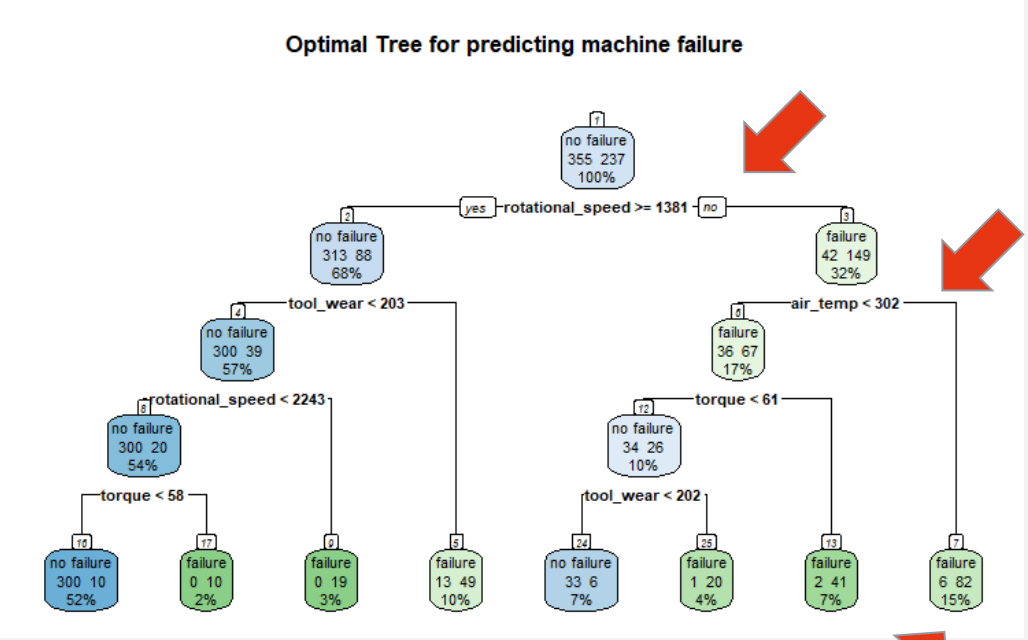
27 DAYS!

# Predictive Maintenance

## 1. Rule-Based Alerts through Real-time Monitoring

Using the CART model, a monitoring system can be implemented that triggers alerts when the conditions specified in the rules are met.

The logistic regression model can provide probabilities of failure, which can be used alongside the rule-based system to make better decisions.

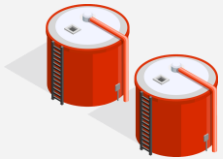


Liyi

# Predictive Maintenance

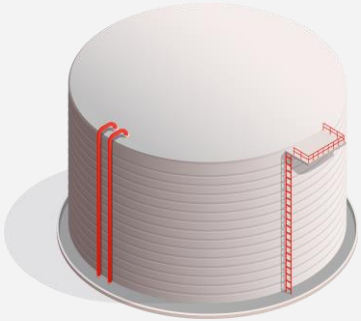
## 2. Operational Adjustments

Adjust operational parameters that are significant to avoid entering high-risk zones.



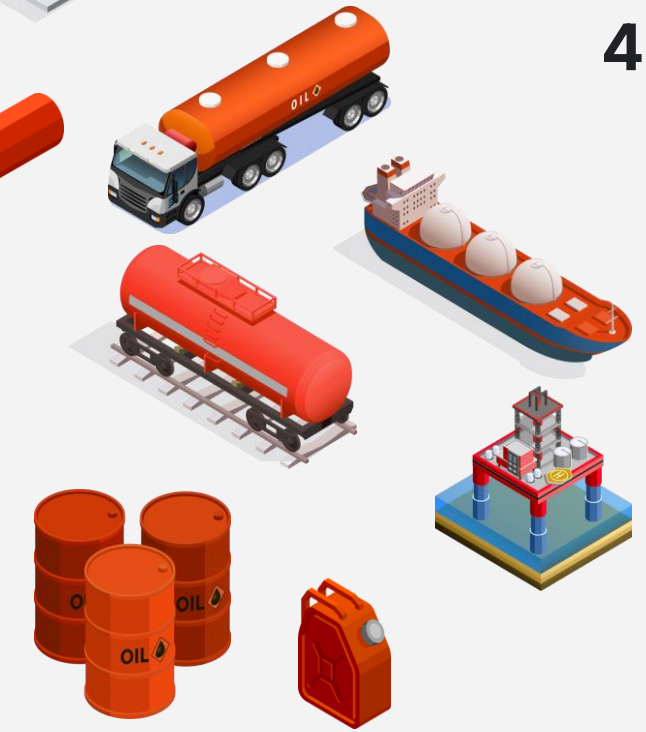
## 3. Resource Optimization

Prioritise maintenance resources to equipment that frequently operates near the failure conditions.



Liyi

# Predictive Maintenance




## 4. Equipment Design and Purchasing

Aramco can use the data to make informed decisions in the design and purchase of new equipment.

New equipment can be designed or selected to operate more reliably under those conditions.

Companies using predictive maintenance achieve a 5 to 10% improvement in production efficiency, and a 20 to 30% decrease in maintenance costs compared to using time-driven maintenance philosophies.

# Navigating the Alternative Energy Market

## 1. Demand Forecasting

Linear Regression using C02 Emissions and Energy Intensity.

Aramco can implement a demand forecasting system using these variables as key inputs.

## 2. Market Diversification Strategies

Aramco can target investment in renewable energy in regions where C02 Emissions and energy intensity cross the identified thresholds, which indicate a high potential for renewable adoption.

This will allow Aramco to make more precise investment decisions.

Regions with higher energy intensity are more likely to adopt renewable energy sources more aggressively.

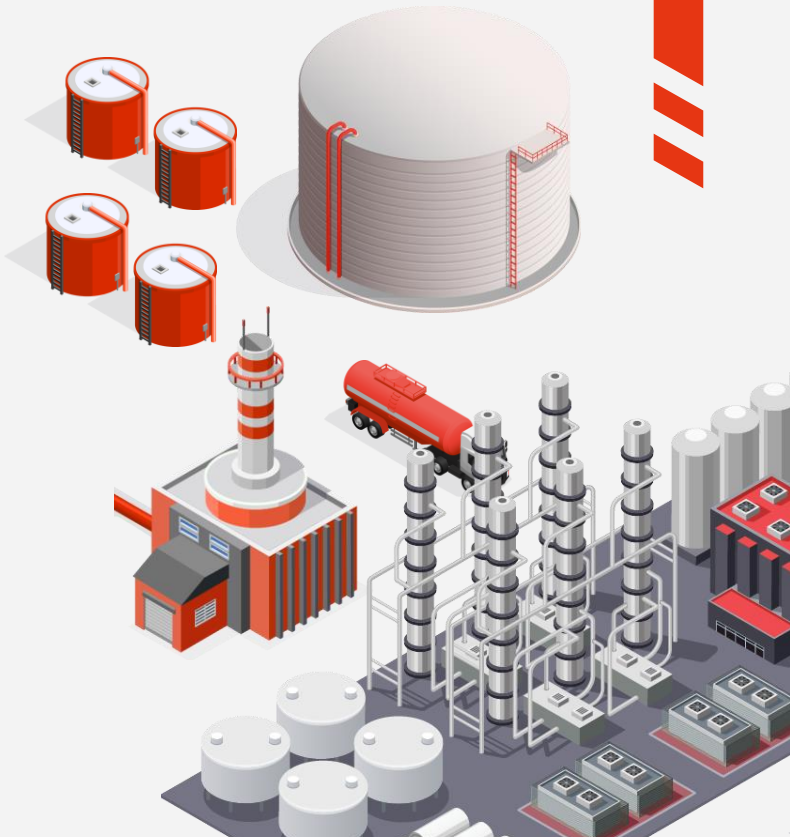
# Navigating the Alternative Energy Market

## 3. Policy Analysis

C02 Emissions and Energy Intensity in the Linear Regression model highlight that policy changes affecting these variables are likely to have a significant impact on the renewable energy market.

Aramco can engage in policy analysis and advocacy in line with their ESG goals.

Aramco could also create an adaptive business model that can capture the impact on renewable energy demand accurately.



Liyi

# Thank you!

**Do you have any questions?**