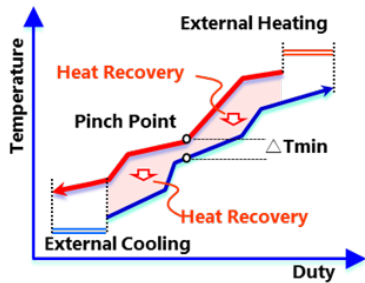
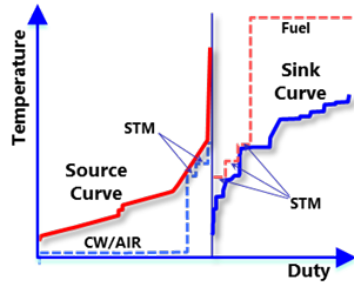


# Decarbonization

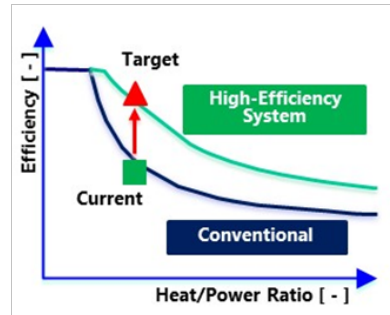
JGC Group provide a large variety of Decarbonization Program which is the proprietary GHGs assessment solution and optimized operation service based on our successful experiences in countless EPC & O&M fields.



Energy Utilization and Optimization of Heat Recovery System

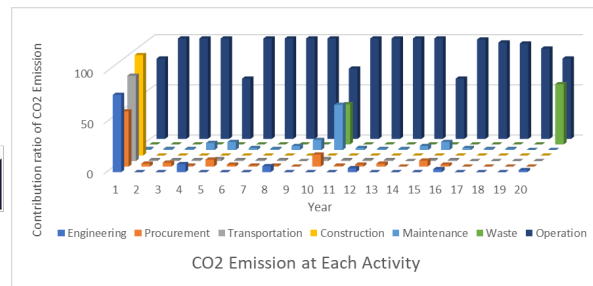
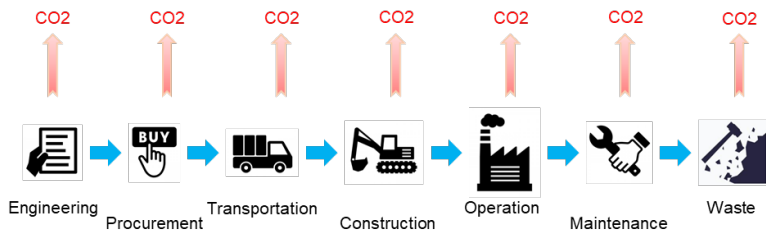


Optimization of Site-Wide Energy Usage



Optimization of Power-Steam Supply System

## Pinch Analysis



CO2 footprint of Plant Lifecycle/Life Cycle Management

Service Menu

Return to OE Service menu

## ◆ Decarbonization Program

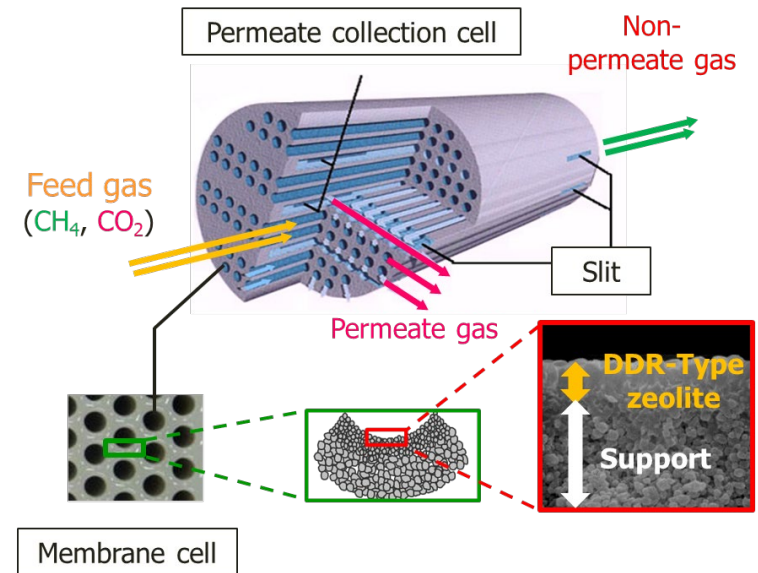
GHG Quantification Service (HiGHGuard™)

Life Cycle CO2/Management

CO2 Removal Solutions

Energy Optimization

Fired Heater Improvement



DDR Membrane - High Performance Separation Technology



# Operational Excellence Services

## Decarbonization GHG Quantification Service



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# GHG Quantification Service

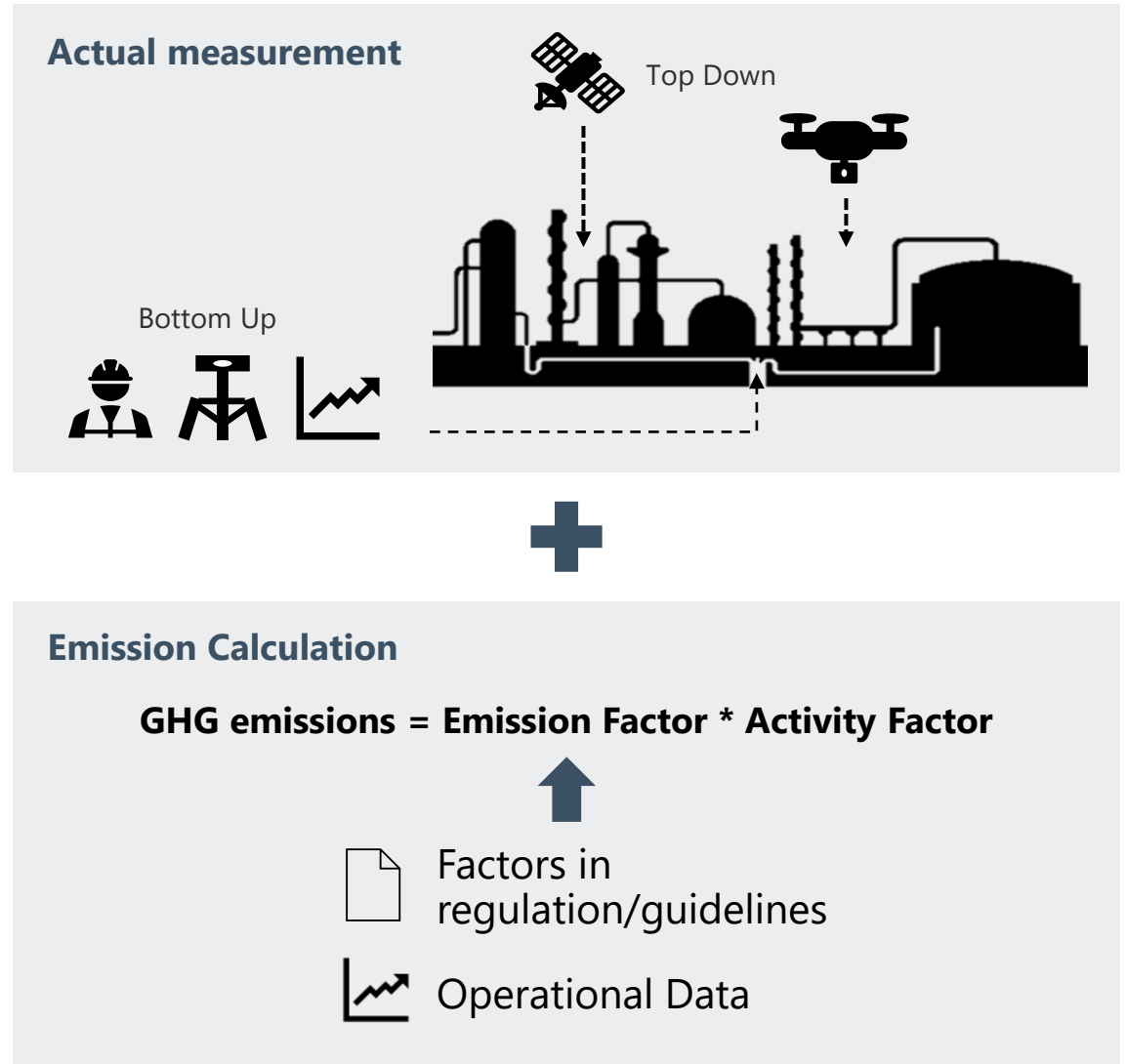
## Do you have any of these issues?

- ☹️ **Difficulty in quantifying GHG (including CH<sub>4</sub>)**
- ☹️ **Need to quantify emissions in actual operation**
- ☹️ **Identifying baseline for decarbonization project**

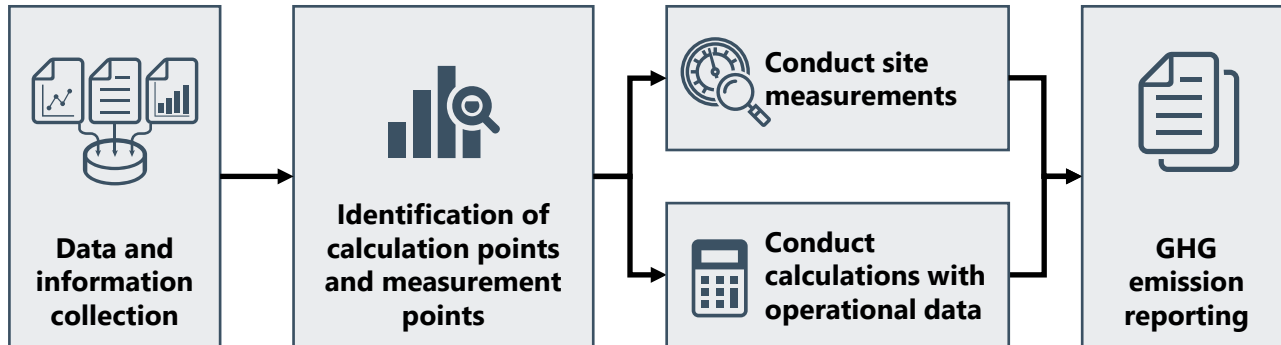
## GHG Quantification

- Quantify GHG (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O) by actual measurement and engineering calculation.
- Conduct actual measurement with drone, satellite, handheld sensor, IR camera
- Provide optimized MRV(\*) methodology
- Reporting the GHG emission to the authorities.

(\*) Measurement, Reporting and Verification



## Workflow & Results



### Steps

- Identify measuring points and calculation points from design documents.
- Conduct engineering calculations / Actual measurements
- Report to client or government agency with preset format

### JGC is

- able to select the most appropriate MRV methodology from those proposed by international organizations and standards/guidelines
- familiar with a variety of plants and can provide the best combination of drones, satellites, and handheld sensors

## Our Strengths

- Professional HSE, Process, Mechanical Engineer Teams
- Dispatched technical experts to participate in various international discussions on GHG Measurement, Reporting and Verification (MRV).
- Experience in EPC and O&M of many types of facilities in many locations around the world.
- Collaboration between oversea group companies and local companies.

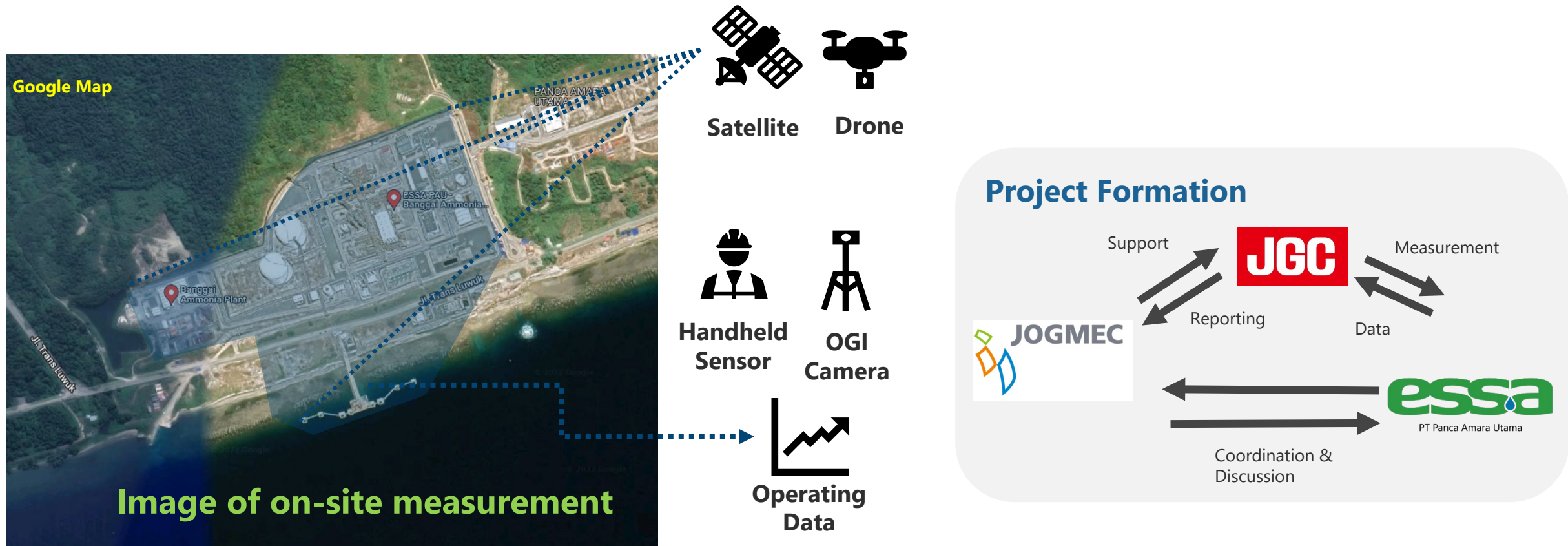
## Our Background

- JGC has been commissioned by Japan Oil, Gas and Metals National Corporation (JOGMEC) to develop their guidelines.
- The Institute of Energy Economics, Japan (IEEJ) has contracted JGC as a technical adviser for GHG MRV

(\*) PAU: PT Panca Amara Utama

## Project in Actual plant

- JOGMEC/JGC completed **direct measurement** to quantify Methane emission in PAU(\*) Ammonia Plant. (Dec-2022)
- **Satellite / Drone / Handheld Sensor / Camera** have been used in the project
- CO2 calculation has been conducted using operating data.





## Decarbonization Life Cycle Assessment/ Management (CO2 Footprint)



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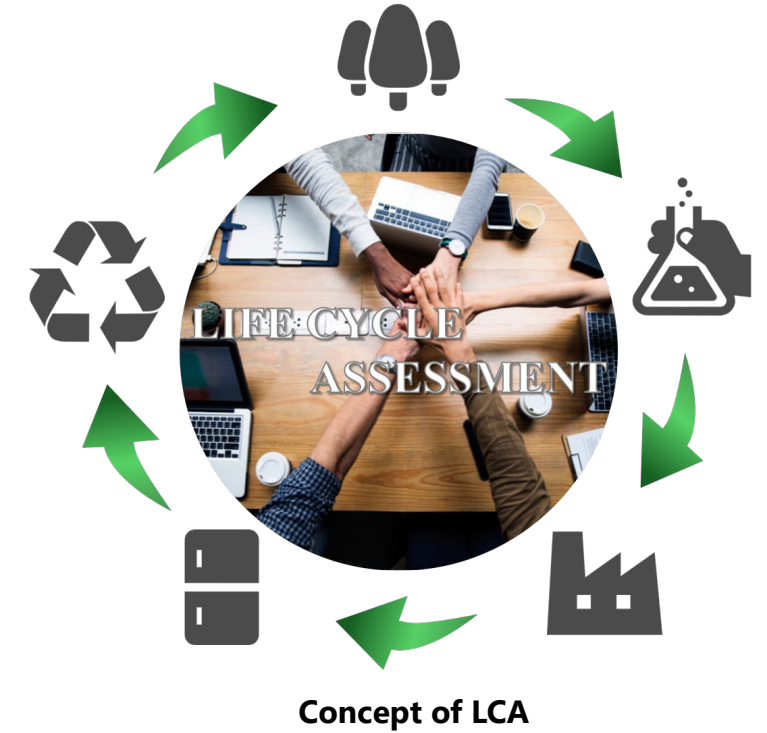
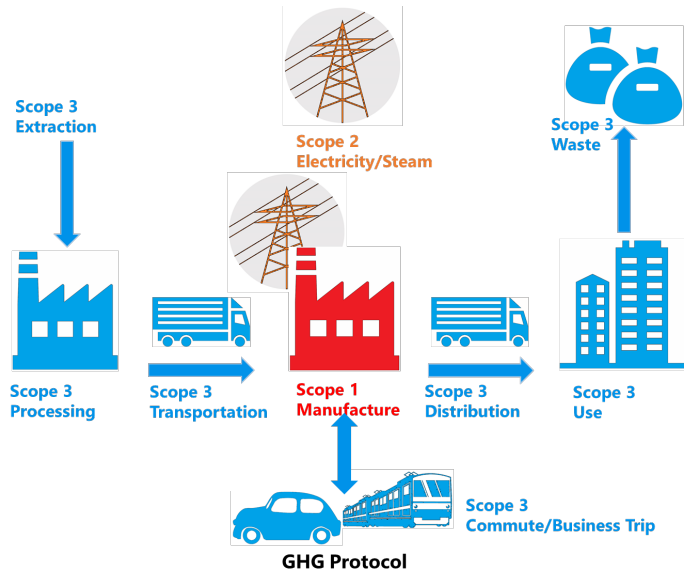
<https://www.jgc.com/en/business/epc/operation-maintenance/service/>

# Life Cycle Assessment/Management (CO<sub>2</sub> Footprint)

## What is the Life Cycle Assessment (LCA)?

LCA is a method of assessing the environmental impact of your product or service throughout its life cycle (resource extraction, raw materials, product production, distribution, consumption, disposal, recycling) or at a specific stage. LCA can objectively and quantitatively evaluate whether a product is "good" or "friendly" for the environment, human body, and society.

## Advanced Application of LCA (LCM) to ....



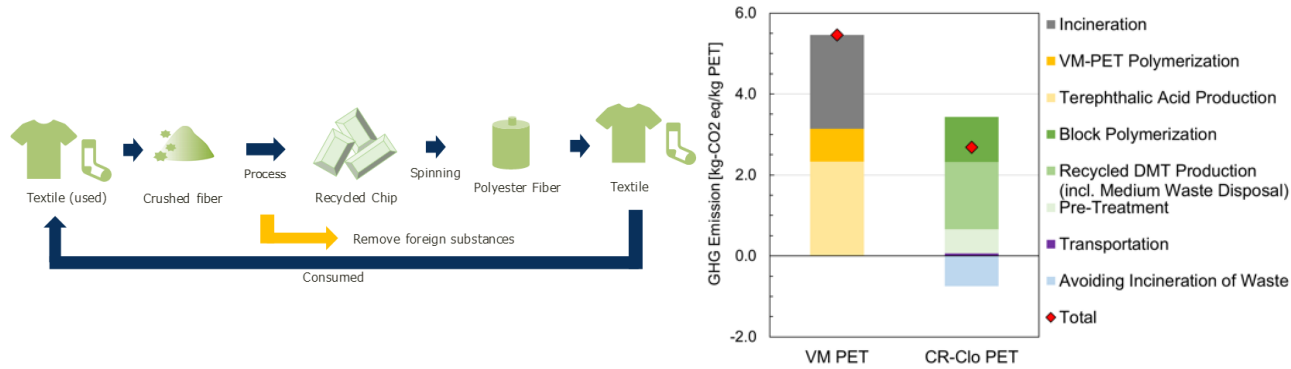
High Client Concern on Environment Impact, Optimized Plant Life Cycle (Engineering, Procurement, Construction, Commissioning, Start up, Maintenance, Manning, Turnaround, Demolition) , GHG Protocol (Scope 1/2/3)

# Life Cycle Assessment/Management (CO<sub>2</sub> Footprint)

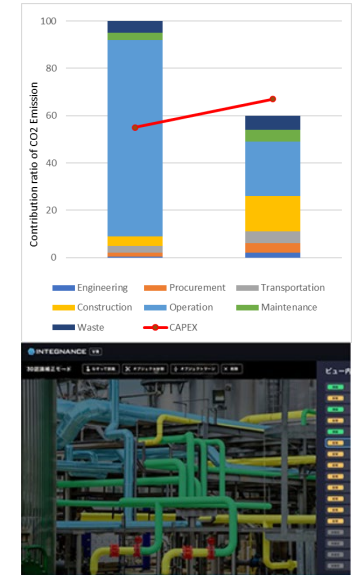
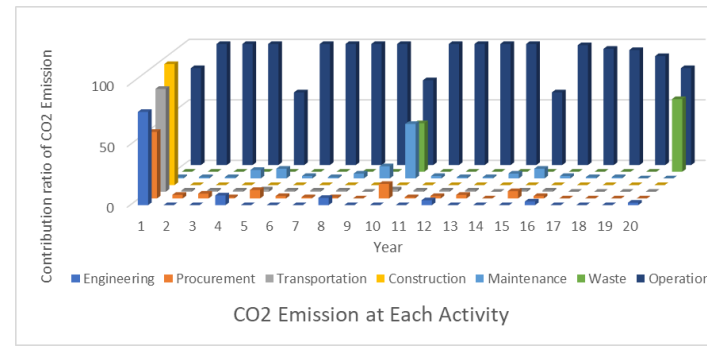
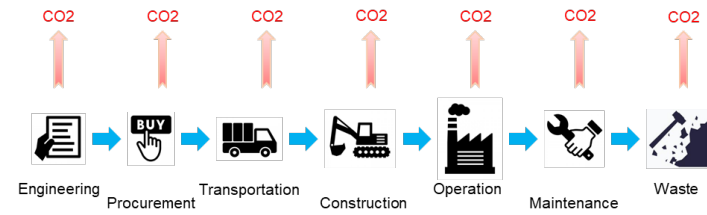
Return to Decarbonization menu

## Case Study, Experiences and expectations

### LCA of your product or service (e.g. Polyester Chemical Recycling)



- Numerical result of CO<sub>2</sub> emissions
- Higher CO<sub>2</sub> reductions are expected compared with conventional process
- Visual presentation of hot spots
- The scope of evaluation, methods, and assumptions that greatly affect the results, it depends on the implementers and companies



- LCA case studies for new decarbonized technologies and made presentation in the International Conference (EcoBalance 2022)
- Calculate CO<sub>2</sub> footprint (Scope 1/2/3) for CDP Report 2021 and 2022, JGC Holdings got Score B.
- Attend the 8th S-LCA Conference 2022 – Leave No One Behind -

### CO<sub>2</sub> footprint of Plant Lifecycle/Life Cycle Management

- Numerical approach for plant life cycle (GHG Protocol Scope 1/2/3)
- With Data-centric (DX), environmental impact as well as the operation data, can be monitored in real time, and identify the hotspots.
- Present data visualizations of high CO<sub>2</sub> emission hot spots during maintenance periods
- Trade off between CAPEX/OPEX and CO<sub>2</sub> emission rate for optimization







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## Decarbonization CO2 Removal Solutions



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# CO2 Removal Solutions

## Challenges for CO2 Capture in Operating Assets

### Management of Increased CO<sub>2</sub> in Feed Gas

CO<sub>2</sub>



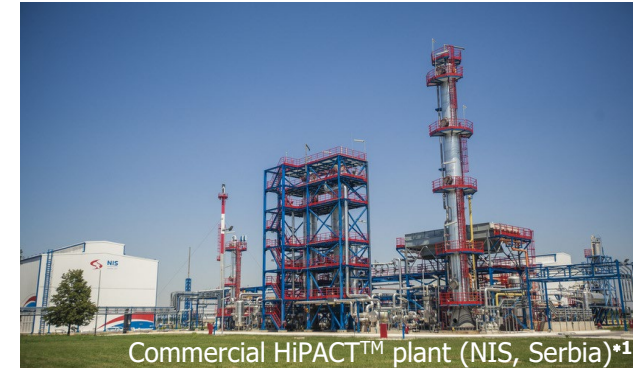
- ✓ Natural gas/associated gas quality varies over the life of oil/gas fields.
- ✓ Unexpected increases of CO<sub>2</sub> in the feed gas requires additional CO<sub>2</sub> capture units/enhancement of the CO<sub>2</sub> capture performance.

### Limited Space and Utilities



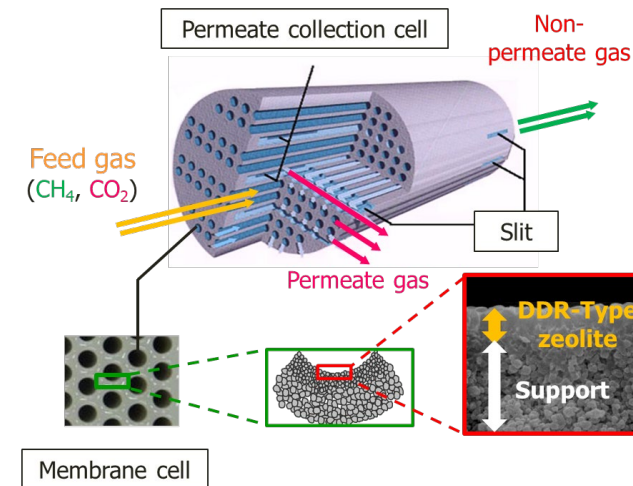
- ✓ Limitation in the available space to accommodate the new unit/expansion of the unit.
- ✓ Limitation in the available utilities to operate the CO<sub>2</sub> removal unit

## HiPACT® - an Innovative CO<sub>2</sub> Capture Process



Commercial HiPACT™ plant (NIS, Serbia)\*1

## DDR Membrane - High Performance Separation Technology



# CO<sub>2</sub> Removal Solutions – DDR Zeolite Membrane

## DDR Zeolite Membrane

### Technology

- Technology jointly developed by JGC and NGK
- World's largest zeolite membrane element

### Advantages

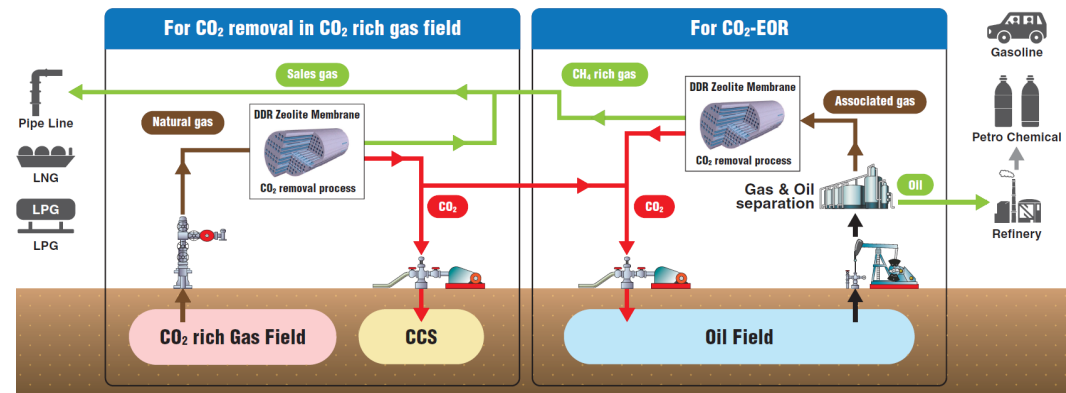
- Enhanced separation performance  
= minimal hydrocarbon loss
- Tough under high pressure, high CO<sub>2</sub> concentration  
= longer membrane life
- Significant lifecycle cost saving (20-30%)



### Application

- Natural Gas Processing (CO<sub>2</sub> removal in CO<sub>2</sub> rich gas fields)
- CO<sub>2</sub> recovery from associated gas for CO<sub>2</sub>-EOR(\*) projects

(\*) EOR: Enhanced Oil Recovery



### Technology Development Status

- Field tested at U.S. oil field (2017, completed)
- Commercial scale field test at U.S. oil field (from 2020)

Details of the technology can be found at:

<https://www.jgc.com/en/business/tech-innovation/environment/ddr-membrane.html>

# CO2 Removal Solutions - HiPACT®

Return to Decarbonization menu 

## HiPACT® - CO2 Capture Process

### Technology

- Chemical absorption process, using newly developed absorption solvent (jointly developed with BASF)

### Advantages

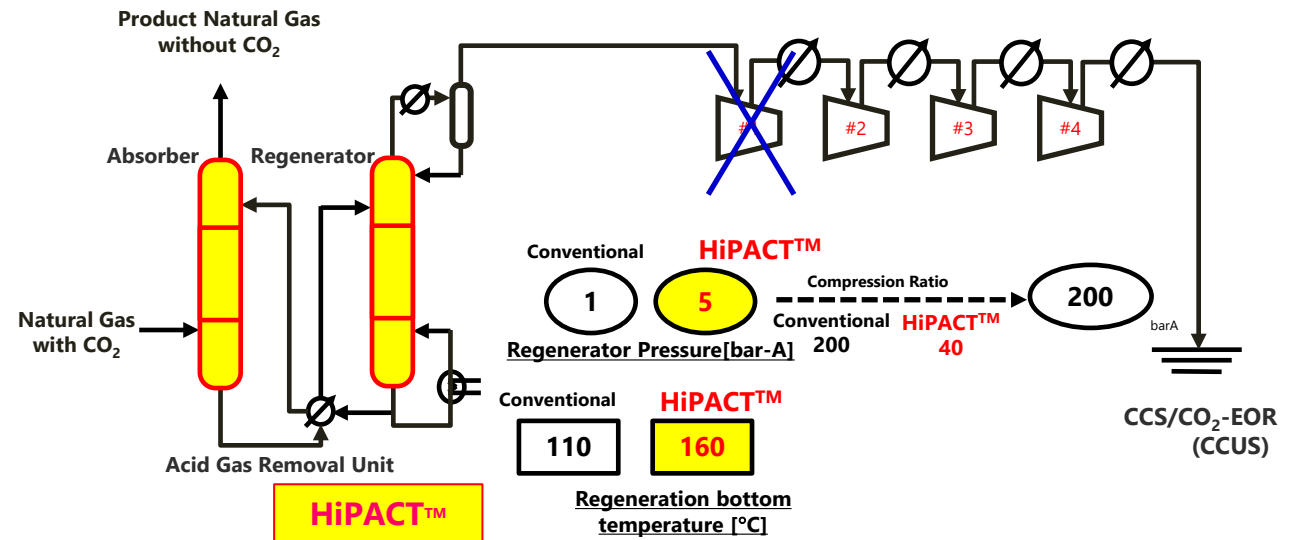
- Highly stable against thermal degradation
- Enables high pressure CO<sub>2</sub> stripping, leading to significant energy and cost saving (25 to 35% reduction)
- Reducing the number of compression stages, optimizing the space



Commercial HiPACT™ plant (NIS, Serbia)\*1

### Reduction of initial investment and reduction of operating costs

by high pressure CO<sub>2</sub> stripping process



Details of the technology can be found at:

<https://www.jgc.com/en/business/tech-innovation/environment/hipact.html>



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**Decarbonization**  
**Energy Optimization**



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# Energy Optimization

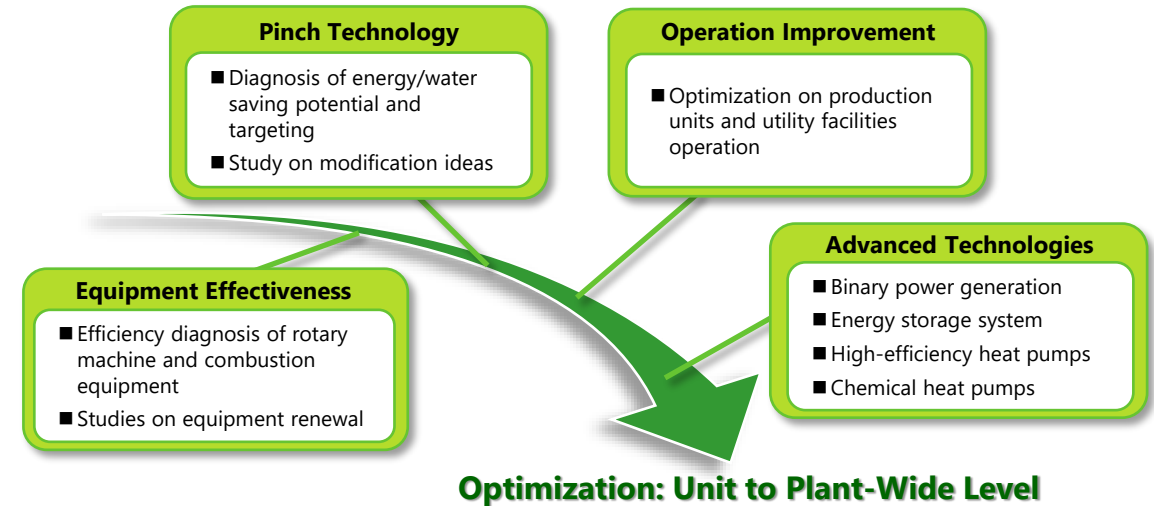
## Do you have any of these issues?

- ☹️ **How to reduce energy consumption?**
- ☹️ **How to eliminate equipment bottlenecks?**
- ☹️ **What kind of equipment should be updated to improve efficiency?**

## What is our service ?

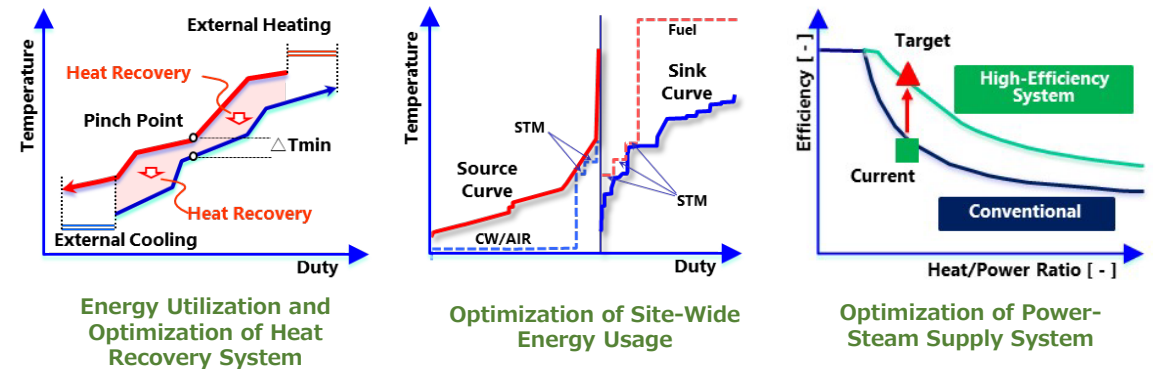
- **Equipment Effectiveness:** Diagnosis to identify the efficiency of existing facilities to be improved and suggestions for types of equipment to be modified.
- **Pinch Analysis:** Identify heat recovery target and create solutions such as heat recovery networks that balance the trade-off between investment costs and energy savings.
- **Operation Improvement:** Studies on unit operation and utility facilities modifications to improve energy efficiency.
- **Advanced Technology:** Studies and proposals on the introduction of high-efficiency equipment and new heat recovery technologies.

## Our Approach

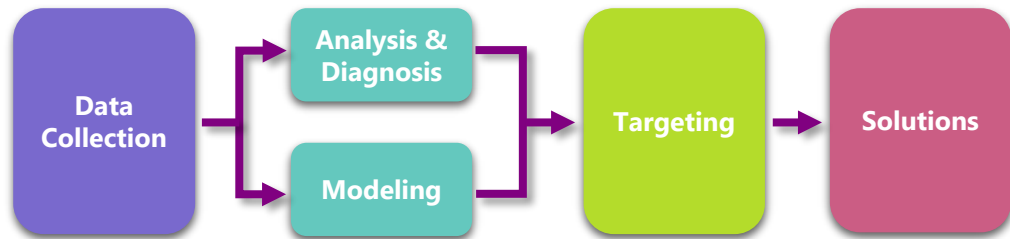


## What is Pinch Analysis?

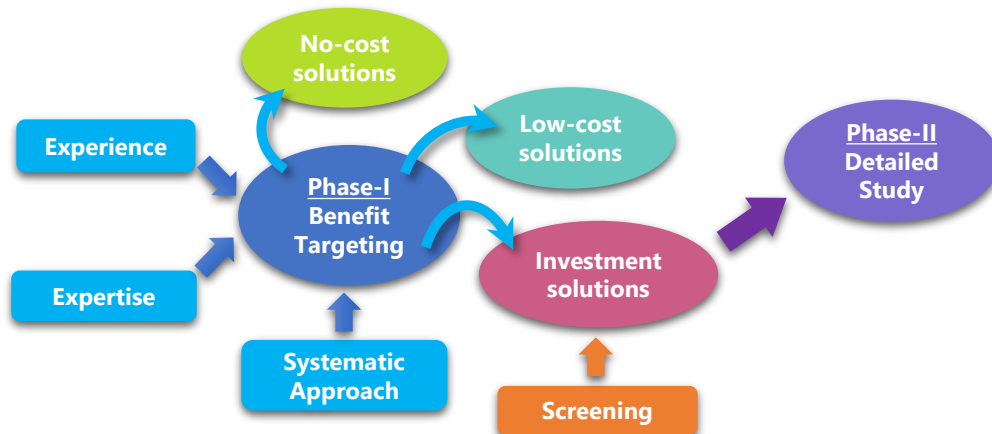
### Systematic and Visualization Methods to Identify the Target



## Workflow & Result



- Plant Data collection(Operating Data, Climate Data)
- Analysis and diagnosis
- Modeling for Pinch Analysis, and Targeting
- Prioritization of solutions into tree categories as Phase-I
- As Phase-II, detailed study to materialize the investment solutions proposed in Phase-I



## Our Strengths

- The proven and successful experiences in executing similar consultancy services.
- Extensive technical knowledge and know-how for energy and water conservation.
- Qualified professionals.
- Collaboration between overseas EPC-capable group companies and out-sourcing for consultancy services.

## Our Experiences

**50+**  
**Projects**

Industry	Japan	Overseas
Petroleum Refinery	26	11
Petrochemical	6	4
Chemical	5	-
Steel	1	-
<b>Total</b>	<b>38</b>	<b>15</b>

- Contributed to over 50 projects in various phases (FS, Pre-FEED, FEED, EPC, Revamps) for Petroleum Refinery, Petrochemical, Chemicals, etc.
- We are certified by a national oil company as an energy consultant.



# Operational Excellence Services

## Decarbonization Fired Heater Improvement



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# Fired Heater Improvement

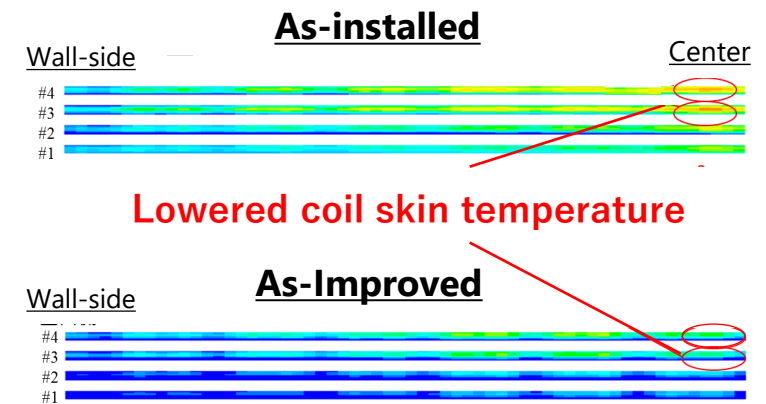
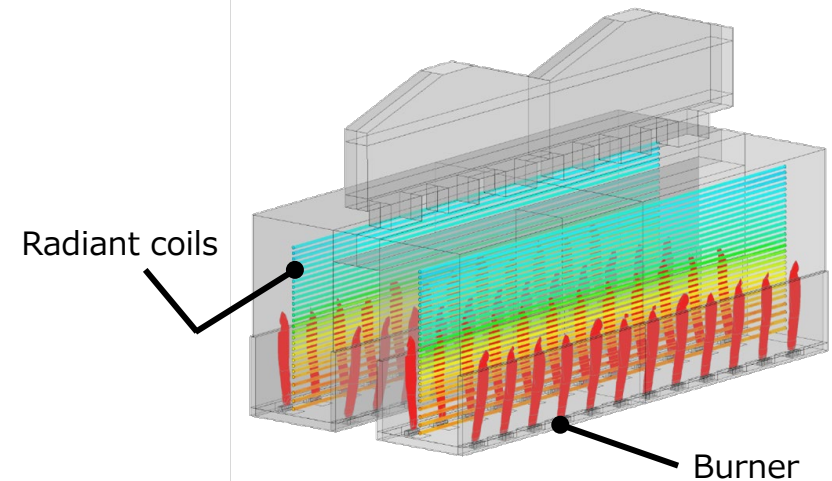
## Do you have any of these issues?

- ☹️ **Poor performance and unreliable operation**
- ☹️ **Reducing maintenance interval due to severe material degradation**
- ☹️ **Need for engineering consulting partner for heater modification**

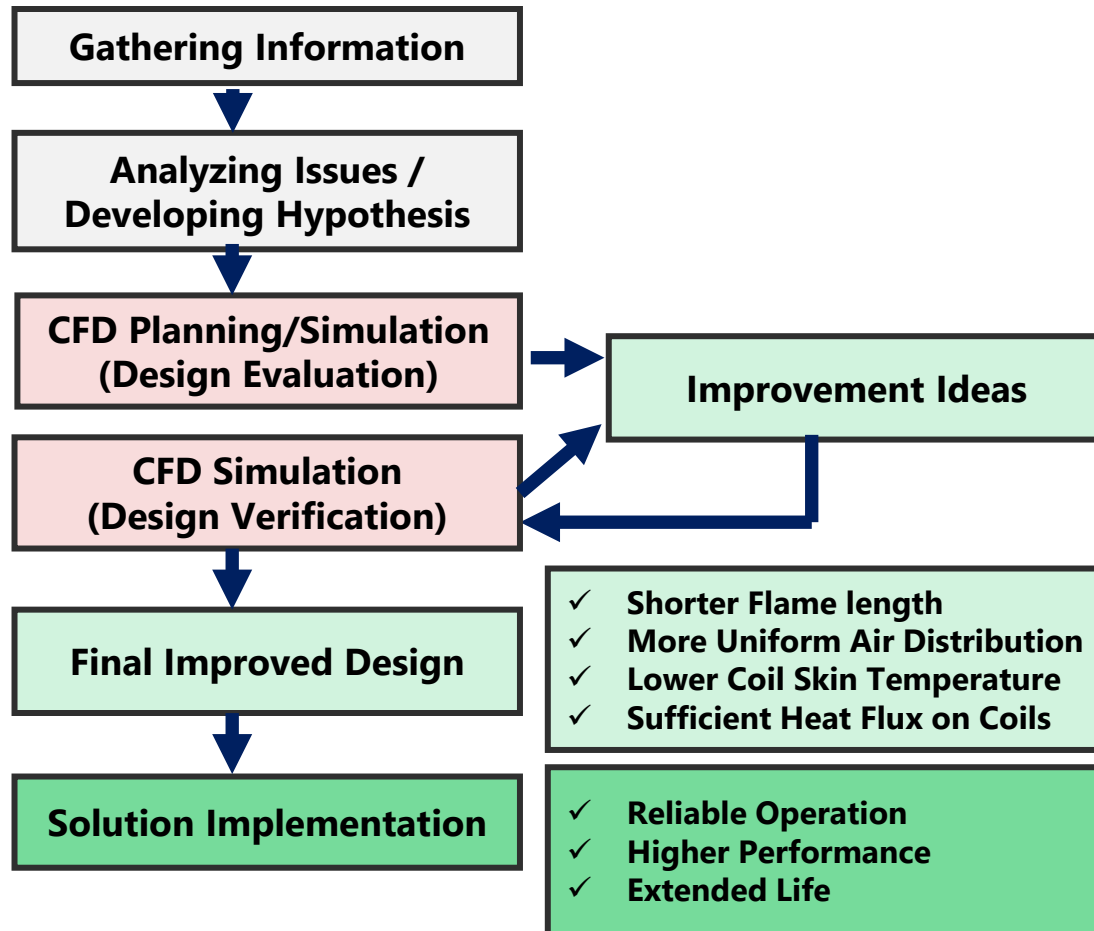
## Fired Heater Improvement Solution

- Utilized **Computational Fluid Dynamics (CFD)** to simulate Combustion and Heat Transfer
- Assessed as-installed Heater Performance based on operation data and CFD Results
- Identified O&M Issues and their Root Causes
- Proposed and Evaluated Performance and Reliability Improvement Plan
  - Burner Layout Optimization for Replacement
  - Windbox Modification for Uniform Air Flow Distribution to each burner
- Provided the Technical Guidance for the Implementation of the proposed solutions

### Examples of combustion and heat transfer analysis of Furnace (CFD)



## Workflow & Result



## Our Strengths

- Years of experience in serving domestic customers for performance improvement of fired heaters utilizing the advanced CFD simulation
- Extensive experience in Combustion and Heat Transfer modeling and evaluating heater designs
- Collaboration with Material Engineering experts
- Customer-Focused Global Engineering Service Provider

## Our Experiences

**50+**  
Plants

Fired heater design evaluation and improvement studies with the advance CFD simulations

**15+**  
Years

Simulation-based engineering service for plant diagnosis and lifetime improvement