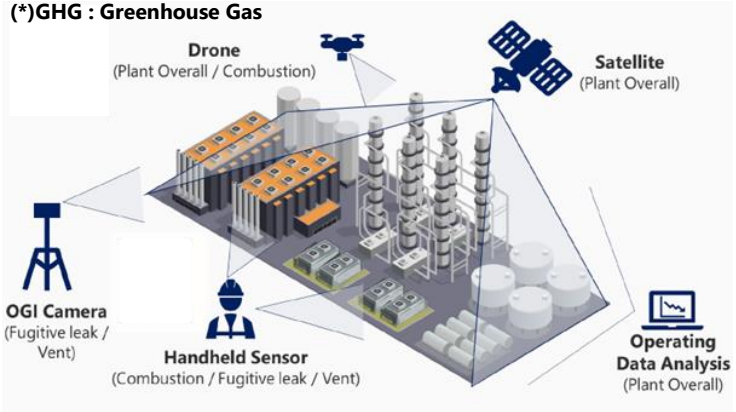
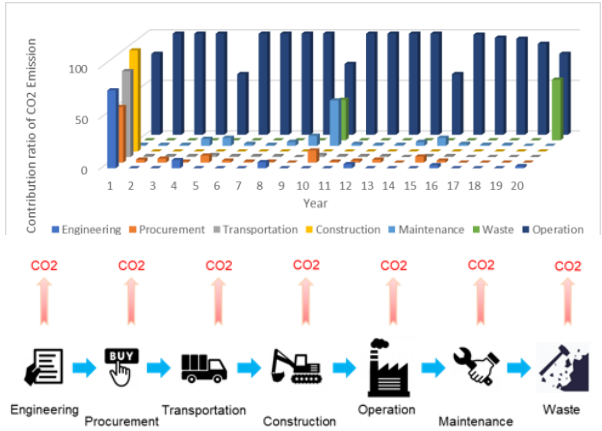
Decarbonization

JGC Group provides a large variety of Decarbonization Programs which are the proprietary GHG(*)s assessment solution and optimized operation service based on our successful experiences in countless EPC & O&M fields.

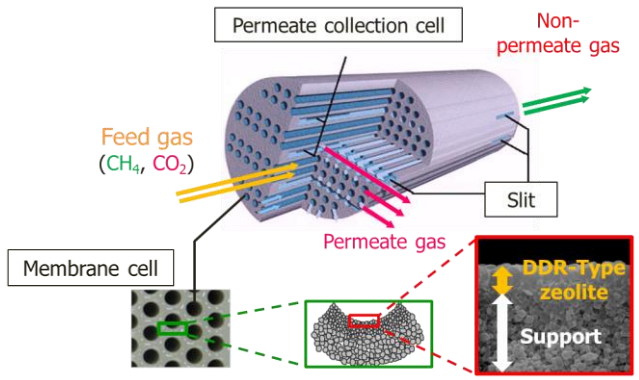
(*)GHG : Greenhouse Gas



HiGHGuard™(GHG Management Service)

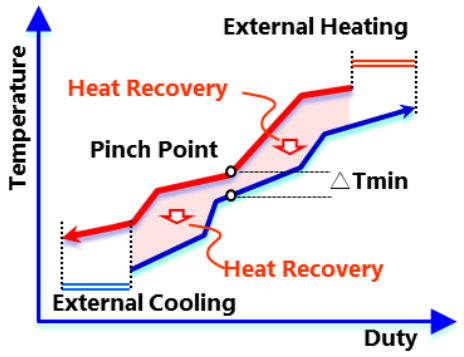


Life Cycle Assessment/Management (CO2 Footprint)

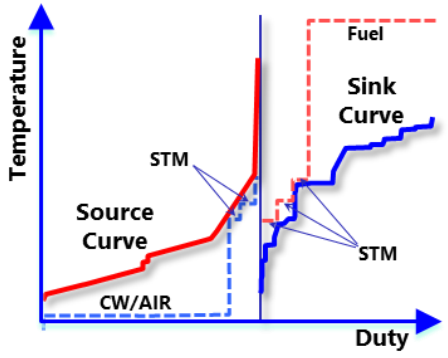


DDR (*) Membrane (CO2 Removal)
High Performance Separation Technology

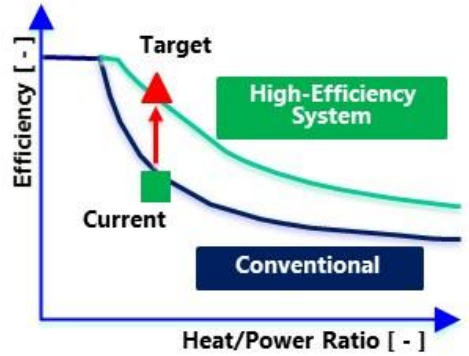
(*)DDR : Deca-Dodecasil 3R, A type of zeolite with a specific crystal structure



Energy Utilization and Optimization of Heat Recovery System



Optimization of Site-Wide Energy Usage



Optimization of Power-Steam Supply System

Energy Optimization-Pinch

Service Menu

- **Decarbonization Program**
  - HiGHGuard™ (GHG Management Service)
  - Life Cycle Assessment / Management (CO2 Footprint)
  - CO2 Removal Solutions
  - Energy Optimization
  - Sustainable Combustion & Heating Optimization

Operational Excellence Services

Decarbonization

HiGHGuard®

(GHG Management Service)

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GHG Management Service

HiGHGuard

Do you have any of these issues?

- ☹ **Need to comply with EU Methane Regulation**
- ☹ **Difficulty in quantifying CH_4 emissions**
- ☹ **Need to quantify emissions in actual operation**
- ☹ **Difficulty in selecting appropriate combinations of measurement technologies**

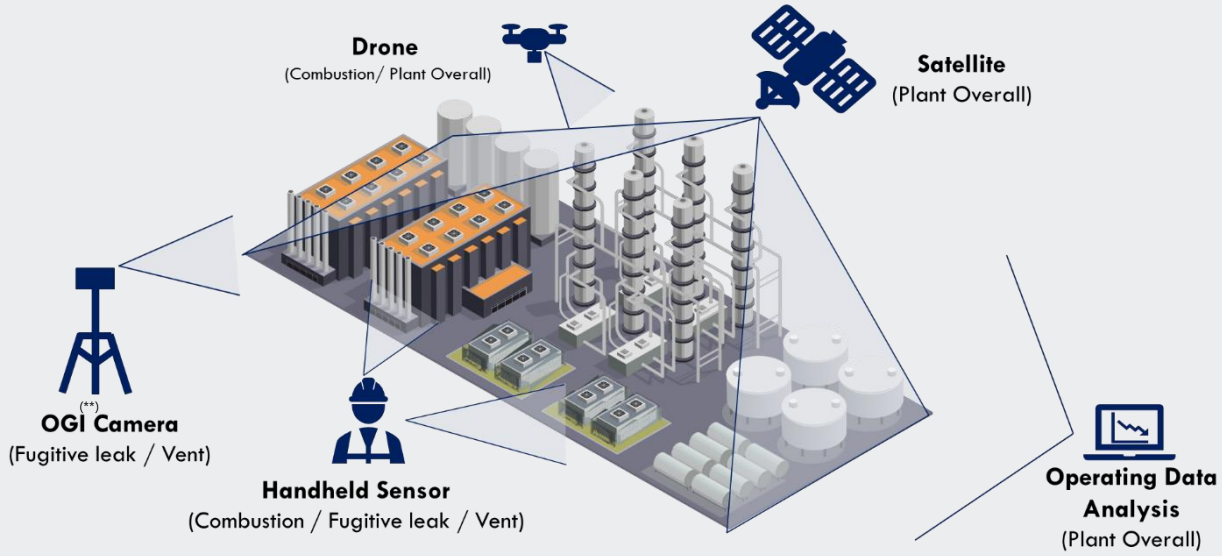
GHG Management Service

- Provide optimized MRV(*) methodology.
- Conduct actual measurement using drones, satellites, handheld sensors, IR cameras etc., and engineering calculation.
- Report GHG emission to the authorities.
- Provide technical consultation including Zero Routine Flaring (ZRF) study.

(*) MRV: Measurement, Reporting and Verification

Actual measurement

(**) OGI: Optical Gas Imaging



Technical evaluation

✓ Only company in Asia to evaluate methane quantification technology.

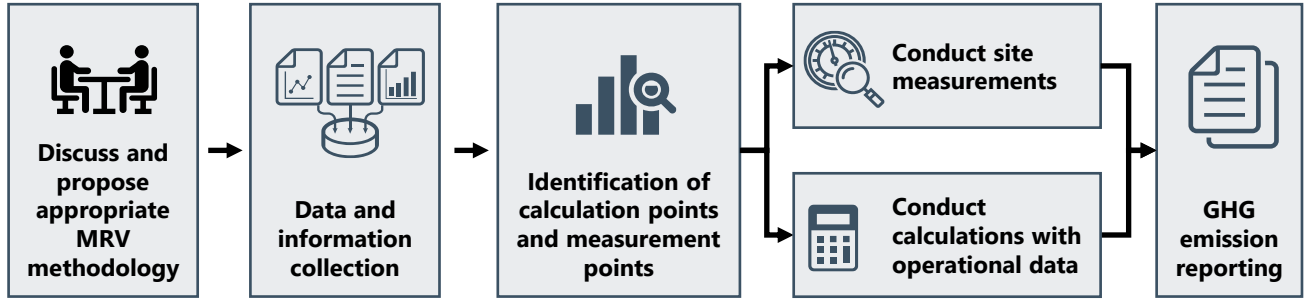
Technical consultation

✓ Zero routine flare (ZRF) study
✓ Operation optimization

GHG Management Service

HiGHGuard

Workflow & Results



Steps

- Discuss and propose appropriate combinations of measurement technologies.
- Identify measurement and calculation points based on design documents.
- Conduct engineering calculations and actual measurements.
- Report to client or government agency with preset format.

JGC is

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

Our Strengths

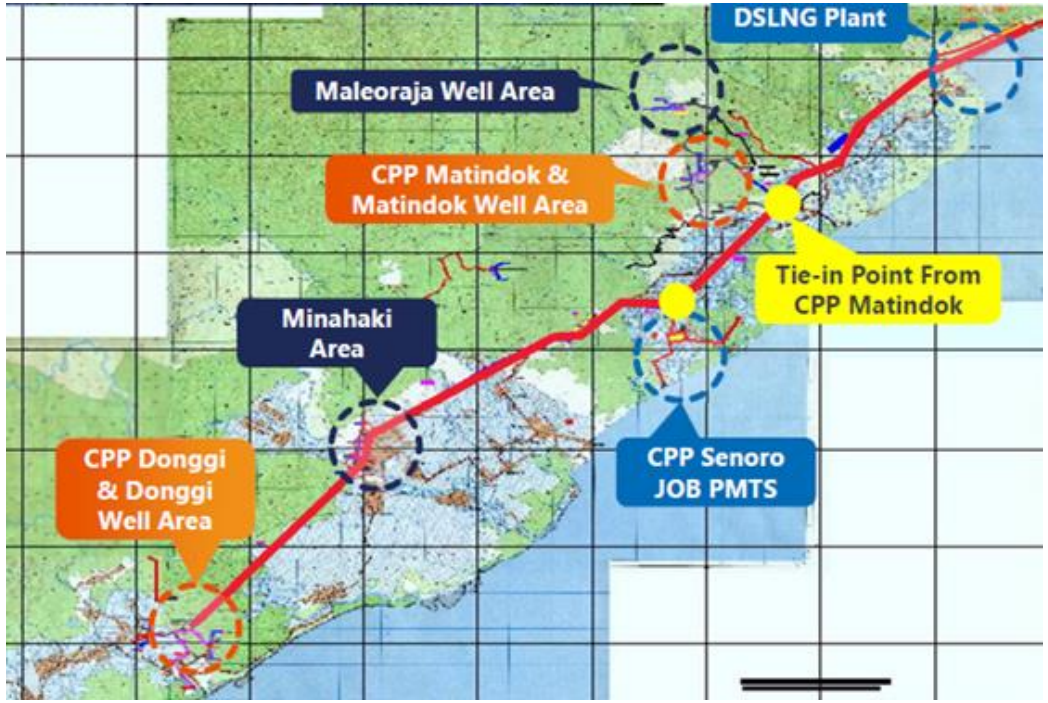
- The only company in Asia to evaluate methane quantification technology in own facilities (JGC METEC).
- Capability to reliably execute MRV based on the experience in EPC and O&M of many types of facilities in many locations around the world.
- Experience in MRV of many types of facilities in several countries.
- Professional HSE, Process, Mechanical Engineer Teams.

Our Background

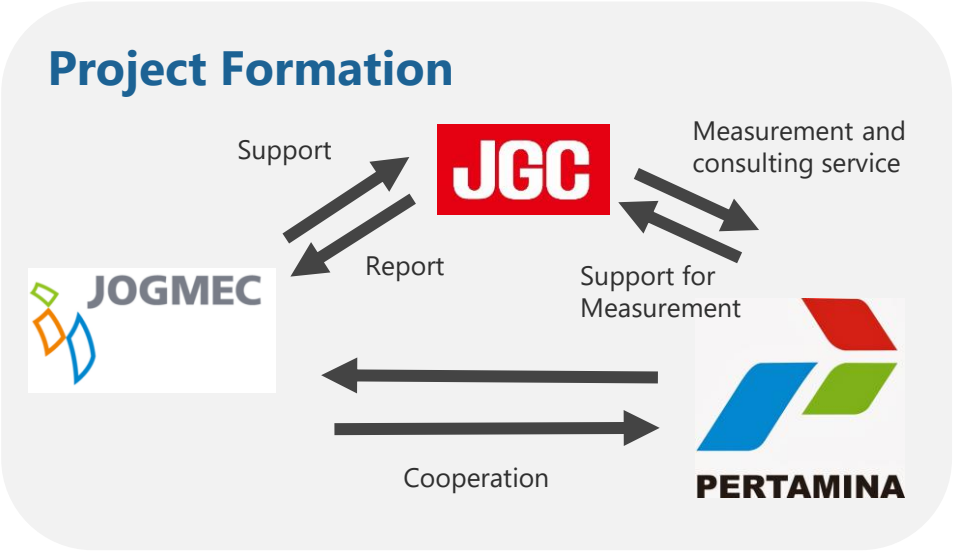
- JGC has been commissioned by Japan Oil, Gas and Metals National Corporation (JOGMEC) to develop their guidelines.
- The Institute of Energy Economics, Japan (IEEJ) has contracted JGC as a technical adviser for GHG MRV

Project in Actual Plant

- JOGMEC/PERTAMINA/JGC completed **direct measurement** to quantify Methane emission in **natural gas production facilities**. (2024-2025)
- **Satellite / Drone / OGI Camera / Handheld Sensor** have been used in the project.
- Contribute to Pertamina's **Zero-Routine Flaring (ZRF)** targets through ZRF study.



Project Area Map



Case Study : Feasibility Study for Southeast Asia METEC (SEA METEC)

Return to Decarbonization menu

Feasibility Study for Southeast Asia METEC

(*) METEC: Methane Emissions Technology Evacuation Center
(**) LDAR: Leak Detection and Repair
(***)OGI: Optical Gas Imaging

- SEA METEC is a facility designed for LDAR training and the evaluation of measurement technologies, established by JOGMEC and PETRONAS.
- JGC conducted **a feasibility study for SEA METEC** based on its expertise from JGC METEC.
- **JGC is supporting the establishment of SEA METEC**.

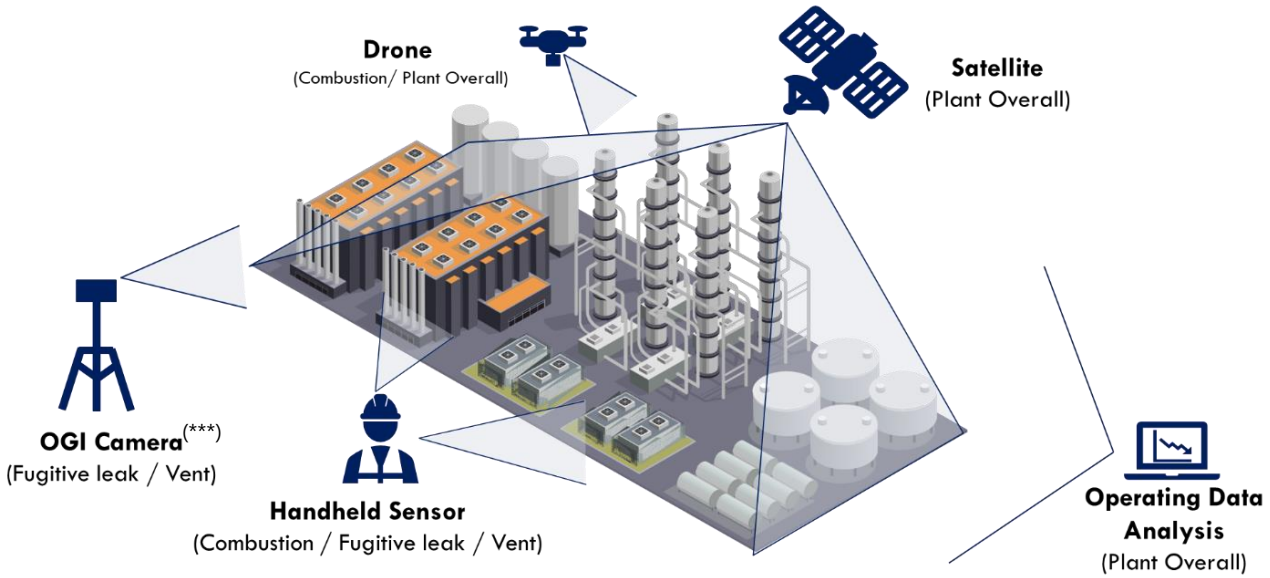
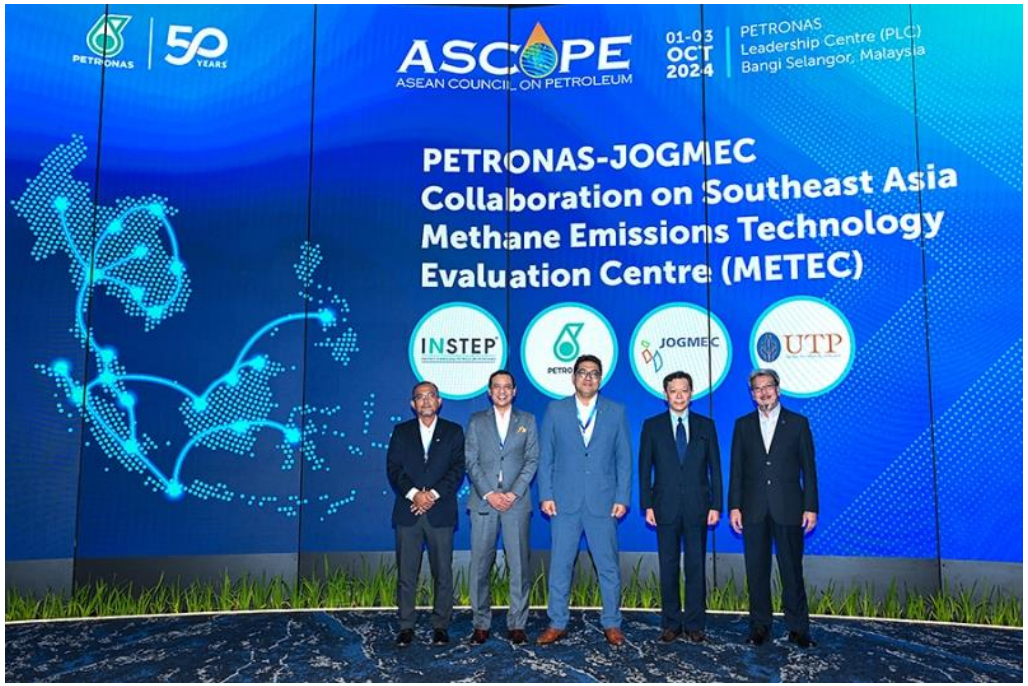


Image of on-site measurement



https://www.jogmec.go.jp/english/news/release/news_10_00076.html

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Life Cycle Assessment/ Management (CO2 Footprint)

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Life Cycle Assessment/Management (CO2 Footprint)

What is the Life Cycle Assessment (LCA)?

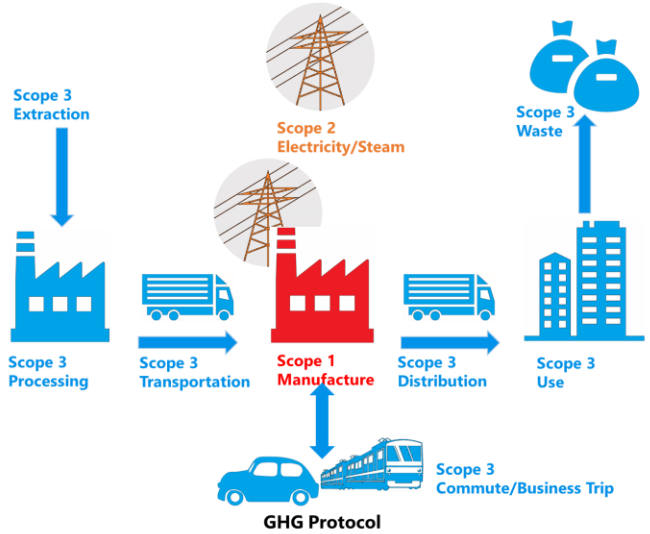
- LCA is a method of assessing the environmental impact of your product or service throughout its life cycle (or at a specific stage) :

  Resource extraction, raw materials, product production, distribution, consumption, disposal, recycling

- LCA can objectively and quantitatively evaluate whether a product is "good" or "friendly" for the environment, human health, and society

Concept of LCA

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

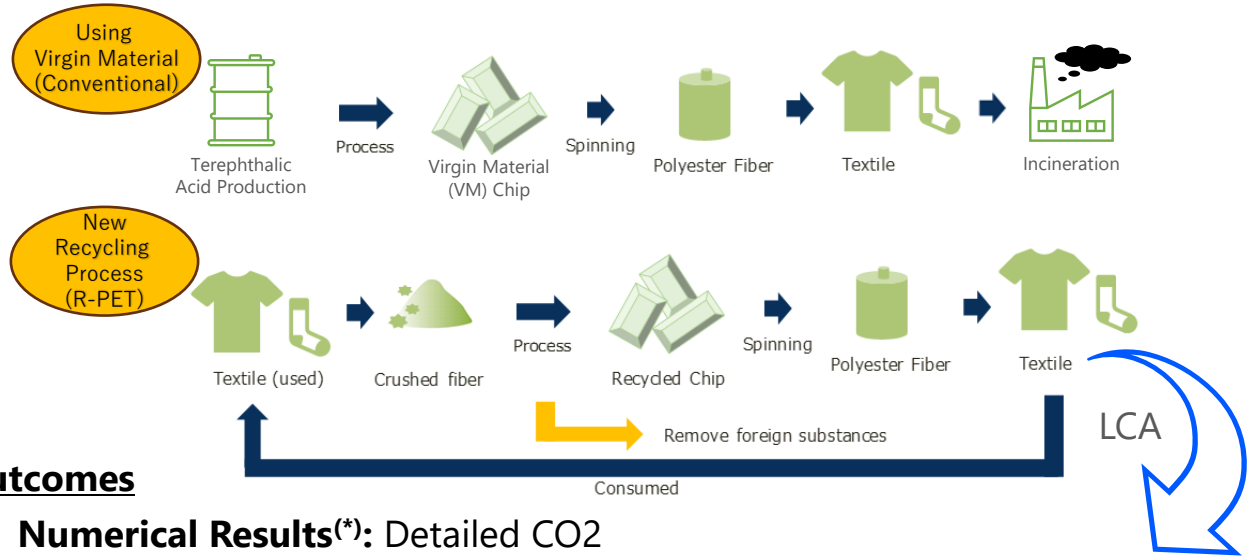


High Client Concern on :

- Environmental Impact
- Optimized Plant Life Cycle
  (Engineering, Procurement, Construction, Commissioning, Startup, Maintenance, Manning, Turnaround, Demolition)
- GHG Protocol (Scope 1/2/3)

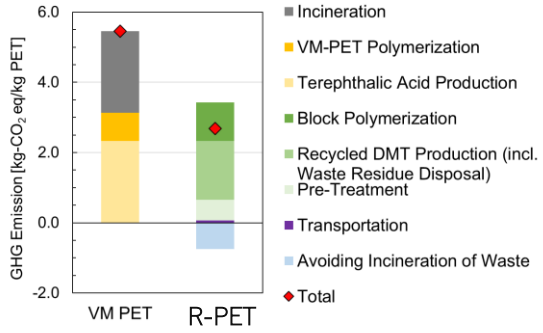
Life Cycle Assessment/Management (CO2 Footprint)

Case Study : LCA for New Recycling Technology



Outcomes

- **Numerical Results(*):** Detailed CO2 emissions data for each process stage
- **Higher CO2 Reductions:** The new recycling process is expected to achieve significantly higher CO2 reductions compared to the conventional process
- **Visualization of Hot Spots:** Identification and visualization of high CO2 emission hot spots



Achievements

- **Conference Participation:**
  - Presented at the Conferences (EcoBalance 2022/24, LCM 2023/25, the Society of Chemical Engineers, Japan 2026)
  - Attended the 8th S-LCA Conference 2022 – Leave No One Behind –

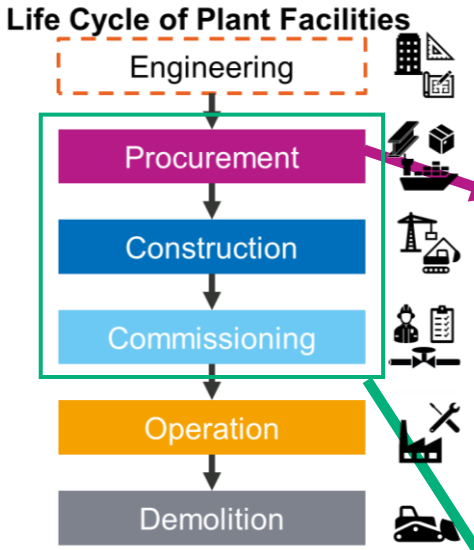
- **CO2 Footprint Calculation:**
  - Calculated CO2 footprint (Scope 1/2/3) for CDP Report from 2021

(*)The scope of evaluation, methods, and assumptions that greatly affect the results, it depends on the implementers and companies

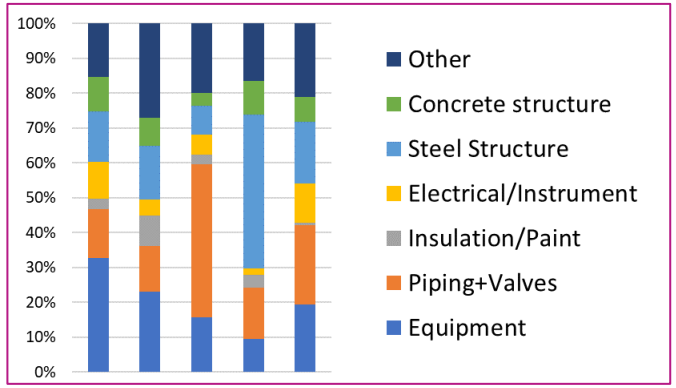
Life Cycle Assessment/Management (CO2 Footprint)

Return to Decarbonization menu

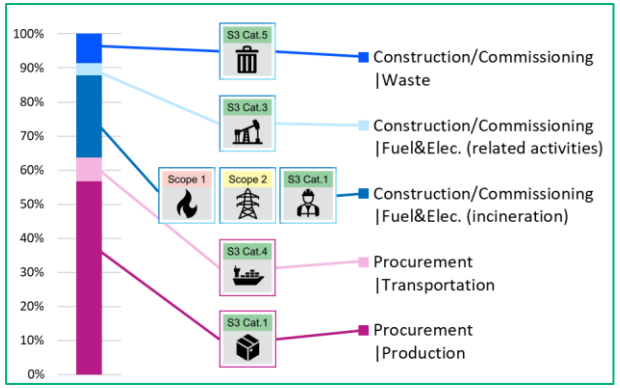
Case Study : LCA for EPC Business



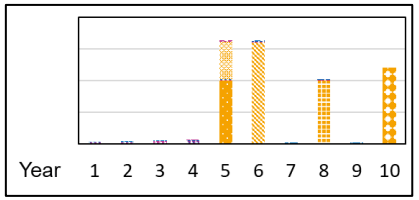
GHG emissions for procured equipment/materials across multiple projects.



GHG emissions from Procurement phase through to Commissioning



Report for annual GHG emissions of a contractor Scope 3



Outcomes

- **Numerical Approach for Plant Life Cycle:** A comprehensive assessment is applied to focus on for GHG Protocol scopes (1/2/3)
- **Real-Time Monitoring:** With a data-centric (DX) approach, both environmental impact and operational data can be monitored in real time, allowing for the identification of hotspots
- **Visualization of CO2 Emission Hot Spots:** High CO2 emission hot spots are visualized throughout the plant life cycle
- **CAPEX/OPEX and CO2 Emissions Relationship:** Understanding the relationship between CAPEX, OPEX and CO2 emissions

Our Strength

- **Broad LCA Expertise:** Conducting Life Cycle Assessment (LCA) not only for the manufacturing business but also for the construction industry
- **Process Engineering Perspective:** Utilizing a process engineering perspective to optimize material flow and reduce GHG emissions
- **Advanced Visualization:** Capability to visualize emissions using the in-house 3D maintenance viewer INTEGNANCE VR See Details

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CO2 Removal Solutions

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CO_2 Removal Solutions

Challenges for CO2 Capture in Operating Assets

Management of Increased CO_2 in Feed Gas

- ✓ Natural gas and associated gas quality varies over the life of oil and gas fields.
- ✓ Unexpected increases of CO_2 in the feed gas requires additional CO_2 capture units or enhancement of the CO_2 capture performance.

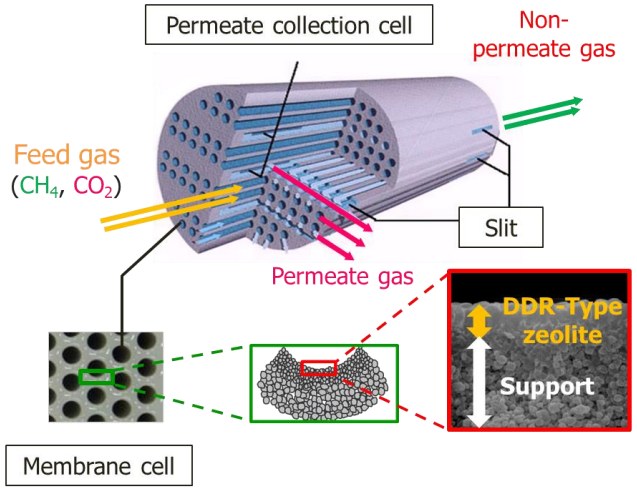
Limited Space and Utilities

- ✓ Limitation in the available space to accommodate the new unit or expansion of the unit.
- ✓ Limitation in the available utilities to operate the CO_2 removal unit

HiPACT® - an Innovative CO_2 Capture Process


Commercial HiPACT™ plant (NIS, Serbia)*1

DDR Membrane - High Performance Separation Technology



CO_2 Removal Solutions – DDR Zeolite Membrane

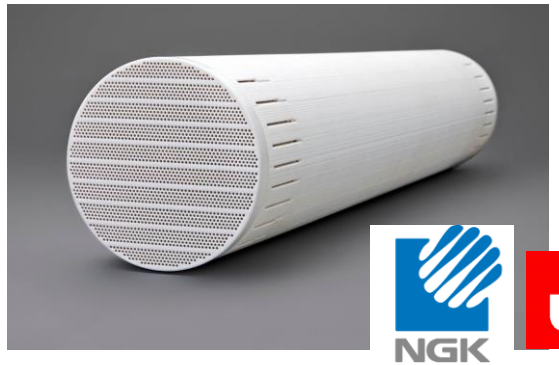
DDR Zeolite Membrane

■ Technology

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

■ Advantages

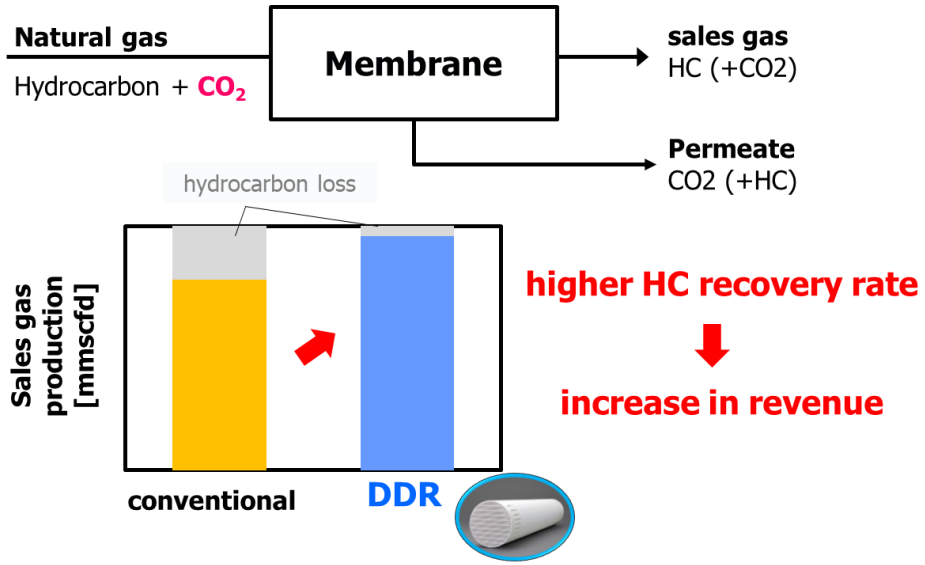
- Enhanced separation performance
  = minimal hydrocarbon loss
- Tough under high pressure, high CO_2 concentration
  = longer membrane life
- Significant lifecycle cost saving (**20-30%**)



■ Application

- Natural Gas Processing (CO_2 removal in CO_2 rich gas fields)
- CO_2 recovery from associated gas for CO_2-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

CO_2 Removal Solutions - HiPACT®

HiPACT® - CO_2 Capture Process

Technology

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

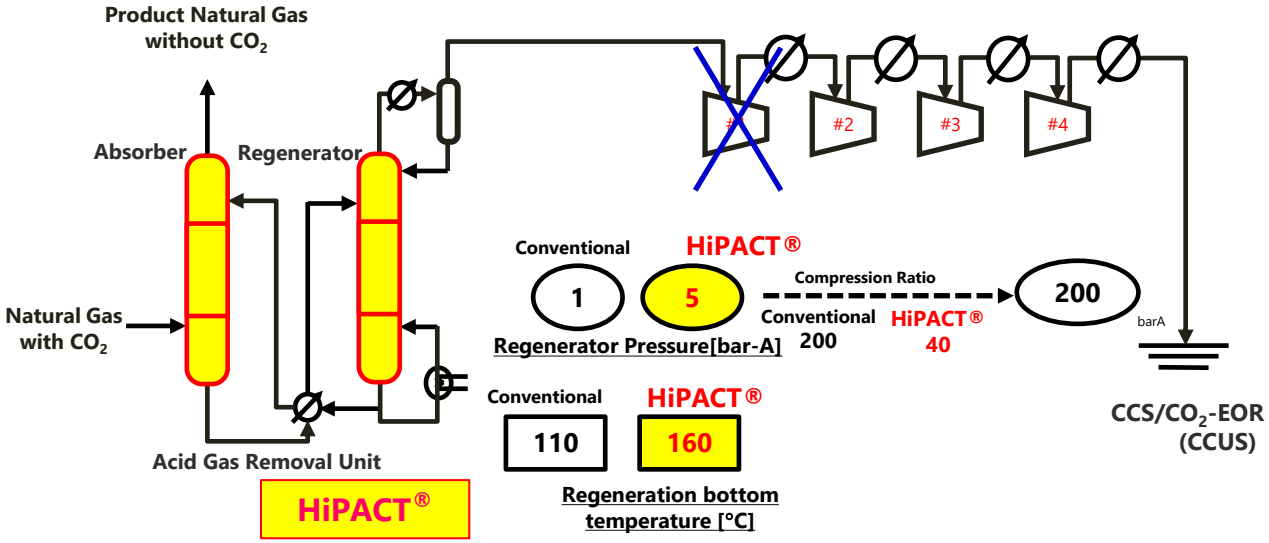
Advantages

- Highly stable against thermal degradation
- Enables high pressure CO_2 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_2 stripping process

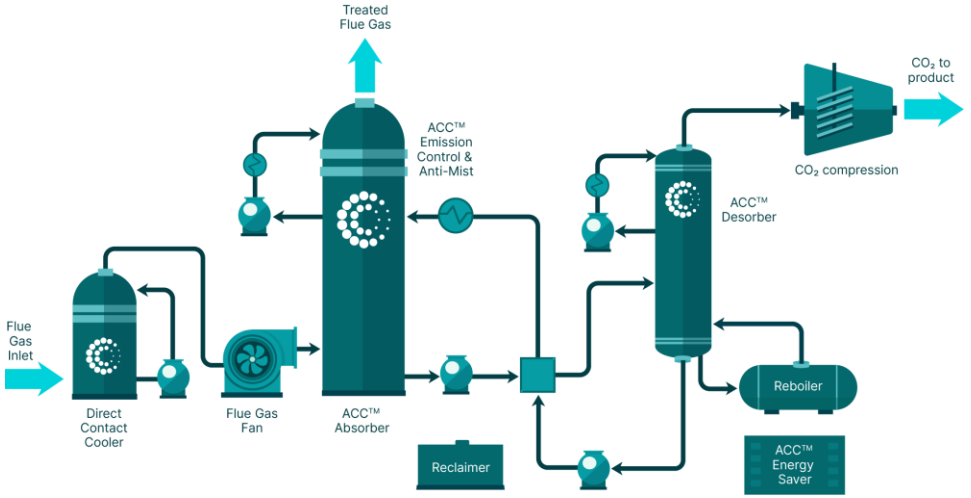


Details of the technology can be found at:
https://www.jgc.com/en/business/tech-innovation/environment/hipact.html

CO_2 Removal Solutions – flue gas (e.g. gas turbine)

Return to Decarbonization menu

JGC and SLB Capturi initiated strategic collaboration dialogue.



- Applied to hard to flue gas in abate industry: Cement, Biomass Power, Waste Energy
- The solution contributes to GHG reduction in FPSO (e.g. CO_2 capture from gas turbine flue gas)
- There is a dedicated design concept suited to offshore application.

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Energy Optimization

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Energy Optimization

Do you have any of these issues?

☹ **How to reduce energy consumption?**

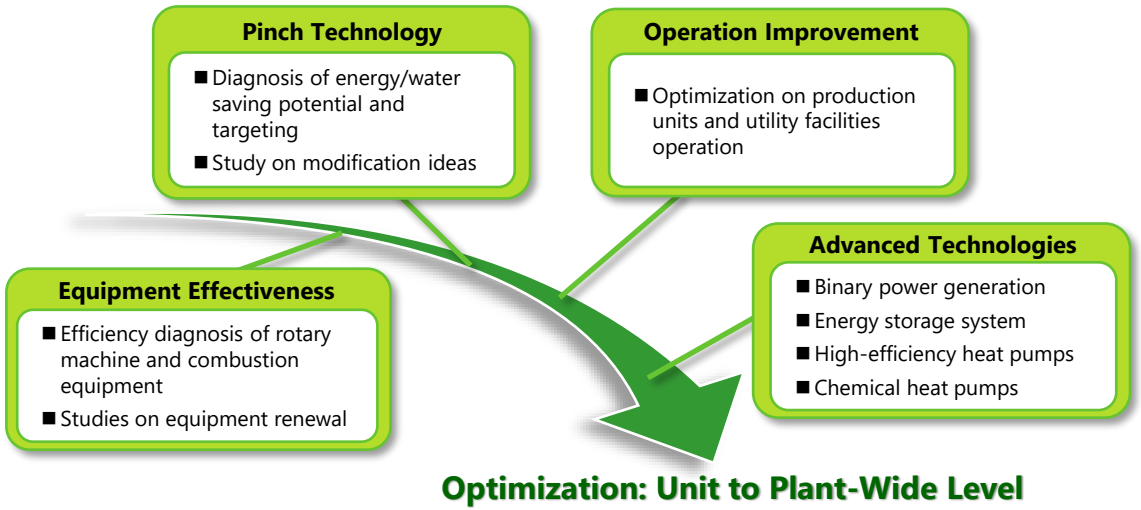
☹ **How to eliminate equipment bottlenecks?**

☹ **What kind of equipment should be updated to improve efficiency?**

What is our service ?

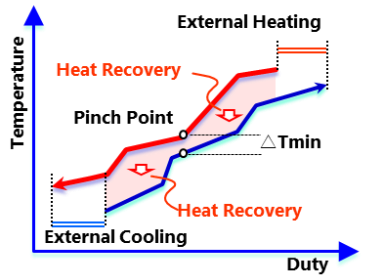
- **Equipment Effectiveness**: Diagnosis to identify the efficiency of existing facilities to be improved and suggestions for types of equipment to be modified.
- **Pinch Analysis:** Identify heat recovery target and create solutions such as heat recovery networks that balance the trade-off between investment 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

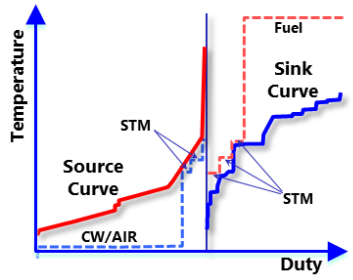


What is Pinch Analysis?

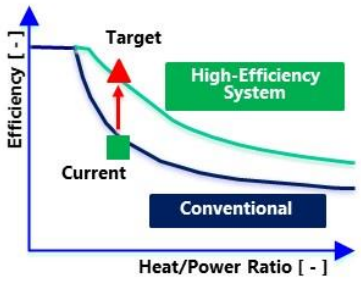
Systematic and Visualization Methods to Identify the Target



Energy Utilization and Optimization of Heat Recovery System



Optimization of Site-Wide Energy Usage

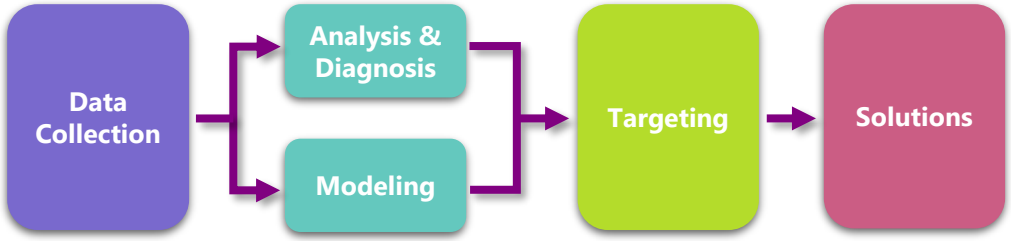


Optimization of Power-Steam Supply System

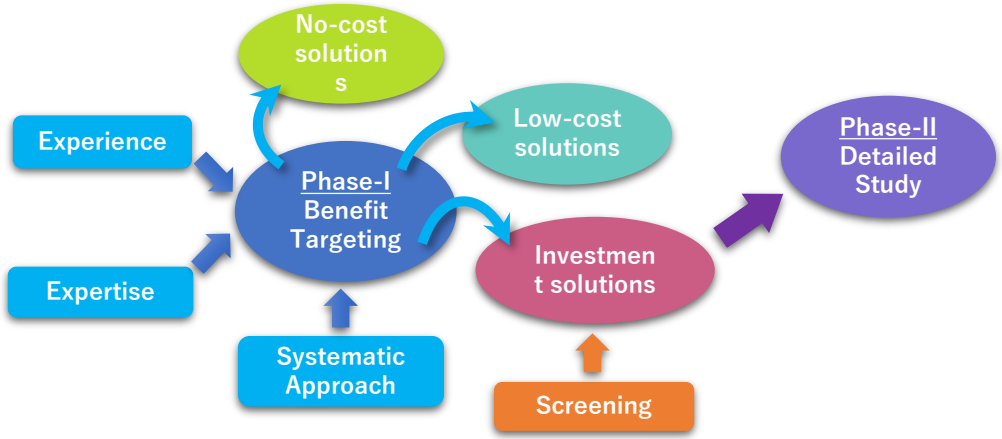
Energy Optimization

Return to Decarbonization menu

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 oversea 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	-
Total	38	15

- 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

Sustainable Combustion & Heating Optimization

Achieving stable heater operation and reducing carbon emissions

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Sustainable Combustion & Heating Optimization

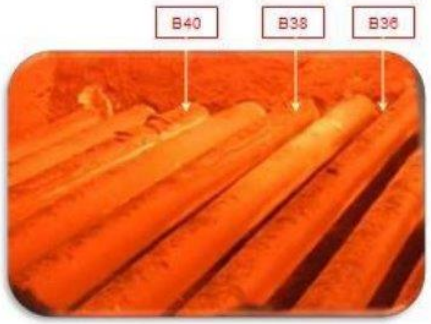
Do you have any of these issues / challenges ?

- ☹ **Frequent trips, tube damage, or unstable heater operation**
- ☹ **Pressure to reduce CO_2 emissions and meet CI(*) targets**
- ☹ **Difficulty in identifying root causes of incidents**
- ☹ **Integration of multiple fuel networks**
- ☹ **Transition to electrification and reduced fossil fuel dependence**

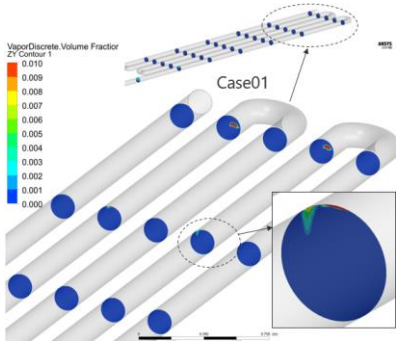
(*) carbon intensity

Our Solutions

- Identify optimal decarbonization pathways
  (efficiency improvements, hydrogen, electrification)
- Evaluate combustion and heating system performance
  (flame stability, NOx, flashback, control philosophy, fuel systems)
- Perform root cause analysis
  (based on operational data and incident history)
- Identify bottlenecks and engineer practical retrofit solutions
  (based on design and operational data)
- Implement solutions and ensure no recurrences
  (engineering, modification, and operational improvement)



Operating Conditions Assessment



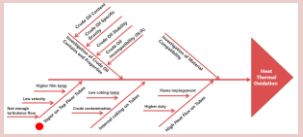
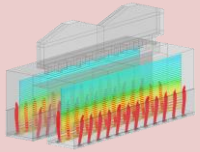
Fluid Behavior Assessment

Detailed Tube Damage Assessment

Driving the Transition to Sustainable / Stable operation

Sustainable Combustion & Heating Optimization

How We Deliver Sustainable Heating Optimization

Example 1 Heater Improvement		Example 2 Decarbonization
Operating Data Review 	**Assess** Understand system constraints	Fuel & constraints 
Cause Identified 	**Analyze** Identify root causes and gaps	CO_2 Reduction Potential 
Practical Solutions 	**Solve** Design practical solutions	H_2 / Electrification Options 
Stable Combustion	**Sustain** Ensure results in operation	Combustion Transformation

Our Strength

End-to-End Delivery from Analysis to Execution

- Deep expertise in combustion and system interfaces
- Integrated engineering across combustion, process, and advanced analysis (CFD, simulation)
- Extensive retrofit know-how for existing facilities
- Practical solutions as an EPC contractor, covering entire plant systems
- End-to-end capability from study to FEED and EPC

Our Experiences

100+

Plants

Evaluation, Improvement and Troubleshooting for IOC and NOC customers

100+

Cases

Evaluation, Improvement and Troubleshooting cases

Sustainable Combustion & Heating Optimization

Return to Decarbonization menu

Case Study : Furnace Tube Overheating (Root Cause Analysis and Optimization)

Issues / Challenges

Client : Oil & Gas Company in Southeast Asia

Equipment : Reboiler Heater (Box Type)

Issues : Hotspot on tube top and tube leakage
(Failure Risk and Operational Instability)

Request : Identify root cause and propose modification plan

Assess & Analyze

Root Cause Analysis from Multi-Angle

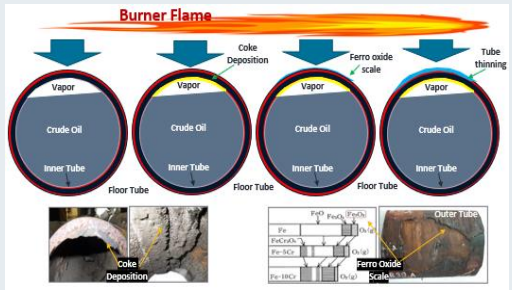
- **Thermal behavior**
  (bulk & film temperature → local vaporization risk)
- **Flow behavior / CFD analysis**
  (vapor accumulation and dispersion)
- **Fluid properties & feed condition**
  (crude characteristics, impurities, upstream effects)
- **Material integrity**
  (corrosion, metallurgy suitability)

Solve

Root Cause : Vapor on Tube Top

Solution

Reduce tube diameter
to suppress vapor layer formation

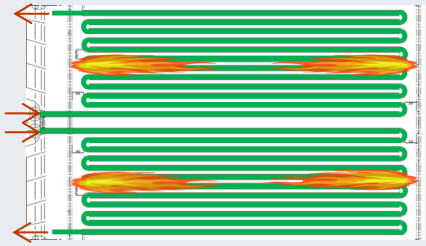


Sustain

Practical Modification Plan

Modified tube configuration results in;

- ■ Vapor layer suppressed
- ■ Hot spot eliminated



Achievement

Identified root cause and delivered a practical solution enabling stable heater operation and improved profitability