Energy and Environment
in Harmony

“Mirai Engineering”
A Grand Opportunity for the Future

未来エンジニアリングへの挑戦

“Mirai” = Future

January 25, 2018

CHIYODA GROUP

CHIYODA CORPORATION

Agenda

1. **Who is Chiyoda?**

2. **What we are faced with?**

3. **“Mirai Engineering”**
   A Grand Opportunity for the Future

   - **Decarbonized Society**
   - **Digital Revolution**

Who is Chiyoda?

Project Lifecycle Engineering

As a front-runner of integrated engineering contractor, Chiyoda can provide wide range of services for success of various types of projects.

Project Lifecycle Engineering

Advanced Engineering Technology

Technology Development

Chiyoda Advanced Solutions

AI Solution

Asset Holding Business

Chiyoda applies its accumulated knowledge and technologies in planning, engineering, procurement, construction, operation and maintenance of various types of process plant and social infrastructure project worldwide.
Chiyoda supports its clients with “Project Life Cycle Engineering”.

Oil / Petrochemical / Metal / Environment / New Energy

Refinery

Petrochemical / Chemical

Metals and Mining

Pharmaceutical / Life Science

LNG / Gas

LNG Plant

Floating LNG Plant Technology

LNG Receiving Terminal

Gas Processing

What we are faced with?

"**Decarbonized Society**" *under the Paris Agreement*

"Holding the increase in the global average temperature to well below 2° C above pre-industrial levels."

"So as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, …..rapid reduction of greenhouse gas emissions with best available science."

"**Digital Revolution**"

Analogous to the 1st Industrial Revolution and 2nd Industrial Revolution, the Digital Revolution marked the beginning of the Information Age. Our industry is changing with IoT, Big Data Analysis, and Artificial Intelligence (AI) Technology.

Long-term Scenario for De-carbonizing Japan

- Japanese Government's long-term outlook of GHG emission reduction announced at 2015 : 20% at 2030 (compared to 2010) .
- Bridge Scenario* of WWF Japan, GHG emission reduction : 81% at 2050 (compared to 2010).

1. Energy Efficiency

   Housing & Buildings, Metal Recycling, EVs & FCVs
2. Renewable Energy

   Power Grid, Hydrogen Infrastructures, Biomass
3. Phasing out Fossil Fuels

   Carbon pricing, Phase out coal-fired power plants
4. Gradual Phase-Out of nuclear power

* Long-term scenarios for de-carbonizing Japan WWF Japan (Feb 2017)

Our Challenge for De-carbonizing

- Hydrogen Value Chain
- SPERA HYDROGEN®

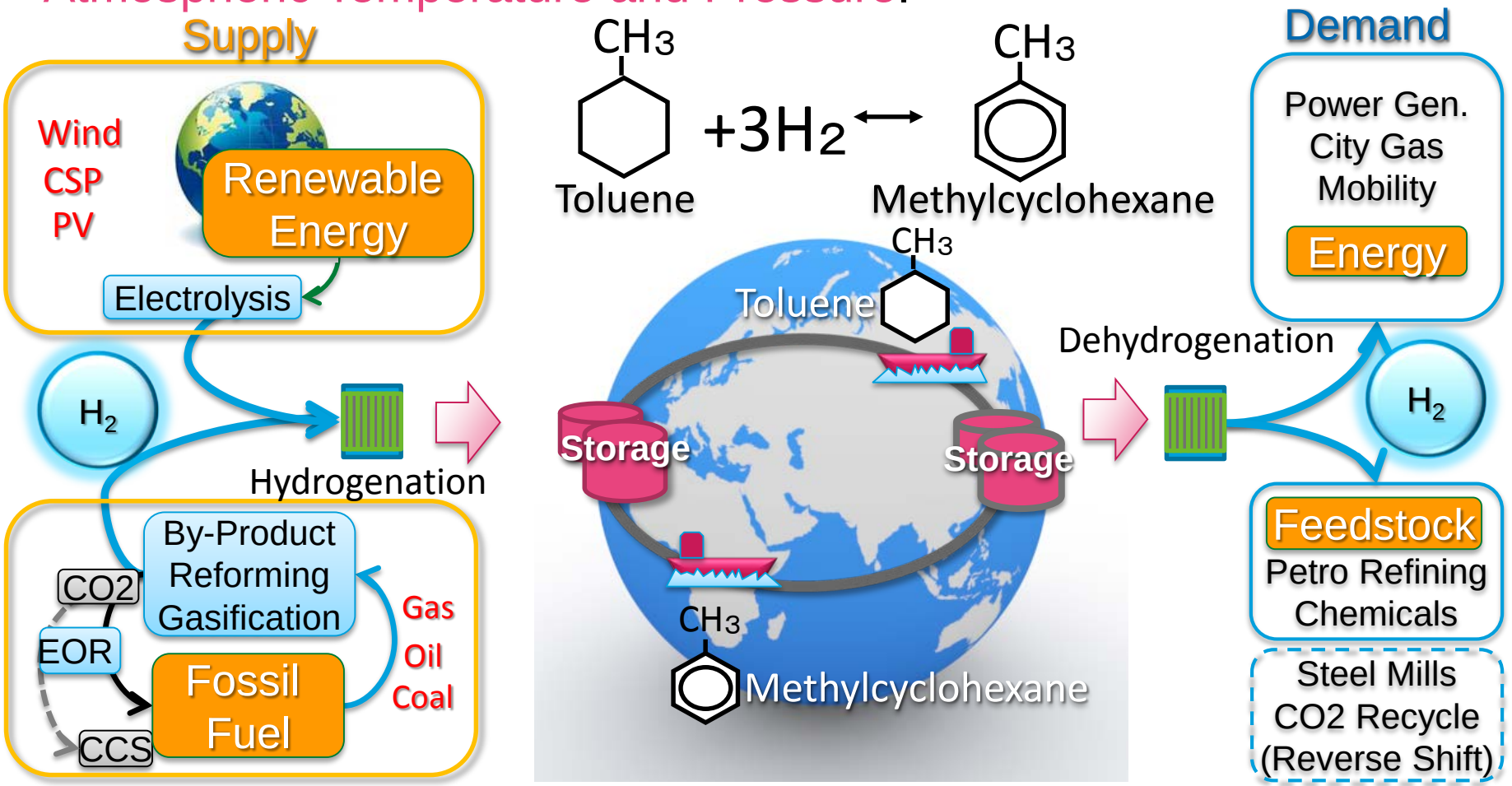
Demonstration Plant will start operation in the year of Tokyo Olympic Games 2020.

- CO2 Utilization
- Euglena Biofuel
- CT-CO_2AR™

  CO_2 Reforming Technology

Hydrogen Value Chain - SPERA HYDROGEN®

Large-scale and long-distance hydrogen storage and transportation by using Organic Chemical Hydride as an H_2 carrier at Liquid under Atmospheric Temperature and Pressure.



Hydrogen Value Chain Demonstration Project

The world's first Global Hydrogen Supply Chain Demonstration

Project Scale

Supply of 210 tons (max) of Hydrogen in 2020.

Hydrogen Supply

Produced by Steam Reforming from the processed gas derived from Brunei LNG Sdn. Bhd.

Hydrogen Demand

Fuel for the Keihin Refinery Thermal Power Plant, an affiliate of TOA OIL Co., Ltd.

Project Schedule

2017-2019 Plant EPC
2020 Demonstration Operation

Project Scheme

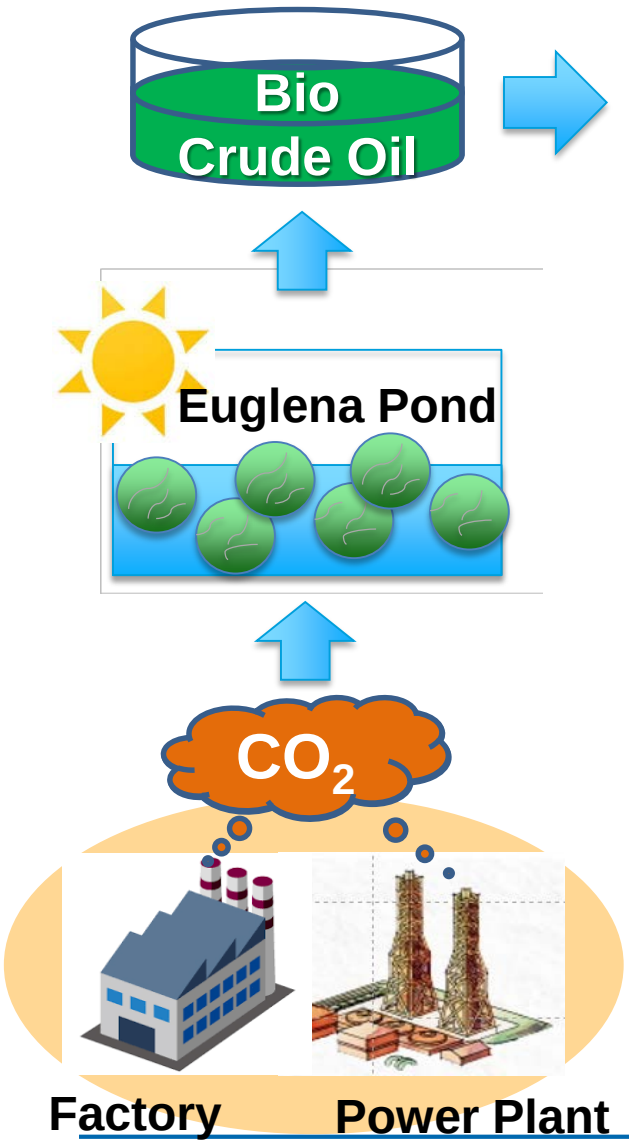
This demonstration project is executed by Advanced Hydrogen Energy Chain Association for Technology Development (AHEAD).

AHEAD

- Chiyoda Corporation
- Mitsubishi Corporation
- Mitsui & Co Ltd.
- Nippon Yusen Kabushiki Kaisha

Euglena Biofuel

Euglena : a genus of single-celled flagellate eukaryotes



Biofuel

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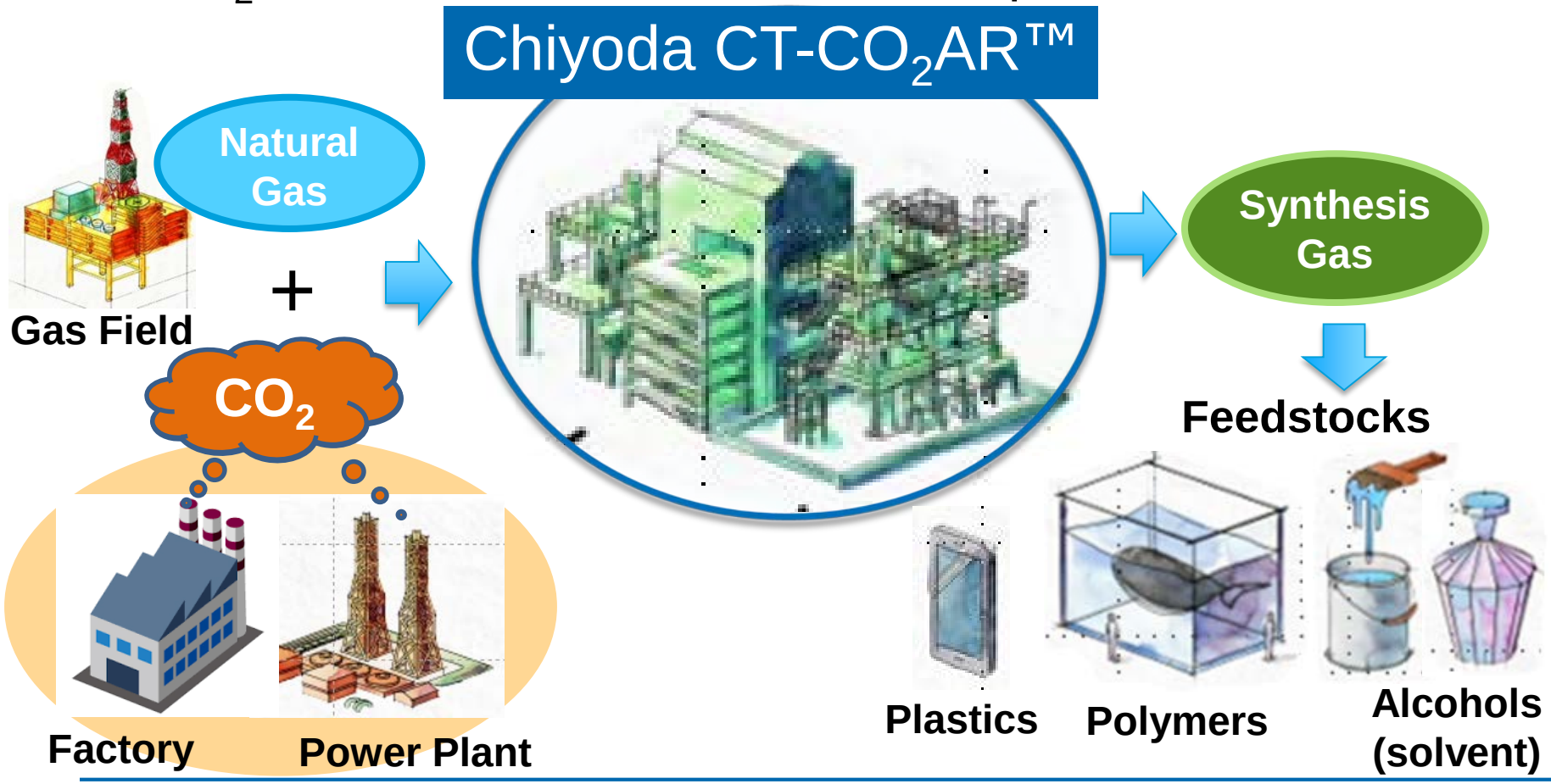
CO_2 Reforming

Chiyoda CT-CO_2AR™ enables efficient utilization of CO2

- Low-quality natural gas fields containing CO_2
- CO_2 emitted from various industrial processes



Chiyoda CO_2 Reforming CT-CO_2AR™

Steam Reforming

CH4 + H2O → 3H2 + CO

H2/CO=2.0

- DME
- Methanol
- FT Synthesis

CO2 Reforming

CH4 + CO2 → 2H2 + 2CO

H2/CO=1.0 CO Production

- Oxo Synthesis
- MMA
- Acetic Acid
- MDI

MMA: Methyl Methacrylate
MDI: Methylene Diphenyl Di-isocyanate

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Digital Revolution in the Industry

- The "**Digital Twin**" is introduced certain industries utilizing new Digital Technologies (Big Data Analysis, and AI) for product lifecycle (design, manufacturing, operation & maintenance) management.
  Since a refinery is a typical automated control manufacturing facility, solutions of new Digital Technologies are aggressively proposed and developed.

- Japanese Refineries are faced with two major issues :

  (1) Retirement of skillful plant staffs for O&M,

  (2) Degradation of aged plant.

  Introduce the new Digital Technologies will be effective to overcome these issues. Japanese government has a strong leadership to accelerate the Digital Revolution named "**Connected Industries**".

Our Challenge of Digital Technology

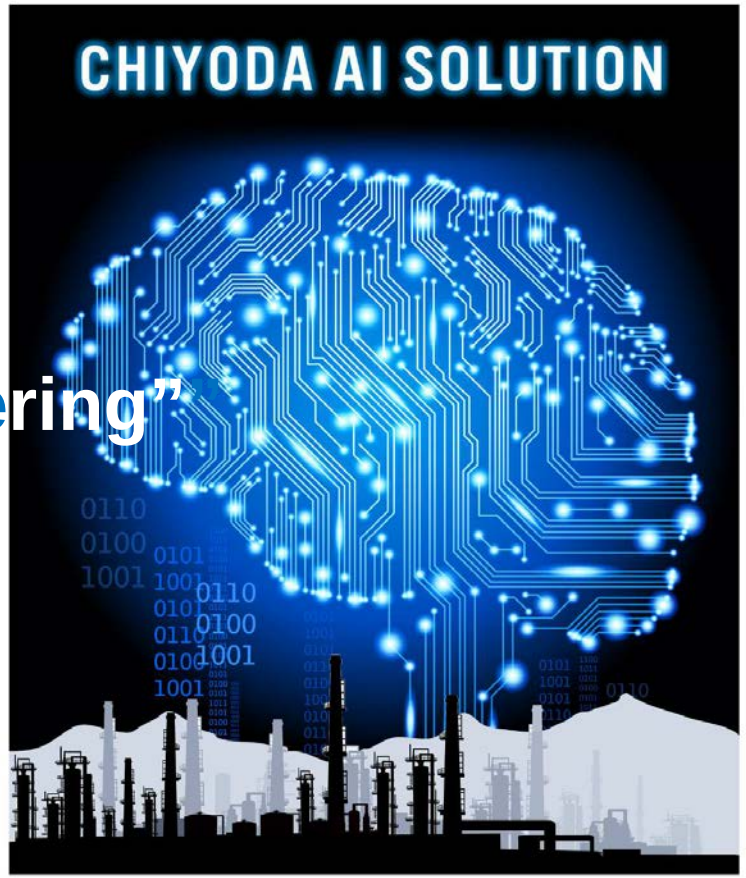
- Innovation of Plant Design

  - AI Technologies for Plant Engineering

- **"Project Life Cycle Engineering"**

  - AI Technologies for Plant Operation & Maintenance

  - Virtual Plant (Digital Twin)



Chiyoda's approach for Future Engineering

- Artificial Intelligence (AI)

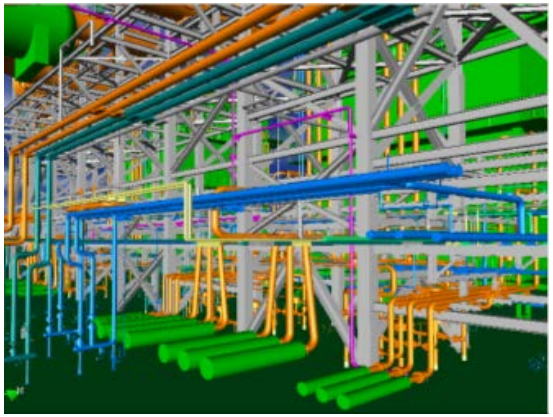
Chiyoda's Core Technology × **AI/Big Data Technology** = **Plant Performance Improvement**

- Virtual Plant (Digital Twin)

REAL/PHYSICAL

TWINS

VIRTUAL



Open Innovation Framework

Acceleration by fully utilizing the “Open Innovation” framework

Plant Big data :
Operation, Malfunction,
Maintenance,
Environment, etc...

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Engineering

×

GRID

AI Development

Analysis by engineering design method. Creation of learning data and evaluation criteria.

∞ReNom

Original framework for **“Deep Learning”**

Learning Data from Physical Model › Plant AI solution **Operation Optimization** ‹ **Combination of Algorithm**

Chiyoda's AI Solutions for Plant O&M

A Analysis and Visualization
Big Data Analytics (visualizes and predicts current and future changes based on accumulated data.)

D Data Accumulation
Big Data (collect and accumulate information generated by a large amount of sensors and IoT devices.)

Engineering
Engineering Knowledge, Simulation Study, etc.

O Optimization・Improve Efficiency
Artificial intelligence etc. (optimization and improvement based on prediction.)

Virtual

Real/Physical

DCS systems

Weather Condition

Field Sensors
Noise, Vibration, image, etc.

Performance Improvement

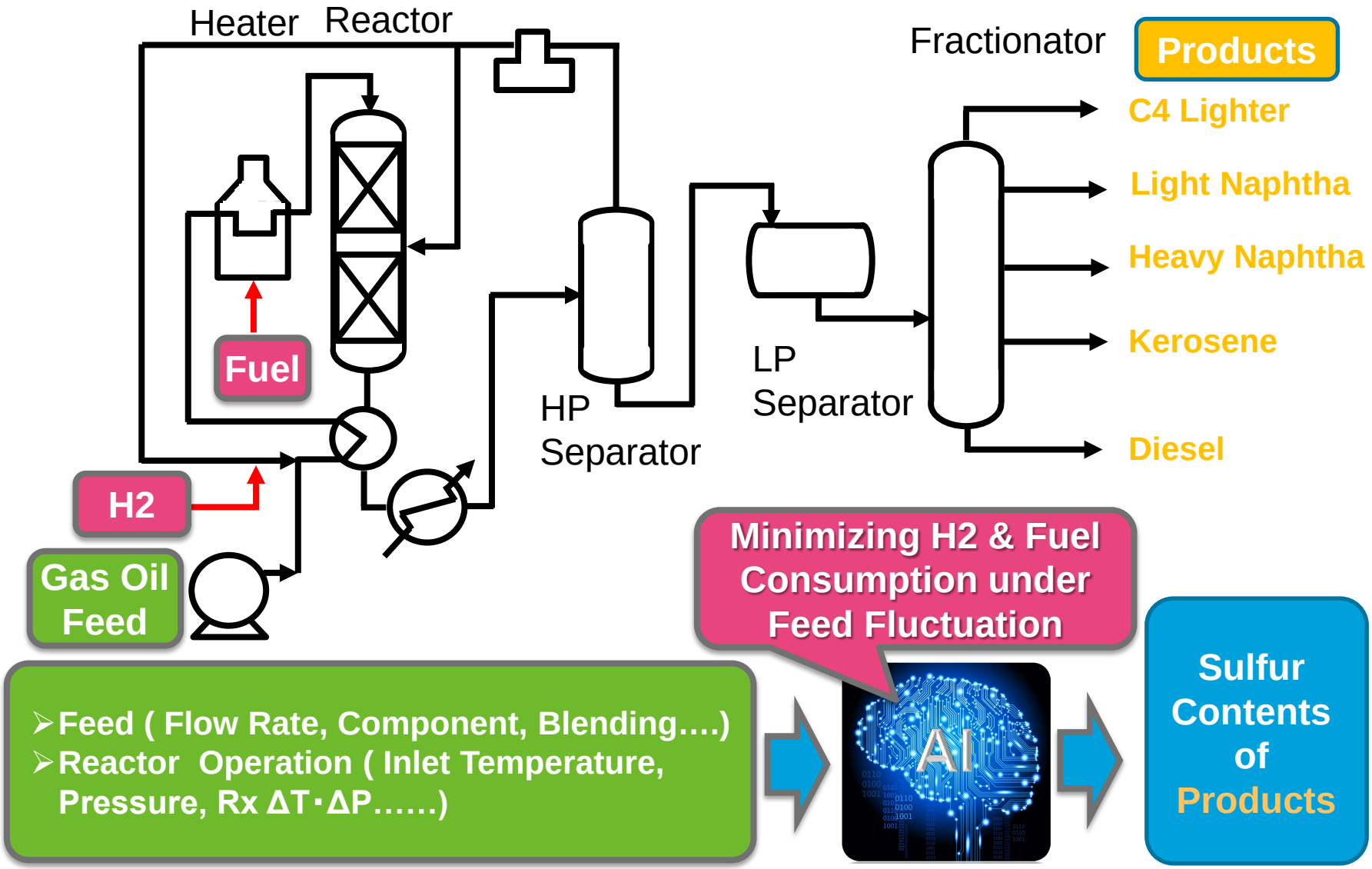
Sensors & Transmitters

Control Valves

Smart Positioners

IoT

Application : De-sulfurization Unit



- Feed (Flow Rate, Component, Blending….)
- Reactor Operation (Inlet Temperature, Pressure, Rx ΔT･ΔP……)

3D Integrated Plant Design

- Major plant design work will be replaced from skillful engineers to AI Technology.

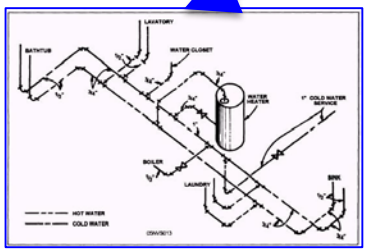
Verification

Design Requirements

- Process Flow
- Plant Layout
- Process Spec.
- Operability
- Constructability
- Maintainability

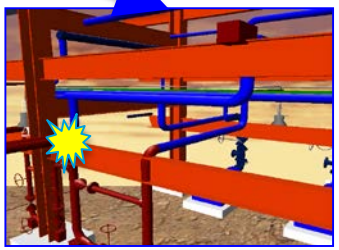
- Client's Comment
- Piping
- Design Specifications
- Instrumentation
- Quality
- Process
- Electric
- Furnace
- Civil
- Equipment
- Architect
- Fire Fighting

Deliverables



Construction Dawning

Material Take off



Crash Check

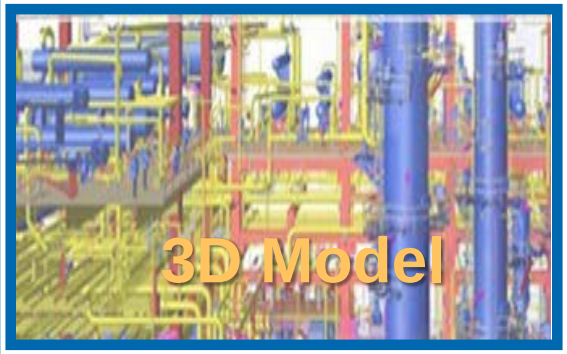
Chiyoda “Virtual Plant” for O&M

Virtual Plant for EPC
Plant Design

Computer Aided Engineering

Plant Process Simulation
Static / Dynamic

3D Plant Design System



Computer Aided Engineering

3D Simulation（CFD, FEM）

Model Transfer

Virtual Plant for O&M

3D Integrated Information Platform

Operation
AI Expert System

Mirror Plant
Dynamic Simulation

3D Simulation

Maintenance
AI Expert System

Data Link

Model Transfer

Real Plant Operation

Data Historian
Advanced Process Control
OPC Server

2D
DCS

3D Laser Scan

Maintenance

Maintenance Management System (CMMS)
Inspection Management System
DWG. Management System

3D
CMMS

CFD : Computational Fluid Dynamics, FEM : Finite Element Method
DCS : Distributed Control System, CMMS: Computational Maintenance Management System）

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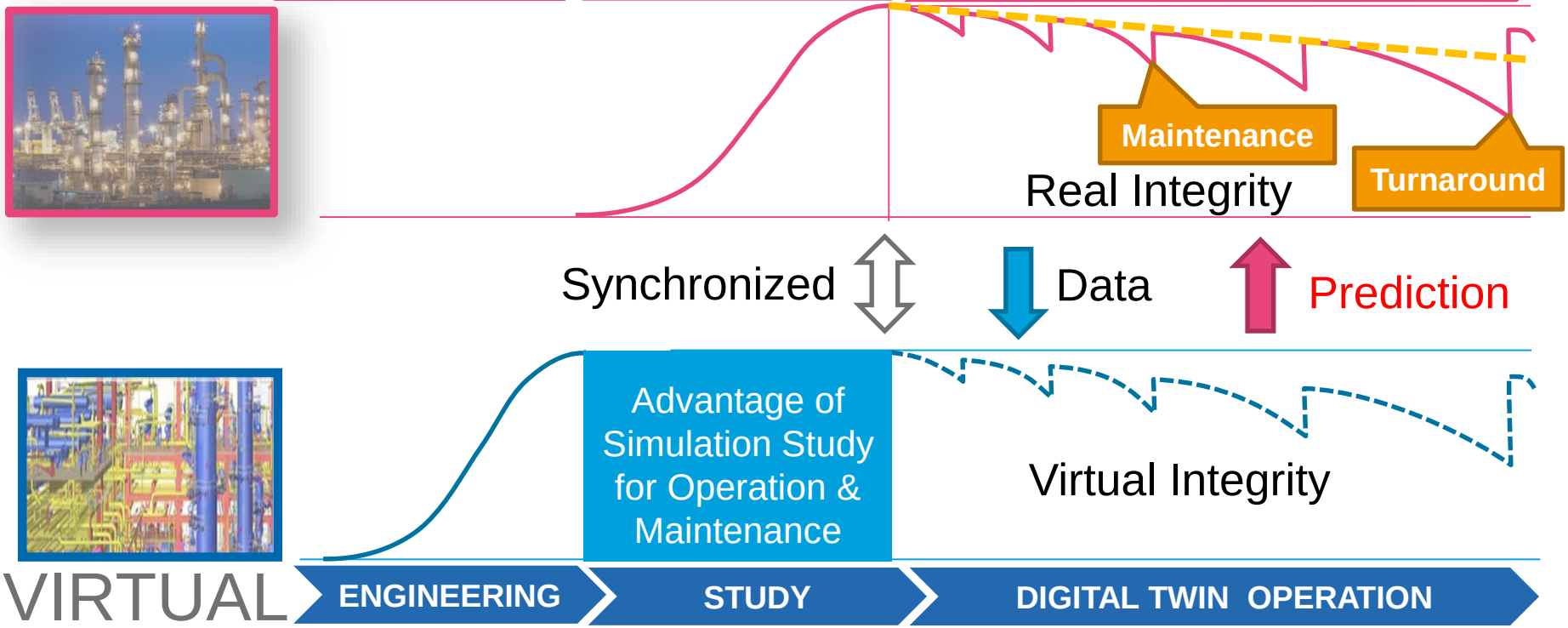
“Project Life Cycle Engineering” by Virtual Plant

- The EPC 3D model will be transferred to Virtual Plant (Digital Twin) for O&M with all engineering knowledge and used as the primary tool for accessing asset information, making decisions and managing operational risk and plant degradation.



Summary

- “**Decarbonized Society**”
- “**Digital Revolution**”

→ **A Grand Opportunity for the Future**

Chiyoda is hoping to contribute the Petroleum Exporting Countries with following technologies;

“Mirai Engineering”

- Hydrogen Value Chain, SPERA HYDROGEN®
- CO2 Utilization
- AI Technology and Virtual Plant

Thank you for your attention.

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