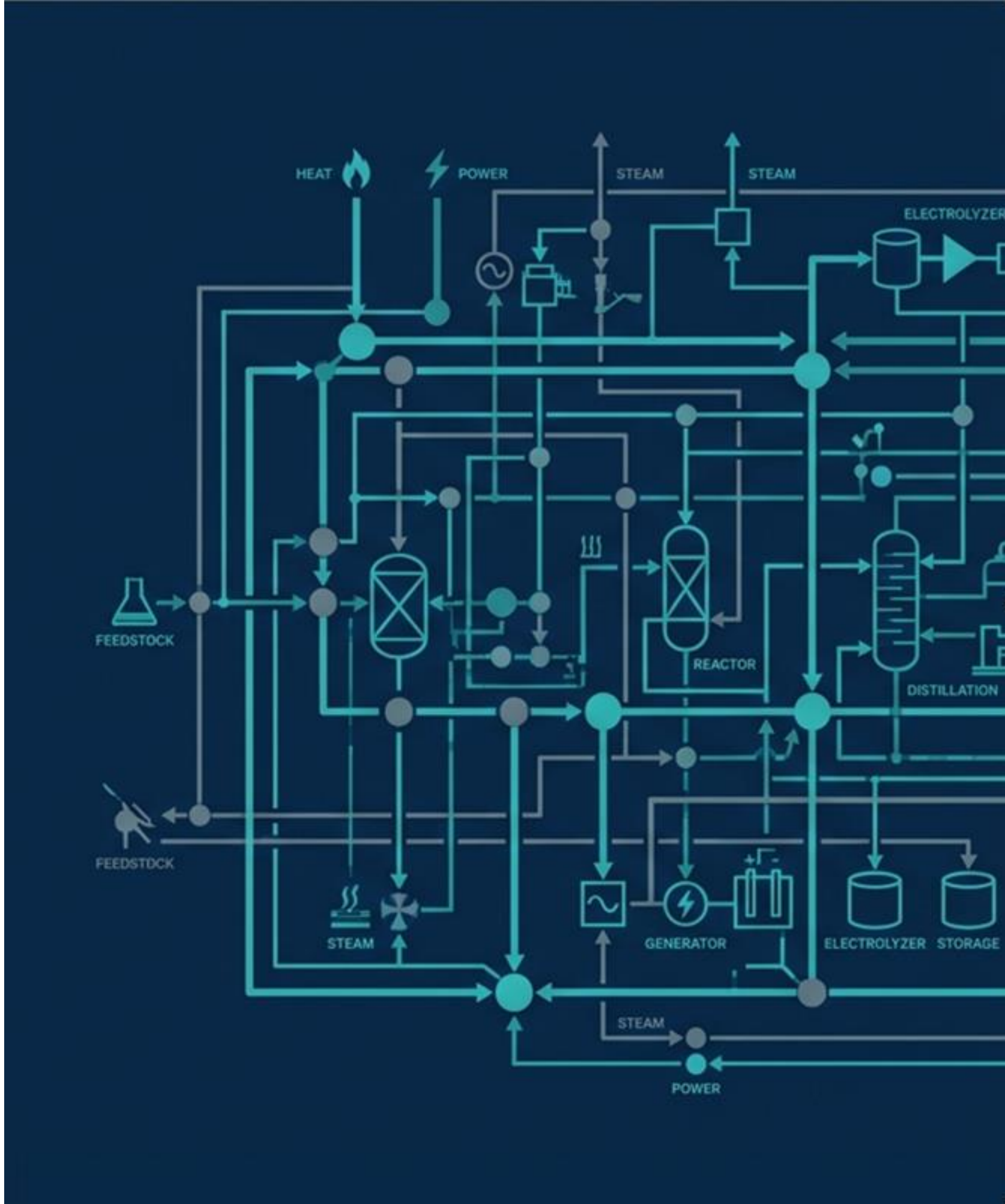
OSVARD

GLOBAL R&D

# Can we electrify the Petrochemical industry?

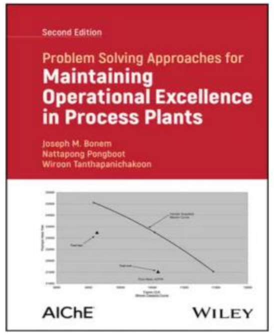

**Smith Wattanasoponvanij**
Director @ Osvard Co., Ltd

**Wiroon Tanthapanichakoon (CHARLES)**
CEO @ Global R&D Co., Ltd

EXECUTIVE SUMMARY

# A decade of expertise accelerating technology development across the petrochemical and energy transition landscape.




CHEMICAL ENGINEERING CEP

SPECIAL FOCUS
Process / Project Optimization

HP

## AIChE-Wiley Co-Author of “Maintaining Operational Excellence in Process Plants”

Specializing in moving technologies from laboratory concepts to commercial deployment. By bridging the critical gap between R&D realities and corporate business alignment, we systematically derisk scale-up and accelerate time-to-market for energy transition technologies.

**10+/ 20+ Years**

Experience in Process Innovation & Decarbonization Strategy.

**3 Pillars**

Core focus spanning Strategy, Scale-up, and Innovation Management.

**Global Impact**

Active consortium footprint across Thailand, Japan, and Europe.

OSVARD

# Proven Know-How and Expertise by International Publications & Invited Speaking by Our Expert: Mr. Smith Wattanasoponvanij

## The Decarbonization Imperative

H2T SPECIAL FOCUS

Process / Project Optimization

- Decarbonizing Steam Crackers – Key Technical Challenges of Transitioning from Natural Gas to Hydrogen (July 2024)
- Decoding the complexities of decarbonization (May 2024)
- Too small to be viable? SMRs and their potential to economy-wide decarbonization

JAPAN ENERGY SUMMIT & EXHIBITION

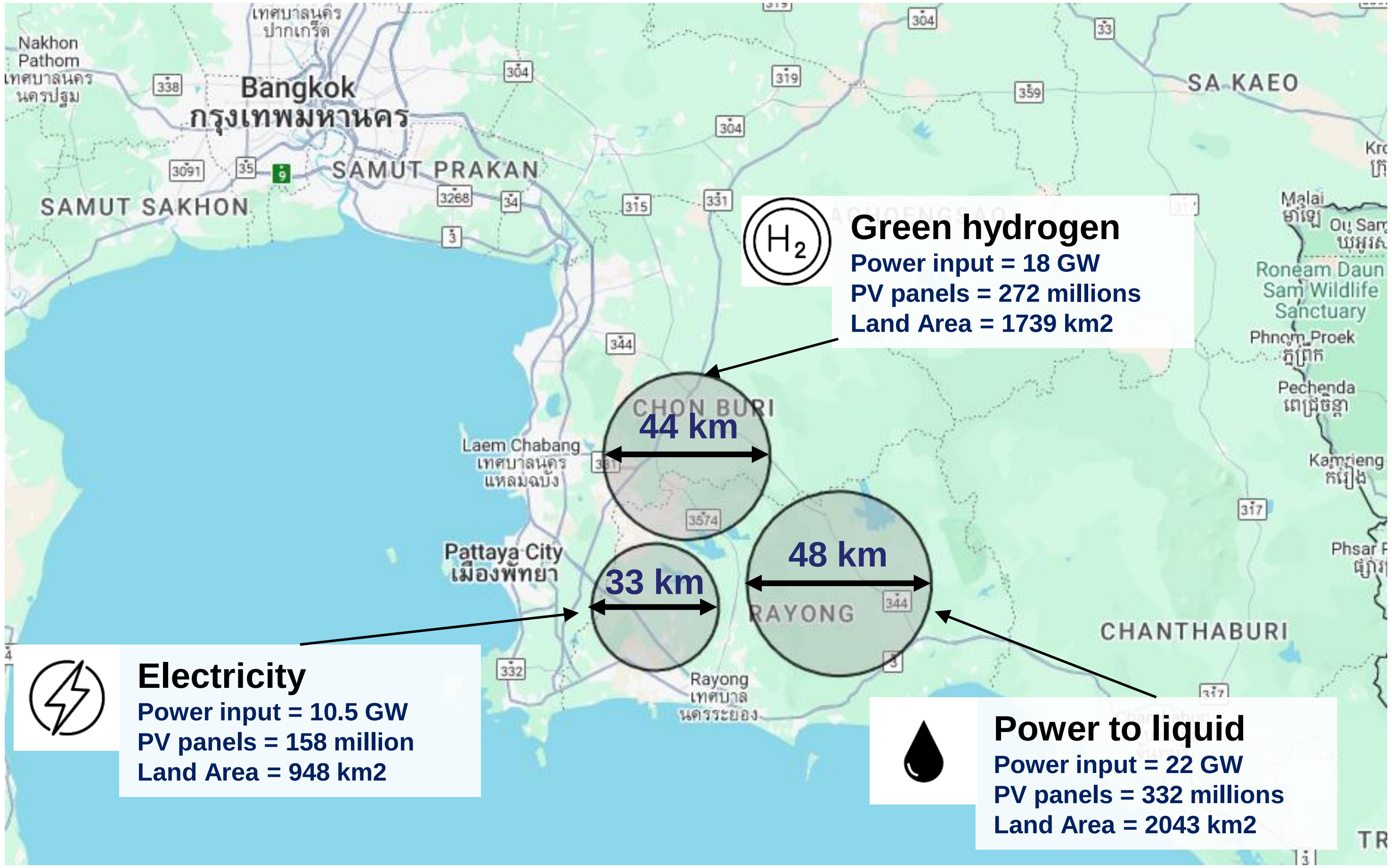
**Topic:** H2 or kWh - Evaluating the Potential of Hydrogen and Electron Economies in Decarbonization
**Date:** May 2024

**Topic:** Can hydrogen really replace natural gas in steam crackers?
**Date:** Feb 2026

FEA FUTURE ENERGY ASIA

# **What-If Case Study**: Are trendy renewable energy technologies like “green hydrogen” and “power to liquid” worth pursuing? How to quantify the decision making?

**What-if Analysis: Estimated land areas of “PV panels” needed for producing electricity, green hydrogen, and power to liquid → “Same 10 GW output”**




| | Electricity | Hydrogen | Power to liquid |
|---|---|---|---|
| **Source of energy** | 100% Renewable Electricity | 100% Renewable Electricity | 100% Renewable Electricity |
| Electrolysis | | **30%** Energy loss | **30%** Energy loss |
| $CO_2$ air-capture FT-synthesis | | | **37%** Energy loss |
| Transport, storage, and distribution | **5%** Energy loss | **26%** Energy loss | |
| **Fuel production efficiency** | **95%** | **52%** | **44%** |

## Efficiency Analysis

**Electricity → 95%**

- Fewer stages of energy loss, lowest no. of win turbine and land area requirement.

**Hydrogen → 52%**

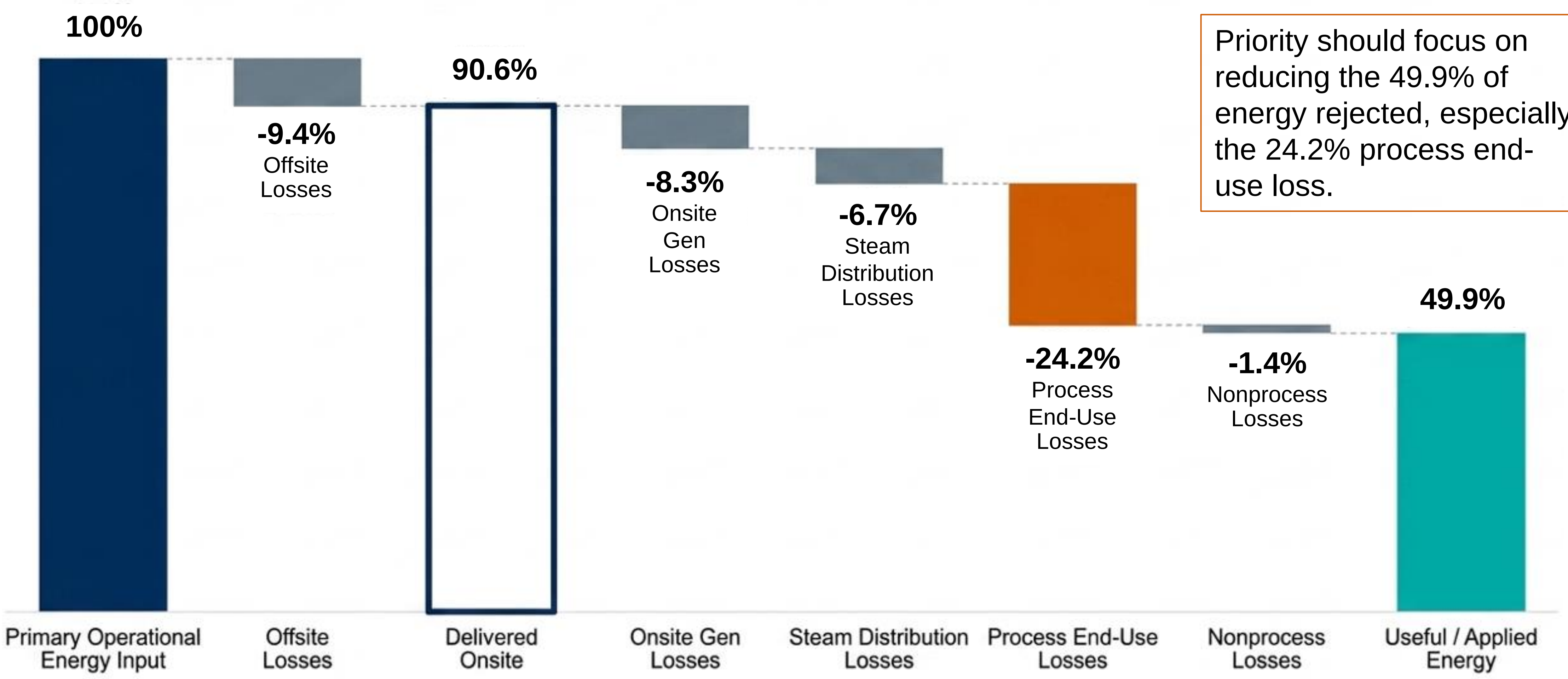
- The multiple stages of energy loss significantly lower the efficiency.

**Power to Synthetic Fuels → 44%**

- The complex process of converting electricity to liquid fuels, highest no. of win turbine and land area requirement

*Ref: Transport & Environment (T&E), https://twitter.com/transenv/status/899976235794788352/photo/1

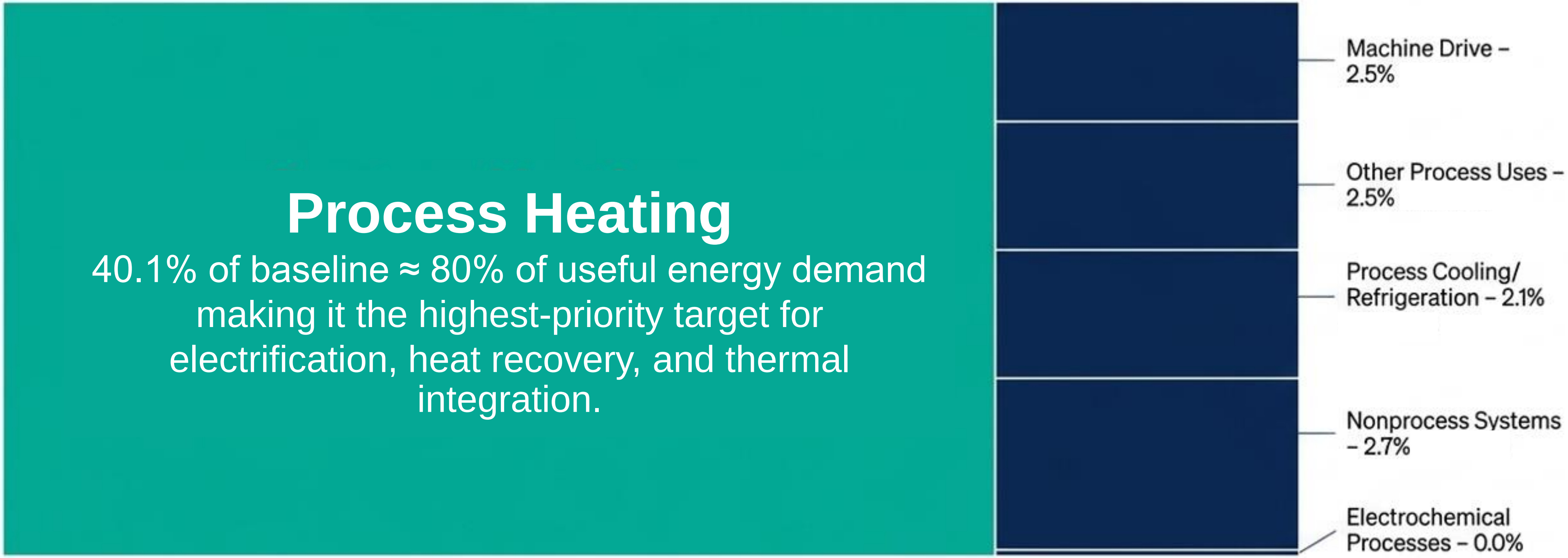
# Energy efficiency in the Petrochemical industry is only 49.9%; half the input becomes useful energy. Reducing the 50.1% losses is the key opportunity




Priority should focus on reducing the 49.9% of energy rejected, especially the 24.2% process end-use loss.

Ref: US DOE

# Most of that useful energy is concentrated in process heating. Therefore, petrochemical decarbonization should prioritize process heat first




Ref: US DOE

OSVARD

# The first three layers reduce operational energy emissions, while the fourth layer addresses the carbon embedded in petrochemical products

Operational Focus

**Layer 1: Process Heat Sources**
Address the 40.1% useful energy demand and 24.2% end-use losses

**Layer 2: Rotating Equipment**
Target the 2.5% machine drive demand while managing site steam balances

**Layer 3: Utilities & Low-Temp Systems**
Eliminate the 6.7% steam distribution losses via heat upgrading

Product Focus

**Layer 4: Emerging Tech. / Feedstock Substitution**
Transform feedstock via molecular substitution

OSVARD

# Layer 1: Site-wide mapping is the foundation of petrochemical electrification because every project affects heat, steam, power, and emissions together.

| Heat Sources & Sinks | Steam Balance | Rotating Equipment | Electrical Systems | Emissions Baseline |
|---|---|---|---|---|
| Quench water | Letdown valves | Compressors | Grid capacity | Current Scope 1 baseline |
| Distillation condensers | Condensate return | Pumps | Transformer limits | Current Scope 2 baseline |
| Feed preheaters | High/medium/low pressure headers | Fans | Harmonic limits | |
| Reboilers | | Record shaft power | | |
| | | Turbine exhaust usage | | |

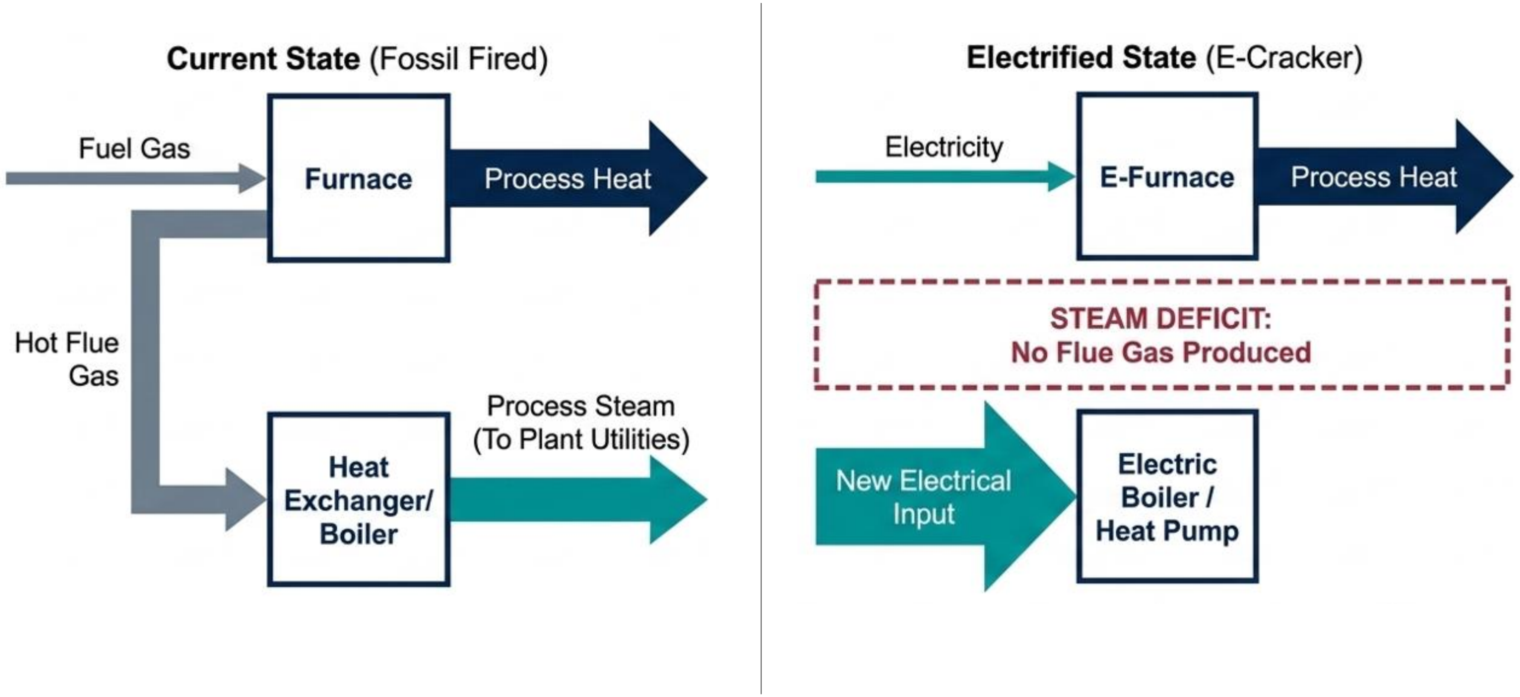
Before choosing any electrification project, we must first map the site's full energy structure to avoid solving one problem while creating another.

OSVARD

# Layer 1 should electrify process heat by matching each duty to the right technology based on maturity, temperature capability, and retrofit feasibility.

| Technology | Tech Maturity | Temperature Capability | Retrofit Potential | Key Advantage | Primary Bottleneck |
|---|---|---|---|---|---|
| Electric Resistance / Ohmic | ◑ | ● | ◑ | No direct combustion, fits cracking coils | Materials durability, electrical safety |
| Electric Radiant Furnace | ◔ | ● | ◕ | Familiar furnace geometry | Heating-element life and uniformity |
| Electric Boiler | ● | ◔ | ● | Commercial and modular | Limited to lower/medium temperatures |
| Industrial Heat Pump | ● | ◔ | ◑ | High efficiency (upgrades waste heat) | Limited temperature range |
| Induction / Microwave | ○ | ◑ | ○ | Fast response, selective heating | Scale-up and material compatibility |
| Plasma Heating | ○ | ● | ○ | Direct-emission elimination | Energy intensity, extreme scale-up cost |

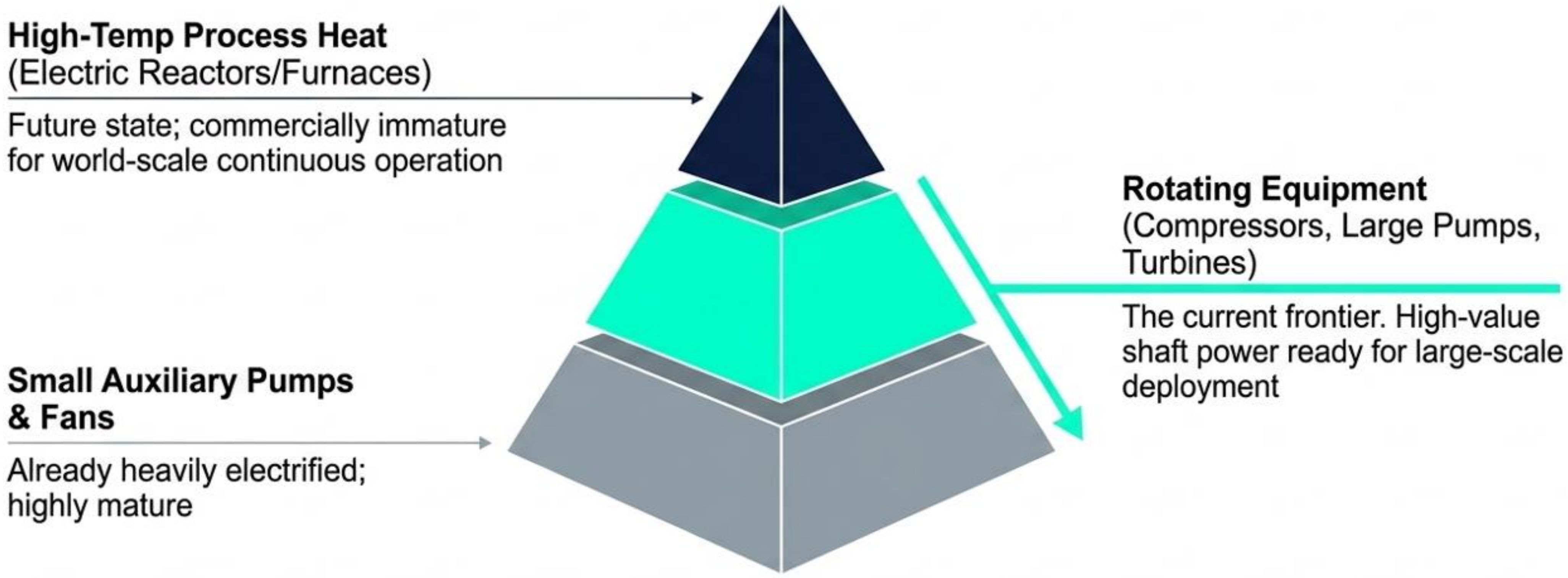
# E-cracker electrification removes furnace combustion, but it also removes the flue-gas heat that previously supported steam generation.




- Fossil-fired furnaces provide process heat and generate steam from recovered flue-gas heat.
- E-crackers provide process heat but produce no flue gas.
- It removes a steam source, creating a steam deficit.
- Additional electric boilers, heat pumps, or utility redesign may be needed.
- Therefore, E-crackers require plant-wide steam and energy-balance redesign, not just furnace replacement.

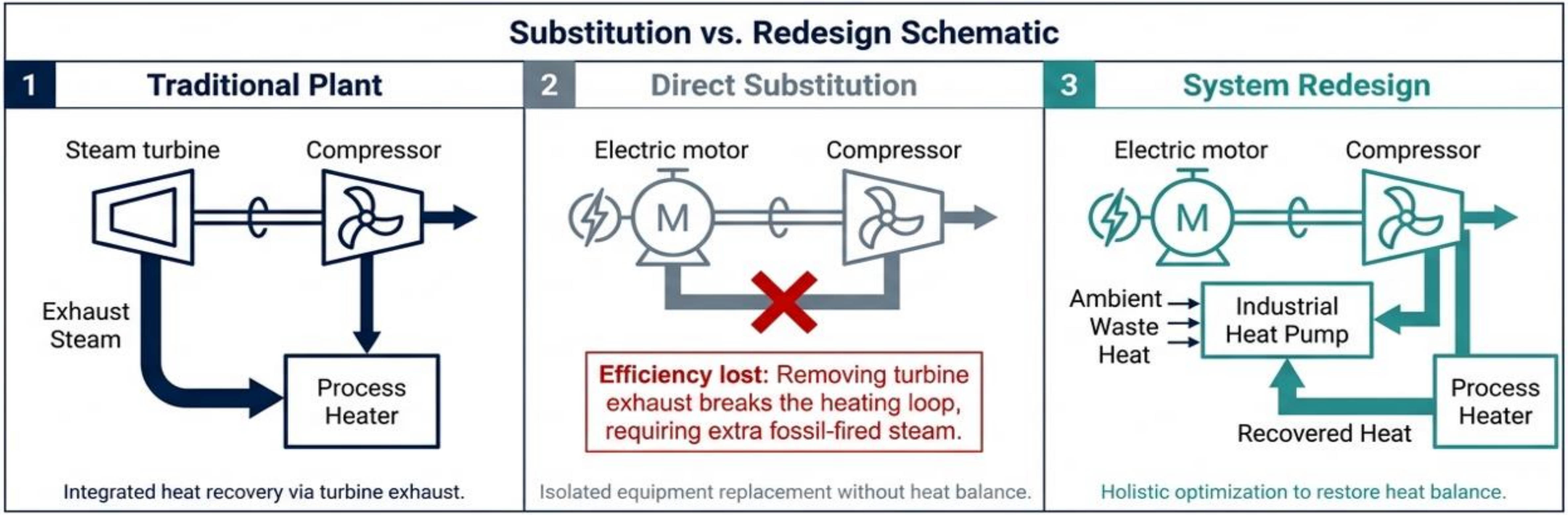
Electrifying the cracker reduces direct combustion emissions, but it also removes a useful steam source, so the plant must redesign its utility system to avoid creating a new energy bottleneck.

# Layer 2: Rotating equipment is the most viable near-term electrification pathway because motors and VFDs are already commercially mature




Electric motors and VFDs are commercially mature, making large shaft-power loads an immediate electrification target — while high-temperature electric reactors still require further validation.

# The framework identifies what to decarbonize; the roadmap defines how to move safely from mapping to deployment.



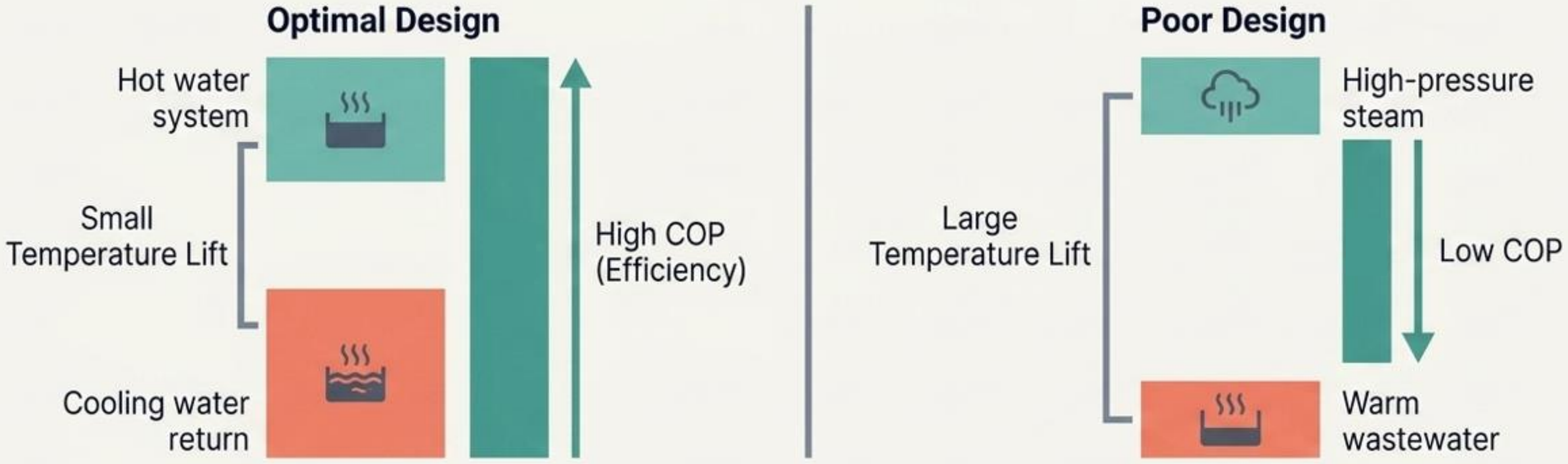

**Electrification is not equipment replacement — it requires a whole-site redesign of heat, steam, and power systems to avoid hidden energy losses.**

OSVARD

# For Layer 3, the goal is not to replace steam with electricity, but to recover, upgrade, and reuse low-grade heat before adding new electric demand.

| Technology | Main Petrochemical Role | Efficiency Multiplier (COP) | Integration Complexity |
|---|---|---|---|
| Industrial Heat Pumps | Upgrade low-grade waste heat into process heat | COP > 1 (High) | ● |
| Electric Boilers | Generate steam for backup and lower-pressure duties | COP ≈ 1 (Low) | ○ |
| Mechanical Vapor Recompression (MVR) | Compress overhead vapor for heat reuse | COP > 1 (High) | ◕ |
| Heat-Pump-Assisted Distillation | Connect condenser heat and reboiler demand | COP > 1 (High) | ● |
| Electric Reboilers | Replace steam in selected separation systems | COP ≈ 1 (Low) | ◔ |
| Refrigeration Heat Recovery | Use rejected refrigeration heat as a heat source | COP > 1 (High) | ◑ |

# Layer 3 Design Rule: Heat pumps create value only when the heat source and heat sink are well matched.




| Sources | Sinks | Design Rule |
|---|---|---|
| Target: Cooling-water return, distillation condensers, warm process wastewater. | Target: Low-pressure steam, feed preheating, stripping columns. | Never apply a heat pump if the source is too cold, intermittent, or physically far from the heat demand. |

# Electric boilers use less energy because of higher efficiency, but the carbon impact is mainly driven by how clean the electricity supply is

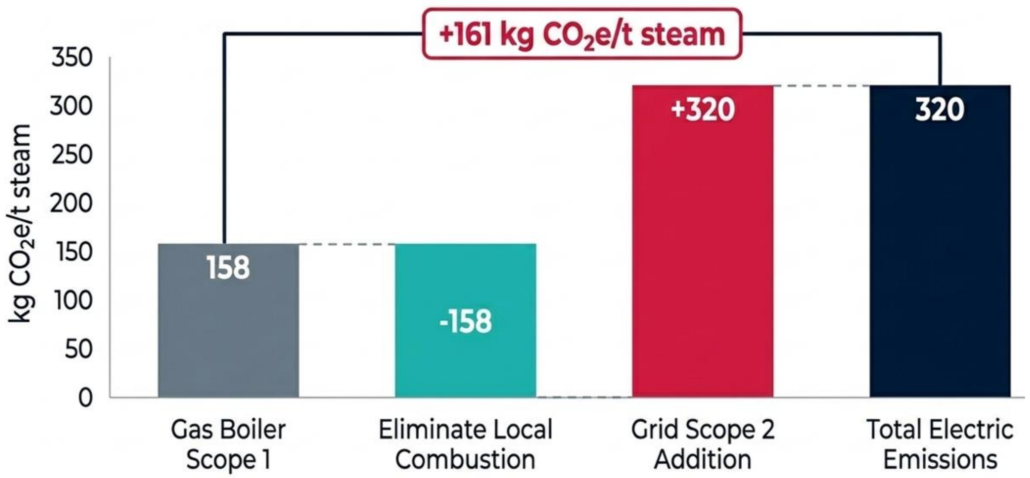
What if we replace steam generation 1 ton/hr with electric boiler?

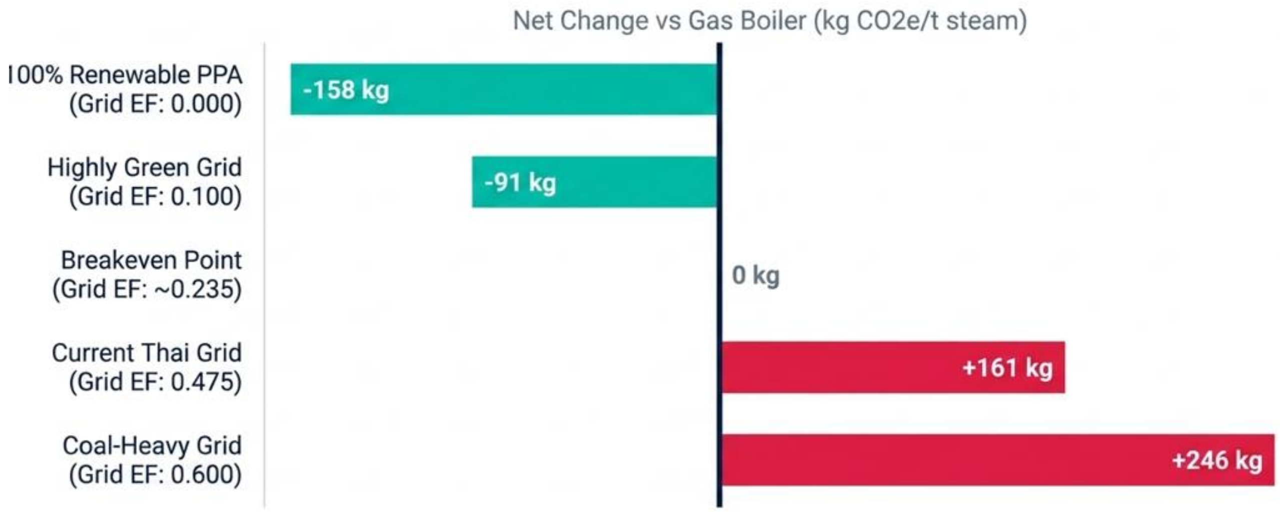
| | Natural Gas Boiler | Electric Boiler |
|---|---|---|
| Useful Steam Heat | **2.4** GJ/t | **2.4** GJ/t |
| Energy Conversion Efficiency | **85%** | **99%** |
| Required Energy Input | **2.82 GJ** natural gas/t | **0.673 MWh** electricity/t |
| Fuel/Power Emission Factor | **56.1 kg** $CO_2$/GJ gas | **0.475 kg** $CO_2e$/kWh |

# Electrification alone is not enough; it must be paired with low-carbon or renewable electricity procurement to deliver real decarbonization.

OSVARD

## What if we replace steam generation 1 ton with electric boiler?



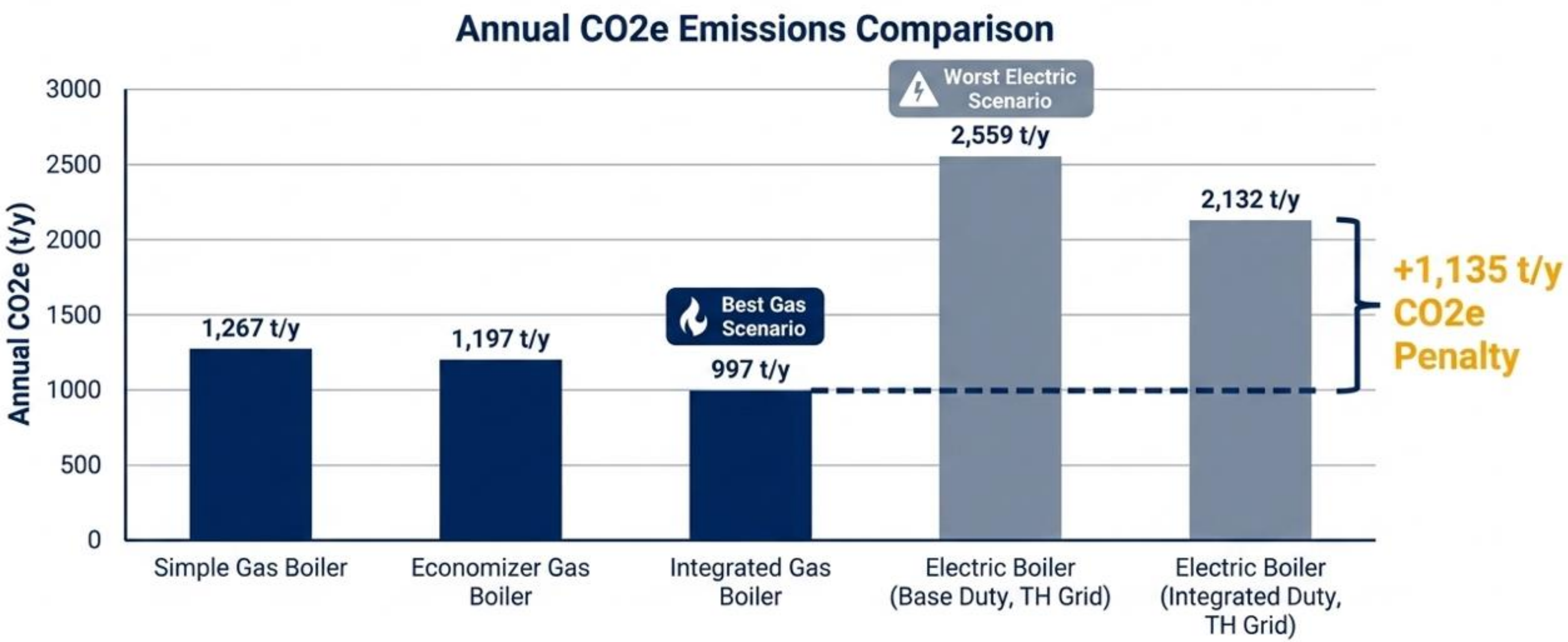




Although the electric boiler uses about 14% less energy, its emissions are about 2x higher because the electricity's carbon intensity is high

Electrification alone is not enough — it must be paired with credible low-carbon or renewable electricity procurement to deliver real decarbonization.

# Electric boilers are useful for flexibility and decarbonization, but they should be the final, not the first step in utility electrification.

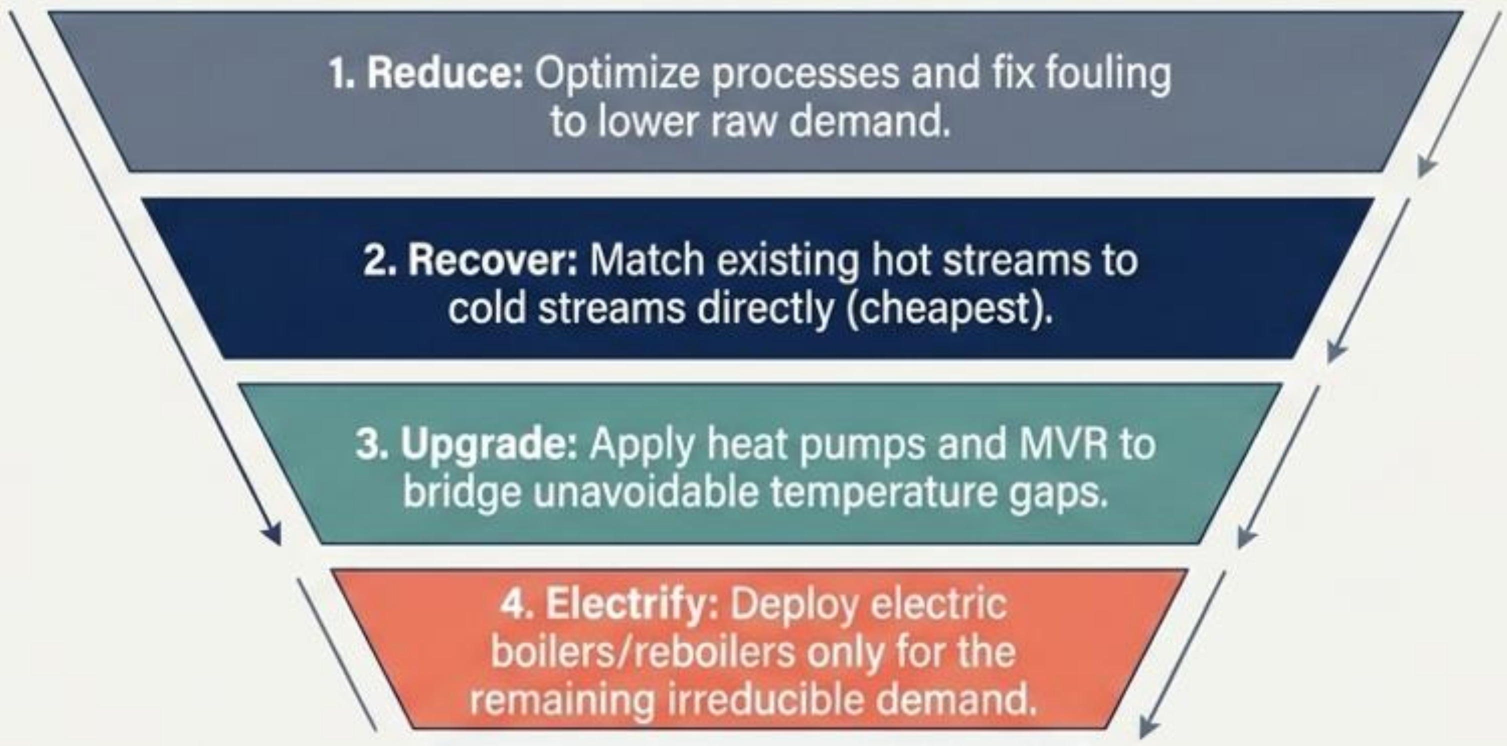
What if we replace steam generation 1 ton/hr with electric boiler?




Without renewable electricity, switching to electric steam adds over 1,100 $tCO_2e$ per year — making electrification worse than the best gas-boiler option.

*Integrated duty case assumes ~0.4 GJ/t steam of recovered waste heat. Actual value must be confirmed by site heat balance and steam conditions.

# Layer 3 ensures electrification is applied only after demand reduction, direct heat recovery, and heat upgrading have been fully exhausted.




1. **Do not electrify first**. Reduce unnecessary heat demand before adding new electric equipment.

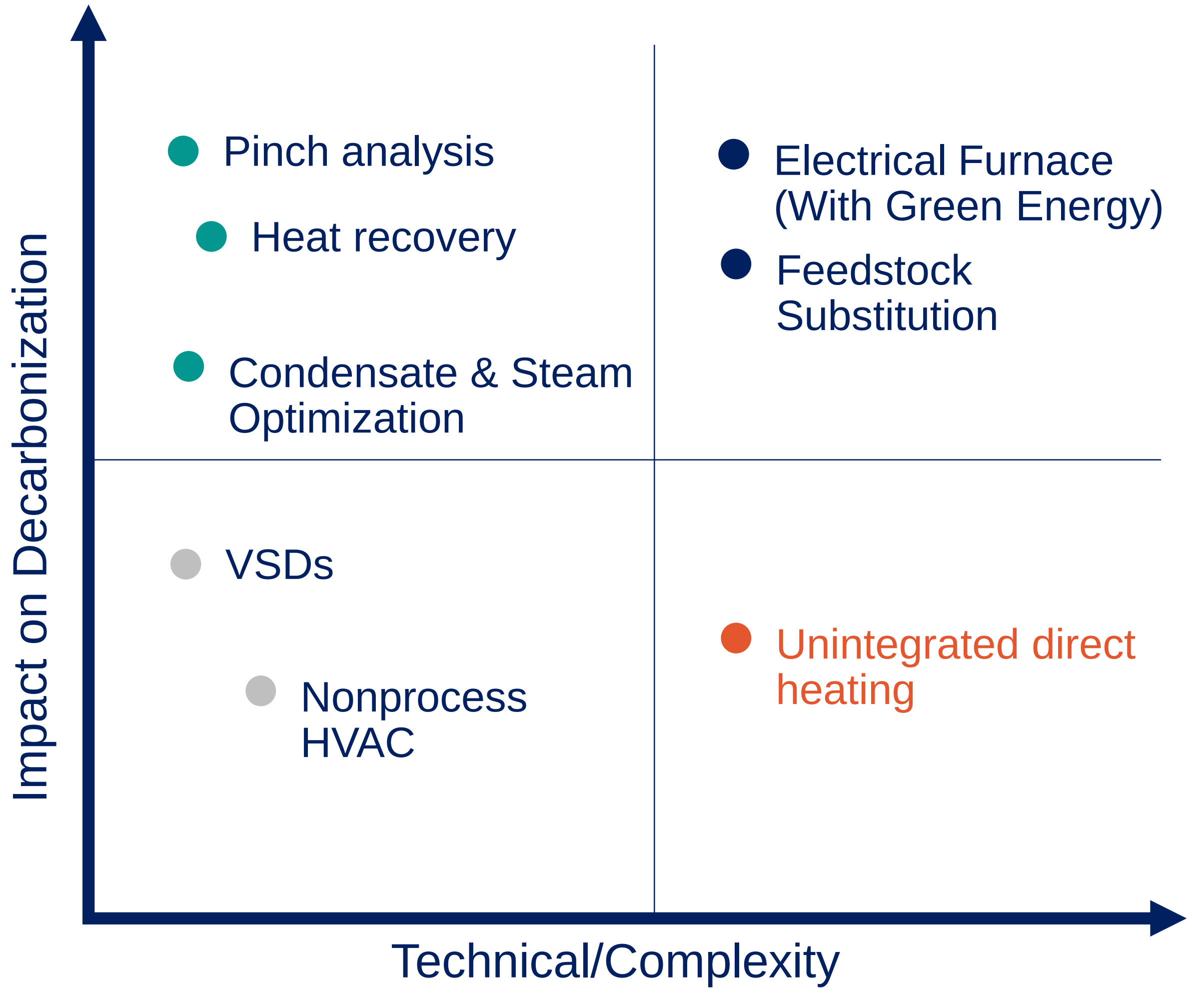
2. **Recover direct heat first**. Existing hot streams should be matched with cold streams before considering new utilities.

3. **Use heat pumps and MVR** only where temperature gaps cannot be solved by direct recovery.

4. **Electrify only the remaining irreducible heat demand** using electric boilers or electric reboilers.

# OSVARD proposes a phased methodology to reduce technical risk and scale deep decarbonization across petrochemical sites.

OSVARD




| | **Low Technical/ Integration Complexity** | **High Technical Integration Complexity** |
|---|---|---|
| **High Decarbonization Impact** | **Priority Deployment**<br>Proven efficiency measures, heat pumps, MVR, e-boilers, motor electrification, steam optimization, and targeted heat recovery.<br>**Focus**: Scale mature technologies first. | **Strategic Transformation**<br>Deep heat-integration redesign, green hydrogen, e-methanol, and circular feedstocks.<br>**Focus**: Pilot, validate, then scale. |
| **Low Decarbonization Impact** | **Foundation & Quick Wins**<br>Site energy mapping, optimization, metering, energy monitoring, and operating discipline.<br>**Focus:** Build baseline and capture no-regret savings. | **Deprioritize / Monitor**<br>Immature point solutions, isolated equipment replacement, or high-cost projects with limited site-wide impact.<br>**Focus**: Avoid premature investment until value is proven. |

OSVARD

# OSVARD helps the chemical industry sites reduce technical risk by moving step-by-step from energy mapping to full feedstock transformation.

**Phase 1: Site Energy Mapping (Now)**

Map heat sources and sinks, steam headers, fuel users, power demand, and operating constraints to establish the whole-site energy baseline

**Phase 2: Mature Technologies (Short-term)**

Deploy proven solutions such as electric motors, heat pumps, MVR, e-boilers, and targeted efficiency revamps to capture early savings and operational learning

**Phase 3: Heat Integration (Mid-term)**

Redesign heat-exchanger networks, steam generation, and utility systems to recover waste heat and rebalance energy after partial electrification.

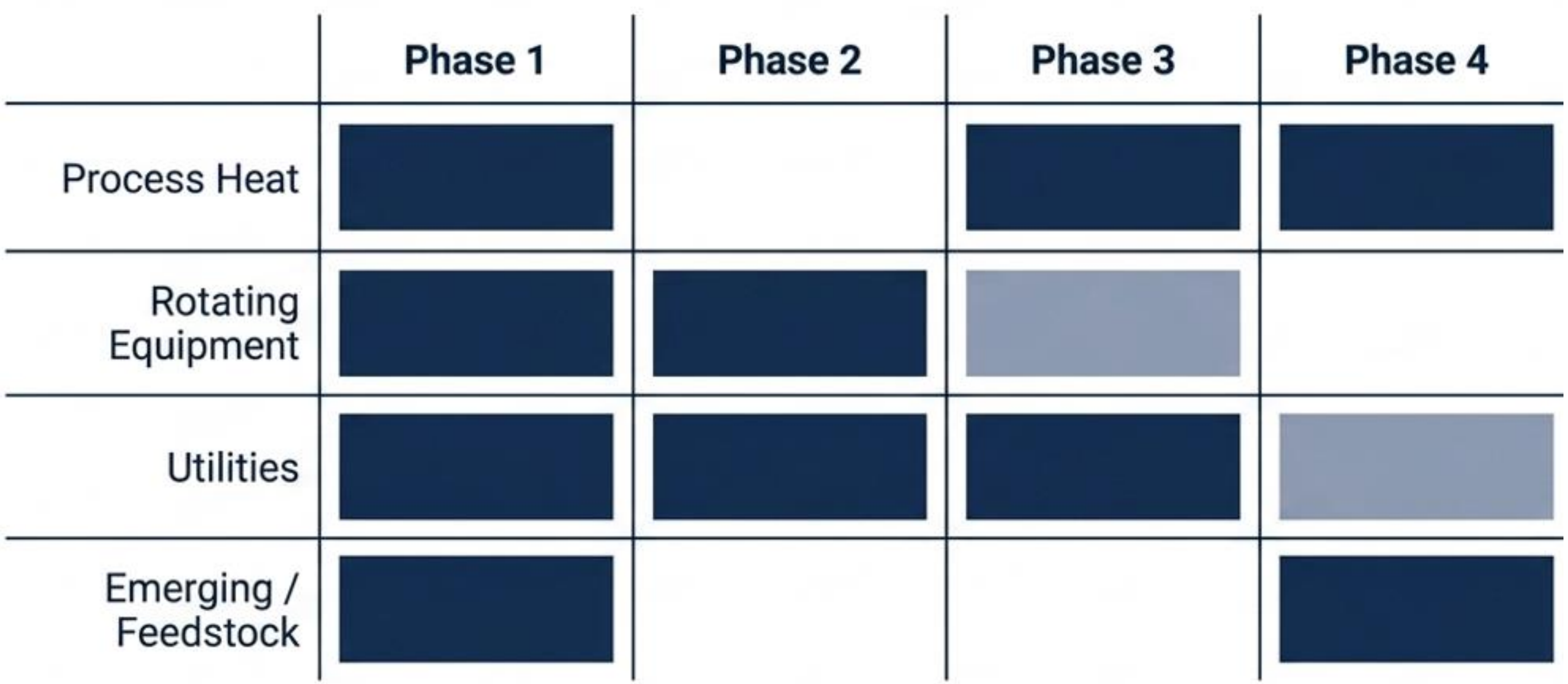
**Phase 4: Emerging Tech./Feedstock Transformation (Parallel/Ongoing)**

Integrate circular feedstocks, bio-based routes, green hydrogen, e-methanol, and low-carbon intermediates to reduce embedded product carbon.

## What OSVARD Studies for Decarbonization

- **Site-Wide Energy & Utility Mapping**: Map heat sources, steam systems, fuel users, power demand, and operating constraints.
- **Energy Efficiency & Loss Hotspot Analysis**: Identify major losses across process heating, utilities, steam systems, and end-use operations.
- **Process Heat Electrification Readiness**: Assess which heat duties can be electrified now and which require pilot validation
- **Heat Integration & Steam Balance Redesign**: Study pinch analysis, heat recovery, condensate optimization, and steam-system impacts.
- **Decarbonization Roadmap & Technology Screening**: Prioritize mature technologies, high-impact electrification projects, and long-term feedstock transformation.

# The framework identifies what to decarbonize; the roadmap defines how to move safely from mapping to deployment.




**"This slide connects the four technical layers with the four execution phases, showing that OSVARD starts with site-wide mapping, then sequences mature technologies, integration redesign, pilots, and feedstock transformation."**

# Q&A

Contact: Wiroon (Charles)

wiroon.t@globalrd.co.th

Line ID: wiroont2

www.globalrd.co.th