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Co-innovating tomorrow™

Bringing Decarbonization to Life™

June 2023

Bringing DECARBONIZATION to Life™

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Bringing Decarbonization To Life ™

Over 400 million tonnes of CO_2 emissions avoided.

The impact KBC's clients have received with our support from energy improvement projects alone

Where Are We Right Now?

Vietnam and Laos record hottest temperatures ever as heat wave grips Southeast Asia

By Tara Subramaniam, CNN
Published 3:24 AM EDT, Mon May 8, 2023

BANGKOK: 41°C

Meanwhile in Thailand, Saturday saw the hottest ever temperature recorded in Bangkok – 41 degrees Celsius (105.8 Fahrenheit).

The capital is among large parts of Thailand that have suffered under temperatures in the upper 30s to low 40s Celsius since late March. In mid-April, the northwest city of Tak became the first place in the country to top 45 degrees Celsius (113 Fahrenheit), according to Herrera, using data from the Thai Meteorological Department.

Last month, Thai Prime Minister Prayut Chan-o-cha expressed concern over "dangerously high temperatures in various parts of Thailand."

Climate crisis calls for rapid transformation of societies

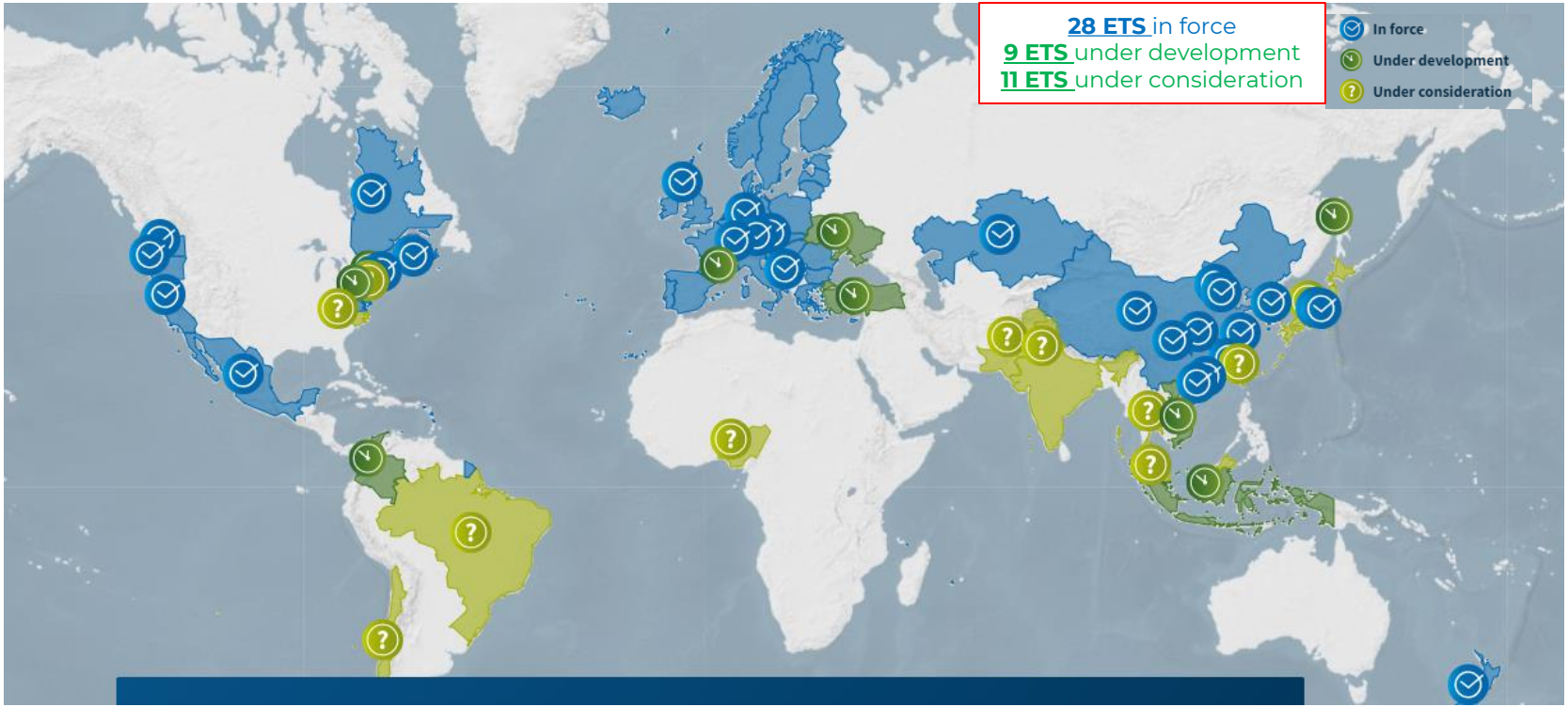
The window is closing! The world is not on track to reach the Paris Agreement goals and global temperatures can reach 2.8°C by the end of the century.

The Emissions Gap Report 2022 finds that the world must cut emissions by 45 per cent to avoid global catastrophe. Solutions to transform societies exist, but the time for collective, multilateral action is now.

Global Emissions Trading Systems (ETS) – Year 2013

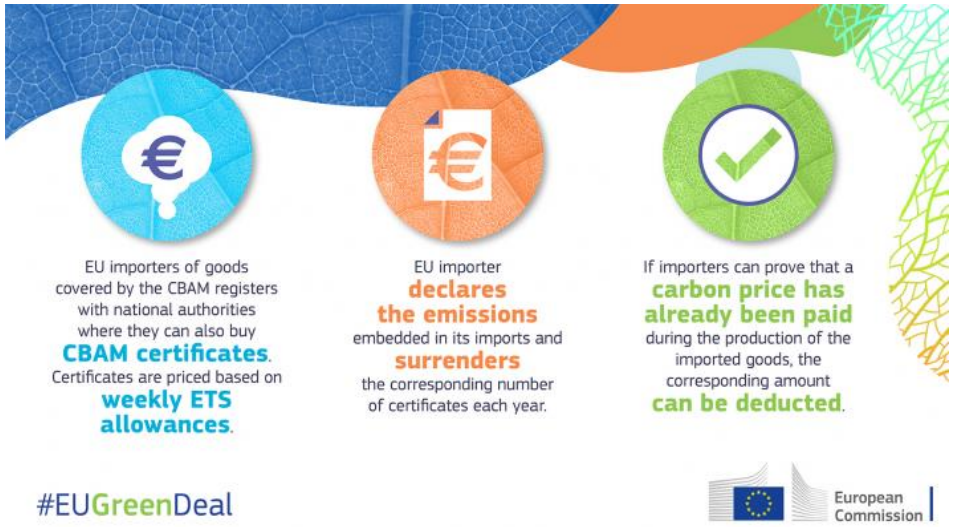
Source: ICAP ETS Map , https://icapcarbonaction.com/en/ets

Global Emissions Trading Systems (ETS) – Year 2023



Source: ICAP ETS Map , https://icapcarbonaction.com/en/ets

EU Carbon Border Adjustment Mechanism (CBAM)



Year 2026

In its first phase, the CBAM will focus on goods most at risk of carbon leakage:

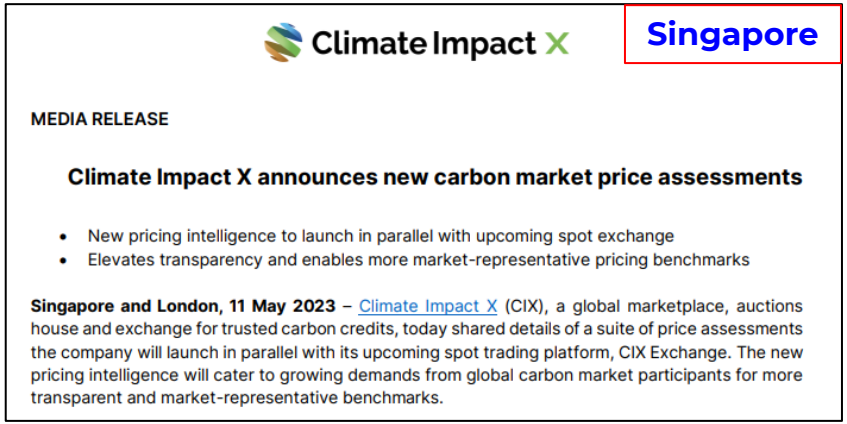
Source: https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en#latest-developments

Putting a Price on Emissions in Asia

Carbon exchanges in Asia are now the norm, not the exception

Thailand

Malaysia



Singapore

Hong Kong

Types of Emissions and Regulatory Response

Operating Emissions (Scope 1 and Scope 2)

- Scope 1 = Emissions from operating facilities
- Scope 2 = Emissions from buying energy for those facilities (electricity, steam, gas, etc.)

- Regulatory Approach:
  - Restrict (Cap) and make excess expensive linked to market demand (Trade)
  - Carbon Offsets and Carbon Credits
  - Carbon Tax (Price to every ton of emission)

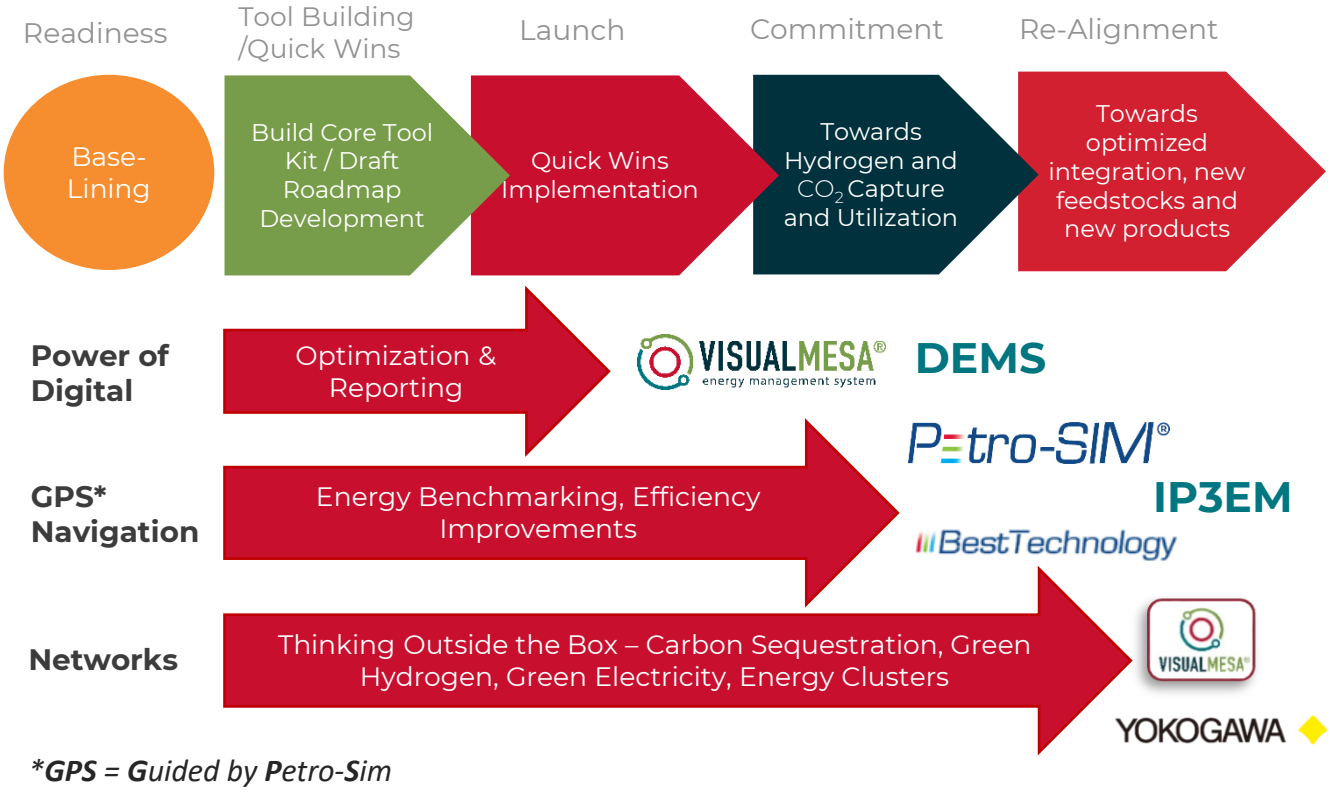
Emissions Companies Create Elsewhere (Scope 3)

- Upstream supply chain (emissions resulting from supplying the facility with their raw materials and consumables)
- Downstream emissions resulting from transporting and using the products ≥ 80%

- Regulatory Approach:
  - Incentivize fuels that generate less emissions

  (i.e. lower carbon intensity raw materials and consumables)

Roadmapping to Net Zero

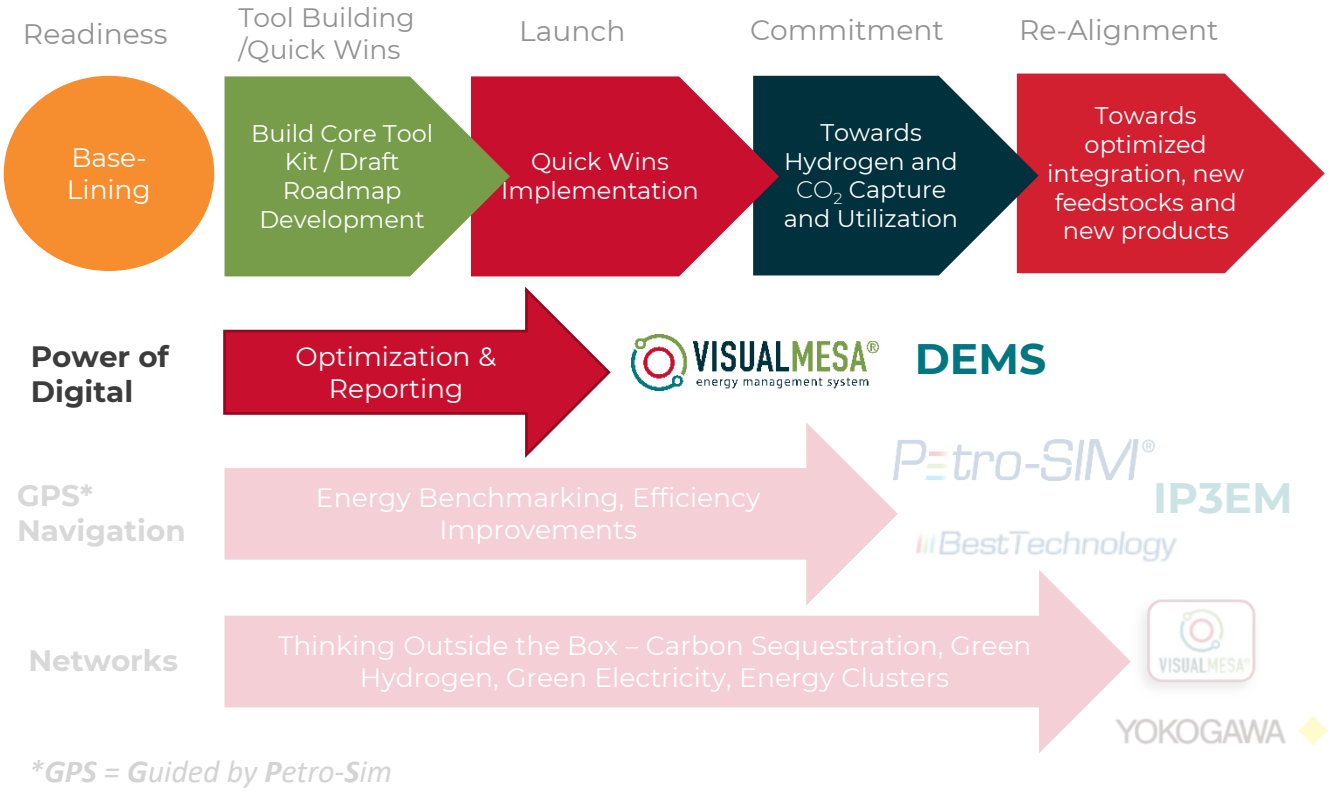


***GPS** = **G**uided by **P**etro-**S**im*

Suite of Technologies

- Use of **Digital Energy Management System (DEMS)** to constantly tune energy and emissions solutions
- Focus on energy benchmarking and efficiency improvements **within your facility**
- Start looking **outside your facility** for help in achieving Scope 1 and 2 Net Zero goals

Energy Management Systems (EMS) As Enablers



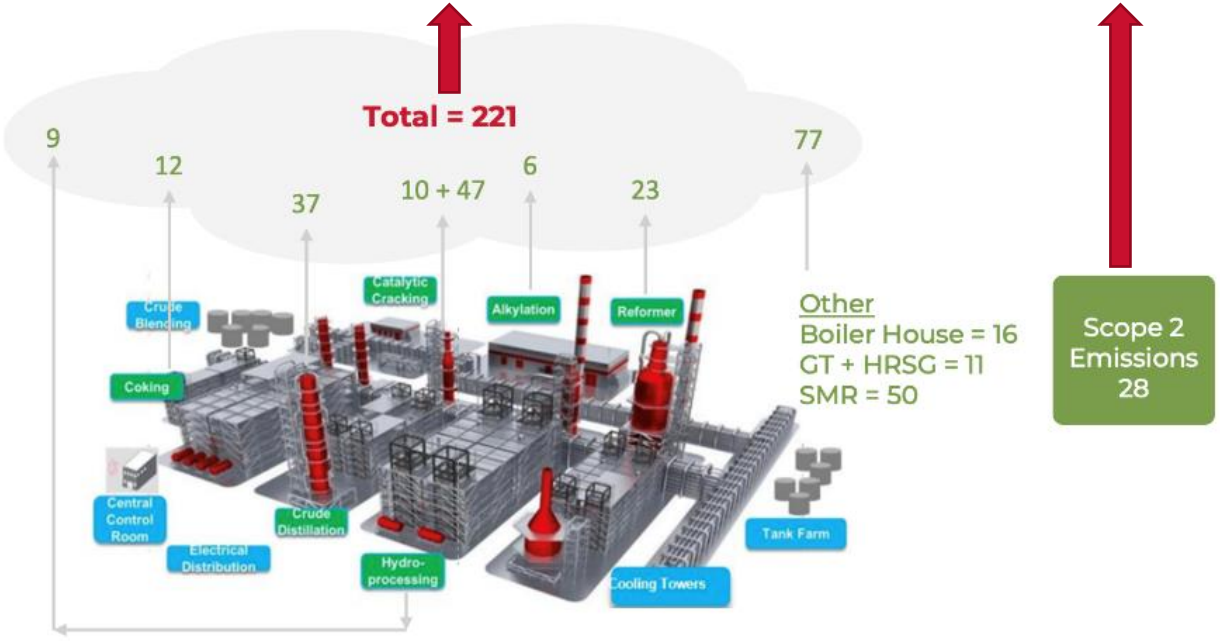
Digital Energy Management System (DEMS)

- Compliance and Reporting, Auditing and Dashboarding
- Energy Supply Optimization
  - Increasingly important as energy supply options proliferate.

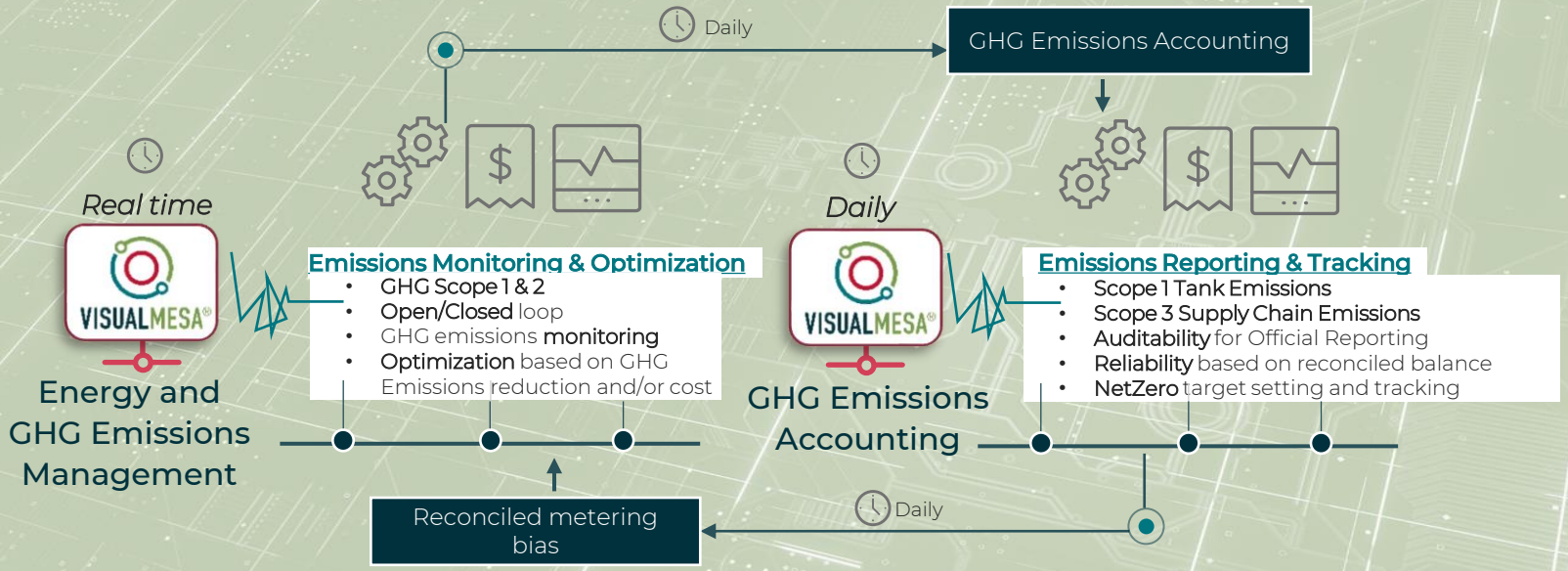
Emissions for a Typical Refinery

Scope 1 & 2 CO_2 Emissions from an Average 150 MMBPD Fuels Refinery (Tonnes CO_2 per Hour)

Scope 1 & 2 Total Emissions = 249 T/H



Emissions Management Solution – Monitoring and Optimization



Insight | Auditability | Compliance | Standardization | Reliability | Frequency | Continuous improvement

Optimization: Step-Change Improvement

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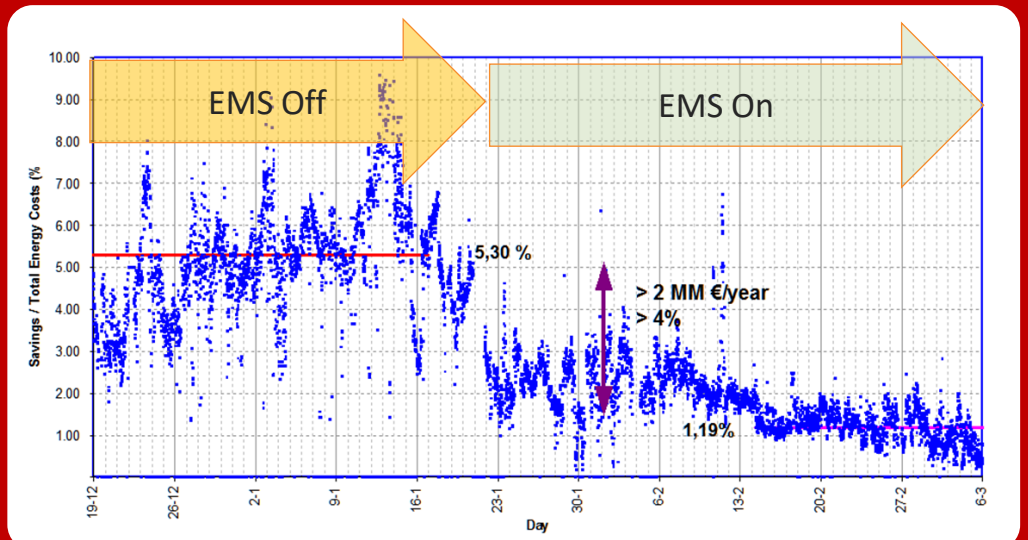
European Integrated Refinery & Petchem Complex

Estimated CO_2 emissions reduction: 36 k ton/year

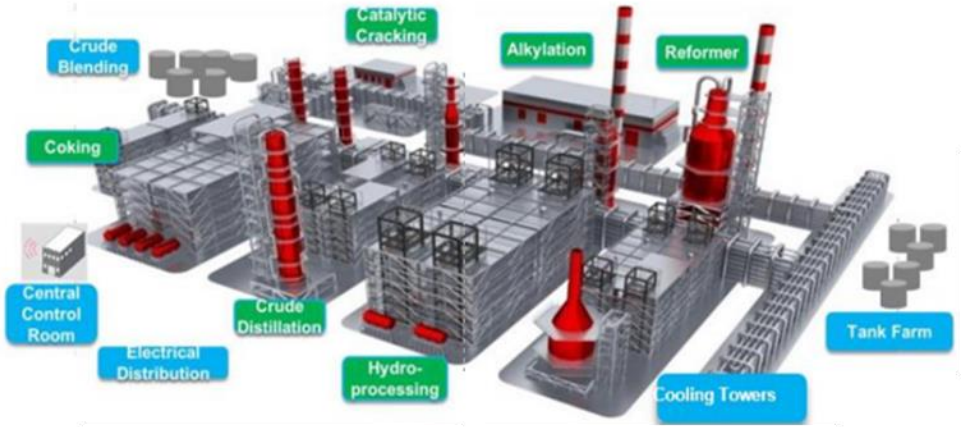


Key Considerations

- Quicker Reactions to Emissions Reduction opportunities
- Real Example of **Visual MESA®** working at a Refinery
- "No regrets" investments. Cost savings aligned with emissions reduction goals, always a good practice

Energy Management System – Financial Incentive

Scope 1 & 2 Total Emissions = 249 T/H
(~ 2 Million Tonnes per Year CO_2)

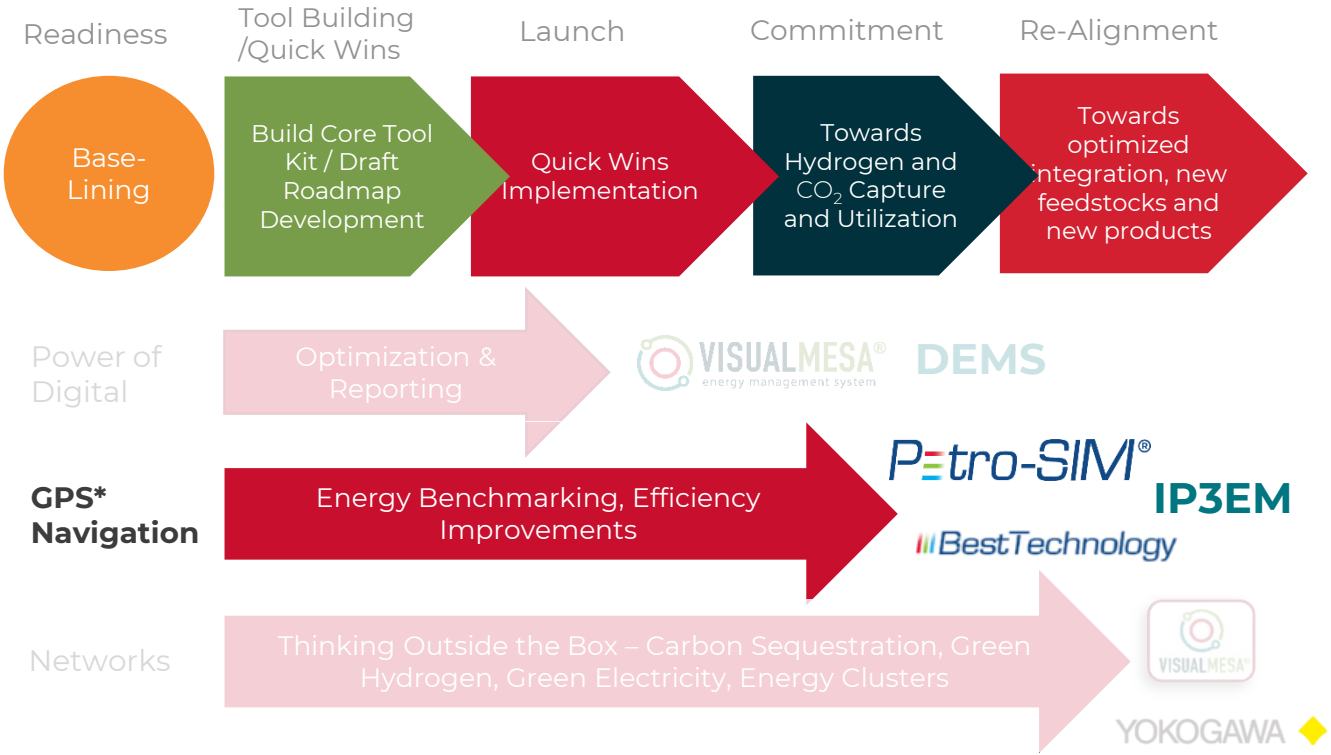


Energy Management System "ON"

3% Reduction of Emissions @ 80Euros / Tonne
(Approx. EU marginal compliance credit cost)

4.5 Million Euros annual savings
EMS System Payback less than 6 months

Roadmapping with GPS* Navigation



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- Role of Energy Efficiency
- Integrated Solutions Process for Emissions Reduction beyond 20%
- Scenario Planning and Investment Evaluations for Future
- A Trusted and Credible Tool for the Future

Energy Efficiency Improvements: A Journey

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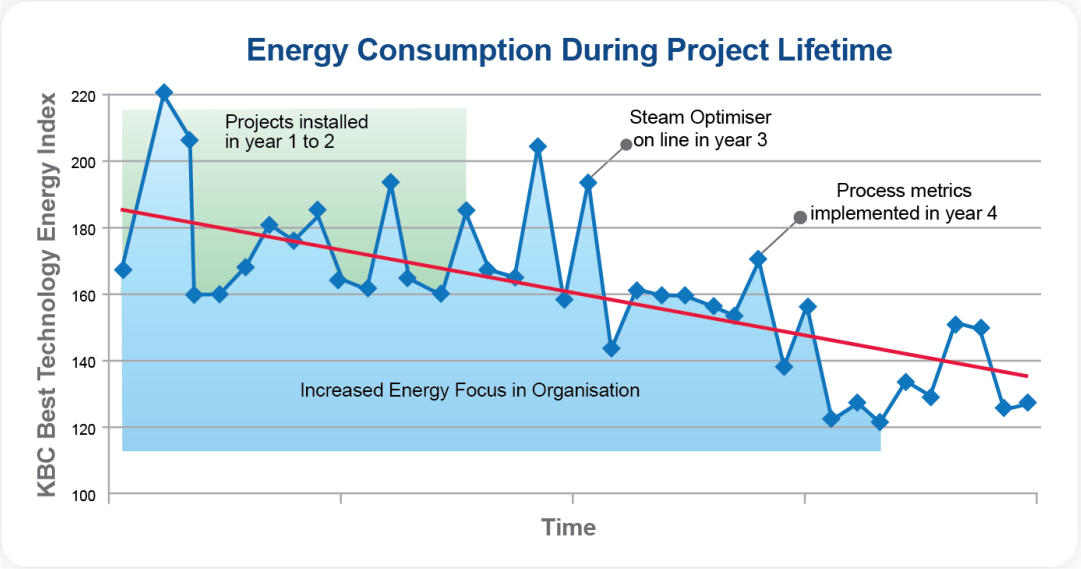
Case Study: Energy Efficiency Improvements at Q2 Refinery

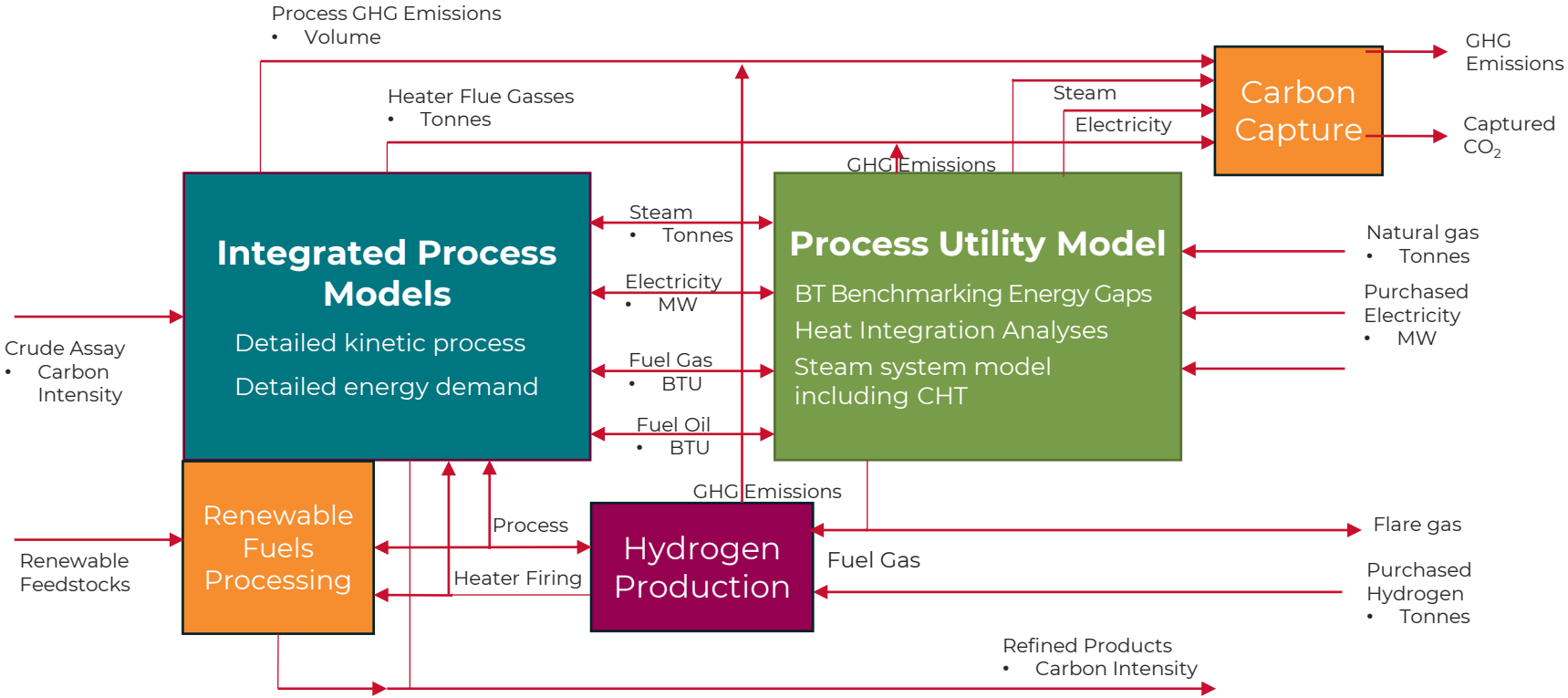


Supported by **energy, process and subject matter experts** with over 20 years experience using **KBC's superior tools and proprietary leading technologies** our client saw a **20% reduction** in energy index over 4 years, resulting in them becoming a **top quartile performer**

Key Considerations

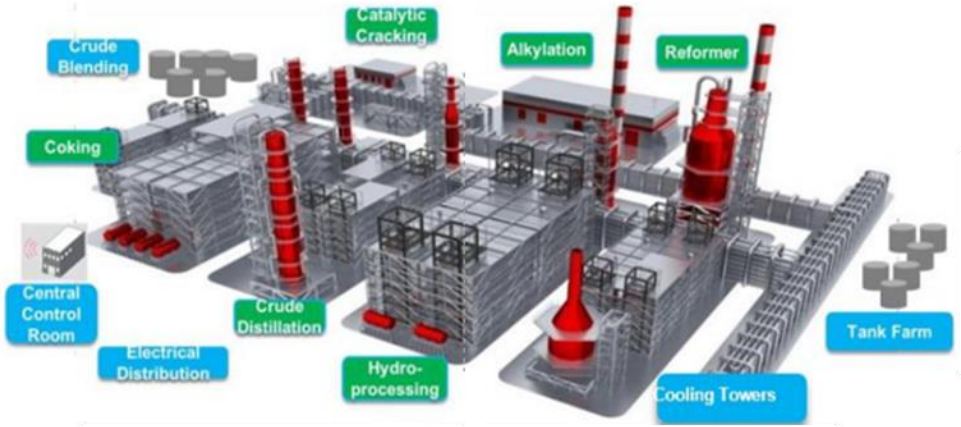
- Multi-year energy improvement approach
- Example of operational and capital projects improvement at a European Refinery
- The road might be "bumpy", but the result is consistent

IP3EM – Energy Process Demand, Utility Supply and Emissions with Integrated Renewable Feedstock Processing



Energy Efficiency Improvement – Financial Incentive

Scope 1 & 2 Total Emissions = 249 T/H
(~ 2 Million Tonnes per Year CO_2)

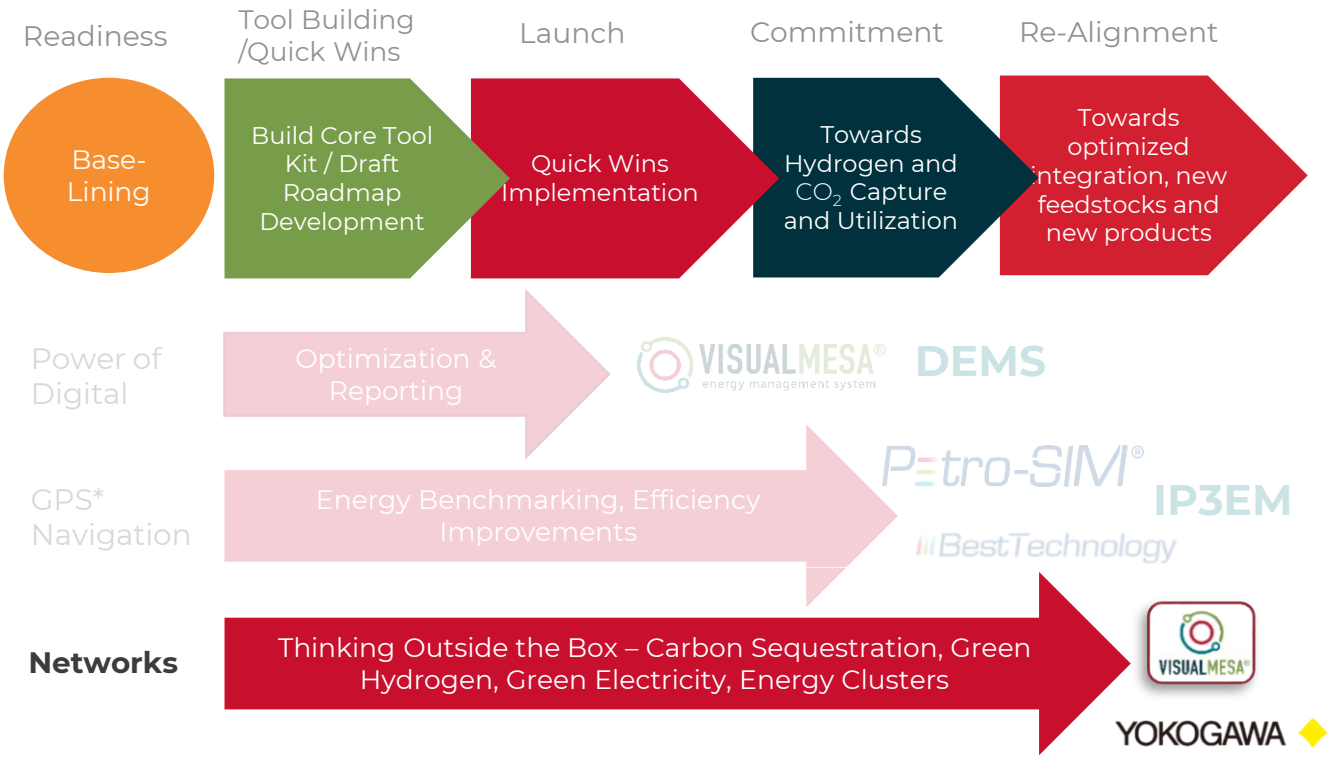


Energy Efficiency Improvement
Quick-Wins and CAPEX Projects
Process Energy Metrics Implementation

15% Reduction of Emissions @ 80Euros / Tonne
(Approx. EU marginal compliance credit cost)

21.6 Million Euros annual savings
Attractive CAPEX project paybacks

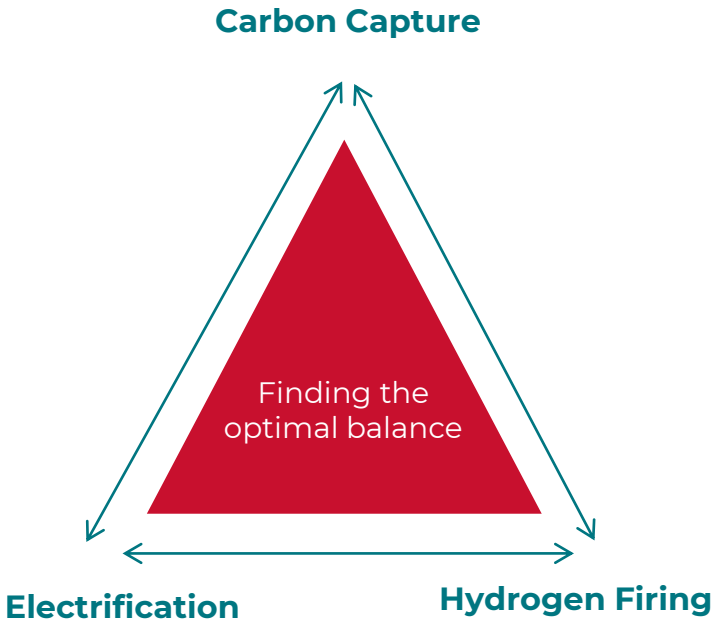
Thinking Outside The Box



- Collective Action for Large Scale Emissions Reduction Projects
  - Energy networks
  - Aggregating Emissions Sources
  - Using Scale to minimize risk and maximize capital efficiencies
- Who is The Client? How to build cases for collective action?

“Going it Alone” – Not an Option

Emissions Impact of Internal Approaches



Crude & Vacuum Electric Heating

Electrification

Stack CO_2 Avoided	-37
Scope 2 Increase	**119**

Base Emissions	221
Net Change	82
New Emissions	**303**

Crude & Vacuum SMR H2 Firing

Hydrogen Firing

Stack CO_2 Avoided	-37
SMR CO_2 Add.	50
Boiler Change	-3
Scope 2 Increase	**0**

Base Emissions	221
Net Change	10
New Emissions	**231**

Crude & Vacuum Stack Capture

Carbon Capture

CO_2 Captured	-33
Boiler Increase	8
Scope 2 Increase	**11**

Base Emissions	221
Net Change	-14
New Emissions	**207**

Carbon Capture Projects Require Significant Capital

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Prax Lindsey Oil Refinery Launches £300 Million Carbon Capture Project

By Prax | 1st February 2023 | Company News

Prax Lindsey Oil Refinery has announced plans to build a £300 million carbon capture plant, as the Prax Group undertakes a huge investment at the site, as it moves towards decarbonising operations and transitioning to a low carbon future.

The Prax Lindsey Carbon Capture Project (PLCCP) will capture more than 85% of the CO2 produced on site, with more than 1 million tonnes of CO2 to be captured every year starting from 2028. Emissions produced on site will be captured via an amine solvent, a well understood and proven technology used in natural gas processing and gas sweetening, with CO2 then transported and stored in depleted gas fields in the North Sea via the East Coast Cluster pipeline.

Pacific Northwest NATIONAL LABORATORY

RESEARCH | PEOPLE

HOME » NEWS & MEDIA

March 11, 2021 | News Release

Cheaper Carbon Capture Is on the Way

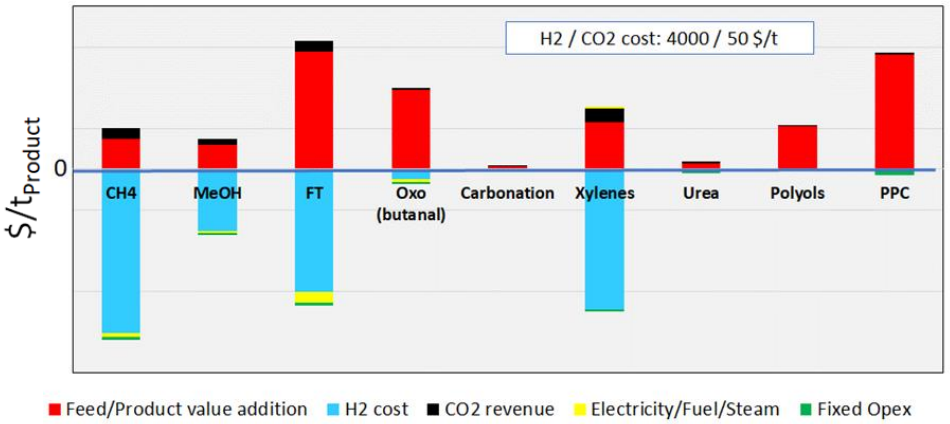
At a cost of $400–$500 million per unit, commercial technology can capture carbon at roughly $58.30 per metric ton of CO_2, according to a DOE analysis. EEMPA, according to Jiang's study, can absorb CO_2 from power plant flue gas and later release it as pure CO_2 for as little as $47.10 per metric ton, offering an additional technology option for power plant operators to capture their CO_2.

Carbon Utilization – Ready For Prime Time?

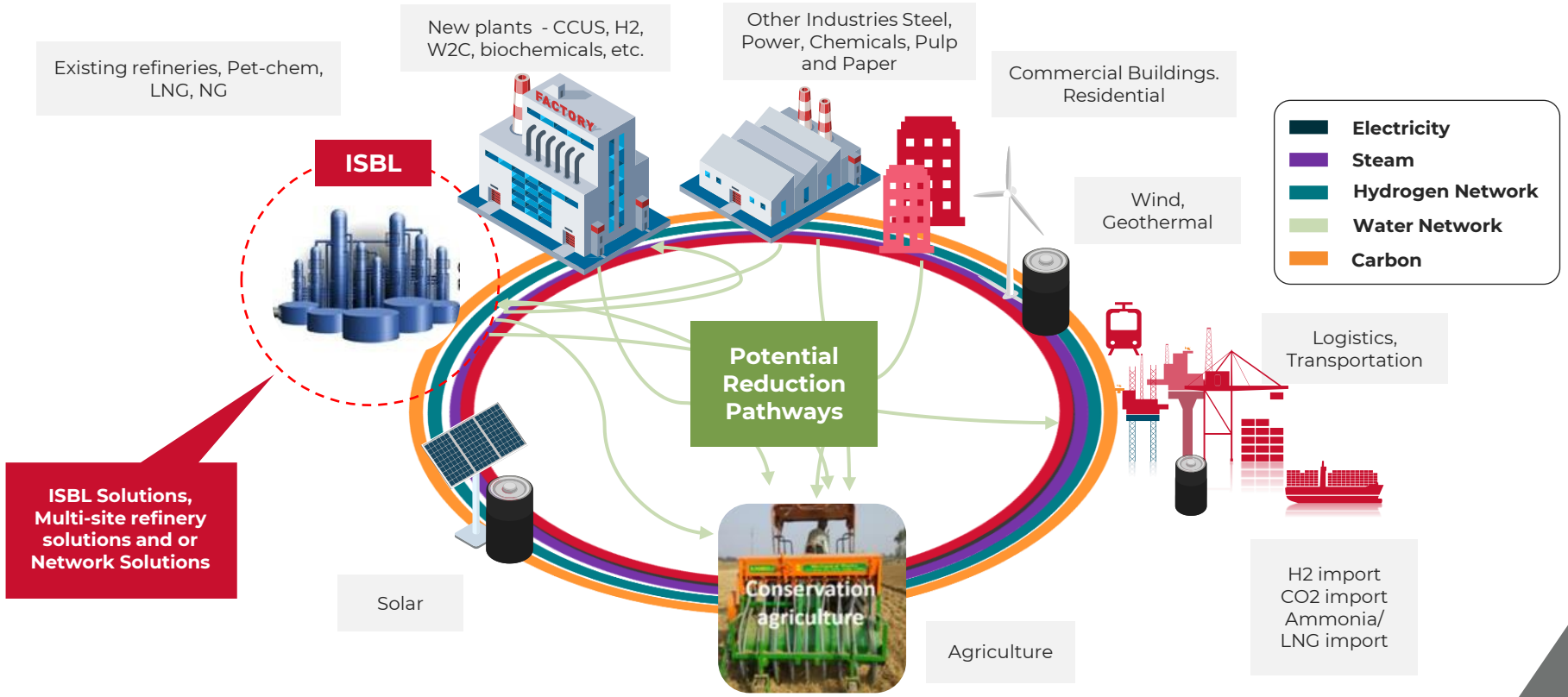
#	Name	Main Product	Non-CO_2 feeds
1	Methanation	Methane	H_2
2	Methanol	Methanol	H_2
3	Fischer-Tropsch	Syncrude / SAF	H_2
4	Oxo Synthesis	Butanal	Propylene, H_2
5	Carbonation	Building material	Steel slag
6	Xylenes	Mixed Xylenes	H_2
7	Urea	Urea	Ammonia (NH_3)
8	Polyols	Polyether carbonate polyol	Propylene oxide (PO)
9	Polymeric Carbonates	Polypropylene carbonate (PPC)	Propylene oxide

Source: KBC Analysis

CO_2 Utilization Operating Margins



Network Solutions for Carbon Intensity Reduction Opportunities



Key Take Aways and Next Steps

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Decarbonization Pathways to Net Zero Emissions

Start with Energy Management and Efficiency	Improvements of 15-20% CO_2 Emission Reduction
Roadmapping with Models	Detailed picture of emissions and a tool to build a reduction plan within and beyond plant boundaries.
Options Beyond Efficiencies	Simulation of Emissions Reduction Options Beyond 20%
Out of the Box Thinking: Networks	Evaluate Emissions and Cost reduction opportunities using broad models of energy and emissions systems across industry networks

KBC Decarbonization Assistance

- Energy Management System
  - Monitoring, Dashboarding, Reporting, Auditing, Certification
  - Energy and Emissions Reduction Optimization
- GPS (Guided by Petro-SIM®) Roadmapping
  - Energy Efficiencies (SER), Profit maximization (PIP)
  - IP3EM
    - Refineries
    - Petrochemical facilities
    - Mid-stream/Upstream
- Technology Evaluation
  - Licensor selection
  - Project risk assessment
  - Project integration analyses
  - Project financing assistance
- Cross-Sector (Network) Emissions Reduction
  - Network opportunity assessments
  - National, Regional and Municipal emissions reduction opportunity assessments

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Thank you

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