Integrated EMS Offering

Holistic Energy Management Solutions

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Agenda

1. Industry Challenges
2. Aspects of an Energy Management System
3. Integrated Approach
   - Sites – Low Energy Complexity
   - Sites – High Energy Complexity
4. Energy sustainability – Co Pilot Services
5. Summary

The Why ?

Energy & Carbon Management - Industry Challenge

Singapore Specific Regulatory Challenge

Proposed requirement	Details	
Enhanced energy management practices for existing facilities	**The most energy-intensive facilities** **Consumption ≥ 500TJ/yr** • Structured EnMS by 2021 • EE opportunities assessments (EEOA) ✓ 1st EEOAs by 2021 and every 6 yrs thereafter ✓ Cover at least 80% of energy consumption	**Next tier energy-intensive facilities** **Consumption 54 – 500TJ/yr** • Structured EnMS by 2022 • EE opportunities assessments (EEOA) ✓ 1st EEOAs by 2021 ✓ review every 3 yrs the need for subsequent EEOAs ✓ Cover at least 80% of energy consumption
Energy performance measurement requirements for new facilities & major expansions	**All new energy-intensive facilities & major expansions i.e. ≥ 54TJ/yr (from 2018)** • Design and construction phase ✓ Plan for and install instruments and meters at system level • Operations phase ✓ Report energy use and energy performance indicators based on measured data ➢ Cover energy-consuming systems that account for at least 80% of total consumption	
Energy efficient design of new facilities & major expansions	**All new energy-intensive facilities & major expansions i.e. ≥ 54TJ/yr (from 2018)** • Design phase ✓ Review facility design, develop economically feasible energy/carbon efficiency measures for incorporation into the new facility and report findings	
MEPS for common industrial equipment & systems	• MEPS to be set at premium efficiency level for single speed 3-phase induction motors (from 2018) • MEPS to be extended to other common industrial equipment and systems over time	

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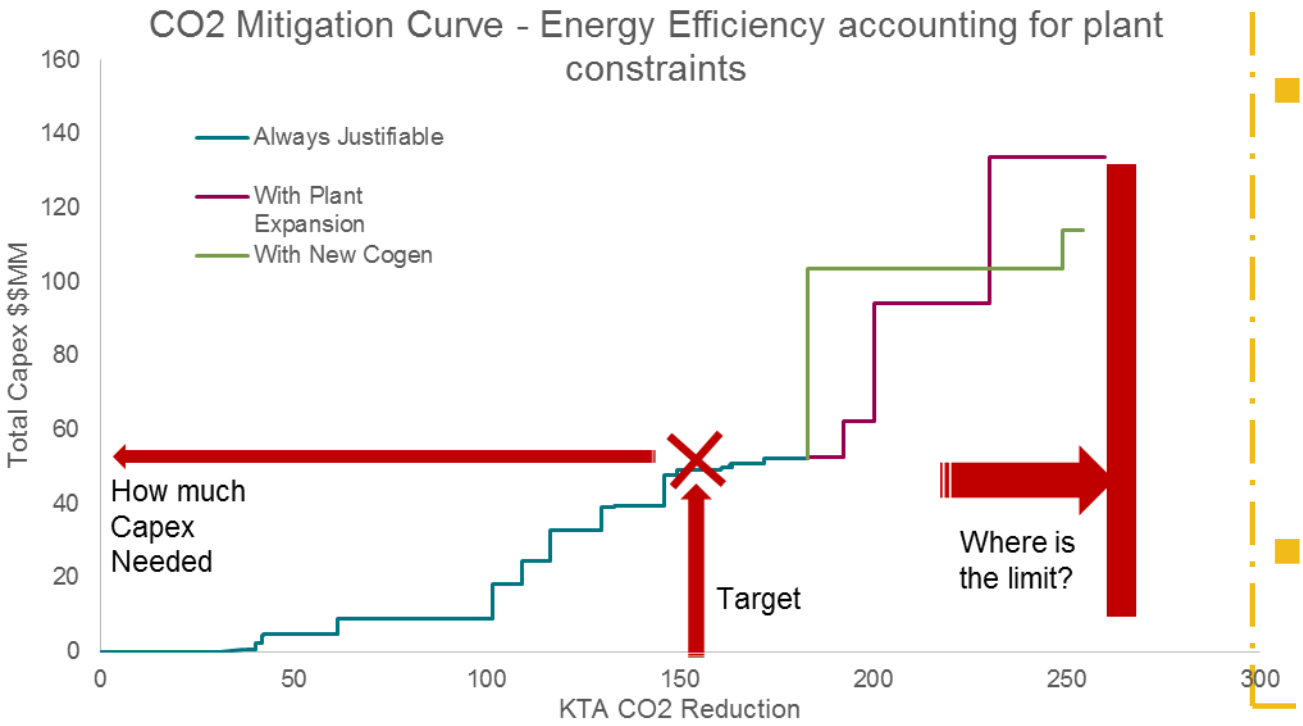
Owner/Facility Perspective

- Compliance
  - Immediate regulatory requirement to complete an EEOA and implement EnMS
    - Before 2021
  - Measurement pre-requisites !
- How does EEOA study fit in with future plans
  - Expansions and revamps- Energy efficient revamp
  - New facilities – Energy efficient design
  - Energy and Carbon strategy of corporate
- Implementation of improvement opportunities
  - Compatibility between opportunities
  - Measuring effectiveness
- Sustainability
  - Visibility and continuous improvement

Global Challenge – Where and How much to spend?

- The sustainability challenge thrown by shareholders of major corporates.



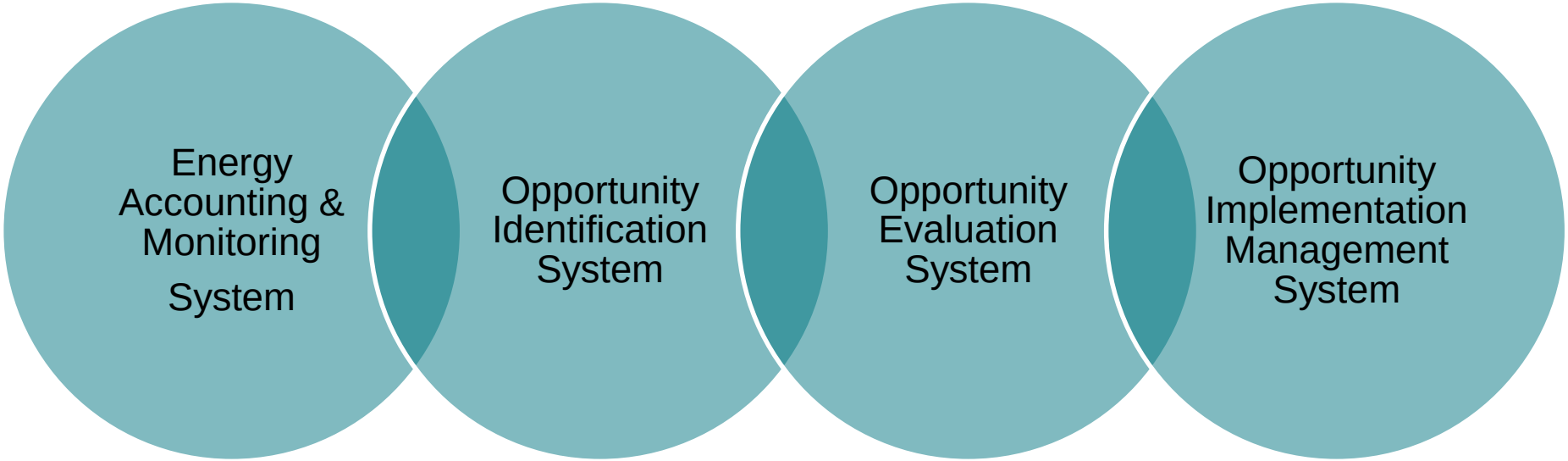
- How Much Saving is possible?
- To achieve a top down Target saving
  - How much to spend?
  - Where to spend it?
    - By site, by unit, by type
    - By Opportunity
- How long will it take and how are we progressing?

The How ?

Aspects of Energy Management System

Energy & Carbon Management Systems

In total, 4 systems are required



- Clear and Consistent Reporting
- Benchmark vs Best Possible
- Determine Priorities

- Identify Gaps & Categorise
  - Technically
  - Organisationally
  - No/low/High Capex
- Understand gaps all the way to Best Performer
- Generate Ideas Systematically
- Prioritise ideas

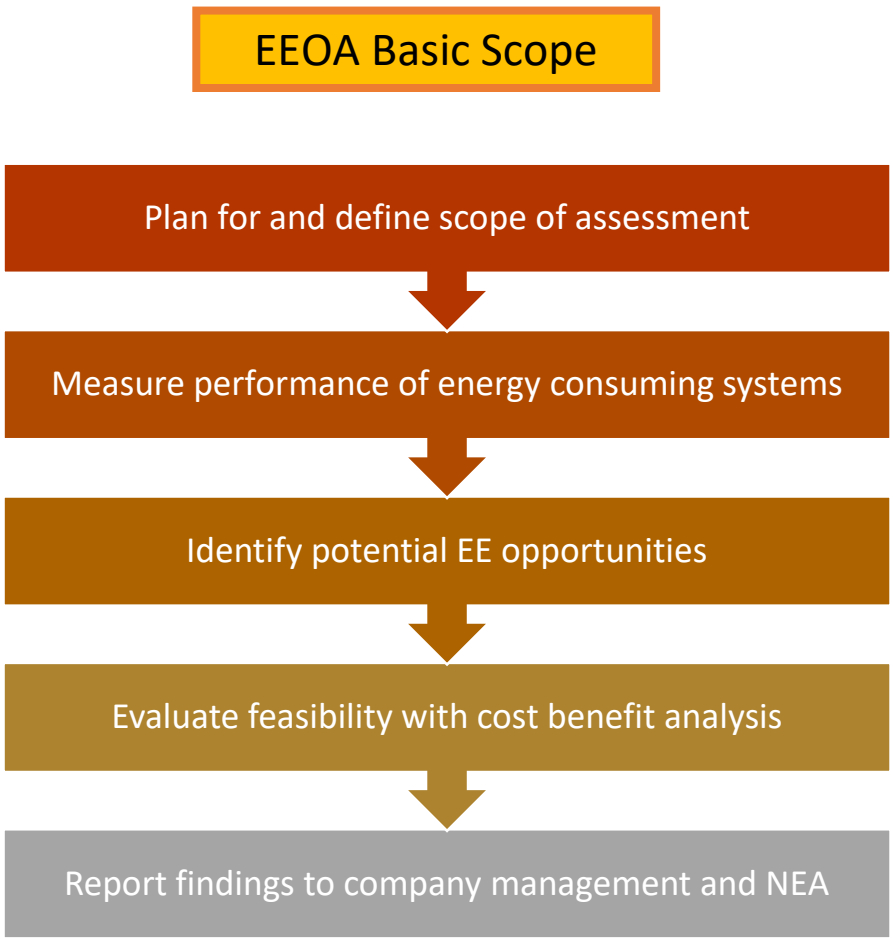
- Detailed Evaluation Tools
- Understand roadmap all the way to Best Technology
  - Conflicts & Synergies
- Portfolio Insights
  - Spend X to save Y
  - Focus Areas

- Track Progress vs Targets
- Set and manage goals
- RASCI

The How ?

Facilities with Low Energy Complexity

Working towards EEOA – KBC/Yokogawa Offering



KBC has ESCO Status and is an accredited EEOA assessor

- ***Strong emphasis on measurement*** of all energy related variables in the facility – Yokogawa has range of instrumentation available.
- ***Measure energy performance***
  - Irrespective of complexity, an energy study should start with benchmarking
  - KBC/PTAI* benchmarks across multiple industries
- ***Identify EE opportunities***
  - Less complex sites have limited handles – Main focus on fired heaters, large pumps and compressors and maybe a few distillation columns
  - KBC Standardised recommendations
- ***Evaluation of EE opportunities***
  - Standardised methodology – Primary Fuel
- ***Report to NEA***
  - Standardised compliant report structure
  - KBC authorised to sign off

** PTAI – Phillip Townsend Associates is a strategic partner for benchmarking*

Zero Step : *Measuring energy use*

Yokogawa has range of instrumentation available

- DPharp EJX series
  - Multi-sensing technology minimize cost by eliminating the need for pressure gauges;
  - Flame explosionproof, intrinsically safe explosionproof, safety standards SIL and EC directives.
  - Compatibility with HART and FOUNDATION fieldbus communication protocols.

- InfraSpec NR800
  - High wavelength resolution, outstanding accuracy and wide scanning range
  - Direct transfer of a calibration model from the laboratory to the process, or among processes.

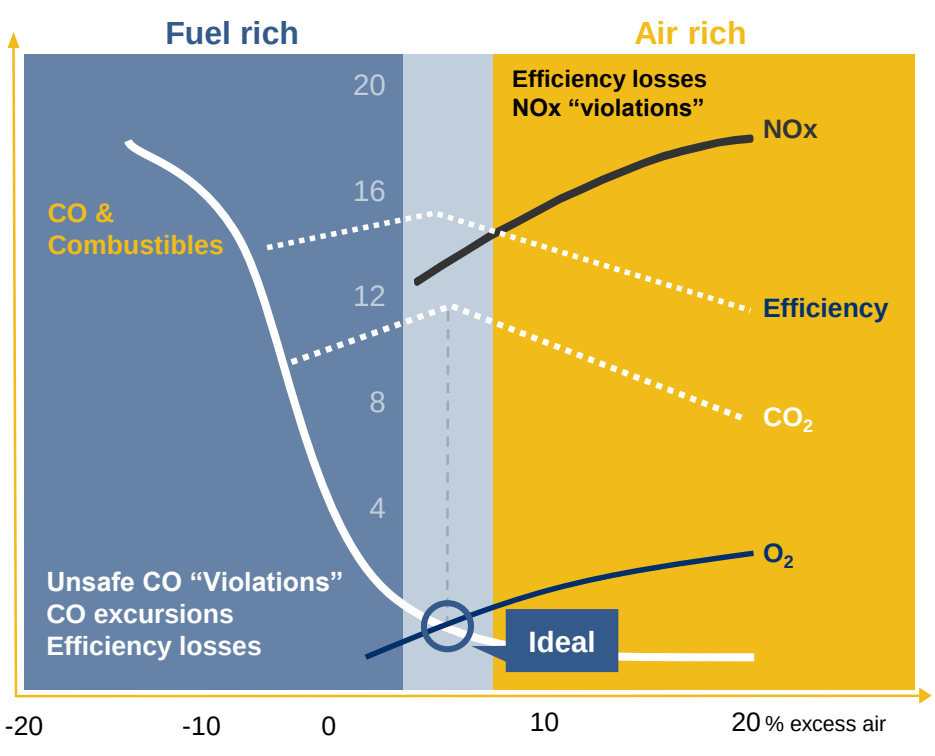
- Tunable Diode Laser Spectrometers (TDLS)
  - The platform design is for in situ measurements which negates the need for sample extraction and conditioning. The non-contacting sensor allows for a variety of process types including corrosive, abrasive and condensing.
  - Proven platform for the measurements of O2, CO, CH4, NH3, H2O and many more NIR absorbing gases.

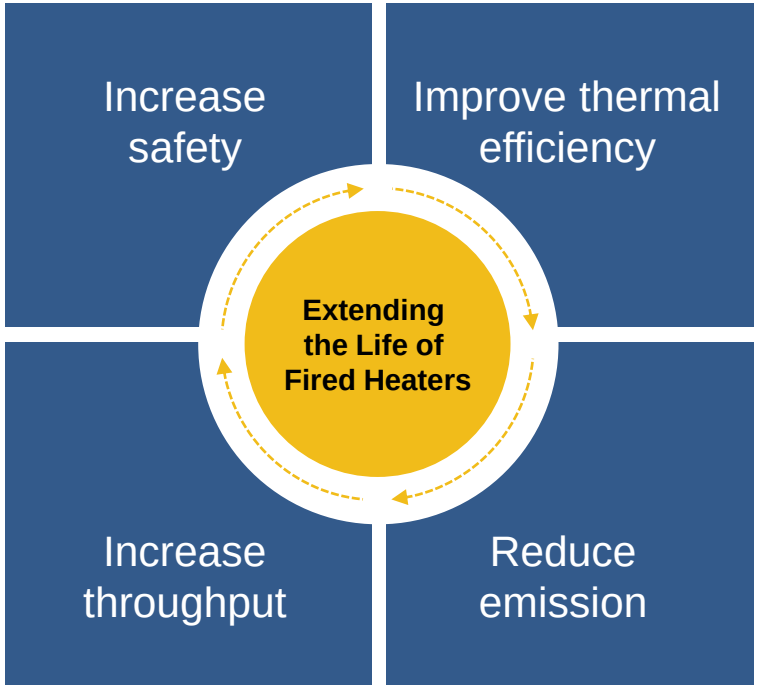
- EWFLO vortex flow meter
  - Combines the field proven sensor and body assembly used in more than 450,000 units worldwide
  - Innovated spectral signal processing (SSP)

Quick win for Fired Heaters: *Combustion One*

CombustionONE

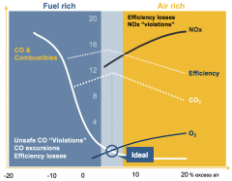
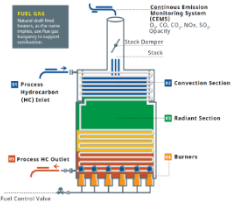
Maintaining excess air in the optimal area for Efficiency, Emissions, Extended heater life and Safety





One-stop service

Yokogawa is the only company who offers a total package of fired heater optimization

TDLS	
Safety and optimum combustion control	
Furnace knowledge	

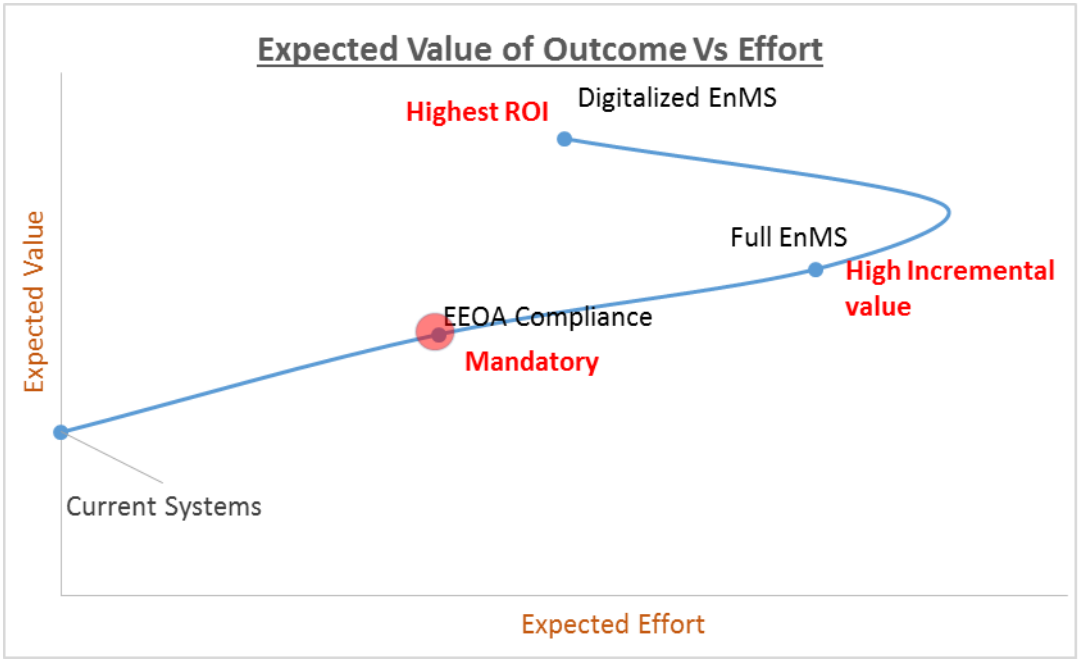
YOKOGAWA

1 SEC. CombustionONE

Digitalized EnMS for Low Complexity Sites

But…. Digitalization of EEOA is better

- Digitalisation minimizes effort and maximizes benefits

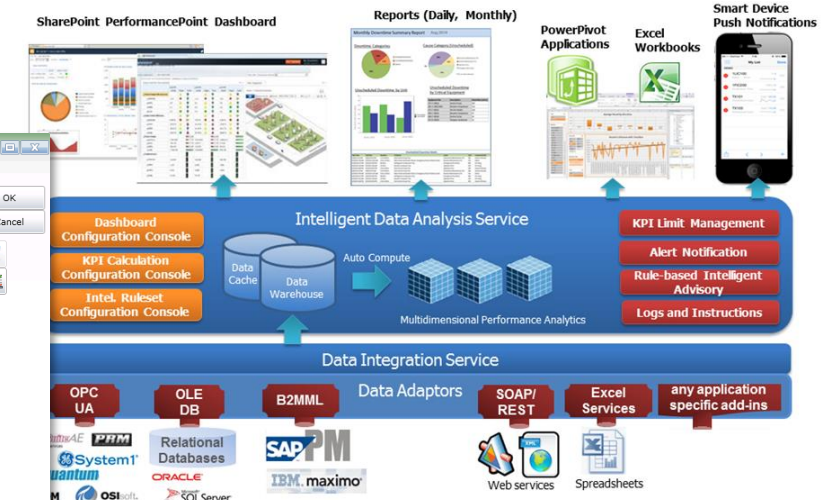


Energy Performance

- Yokogawa/KBC offers various EMS solutions fit different industry complexity

EEOA Standard Report

Automated First Principle Model online monitoring (VM-EM)

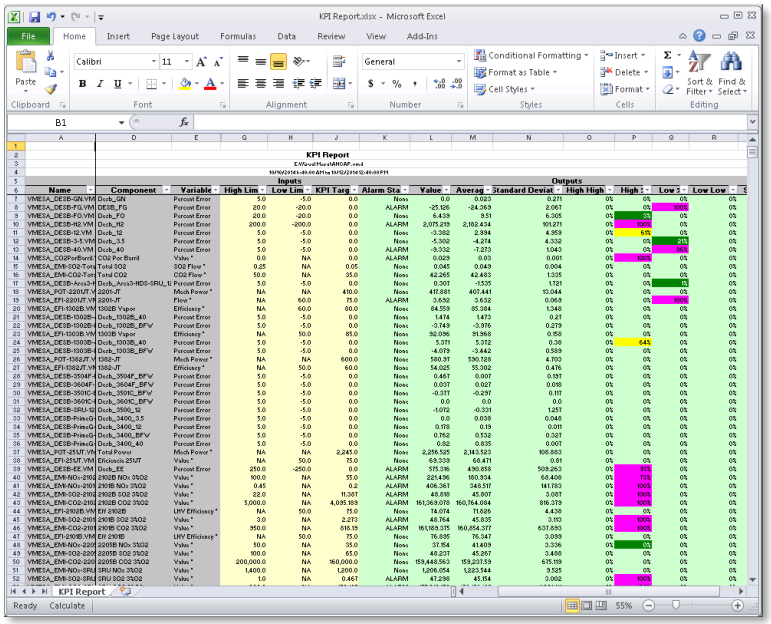


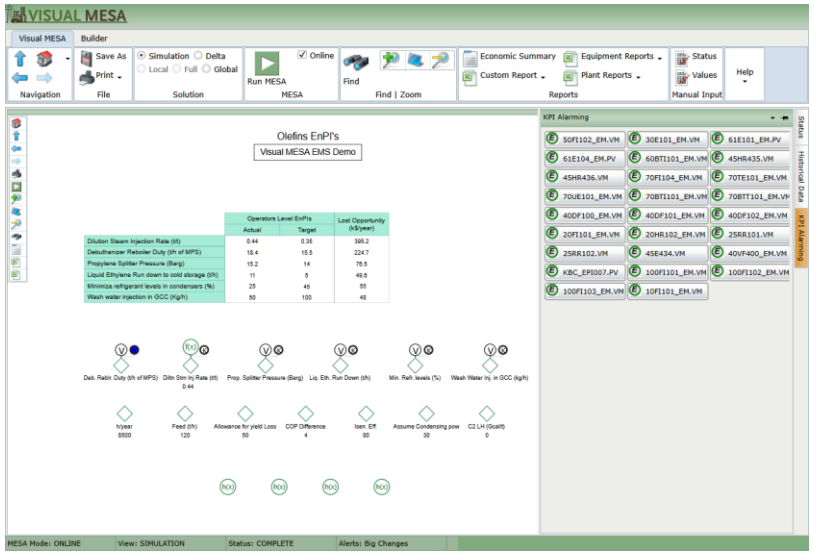
Cooperate level performance monitoring -- An AI empowered decision supporting platform

Visual Mesa Energy Monitor (VM-EM)

- **Energy management is not a one time effort, its all about sustaining.**
  - For less complex sites the need is to have a monitoring system that effectively tracks, historizes performance and lost opportunity
- **KPI blocks for improved alarming, trending and reporting**
  - VM-EM has extensive alarming, trending and reporting capabilities.
  - The KPI output sensors definition allows for variables (i.e., limits, targets) including the alarms historization.
  - KPIs alarms can be trended with user defined color codes and also their alarm limits, when historized.
- **High Frequency Calculations**
  - VM-EM provides model validated real-time data of a site energy system including steam, water, fuel and electricity networks. Allowing also for emissions modeling both by equipment and site-wide and KPIs calculated based on the validated model.
  - For monitoring purposes, VM-EM will execute at a 3 to 5 minutes frequency and massively historize the results for all the KPIs, streams and blocks in the model.

VM-EM Screenshots



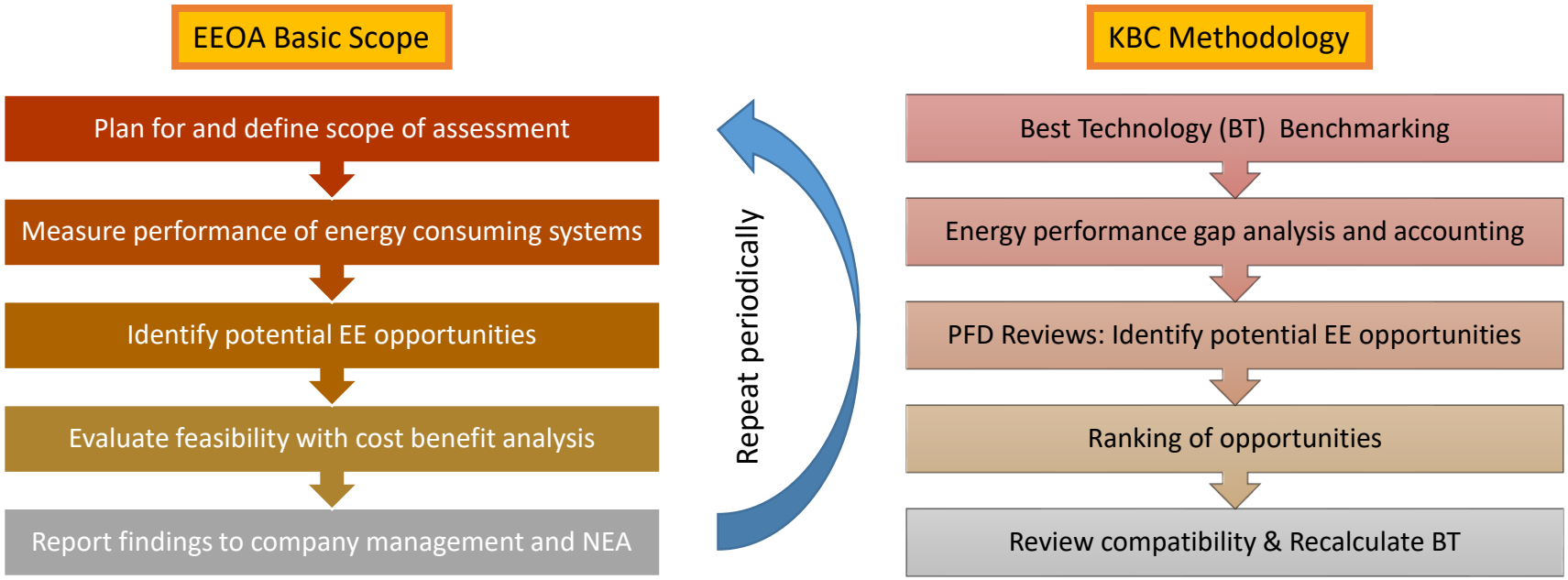


Automate EEOA reporting to NEA

The How ?

Facilities with High Energy Complexity

High Level Methodology for EEOA Compliance

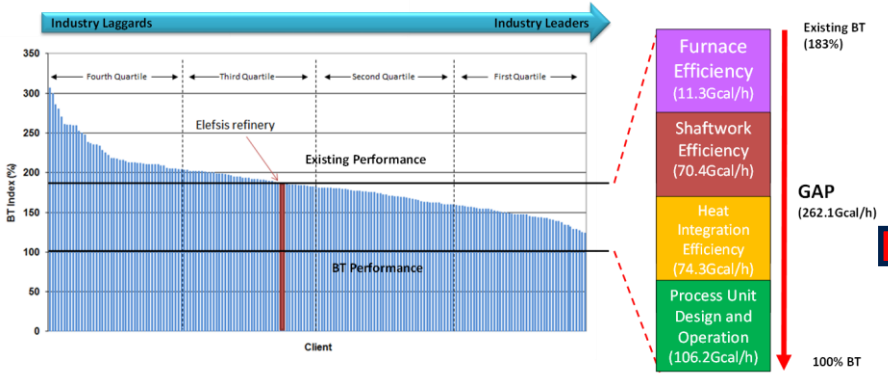


The How ?

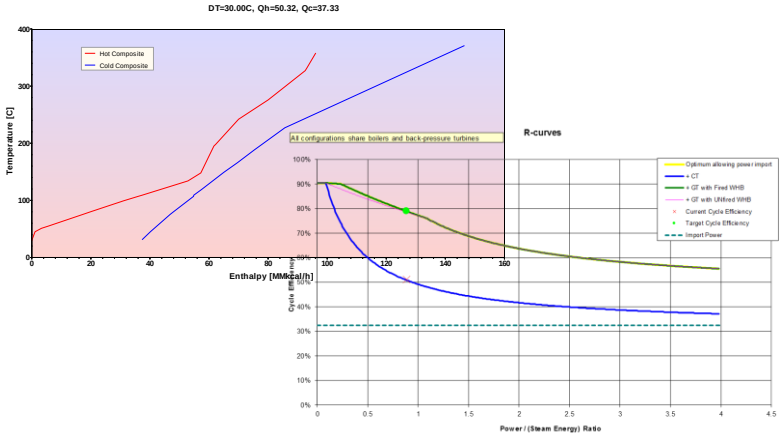
High Level Methodology

Execution Methodology – Complex Sites

Benchmarking & Gap Analysis



Gap Breakdown



Generate List of Opportunities

Techno-Economically feasible ideas

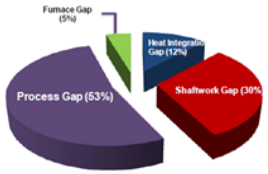
Digitalized EnMS for High Complexity Sites

Digitalized Energy Excellence

VisualMESA™ Energy Management System

BestTechnology

Compare Energy Usage With Best Technology Designs



Petro-SIM™

SuperTarget™

Maximise Heat Recovery

Co-Pilot

Energy Accounting & Monitoring System

Opportunity Identification System

Opportunity Evaluation System

Opportunity Implementation Management System

Interactive visualization supporting decision making

Performance Driven Operation align daily operation with cooperate target


EJX


NR800


TDLS


YEWFLO

Range of Instrumentation that provide reliable measurements for most Energy Efficient Productions

Utilities Optimization

Real-time utilities optimization that make sure the "Process" Energy needs is delivered in the most Optimal way

Plant-wide Energy Optimizer

Plant-wide Dynamics RTO And Adv. Control application that ensure the "Process" is operating in the most Energy Efficient way

CombustionONE

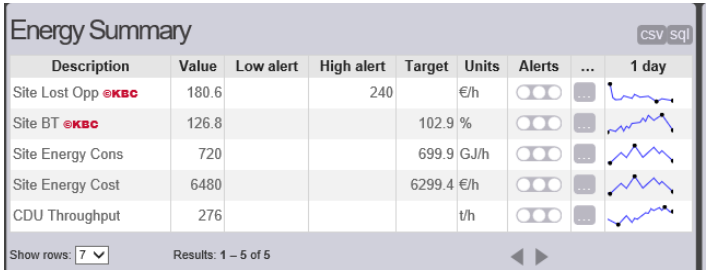
Combustion control logic that makes sure the Safe and optimum combustions resulting in emission reduction

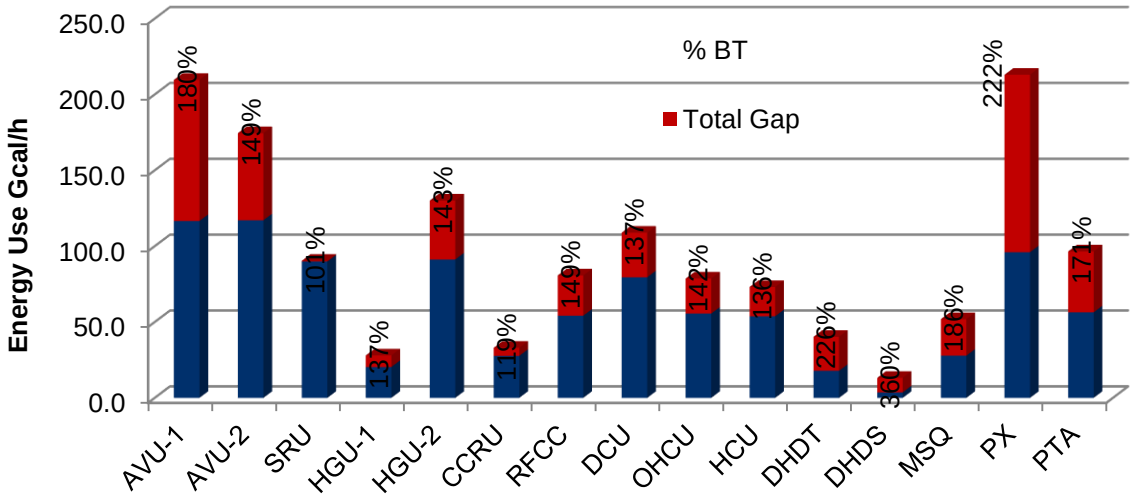
Energy Accounting and BT

- Simplified on-line, site-wide energy balance
  - Automated Data Reconciliation
- On-line real time BT Index Calculation (site wide)
- IT Implementation
  - Create Data-structures that can be reused for all Sites
  - Report Dashboards
  - Automate creation of any other reports
    - Regulatory reporting
    - Corporate reporting

Real-Time Reports – Accounting & Overall BT System

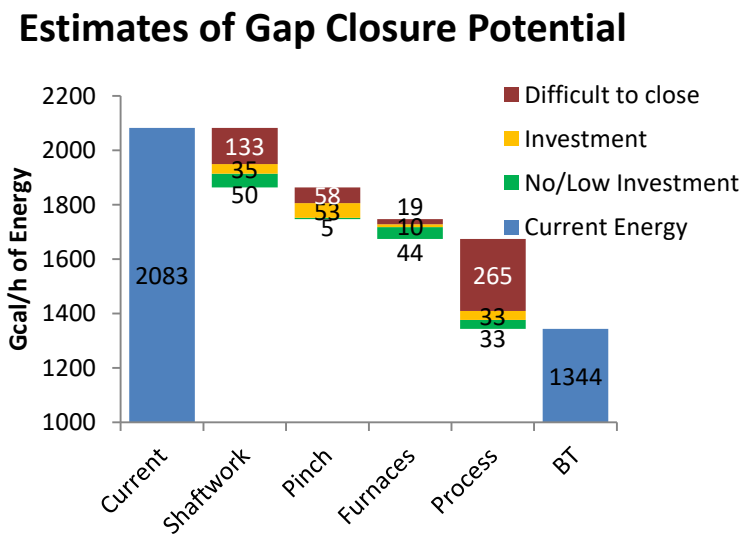
- Top Level KPIs
- Unit by Unit BT and Gap
  - BT Terms, $$ Terms
- Automated Reports for regulatory and other purposes

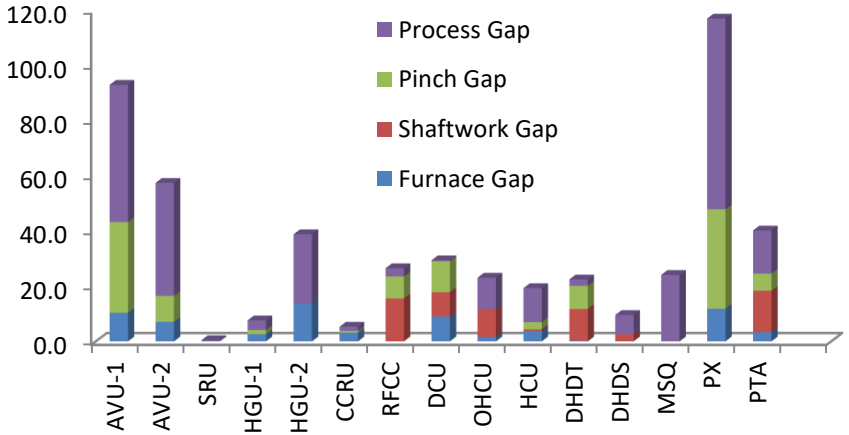


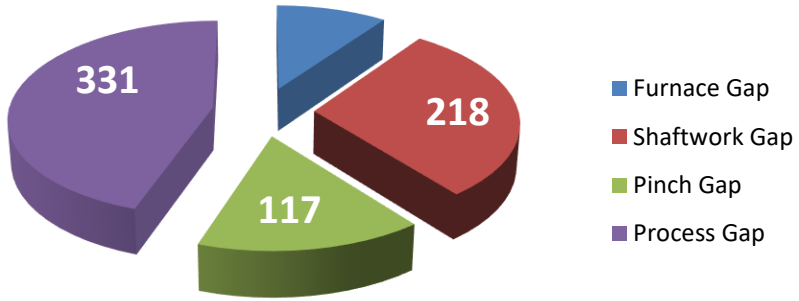


Gap Identification – Reporting

- Breakdown by Theme, unit, site, Type

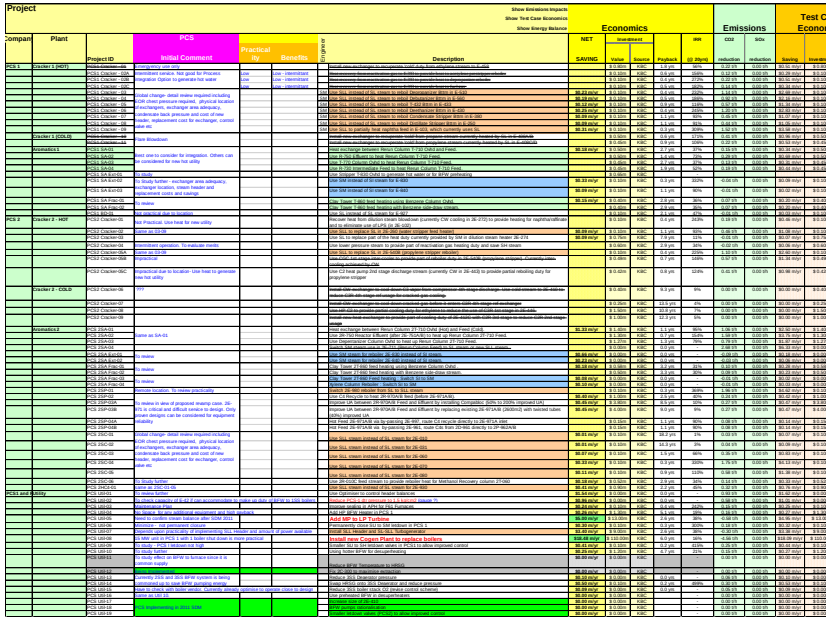






Opportunity Reporting and Visualisation

Energy Performance		
CDU BT Index	136 %	Show Trend
CDU Energy Consumption	229 GJ/h	Show Trend
CDU Energy Consumption	2062 €/h	Show Trend
Lost Opportunity	64 €/h	Show Trend

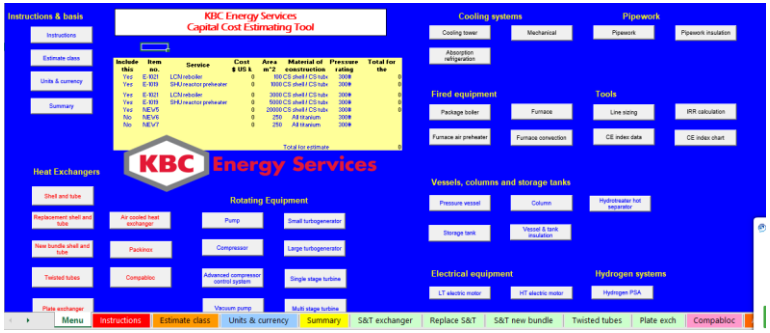


Opportunity Evaluation System

Tools

- Evaluation of Benefits
  - Digital Twin (Visual Mesa & Petro-SIM) to Simulate before and after improvement
  - Utility Model to evaluate battery limit economics
  - RoadMap to evaluate cumulative synergies/conflicts

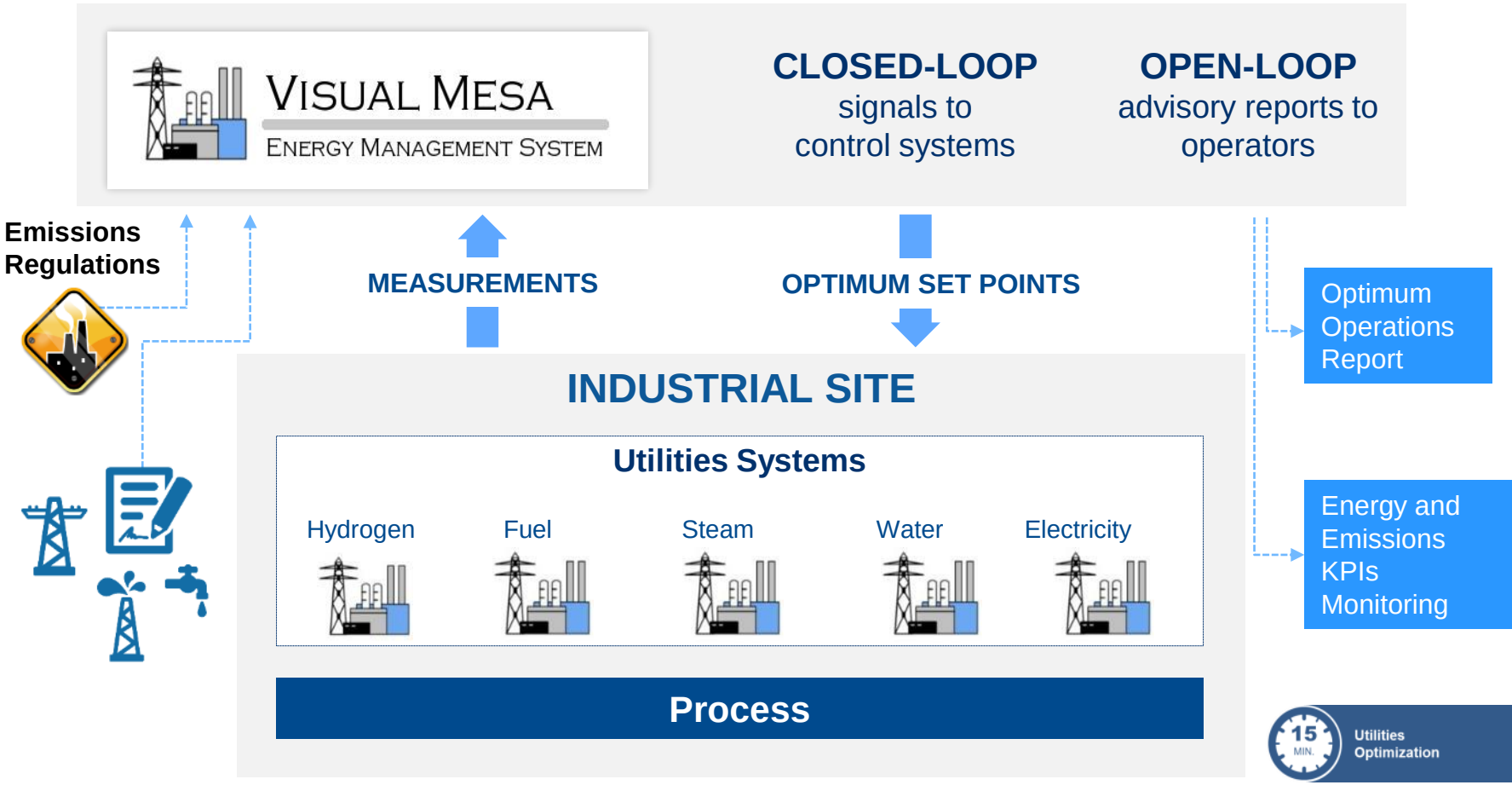
- Evaluation of Costs
  - Cost Estimating Tools and Database



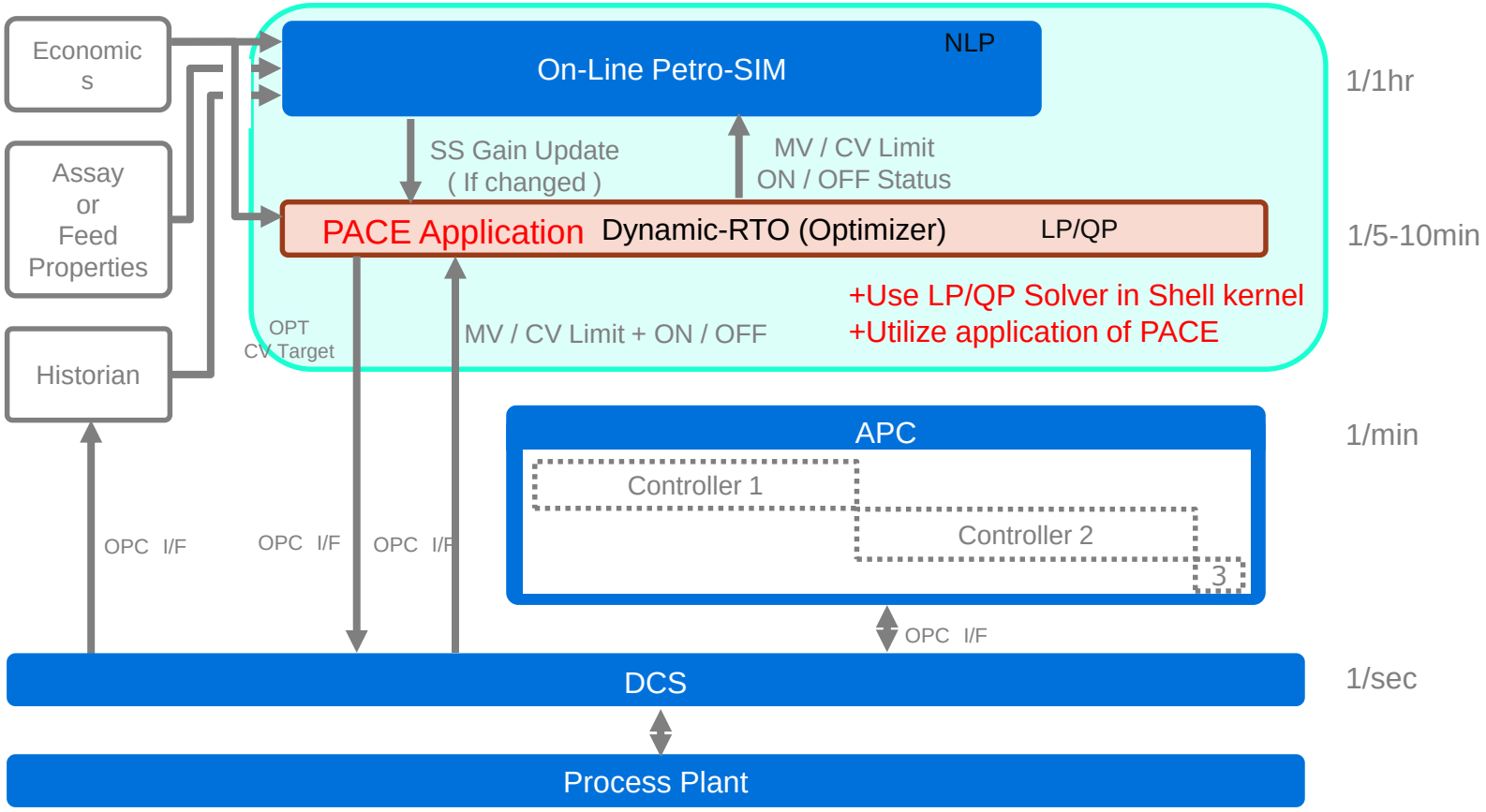
Overall Filtering and Ranking

RTO Digital Twin : Energy real time optimizer (ERTO)

ERTO determines how to manage your energy efficiently and reliably; and provides significant cost savings through economic optimization



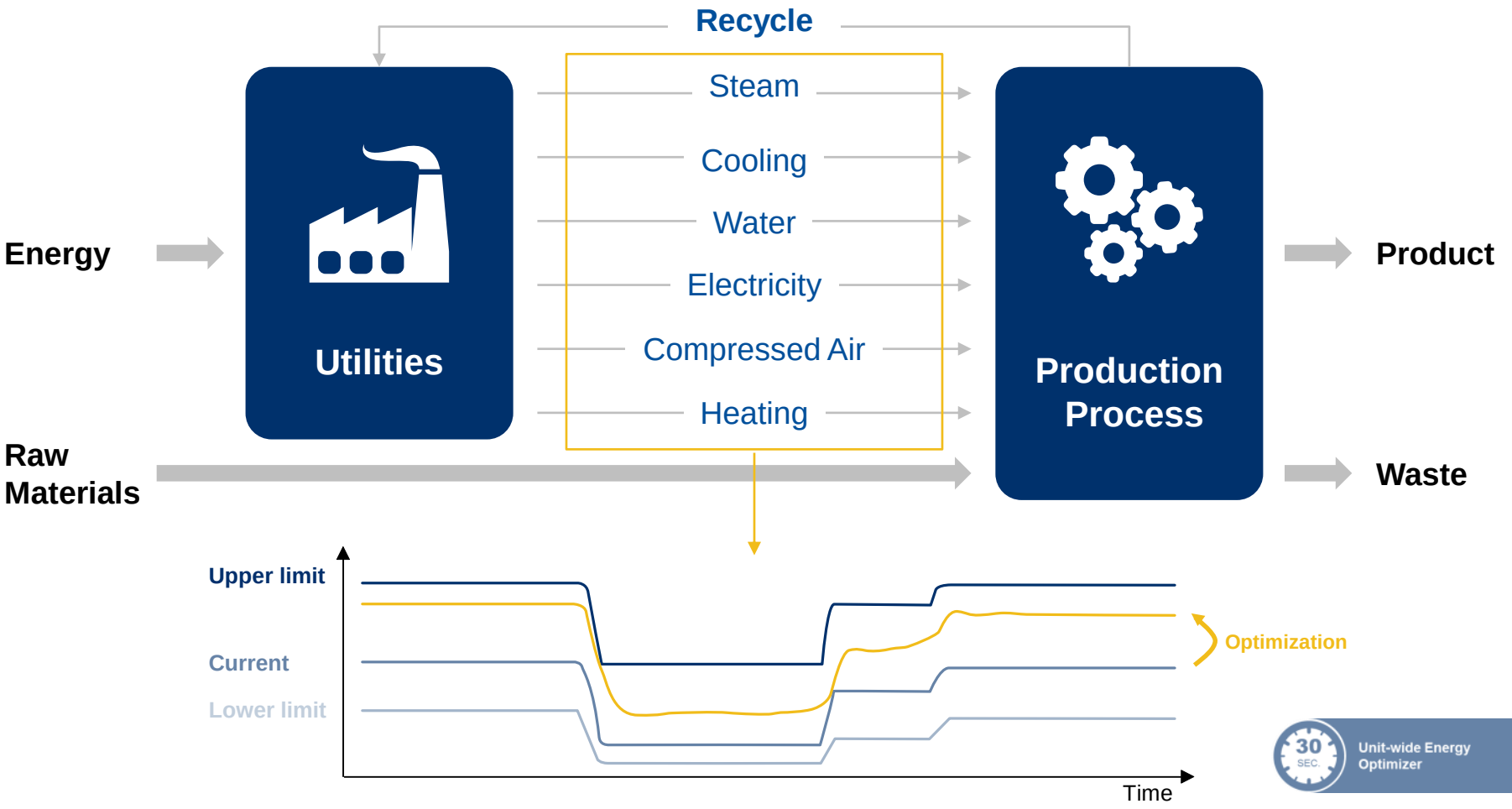
Dynamic RTO



15 MIN. Utilities Optimization

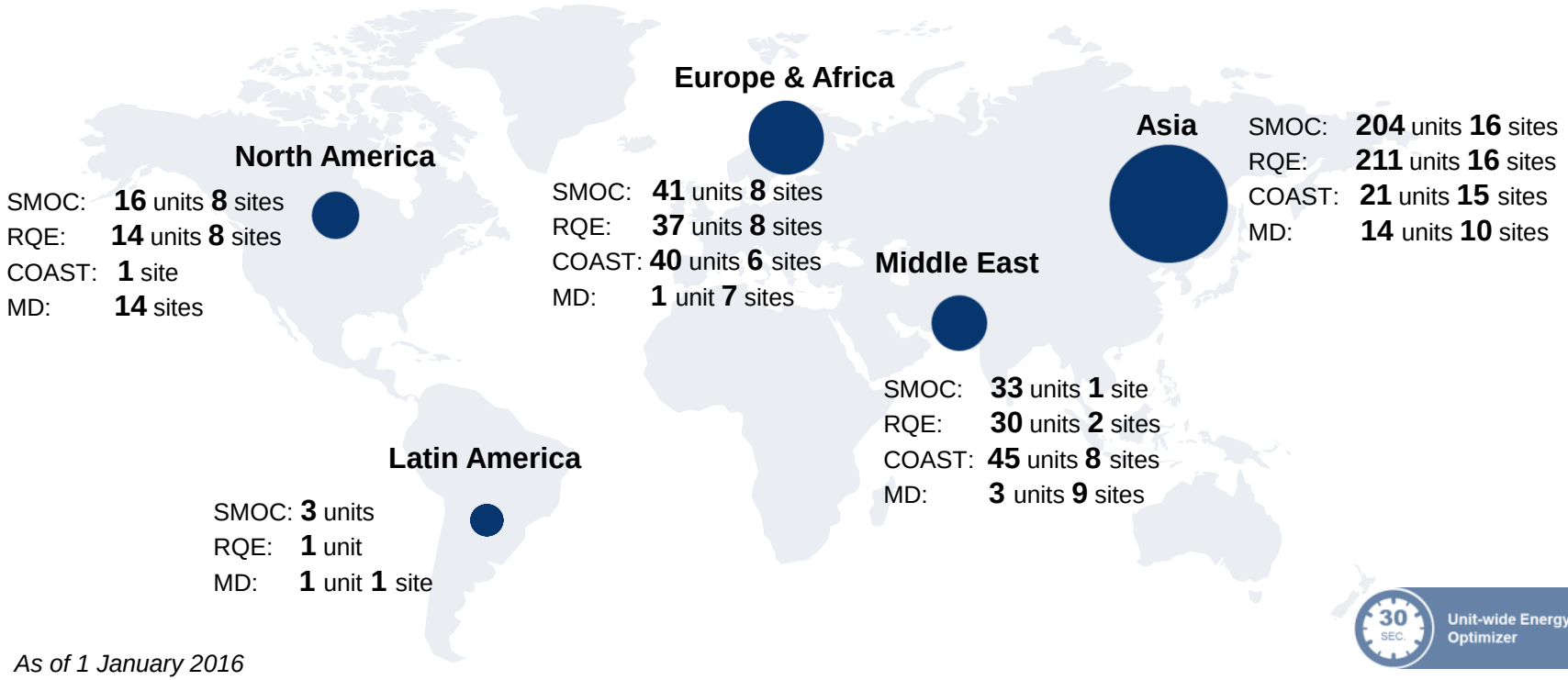
APC effectiveness in energy

APC allows lower energy consumption through optimizing the relevant control loops



APC installed base

SMOC:	RQE:	COAST:	MD:
297 units	**293** units	**106** units	**19** units
33 site licenses	**34** site licenses	**30** site licenses	**41** site licenses

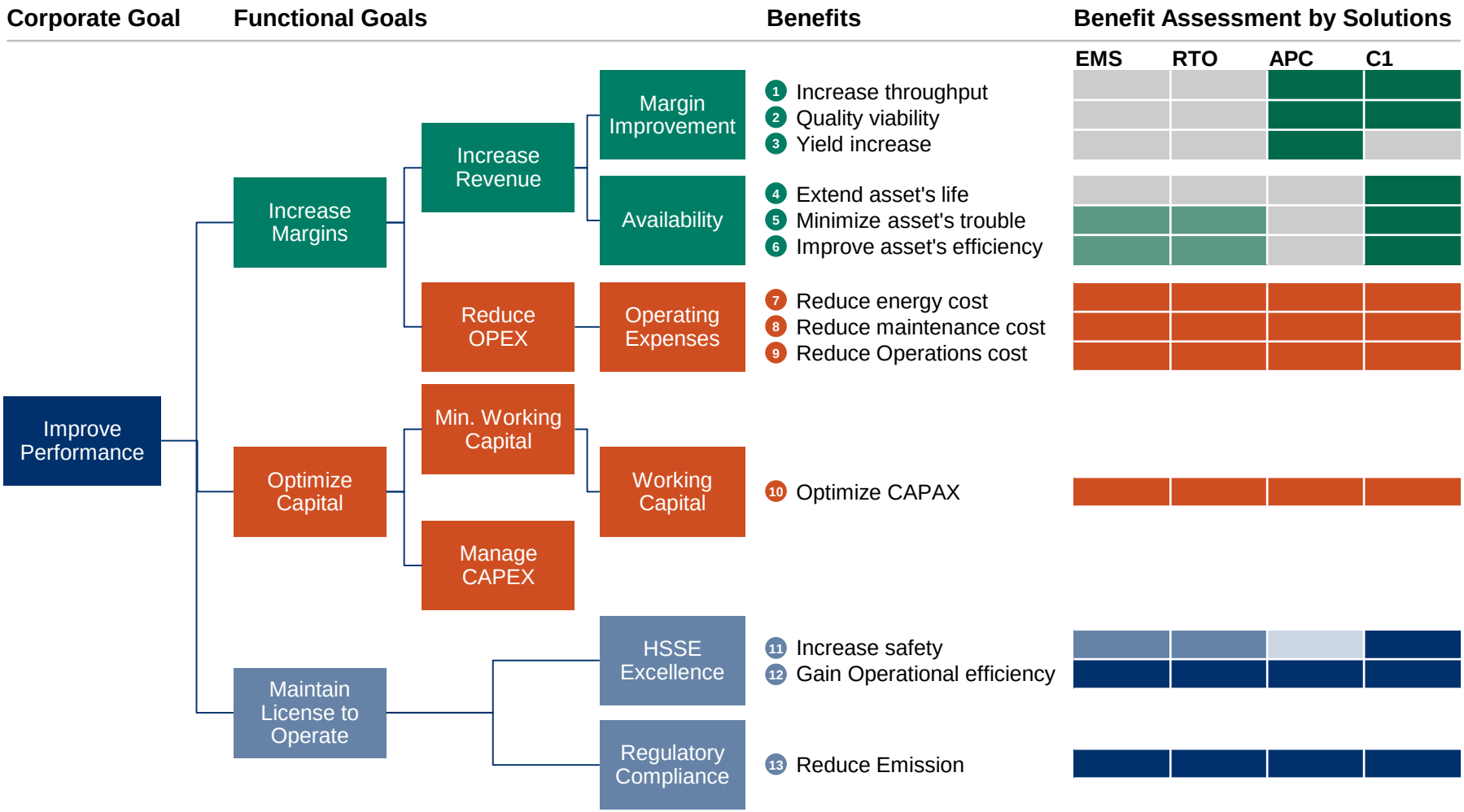


As of 1 January 2016

30 SEC. Unit-wide Energy Optimizer

Your potential benefits

Our OPEO drives value for your business



Summary of Yokogawa KBC Technology Applications

EEOA Basic Scope

- Plan for and define scope of assessment
- Measure performance of energy consuming systems
- Identify potential EE opportunities
- Evaluate feasibility with cost benefit analysis
- Report findings to company management and NEA

Available Technologies

BestTechnology
Compare Energy Usage With Best Technology Designs

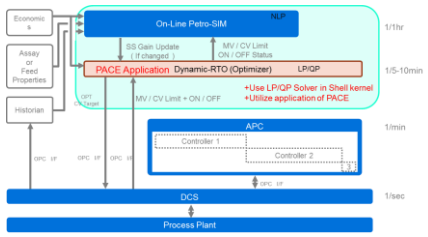
Petro-SIM™

SuperTarget™
Maximise Heat Recovery

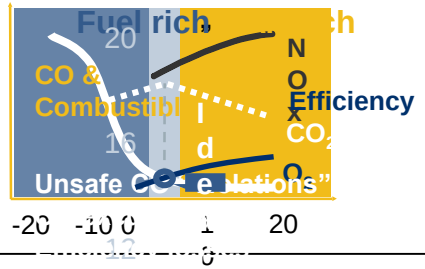
Petro-SIM™

VisualMESA™
Energy Management System

D-RTO & APC



Combsution One



Implementation- Beyond EEOA

Sustain Energy Performance
Co-Pilot Services

Singapore Energy and Sustainability Hub (SESH)

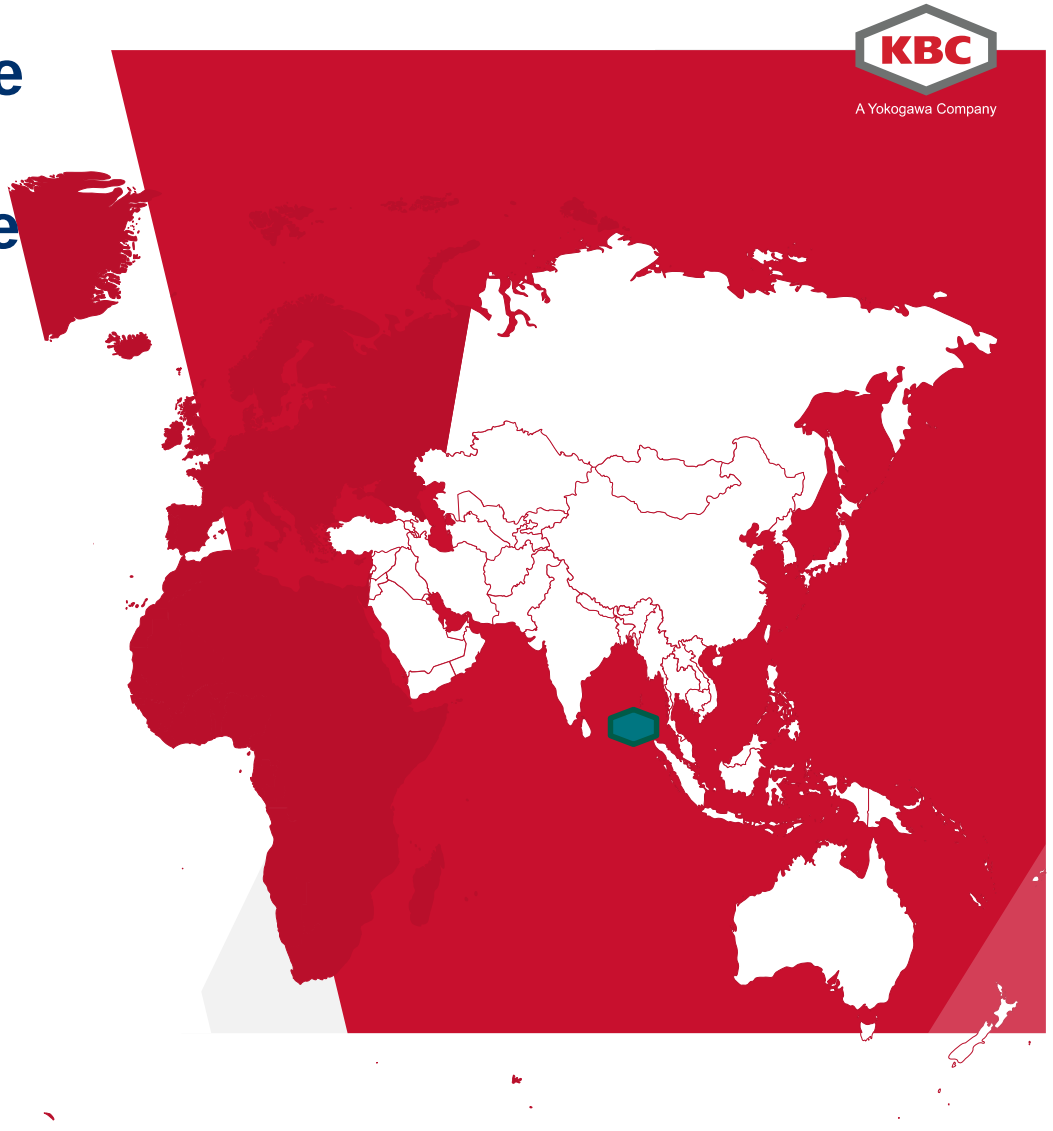
Investment in Singapore Energy & Sustainability Co-Pilot Hub as a centre of excellence

Local team of
Co-Pilot energy experts

Datacentre and IT
implementation team

Investment in the next generation of analytics and apps

- Make world class systems accessible to medium and small scale sites
- Use data analytics to dig deeper
for savings



Service levels – Energy Co-Pilot

Service levels – Energy Co-Pilot

Basic model assurance

- Constant monitoring of IT systems
- Daily monitoring of data and model issues to ensure optimizer is always running and solving

Enhanced model assurance

- Update model in response to changes in physical hardware on site
- Update correlations and performance curves
- Monthly reports and recommendations on model condition

Energy performance and equipment assurance

- Review success in implementing optimizer recommendations
- Ensure full range of degrees of freedom exploited
- Review equipment trends & degradation, make recommendations on operation, cleaning & maintenance
- Support troubleshooting

Strategic energy assurance

- Carry out energy forecasts and look ahead scenarios
- Review and analyze energy performance gaps across site
- Recommend minor / major investment projects to debottleneck and improve energy efficiency
- Review progress vs recommendations and quantify value of Co-Pilot

Summary

Summary

Sites with Low Energy Complexity
• Integrated offering of Yokogawa and KBC for EEOA compliance. KBC is an accredited ESCO/EEOA assessor, that can help secure compliance and deliver value.
• Adequate measurement of energy is an important requirement for compliance – Yokogawa instrumentation
• KBC rich experience, tools and methodology -> Add value over just compliance
• Yokogawa CombustionONE for improving performance of heaters
• Energy Management system (EnMS)- Visual Mesa Energy Monitor
• Yokogawa APC
• Automate and Digitalise EEOA reporting

Summary

Sites with High Energy Complexity
• Integrated offering of Yokogawa and KBC for EEOA compliance. KBC is an accredited ESCO/EEOA assessor, that can help secure compliance and deliver value.
• KBC rich experience, tools and methodology: Best Technology Benchmarking, Pinch analysis, Petro-SIM simulation and optimization, optimizing cogeneration systems, equipment performance benchmarking
• Visual Mesa Real Time Utilities Optimiser – Continually optimize steam, power, fuel and hydrogen
• Yokogawa APC/RTO – Sustain performance
• Yokogawa CombustionONE for improving performance of heaters
• Energy Management system (EnMS)- Visual Mesa Energy Monitor
• Automate and Digitalise EEOA reporting
• KBC Co-Pilot offering

Co-innovating tomorrow™

Thank You