A Yokogawa Company

Energy Optimization Early in Design Process Minimizes Process Energy Consumption – and Minimizes Total Projects Costs

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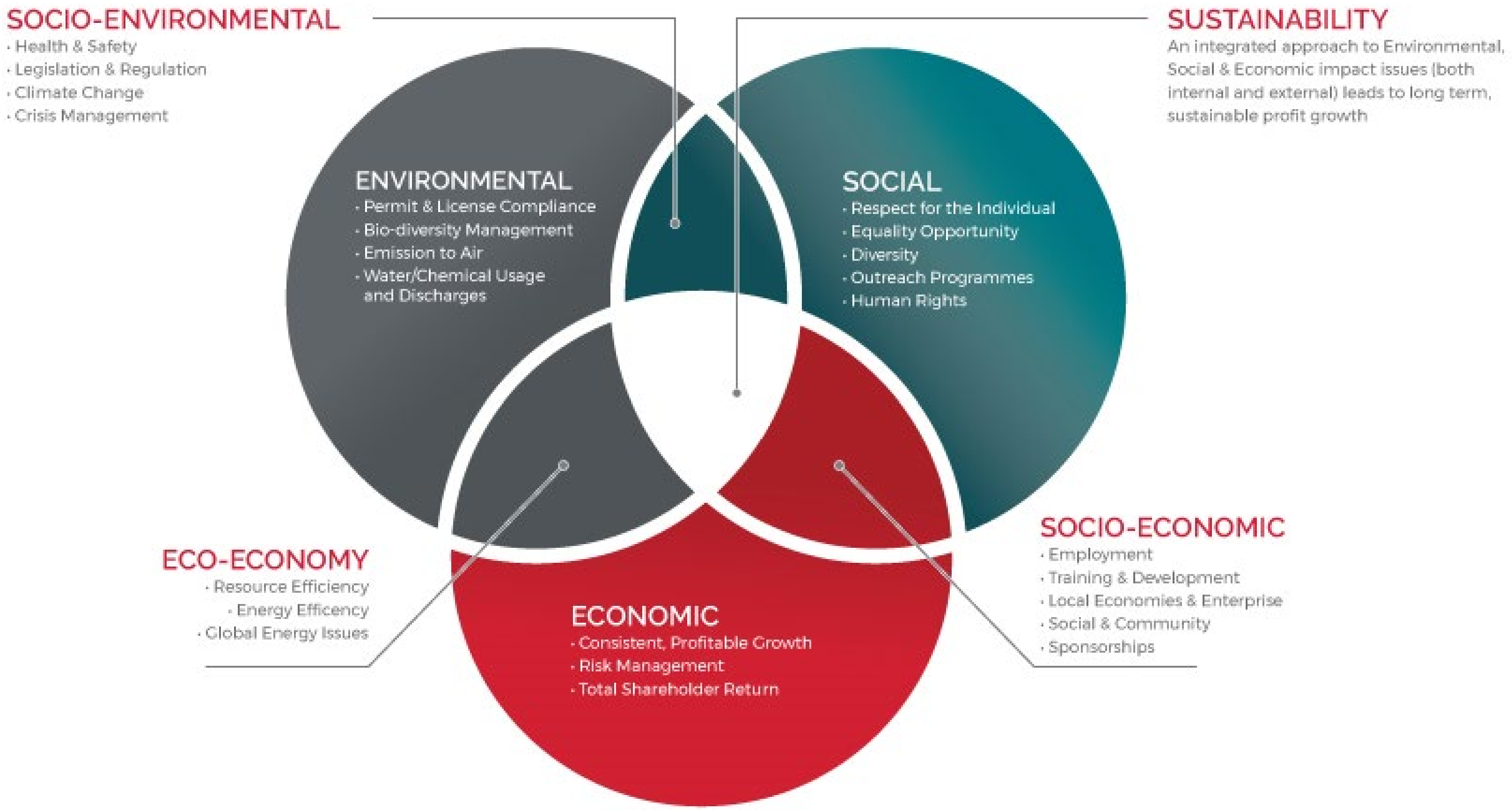
Compelling justifications for investment

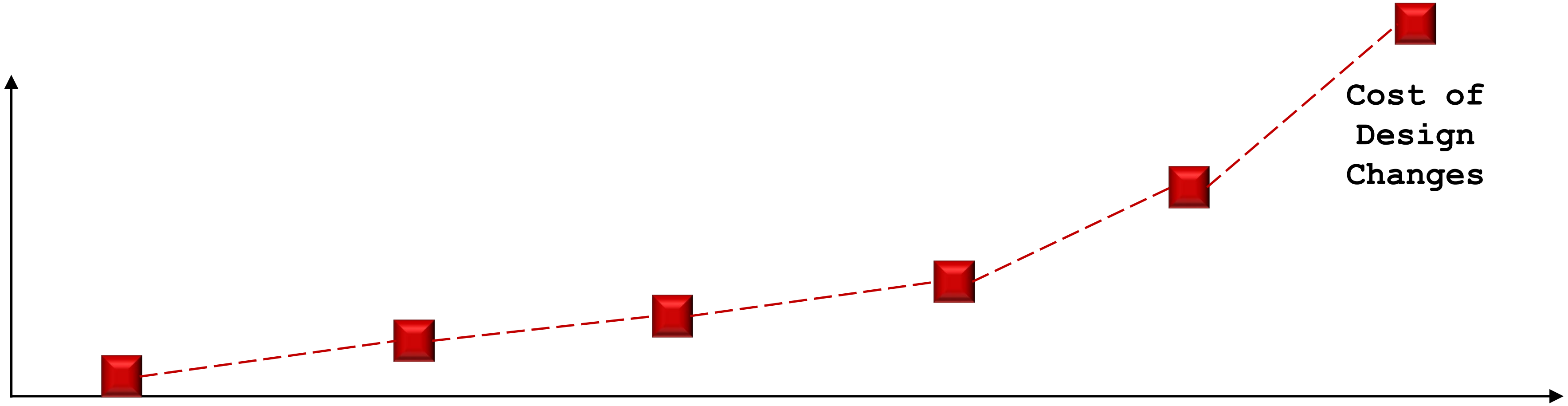
- Switches to Gas
- Changing crude slates
- Push into petrochemicals and chemicals
- Regulatory changes – emissions standard, such as IMO2020

Investments are under pressure from vigilant stakeholders



Traditional design process needs to respond

Cost of change increases but data, information and insight are added



Wait for more definition or make changes before design starts?

FEL 1	FEL 2	FEL 3			
Business Planning Phase	Define Leading Options	Define Execution Plan	Negotiate and Secure Finances	Engineering Procurement Construction	Commissioning and Start-Up

Early In Design

- Limited Data
- Many Interacting Options
- Hard to understand overall picture

Later In Design

- Modification Costly
- Changes lead to delays
- Complex Impacts on multiple systems

CapEx and OpEx savings are in the Gap

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- Many Interacting Options
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Case Study GAP worth
IRR improvement = 1%
CapEx = $103MM
OpEx = $66MM per year
14% less energy

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CapEx and OpEx savings are in the Gap

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Early development of technology models
Requirements captured in the PDP

Early In Design

Case Study GAP worth
IRR improvement = 1%
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Later In Design

Almost no re-work as improvements are designed in from the beginning

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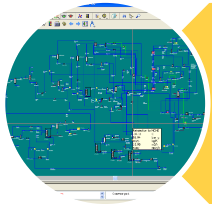
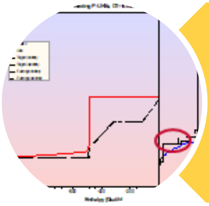
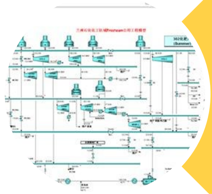
Breaking the Vicious Cycle



Simulation to "patch up" uncertain data
Plant Wide Model to model global impacts



Pinch and TotalSite Analysis to optimise inter unit interactions
Detailed Pinch to improve heat integration



Utility Model to understand steam/fuel/power balances
Optimise driver selection and utility design

Experience & Expertise – anticipate what the design will look like
Best Practice and smart ideas from other plants

Plant Wide, pinch, utility, best technology (BT) now all in Petro-SIM Model

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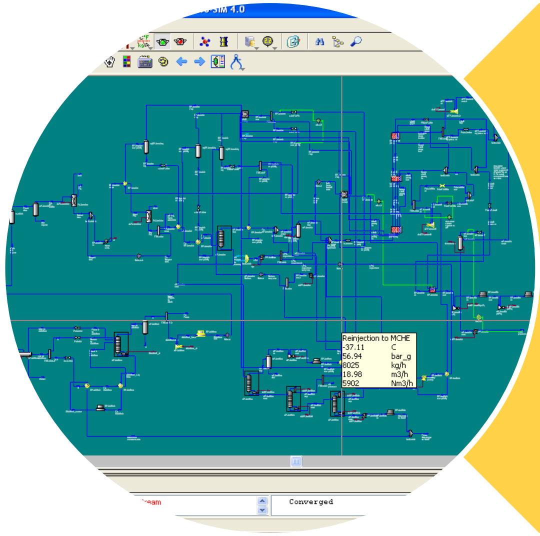

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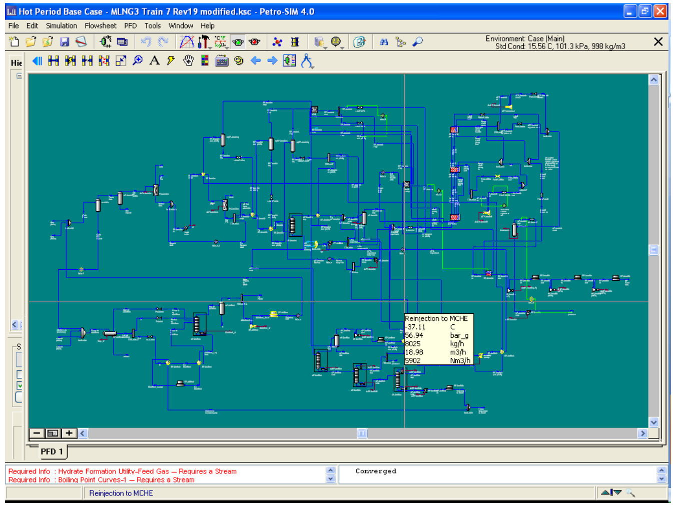
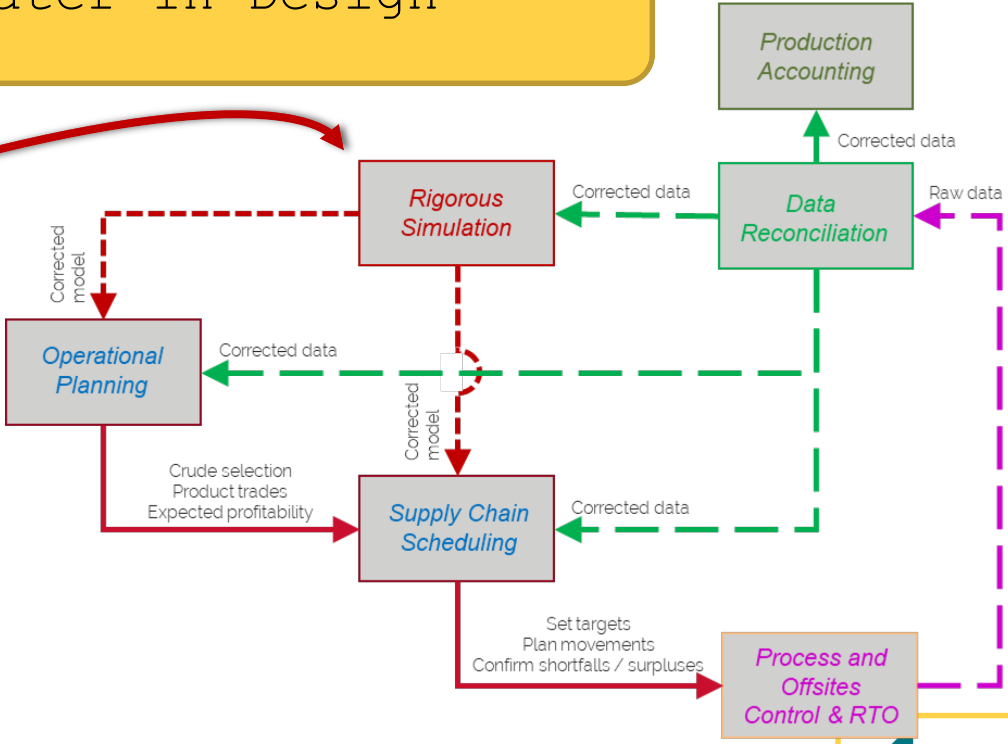
Develops into the Operations Digital Twin

Early In Design



Later In Design



Case Study

Client Situation

- Planning a significant plant expansion

Project Goals

- Minimize Capex
- Reduce energy use by maximizing the efficiency of each new unit
- Improve the integration between the new units and the existing refinery

Objectives

- Minimize Capex
  - Reduce Capex in utility system by reducing energy provided and removed from new units
  - Ensure adequate utility sizing for both new units and the existing refinery for all required normal and abnormal operating cases Improve the integration between the new units and the existing refinery
- Maximize energy efficiency
  - Build improvements with <5 year paybacks into design
  - Ensure suitable integration with existing refinery

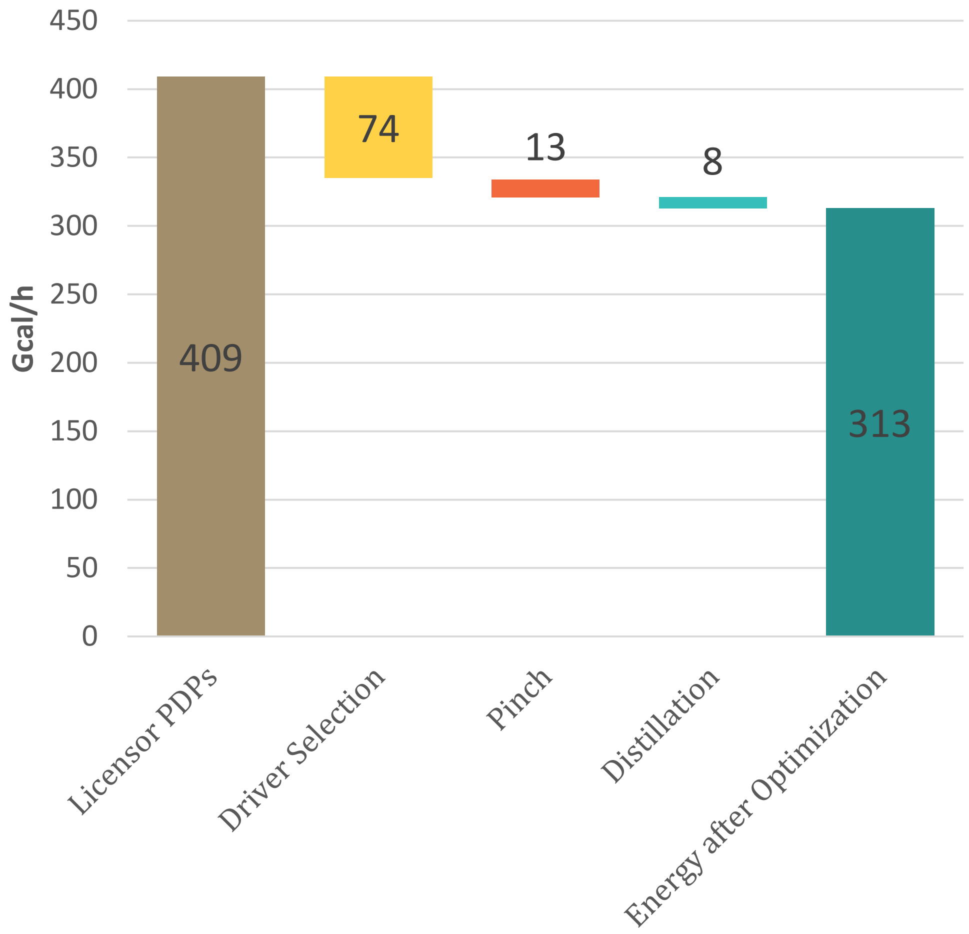
Procedures Performed:

- Before FEED
  - Process Simulation, to fill-in missing data and determine opportunities for process improvements
  - Site wide utility strategy, including power generation/import philosophy and steam conditions to maximise integration potential
  - DT min analysis to optimise capital/energy trade-off for heat recovery design
- In Parallel with PDP/FEED
  - Kick-off meetings with licensors to discuss and agree to proposed improvements
  - Pinch analysis for heat integration improvement
  - Utility/reliability modelling to optimise sparing and utility generation design
  - BT Benchmarking to assure efficiency of design

Objectives

- Before FEED
  - Changed utility strategy to motor-centric rather than turbine-centric, modified electrical design accordingly
  - Opportunities identified in all licensed units
- In Parallel with FEED
  - 14 ideas agreed for implementation
  - 14% energy reduction in final design
  - – 66 MM USD/Y saving
  - 103 MM USD Capital cost reduction
  - Significantly Exceeded Target Savings
  - Improved overall project IRR by more than 1%

Net Impact of Energy Changes



Units	Items	Cost Increase (MM USD)
RHDS	Switching to a motor	-6
HS-FCC	Driver selection	-112
ERU	Driver selection	-22
RHDS	Pinch improvement	21.5
HS-FCC	Pinch improvement	8
C4 block	Pinch improvement	3
C4 Block	Distillation column improvement	3.1
NHDS	Pinch improvement	4
Alkylation	Distillation column improvement	14
SRU	Pinch improvement	1
Utility	Smaller boiler & associated system sizing	-19.9
Utility	LLP header	2
Total		**-103.3**

- Overall Steam generation reduced by 130 T/h
- Fewer boilers required to meet demand

Optimisation in the conceptual or feasibility stage provides:

- Specifications for the Licensor Process Design Package (PDP) before design begins
  - Identify suggested process design features
    - Number of pumparounds on columns
    - Use of hot separators on hydrotreaters
  - Suggested new heat integrations and exchanger approach temperatures
  - Suggested process operating conditions
    - Equipment specifications for key equipment
    - Process operating conditions, including specifications for product transfers between units
- Opportunities to minimize Utilities Capital Costs
  - Recommended driver selection to give the best fit with the overall steam balance
  - Recommendations for additional utilities, such as intermediate or low-low pressure steam headers, to allow units to be cross integrated

Thank You

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