U.S. DEPARTMENT of ENERGY | Office of Energy Efficiency and Renewable Energy

U.S. DOE’s Energy Intensive Industries Initiative

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Industrial Technologies Office (ITO) Major Program Pillars

Energy-Intensive Industries (EII)

Aluminum

Refining

Glass

IRON & STEEL
1,469 TBtu

CHEMICALS
(including production of low-carbon fuels)
4,842 Tbtu

FOOD & BEVERAGE
1,935 TBtu

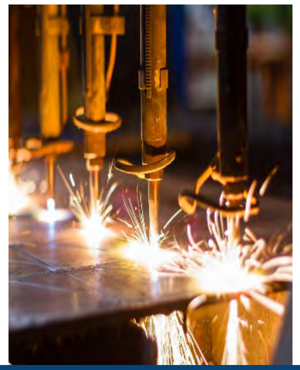
FOREST PRODUCTS
2,883 TBtu

CEMENT & CONCRETE
367 TBtu

Cross-Sector Technologies

Thermal Processes & Systems

Low-Carbon Fuels, Feedstocks, & Energy Sources



Emerging Efficiency

Water & Wastewater Treatment

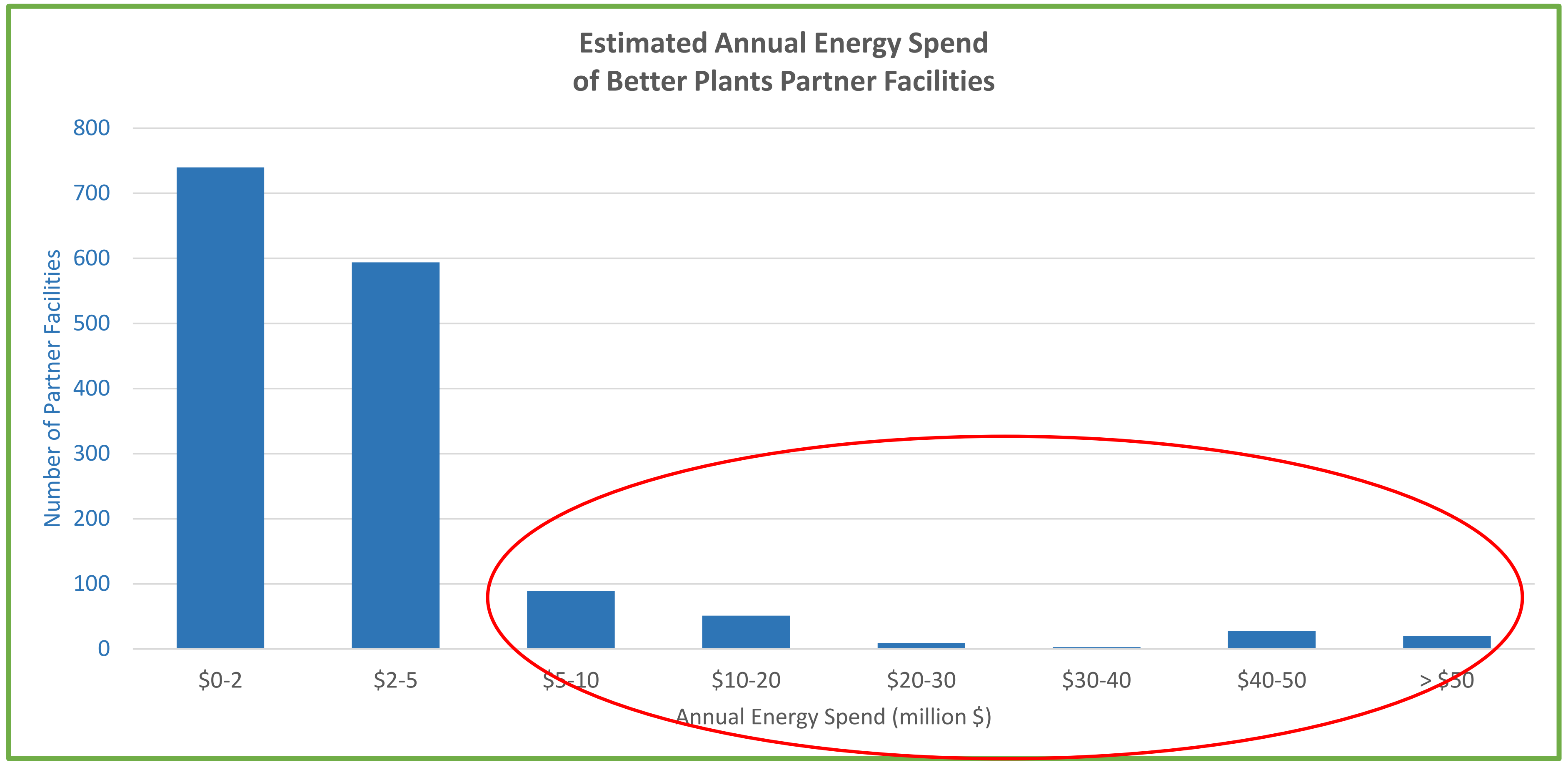
Technical Assistance and Workforce Development

Better Plants® U.S. DEPARTMENT OF ENERGY

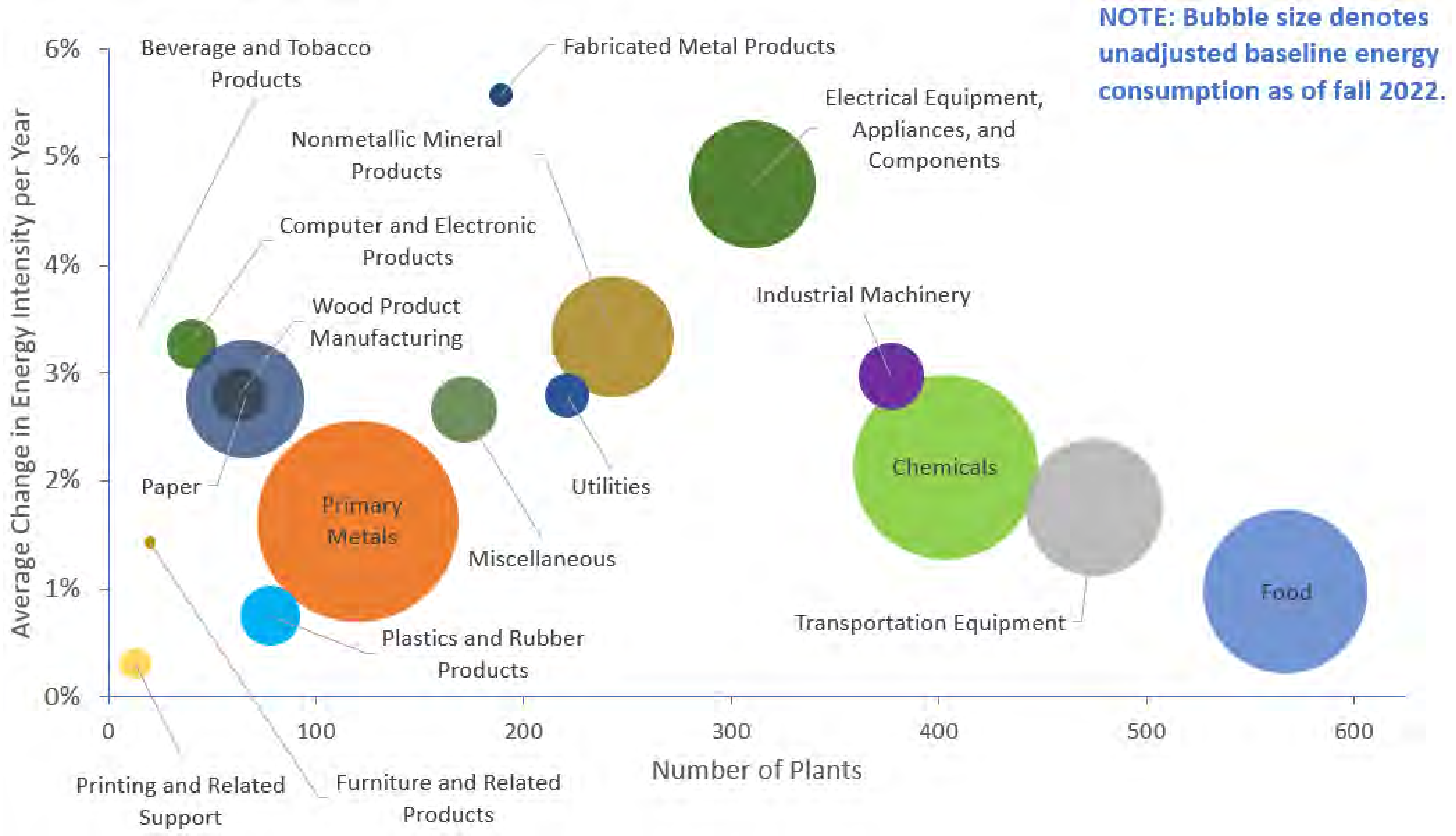
Onsite Energy U.S. DEPARTMENT OF ENERGY

50001 Ready U.S. DEPARTMENT OF ENERGY

Energy Intensive Sectors in "Better Plants" Program



Even a small increase in energy intensity improvement in EII plants results in larger reduction in absolute energy use and emissions.



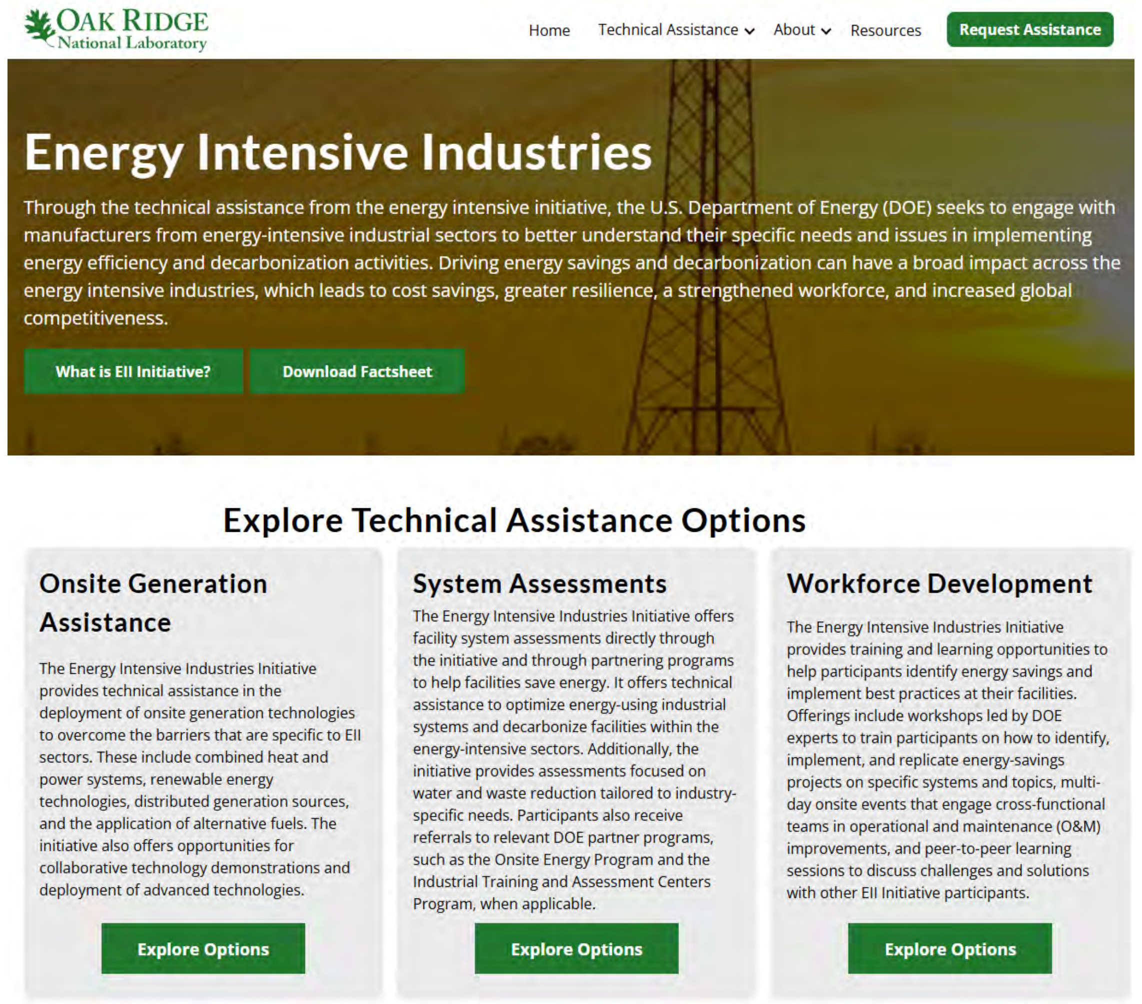
Energy Intensive Industries Pilot

ITO's Energy Intensive Industries pilot was established to support energy-intensive manufacturers in improving energy performance, thereby reducing costs and enhancing global competitiveness.

6 Target Sectors: Iron & Steel, Nonmetallic minerals, Chemicals, Pulp & paper, Food, Nonferrous metals.

Goals:

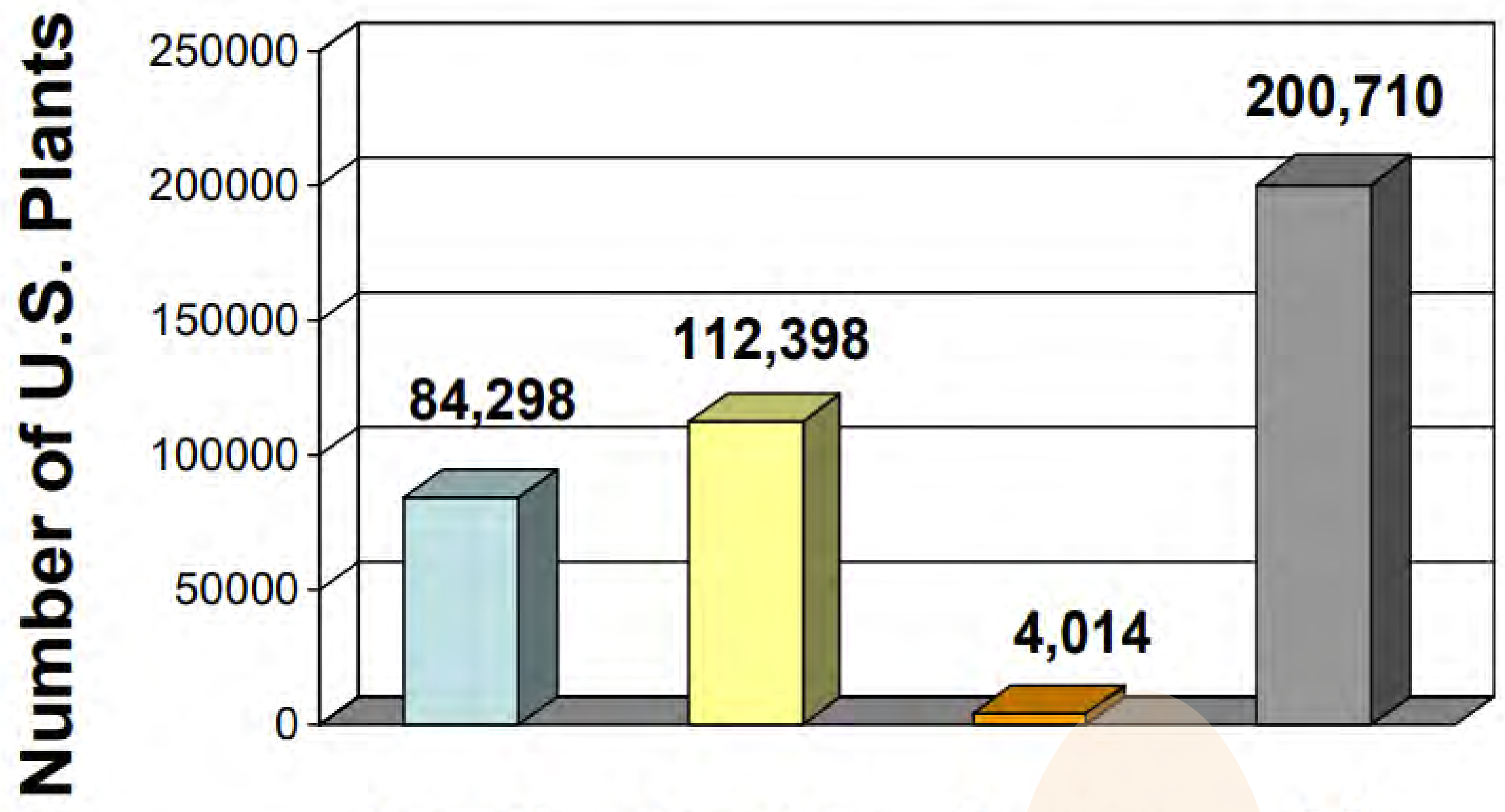
- Support energy-intensive sectors to save energy and reduce costs by facilitating collaboration with DOE
- Support energy-intensive sectors with a wide range of tools, solutions and resources
- Establish a feedback loop to inform DOE R&D priorities
- Develop a voluntary program structure that addresses the unique technical assistance (TA) and workforce development needs
- Provide an on-ramp for greater levels of cooperation with DOE



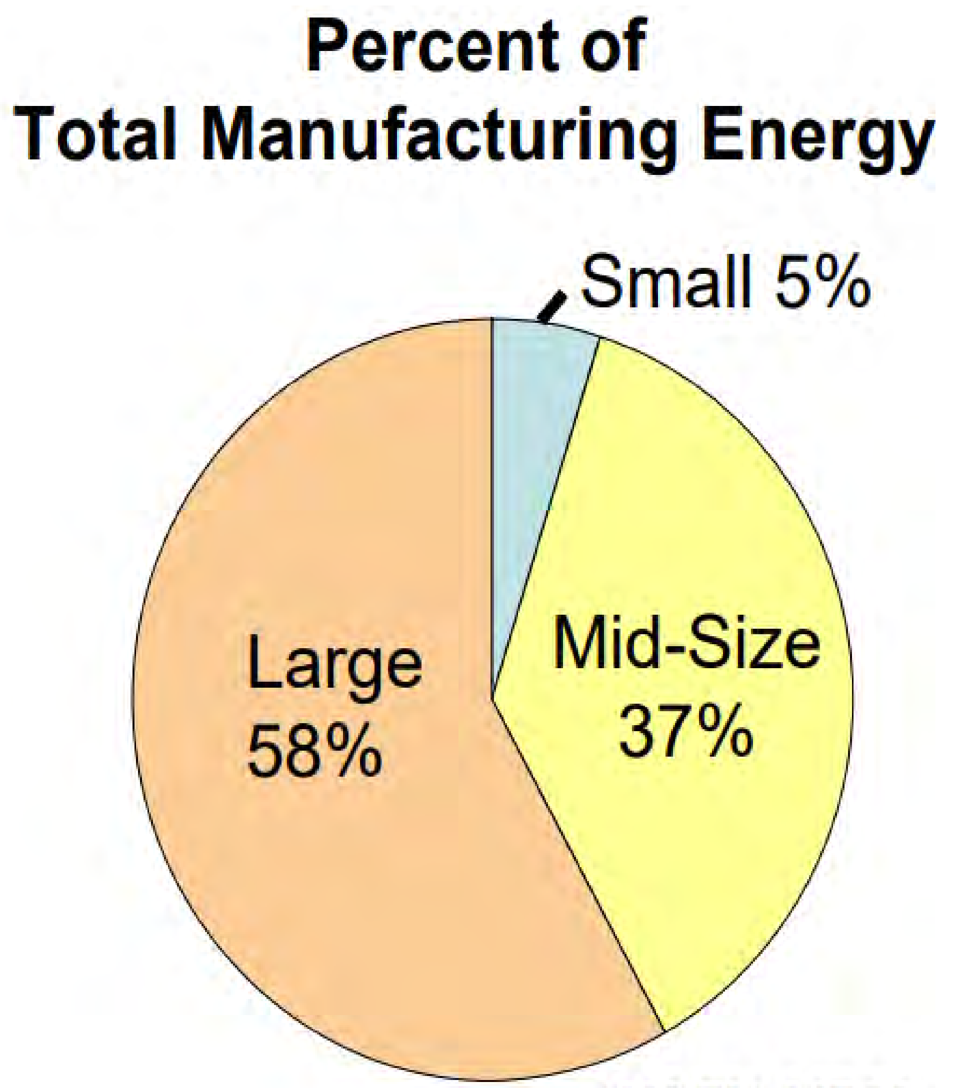
https://eii.ornl.gov/

Focus of Energy Intensive Industries Pilot

U.S. Manufacturing Plants: By Size



	Small Plants	Mid-Size Plants	Large Plants	All Plants
Annual Energy Consumption (Billion Btu/yr)	<25	26-500	>500	
Annual Energy Consumption ($/yr est.)	<$100K	$100K-$3M	>$3M	



2002 EIA MECS

Just over 4,000 plants use almost 60% of U.S. manufacturing energy use

Technical Assistance (TA) Results: Annual Savings by Sector

- Overall savings identified through TAs were estimated at 4.12 TBtu and $32M
  - Average annual savings/facility: 258,000 MMBtu in energy savings, $2M in cost savings

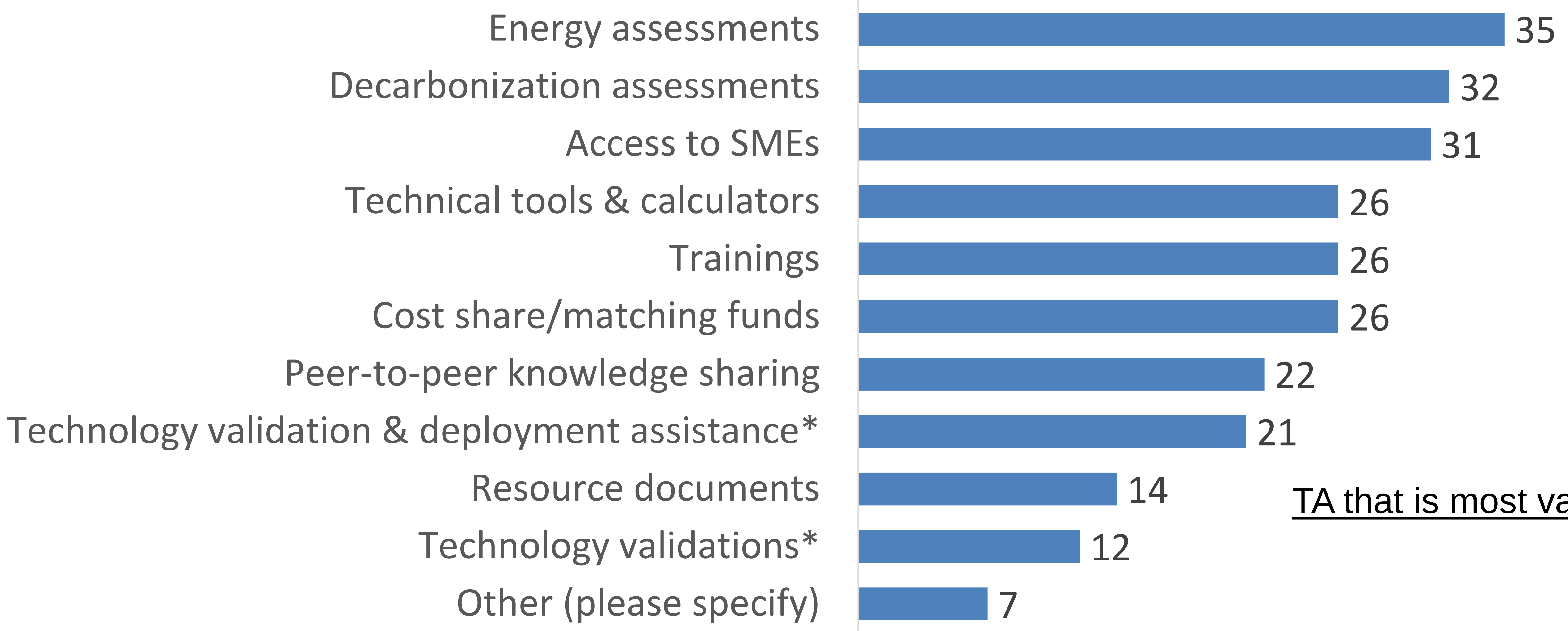
Sector	No. of Facilities	Total energy savings	CO_2 reduction	Water savings	Cost savings
		MMBtu	MT	kGal	$
Chemicals	5	1,832,000	74,000	126,000	12,074,000
Nonferrous metals	3	1,195,000	66,000	0	4,961,000
Iron & steel	4	602,000	56,000	0	5,443,000
Nonmetallic minerals	3	371,000	24,000	0	7,299,000
Pulp & paper	1	121,000	10,000	600	2,020,000
Food & beverage	0	0	0	0	0
Total	**16**	**4,121,000**	**230,000**	**126,600**	**31,797,000**
Average		**258,000**	**14,000**	**0**	**2,000,000**

TA activities performed

- Process Heating
- Energy Treasure Hunt
- Steam
- Process Cooling
- Compressed Air
- Pumps & Fans
- 50001 Ready
- Wastewater
- Waste Reduction
- Plant-Wide Assessment

Key Learnings from the Energy Intensive Industries Pilot

Energy efficiency seems to be the stated priority/preference for most organizations to reduce operational costs and simultaneously meet sustainability targets before focusing on other alternatives



TA that is most valuable – Questionnaire Response

While energy system SMEs are still relevant and desired by energy intensive sectors, there is a need for process/sector specific experts

– Gap in knowledge due to the retirement of experienced personnel

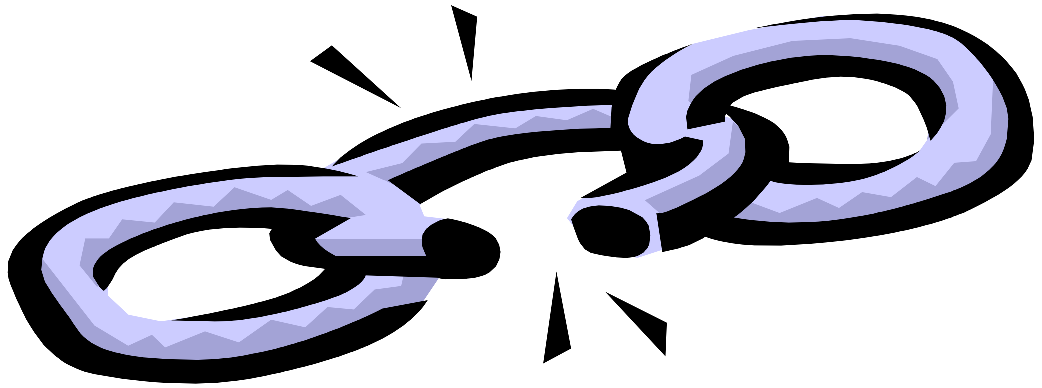
Kicking off the New Program

- The Issues
  - Despite initial measures, substantial low-cost (<2-yr payback) significant energy-saving opportunities remain in Energy Intensive Industries facilities
  - Demand for specialized sector-specific expertise reflects ongoing challenges related to the retirement of experienced personnel and skills gaps
  - Barriers for energy and carbon reduction efforts: high capital costs of technologies, lack of knowledge, and infrastructure readiness

- Our Response
  - Provide technical assistance (training courses, software , and in-plant consulting services) for deployment of advanced process optimization techniques (e..g. Pinch Analysis), practical knowhow, and tools
  - Goal is to help accelerate adoption of industrial efficiency and globally competitive technologies

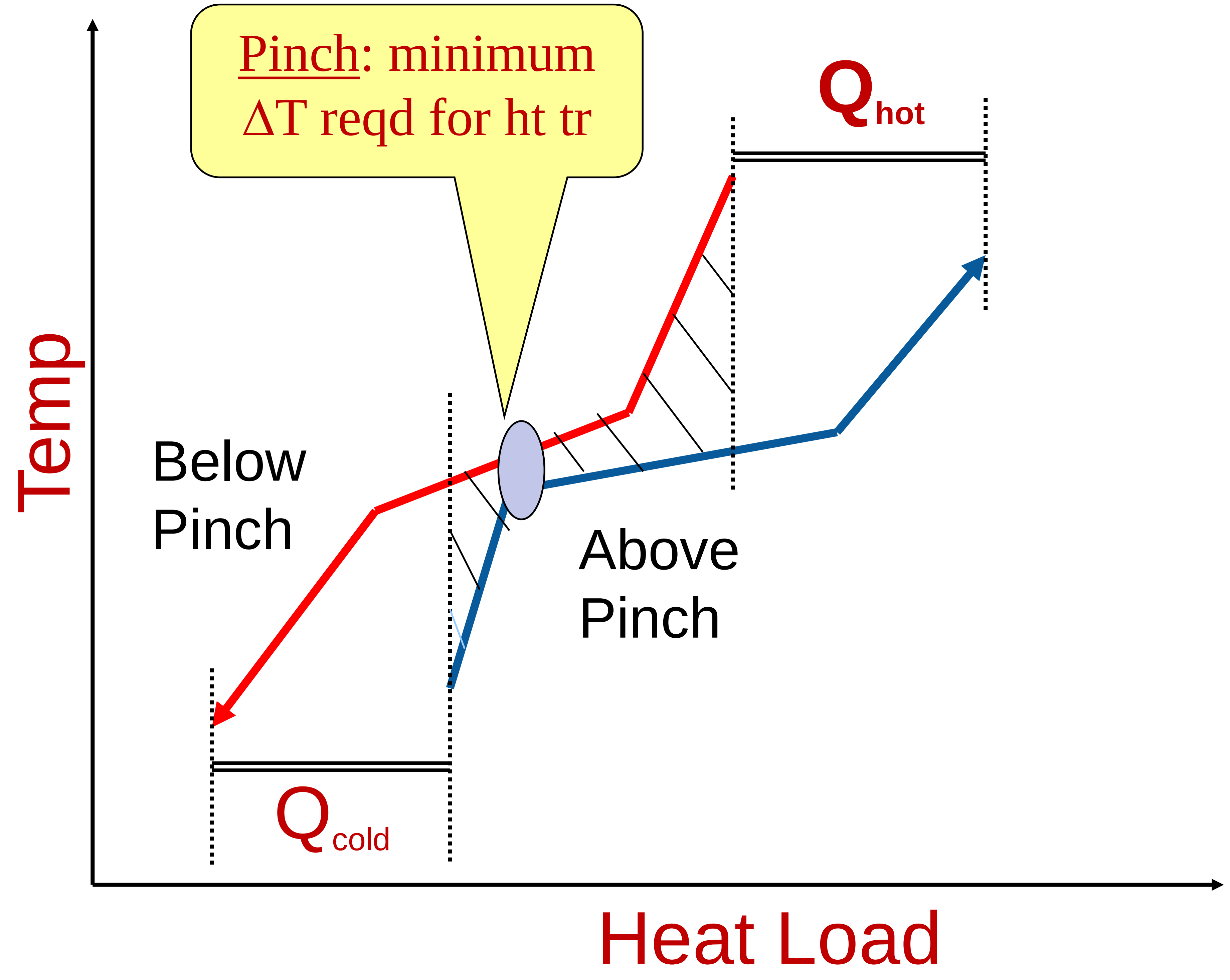
Introduction to Pinch Analysis: What is a “PINCH” ?

- A “Pinch” is the Performance Limiting Constraint in a System
- It is the Weak Link in a Chain or an Organization



- The strategy of Pinch Analysis is to fix the Pinch instead of replacing the Chain, which has the effect of minimizing Capital cost for the same improvement in performance
- All systems have a Primary Pinch and some secondary Pinches
- As soon as you fix/relieve one Pinch, the next in line takes its place
- A Pinch in an Organization is the step in the policy implementation workflow that impedes quick/efficient execution. Eg funding approval

HX Networks: Composite Curves → Energy Targets



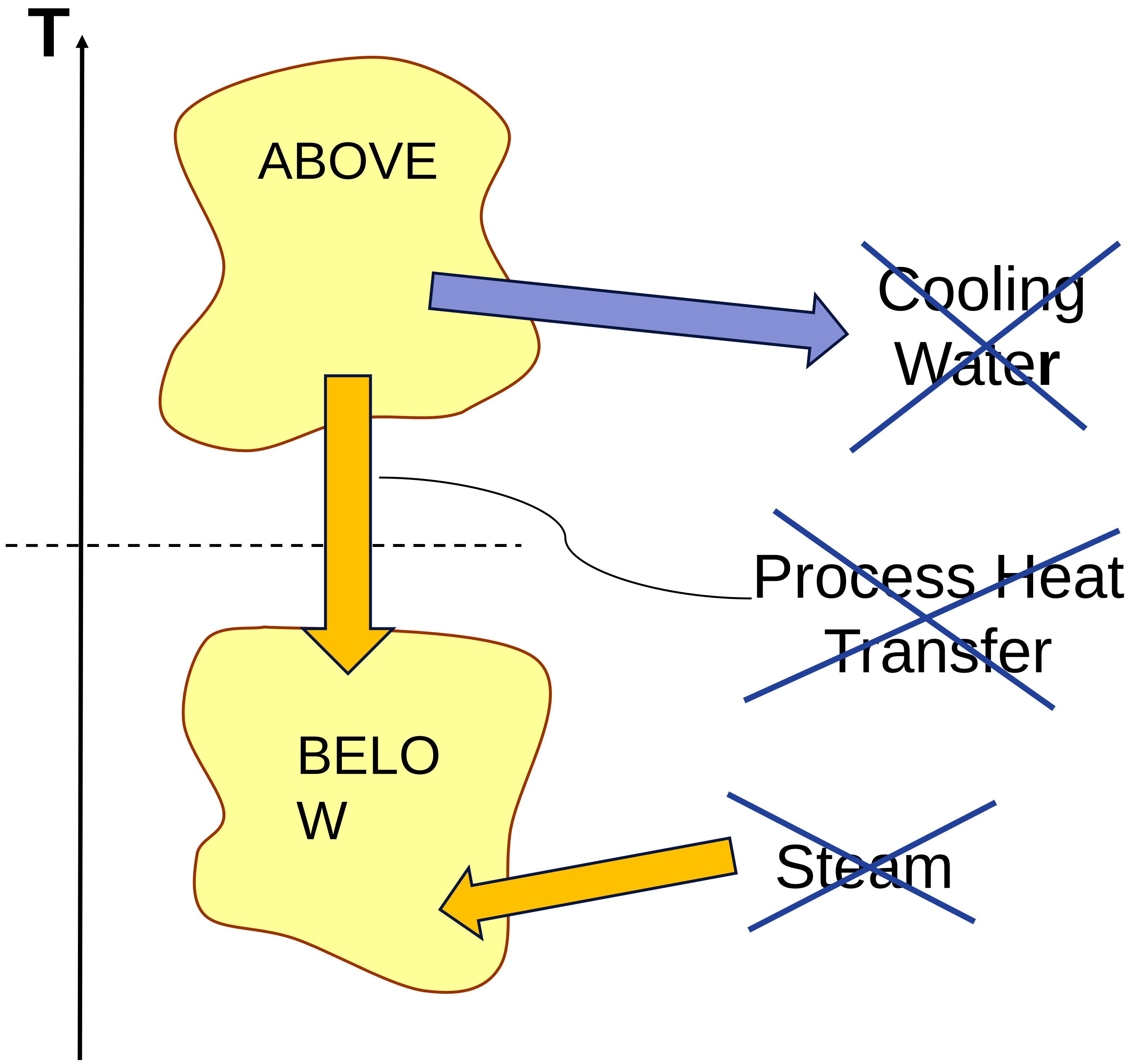
It is possible to combine all the individual Hot and Cold streams into just TWO Hot and Cold “composite“ curves, representing the thermodynamics profile of the process.

The point of closest Approach on the Temp axis is the Process Pinch

Q_{hot} & Q_{cold} are the energy targets (Benchmarks)

Note: HX = Heat exchanger

The Pinch Principle for HENs – Very Simple

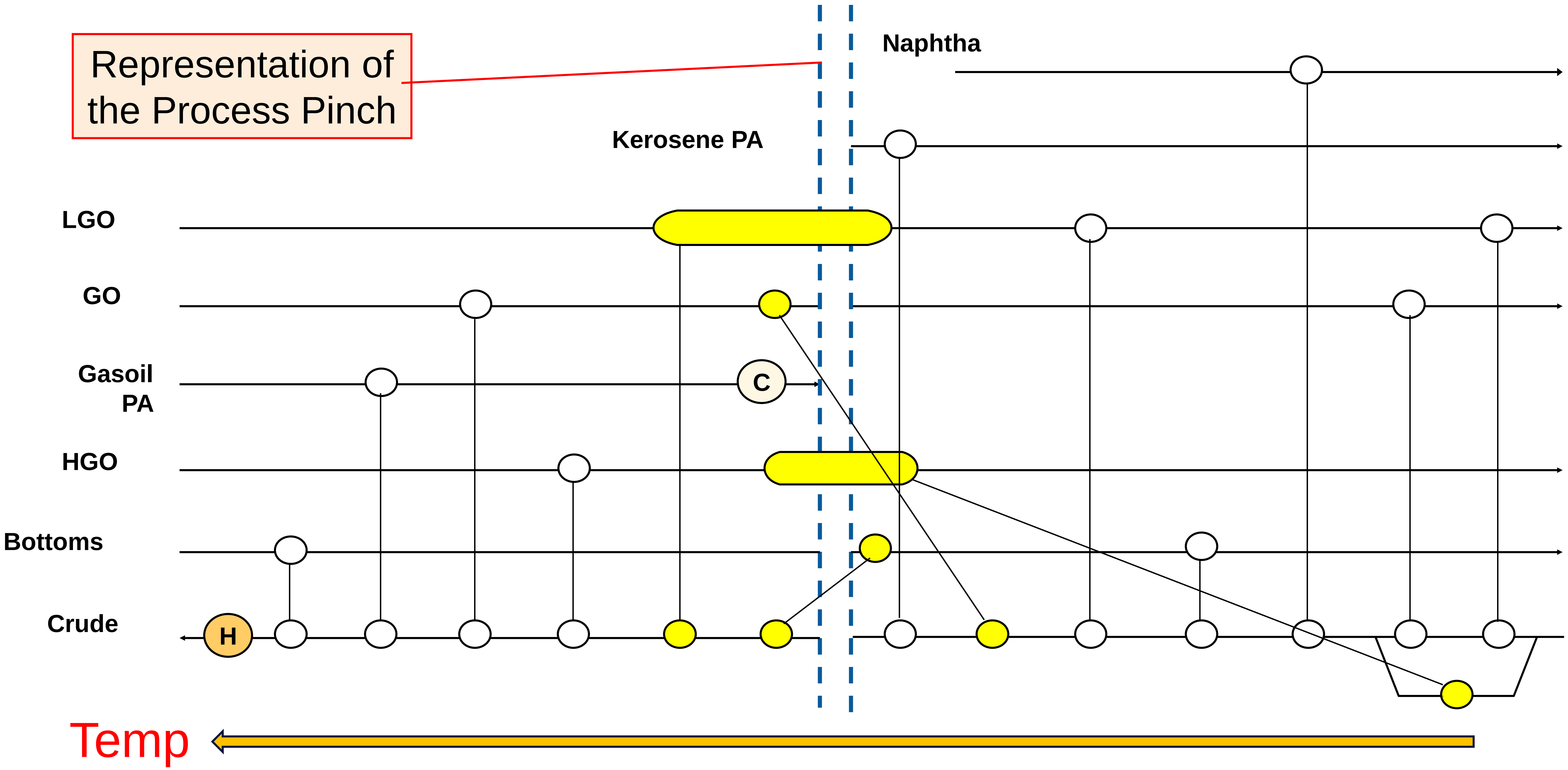


DO NOT

- use Steam below Pinch
- use CW above Pinch
- transfer heat from process streams above Pinch to process streams below Pinch

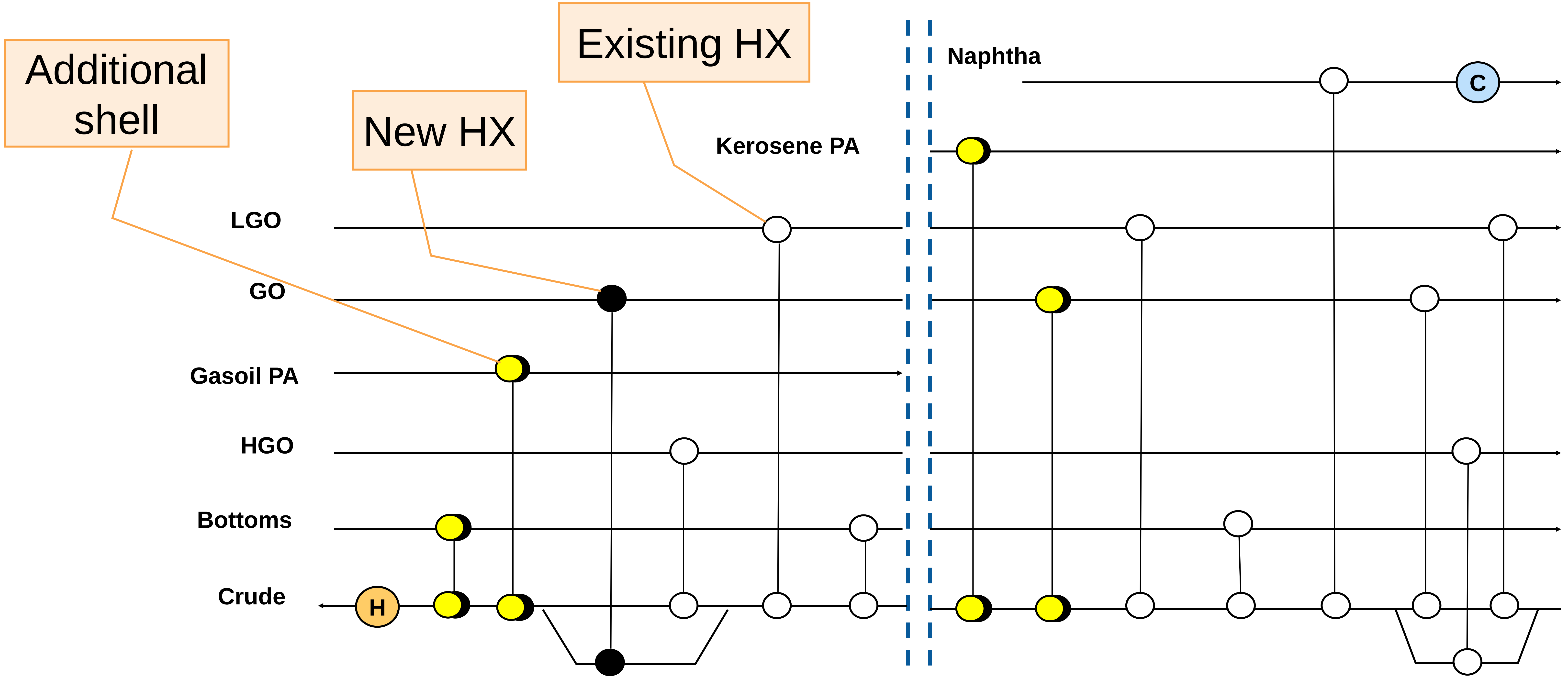
Note: HEN = Heat Exchanger Network

Example: Existing HEN (in Grid format)



Note the conventions for showing HX with full and partial Cross-Pinch heat transfer

Optimized Retrofit



Note that the optimized retrofit eliminates all Cross-Pinch heat transfer

Foundations for Success

GOOD data

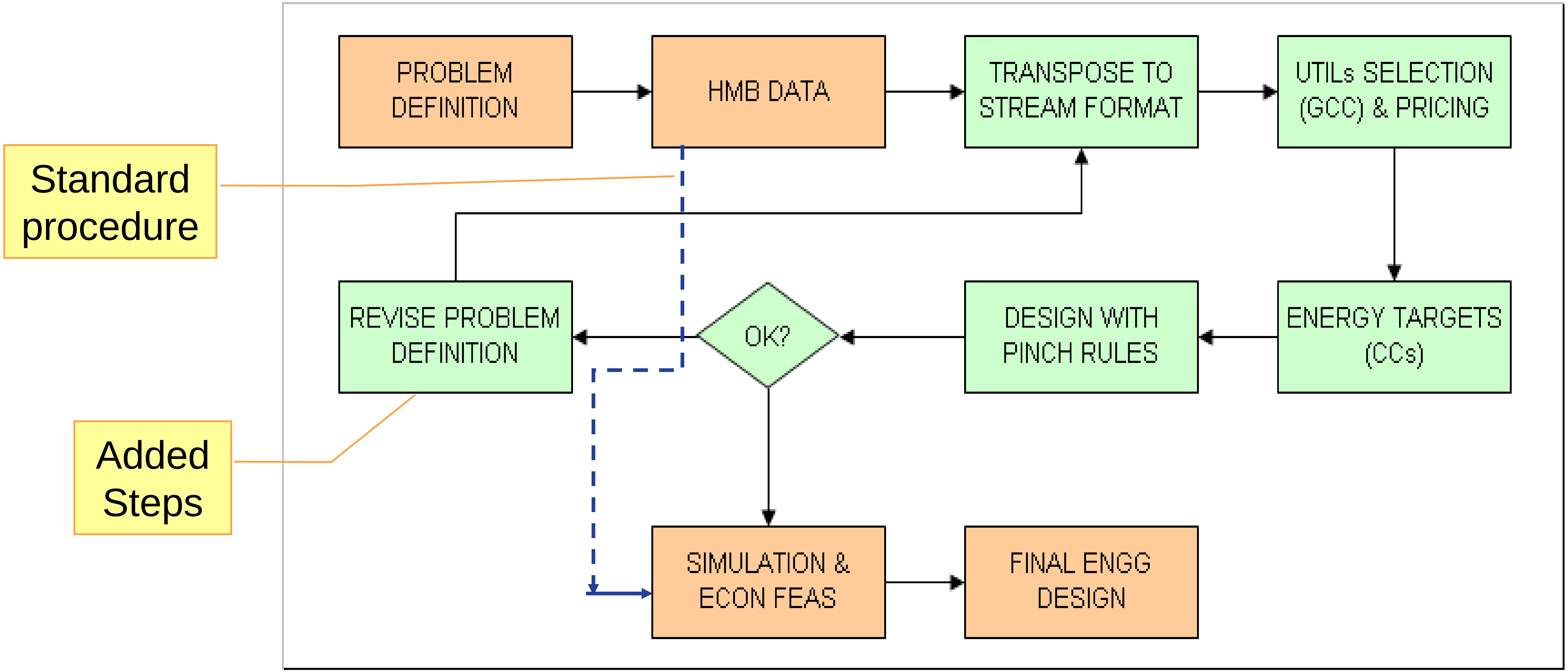
- Updated Process Flow Diagrams
- Validated Heat + Material Balance model (incl properties)
- Equipment data sheets and performance curves at turndown
- Marginal prices for Utilities
- Reliable rapid cost estimating tools
- Plant layout (pipe-racks) – for Retrofit

Correct Data Extraction

Team approach → Engineering + Operations

Management Support

Incorporate Pinch Design Strategy into Project Procedure

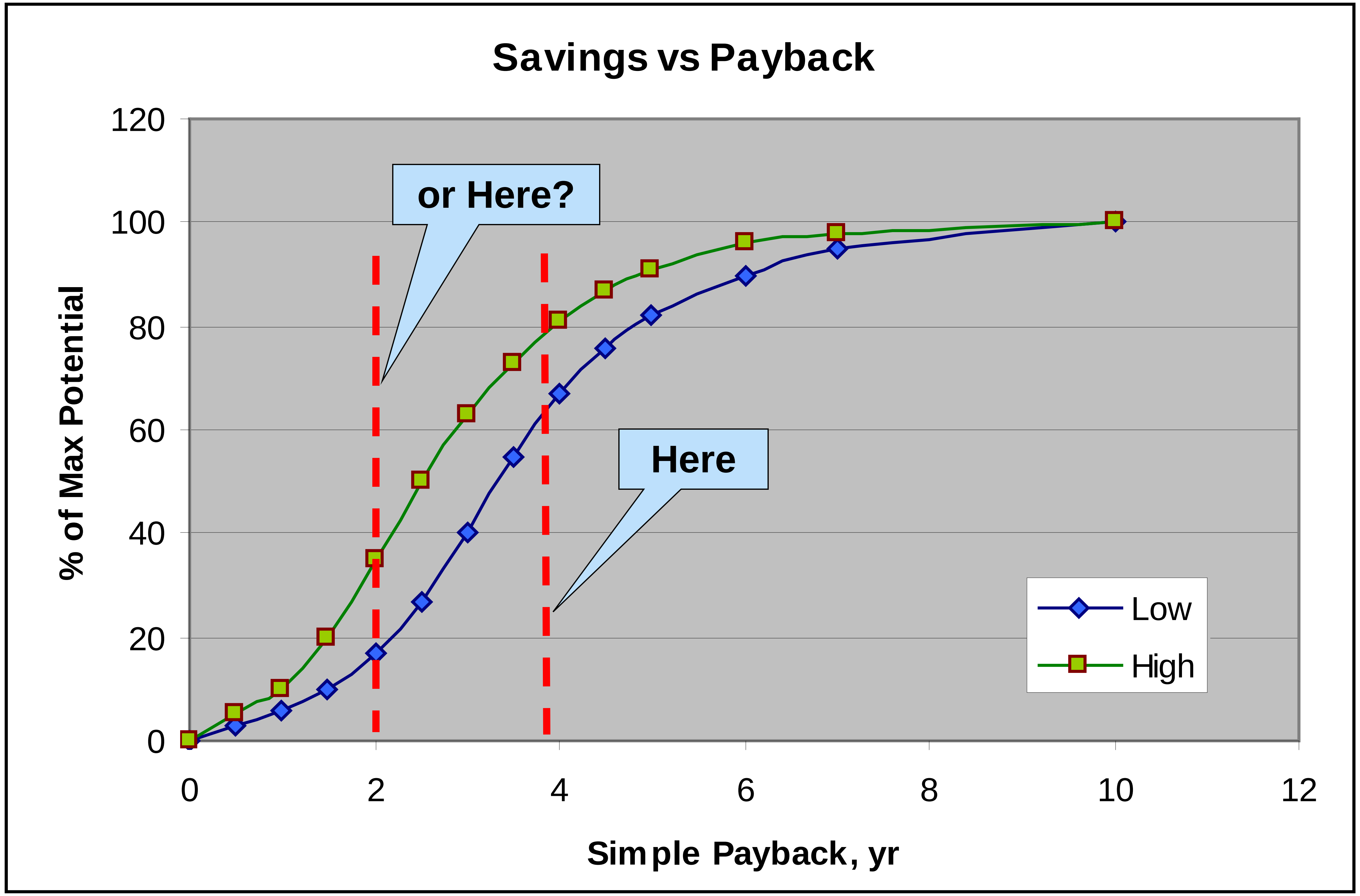


- First structural optimization, using Pinch Analysis (green boxes)
- Then parametric optimization, using simulation models (orange box, after Pinch)

Most Important … MUST choose Reasonable ROI target

- Magnitude of Savings possible = ***f*** (req'd ROI)

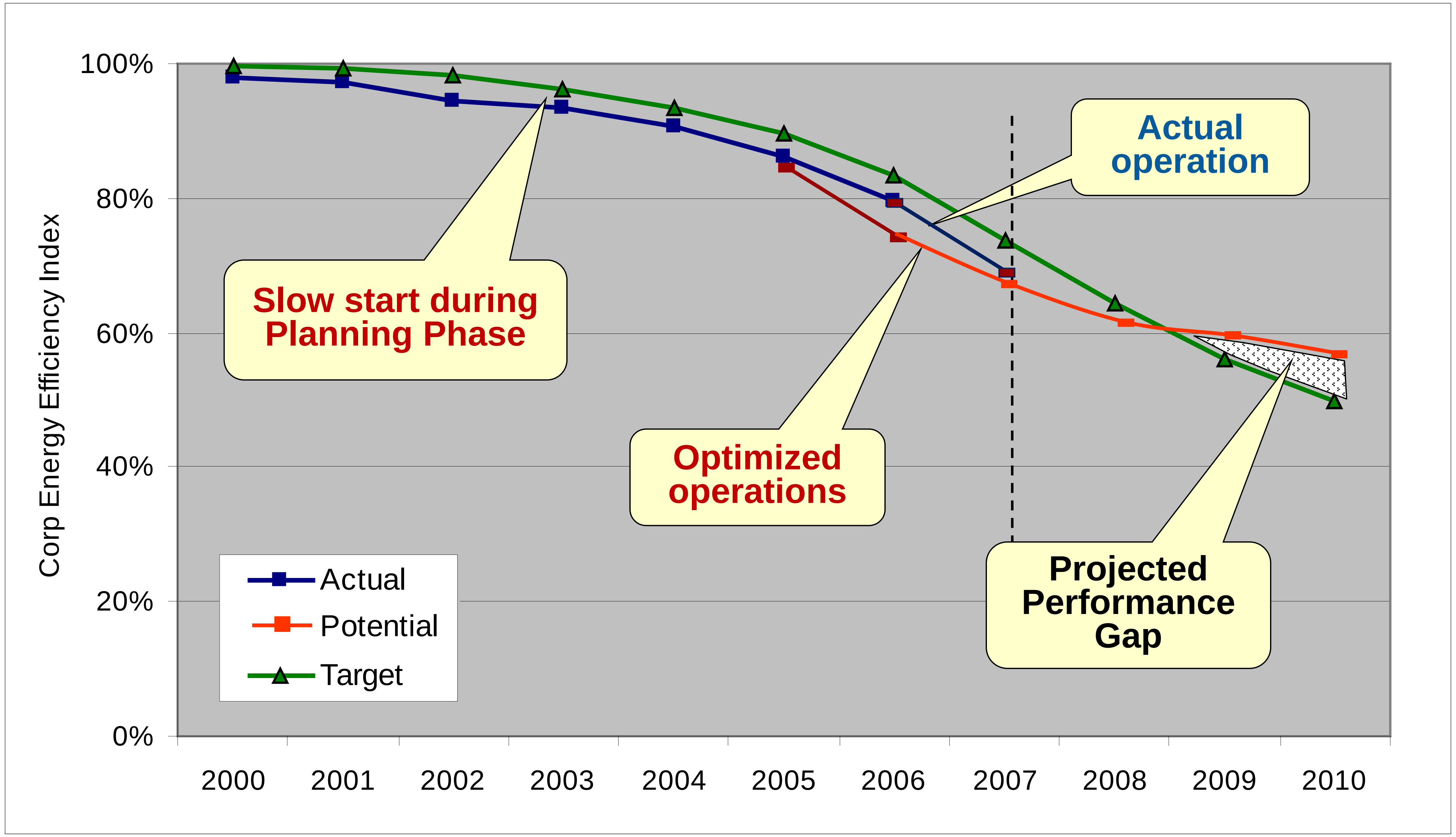
- If you set absurdly high ROI requirements, you will FAIL. This is the principal reason for Energy Efficiency in US Industry having fallen behind foreign competitors



Results for Major Oil/Gas Co in Mid-East (2007)

Energy Efficiency Index =

$$\frac{\text{Actual Energy Cost}}{\text{Energy Cost at Baseline Efficiency}}$$



PROOF that Energy Efficiency programs are economically Feasible, even at low fuel/elec prices, and DOABLE if Corp Mgmt is on board

You Could Achieve Similar Results ….

U.S. DOE stands ready to help

- Webinar Series (starting Oct-Nov, 2025) – Multiple 2-hour sessions
- Software tools
- Potential Energy Assessment of your facility with Technical Support
  - Energy Efficiency Benchmarking
  - Projects identification and feasibility evaluation - On-site and Consulting
- Referrals to Subject Matter Experts, as appropriate

Let us know your interest by providing us with your business card or sendemail to SundaramoorS@ornl.gov