Development and Demonstration of Waste Heat Integration with Solvent Process for More Efficient CO_2 Removal from Coal-Fired Flue Gas

DE-FE0007525

Project Review Meeting

June 24, 2015

Heat Integration with 25 MW KM-CDR at Plant Barry

- **Funded by industry consortium**
- **Fully integrated CO_2 capture/compression**
- **Storage in Citronelle Dome**
- **500 metric tons CO_2/day**

Project Participants

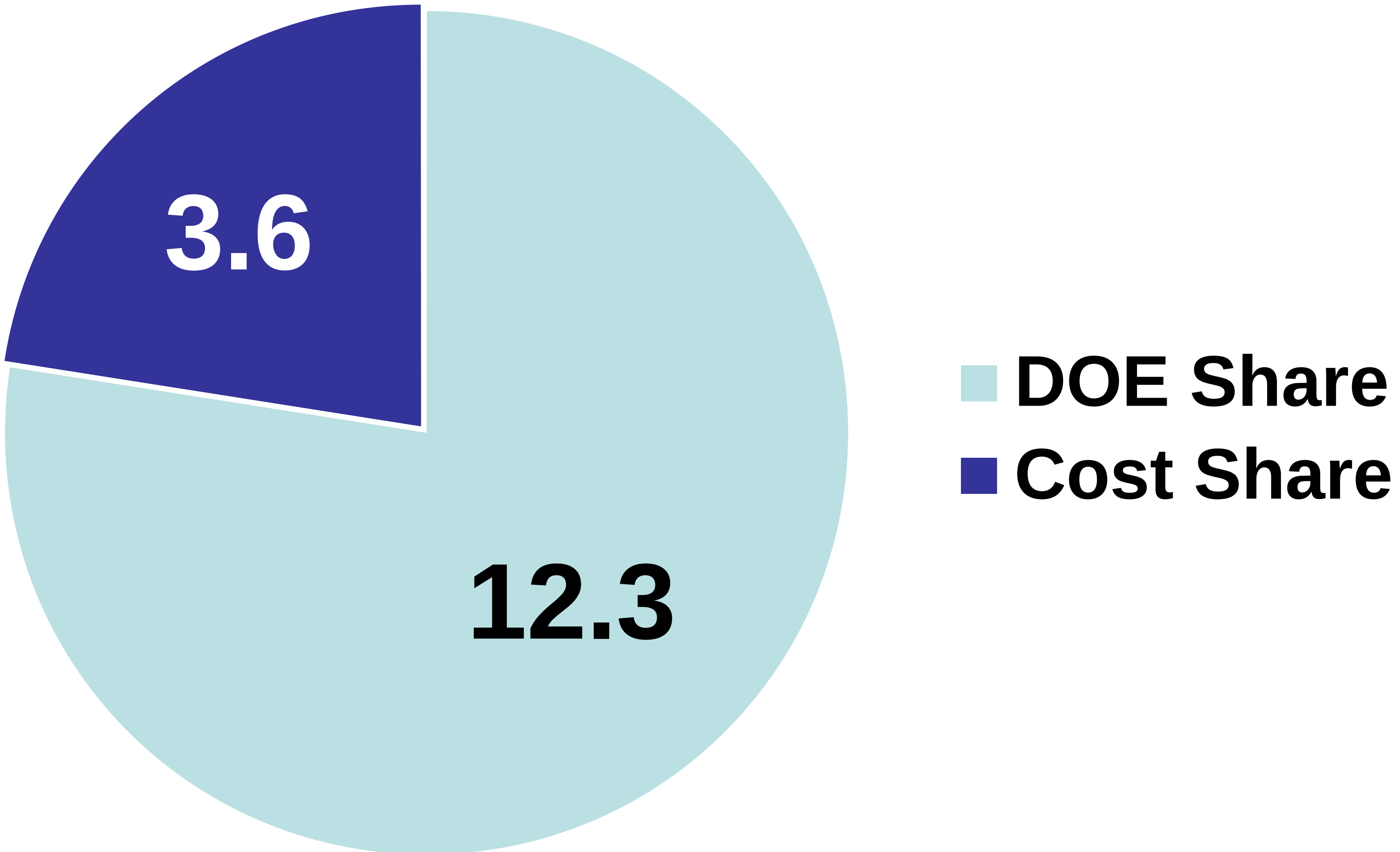
Nick Irvin
Jerrad Thomas

Tim Thomas
Shintaro Honjo
Masayuki Inui

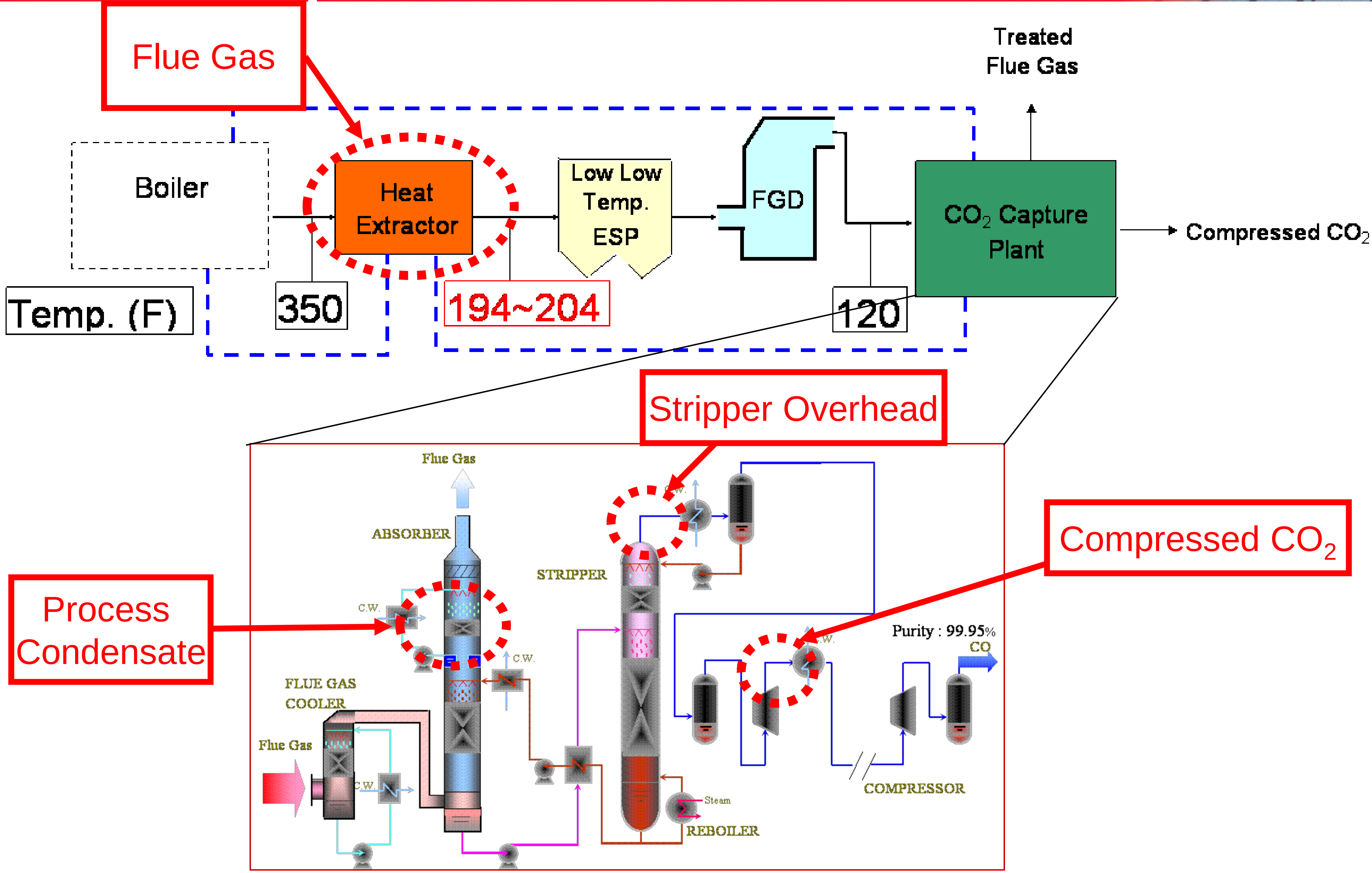
Katherine Dombrowski
Mandi Richardson
Jack Cline

Bruce Lani

Total Project Budget ($MM)



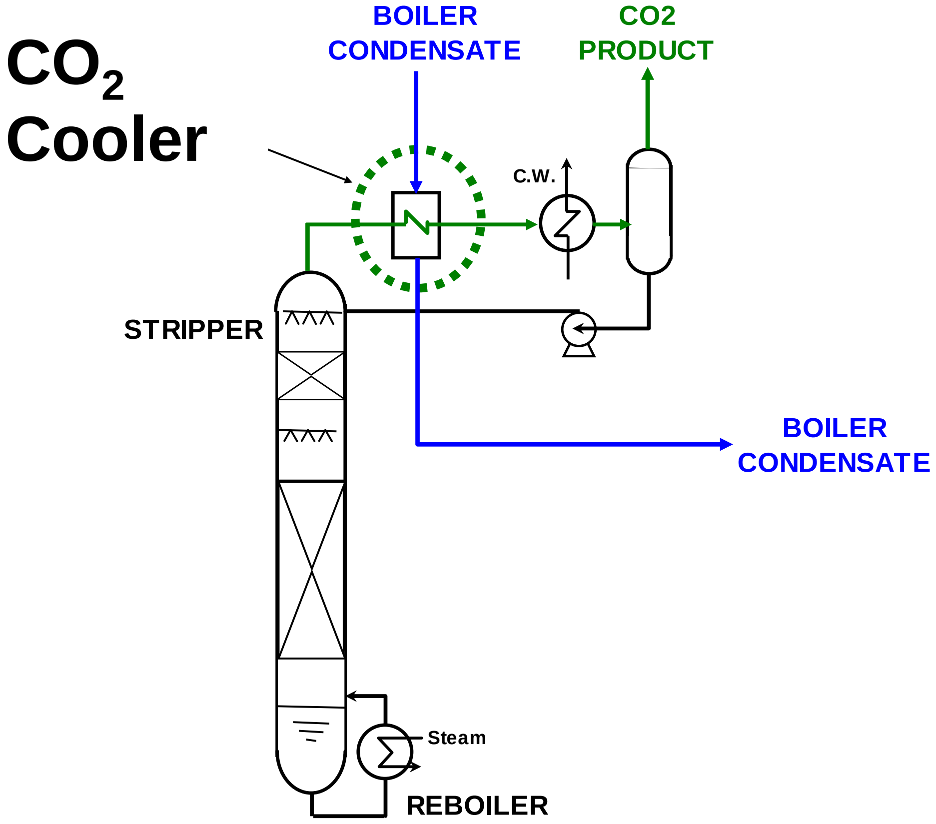
Waste heat sources include flue gas and CCS plant streams



Boiler feed water will be heated with CO_2 Cooler and Flue Gas Cooler

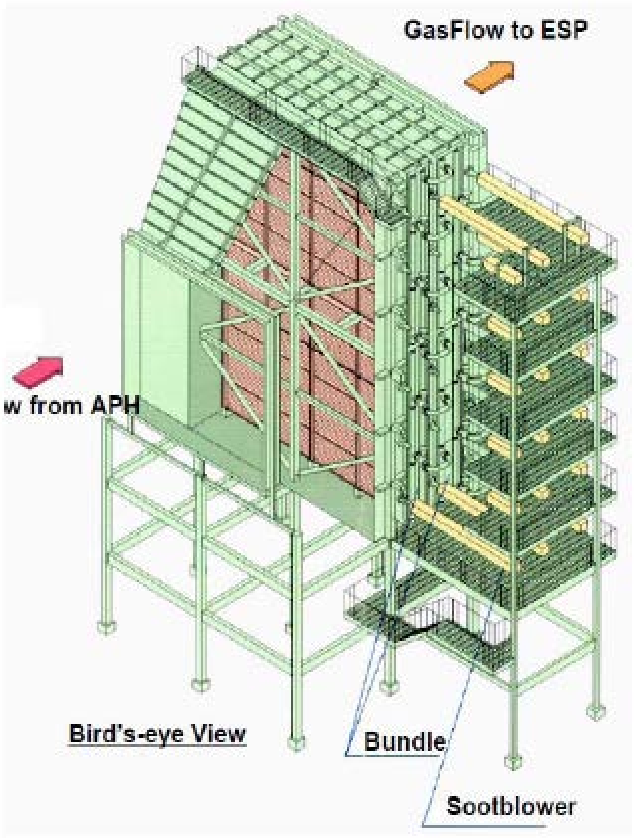
CO_2 Cooler

Standard heat exchanger



Flue Gas Cooler

MHI proprietary heat exchanger

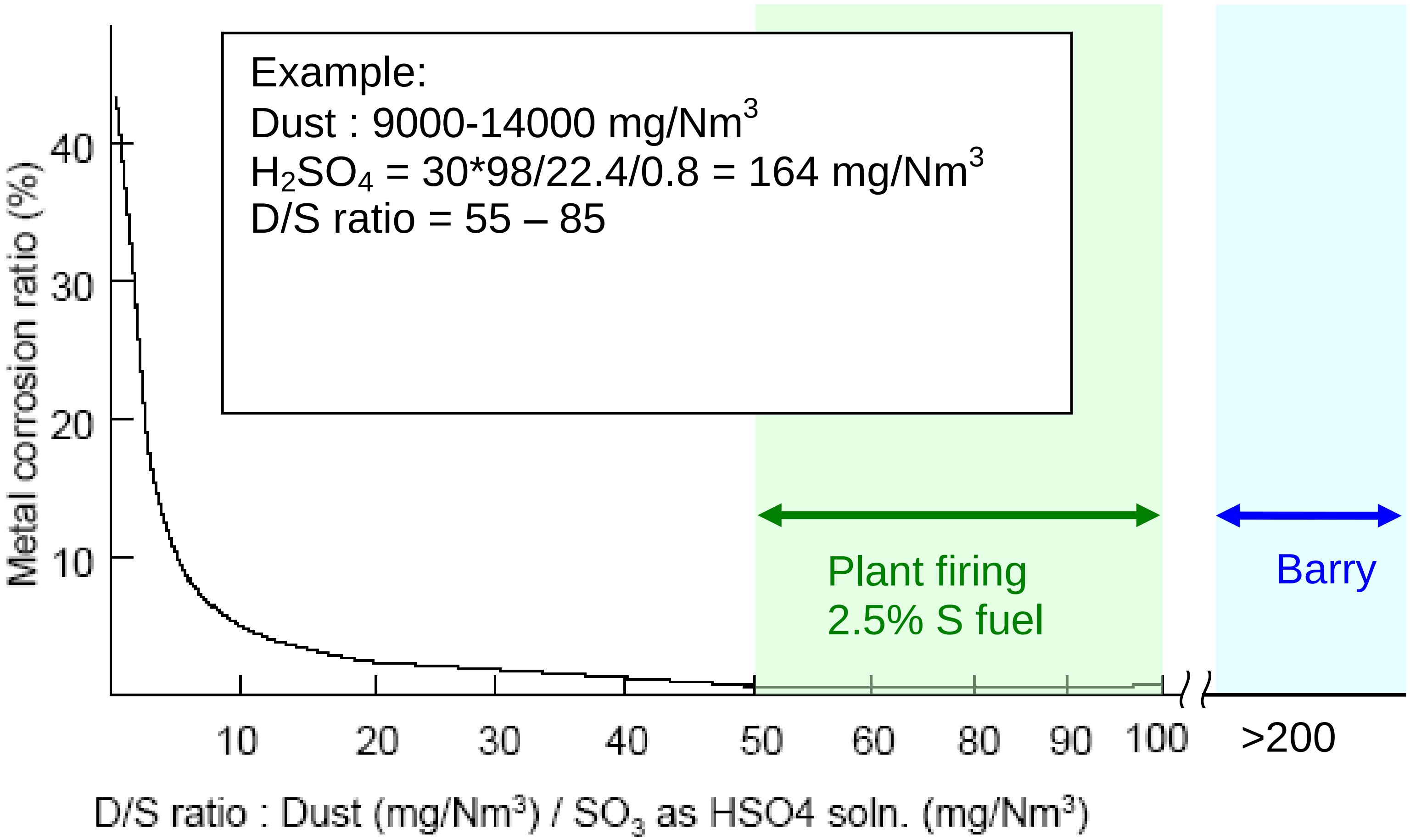


Flue Gas Cooler proven on low S coals

Carbon steel tubes in good condition after 2 years operation at Japanese plant

What happens with higher sulfur coals fired in US?

FGC Requires High D/S Ratio



Uncertainty around the reliability of the system with higher sulfur fuels (> 1% S)

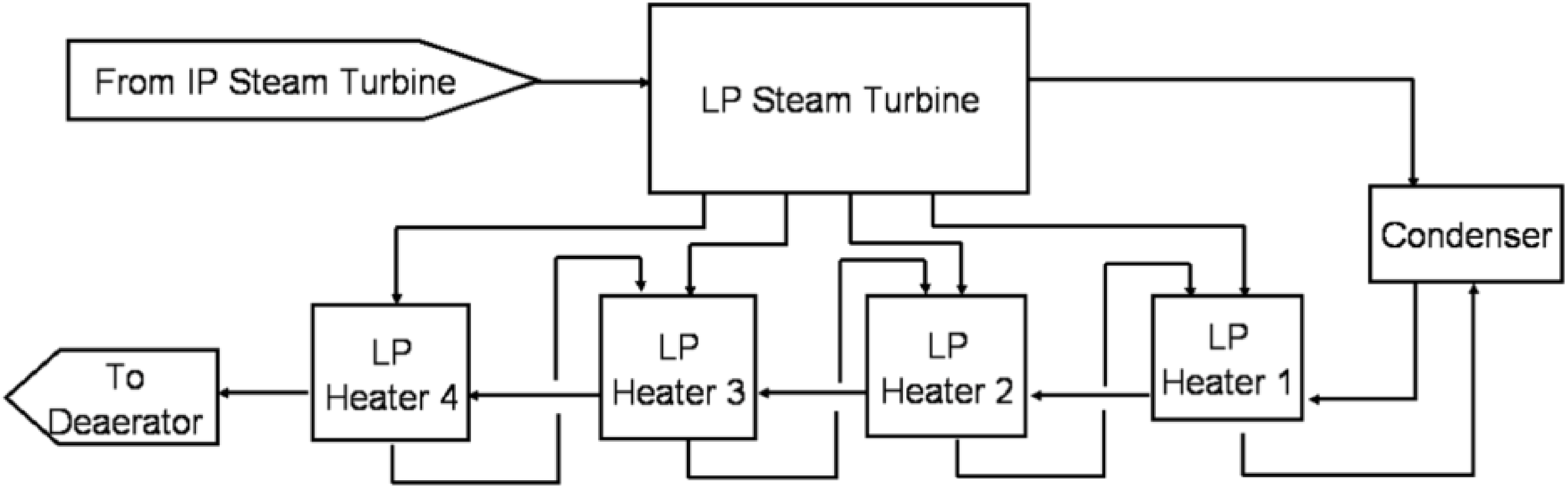
Flue Gas Cooler captures SO_3

- Operates downstream of the APH
- Mechanism for removal of SO_3 from flue gas
  - SO_3 (g) + H_2O (g) --> H_2SO_4 (g)
  - H_2SO_4 (g) --> H_2SO_4 (l)
  - H_2SO_4 (l) condenses on fly ash in flue gas and a protective layer of ash on tube bundles
- Flue Gas Cooler tube skin temperature < SO_3 dewpoint
  - Alkaline species in fly ash (Ca, Na) neutralize H_2SO_4
  - Silicates, etc. physically adsorb H_2SO_4

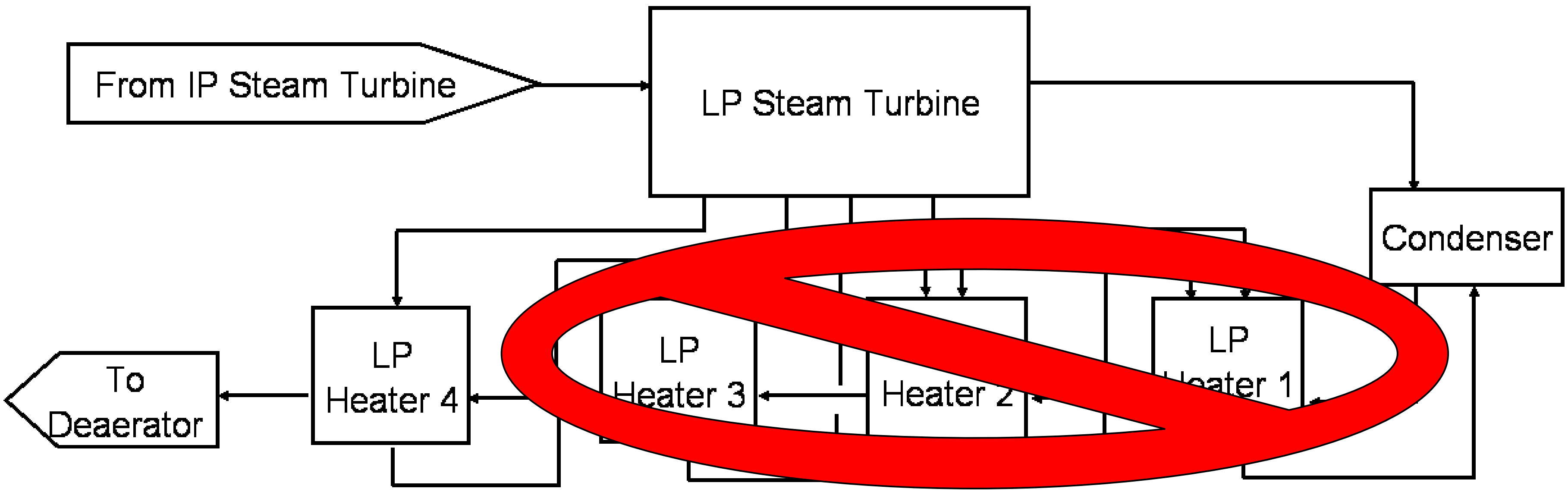
Other benefits of Flue Gas Cooler

- Improve removal of Hg, Se, SO_3 across the ESP
- Reduce AQCS cost
  - Improve ESP performance
  - Improve FGD performance
  - Improve CCS performance
- Potential to simplify boiler/steam turbine cycles
- Improve plant heat rate

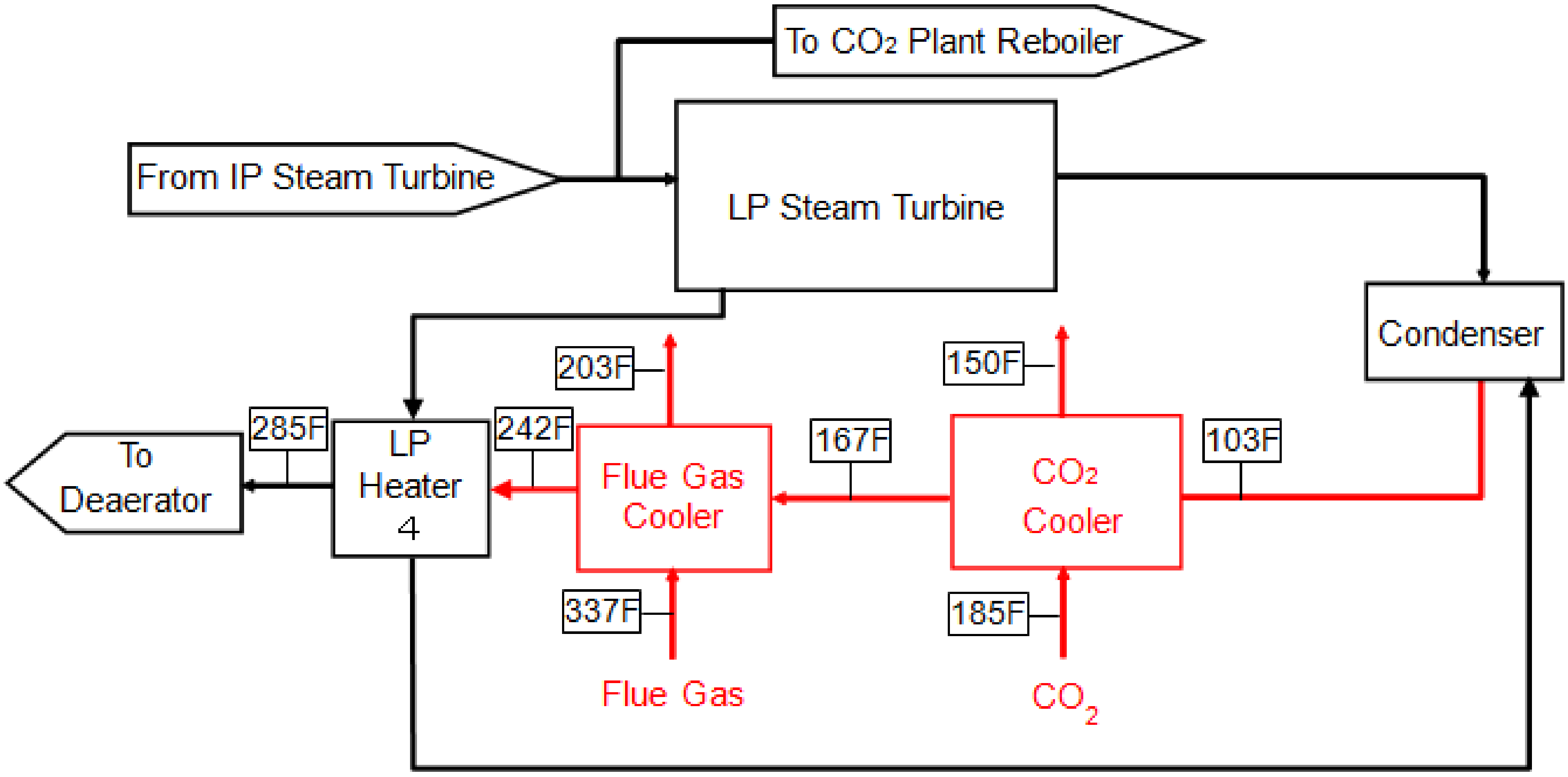
Heat integration eliminates LP heaters 1-3



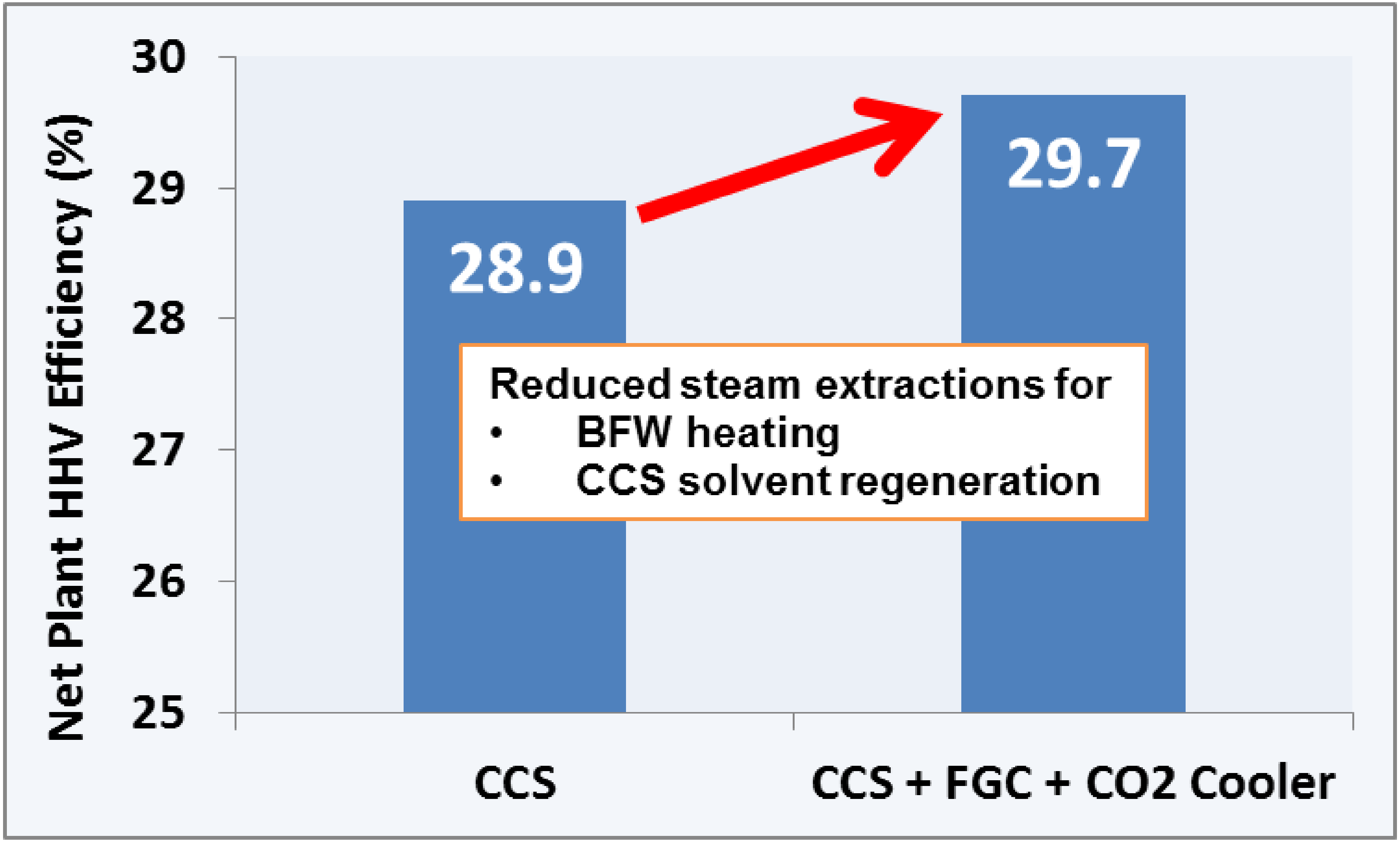
Heat integration eliminates LP heaters 1-3



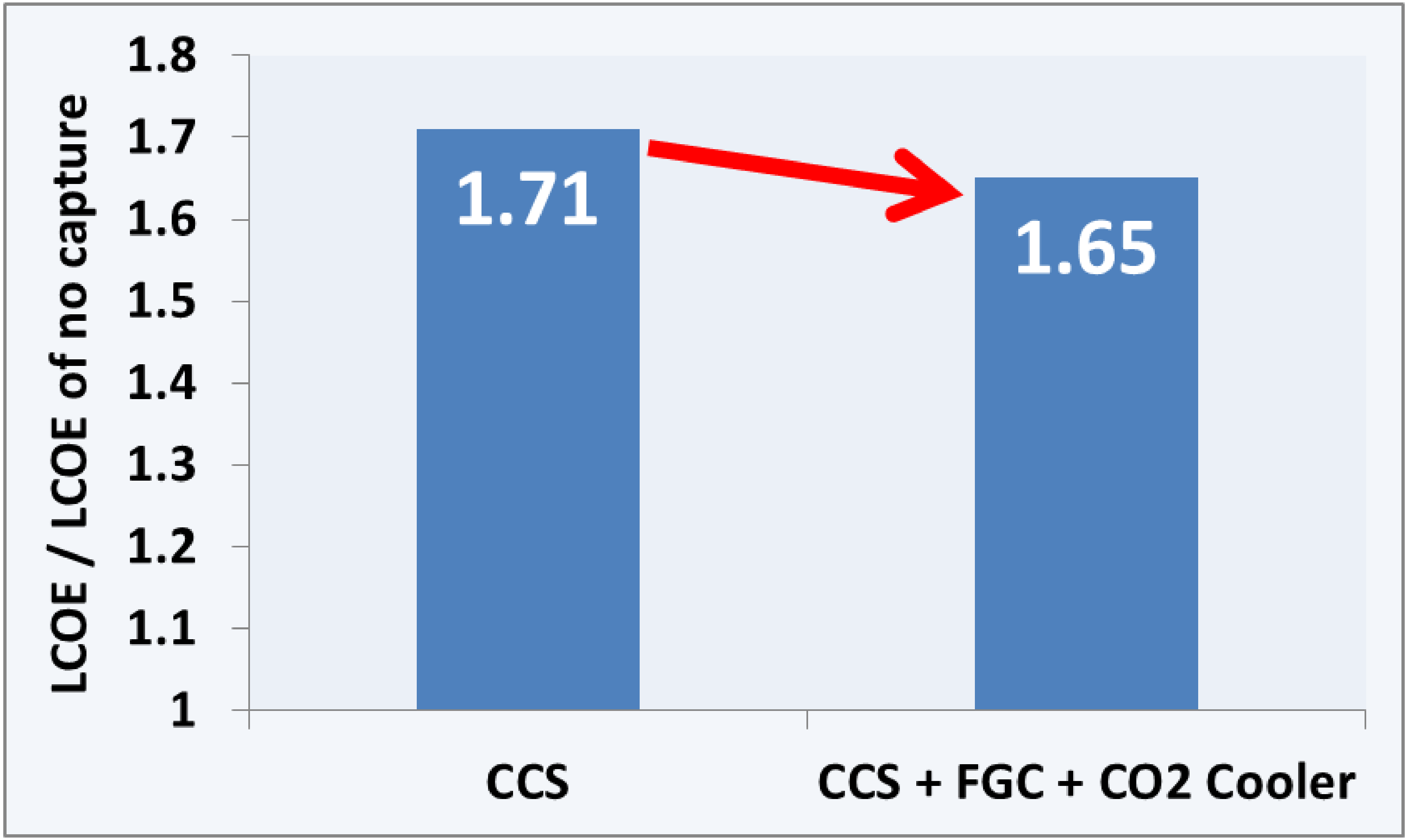
Heat integration eliminates LP heaters 1-3



Heat integration increases plant efficiency



Heat integration decreases cost of CCS



Analysis per 2010 DOE Cost and Performance Baseline

Heat Integration Challenges

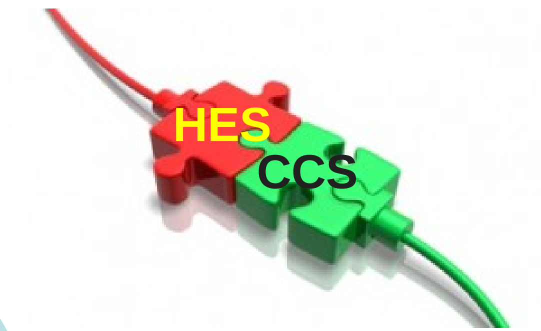
- Highly integrated systems incorporating waste heat recovery have yet to be demonstrated at any scale in the U.S.
- Overcome skepticism in U.S. by proving system reliability
- Process control during transients/perturbations, which are typical in power plant operations
- Removal performance of specific impurities not yet quantified for varying operating conditions
- Uncertainty around the reliability of the system with higher sulfur fuels (> 1% S)

Project Objectives

Quantify tangential benefits

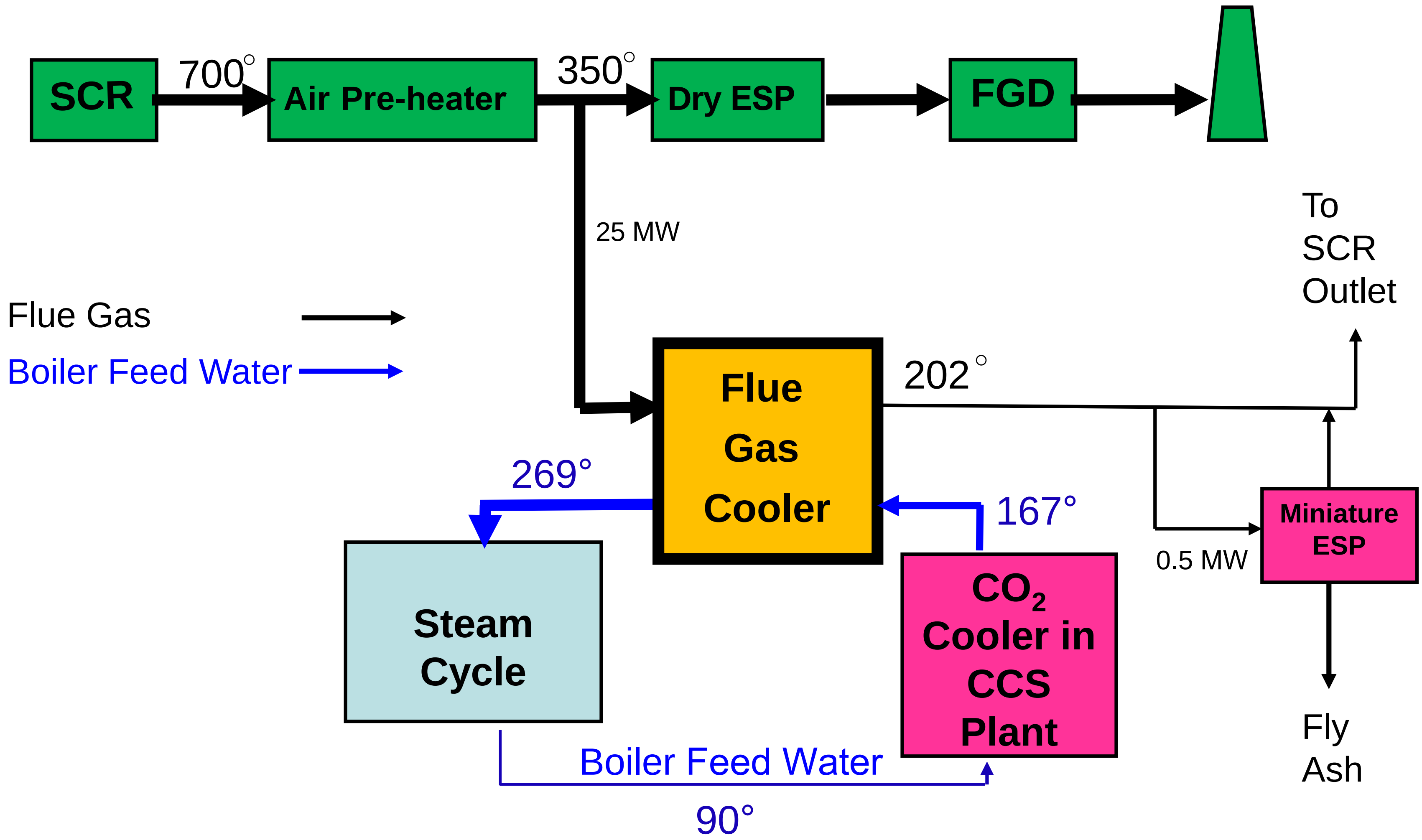
- Better ESP performance
- Increase SO_3, Hg, Se capture
- Reduce CCS solvent consumption
- Reduce FGD H_2O consumption

Resolve operational problems of integration

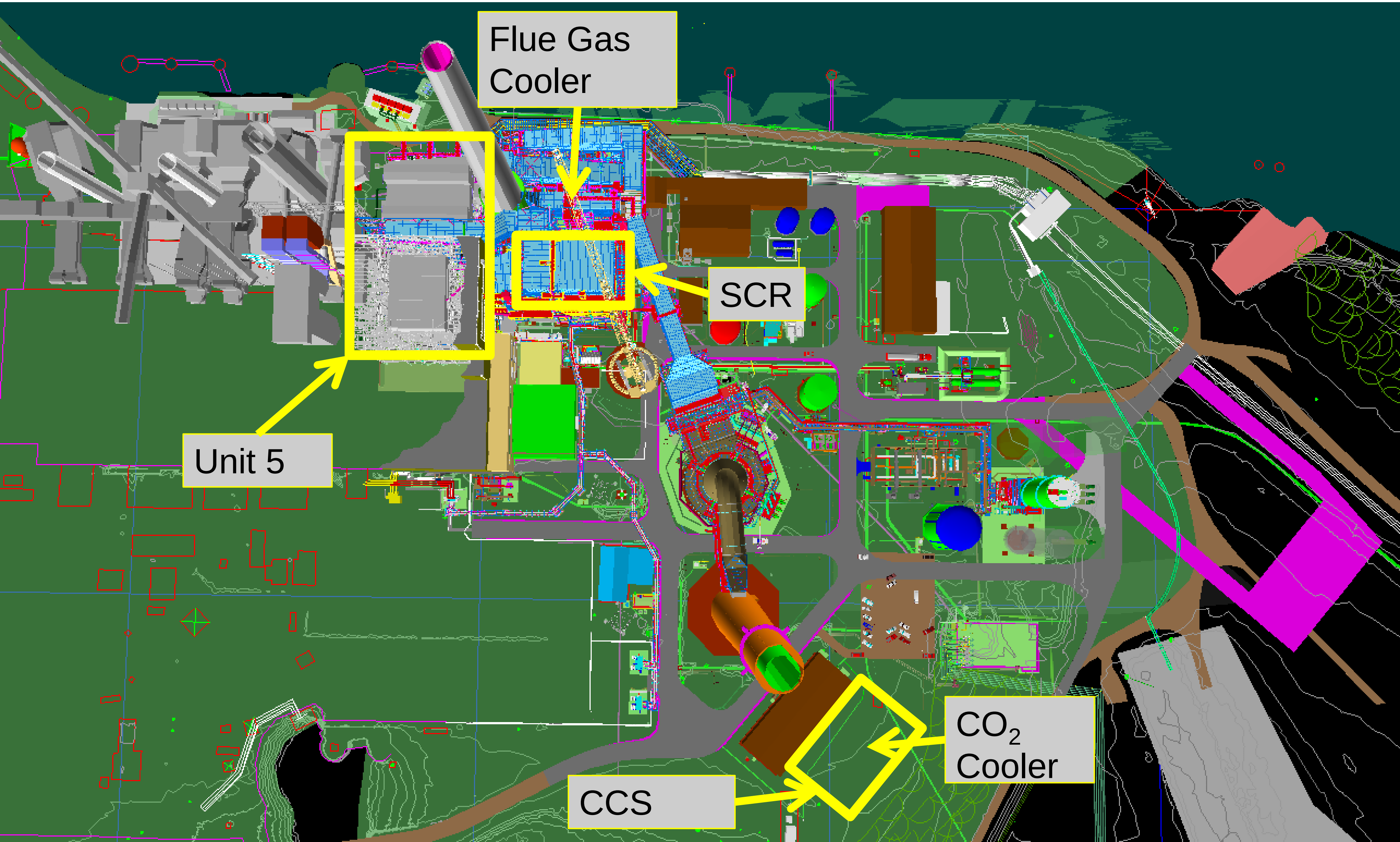


Quantify energy efficiency improvements

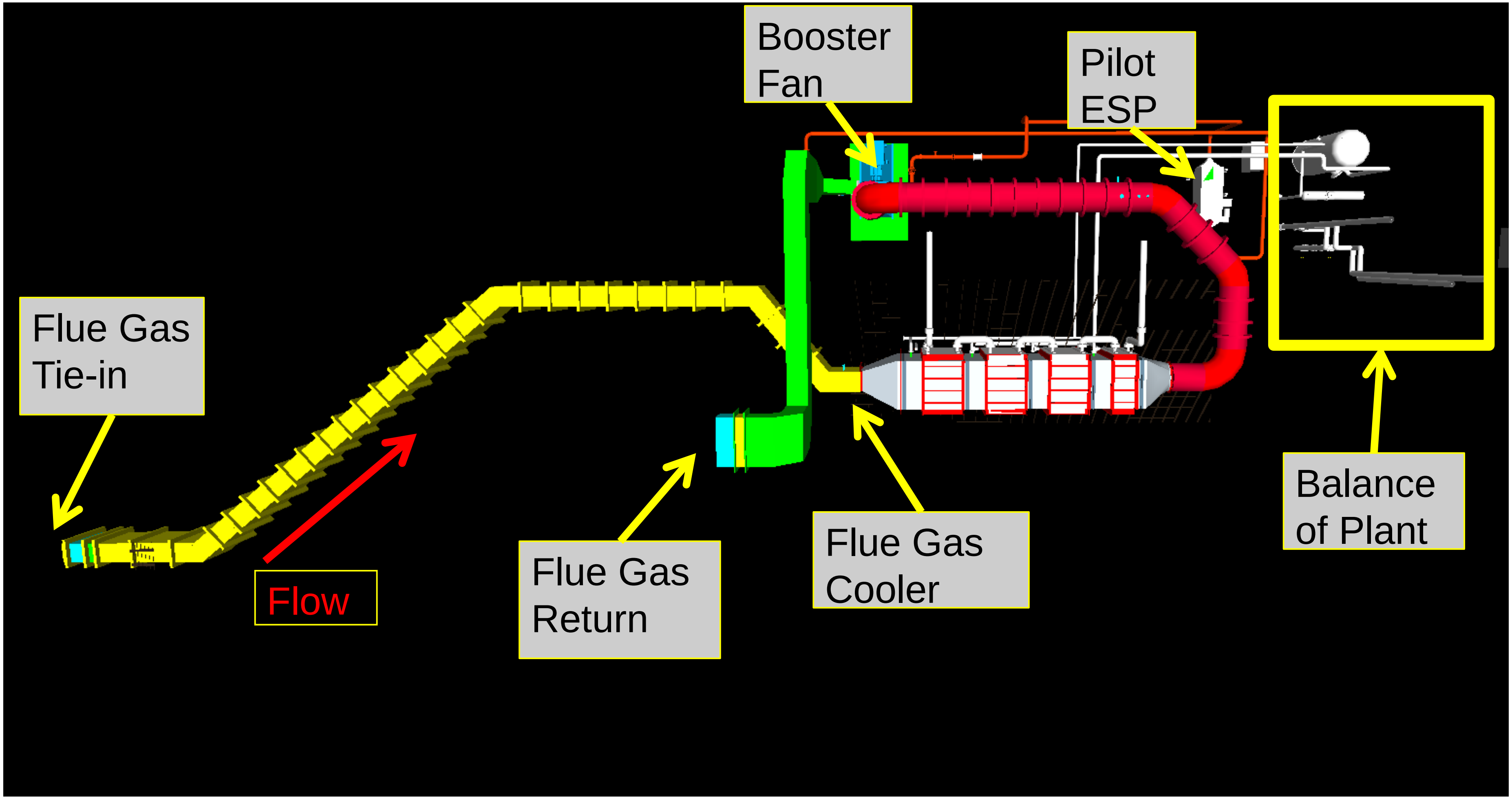
PROJECT = Boiler feed water will be heated with CO_2 Cooler and Flue Gas Cooler



General Layout

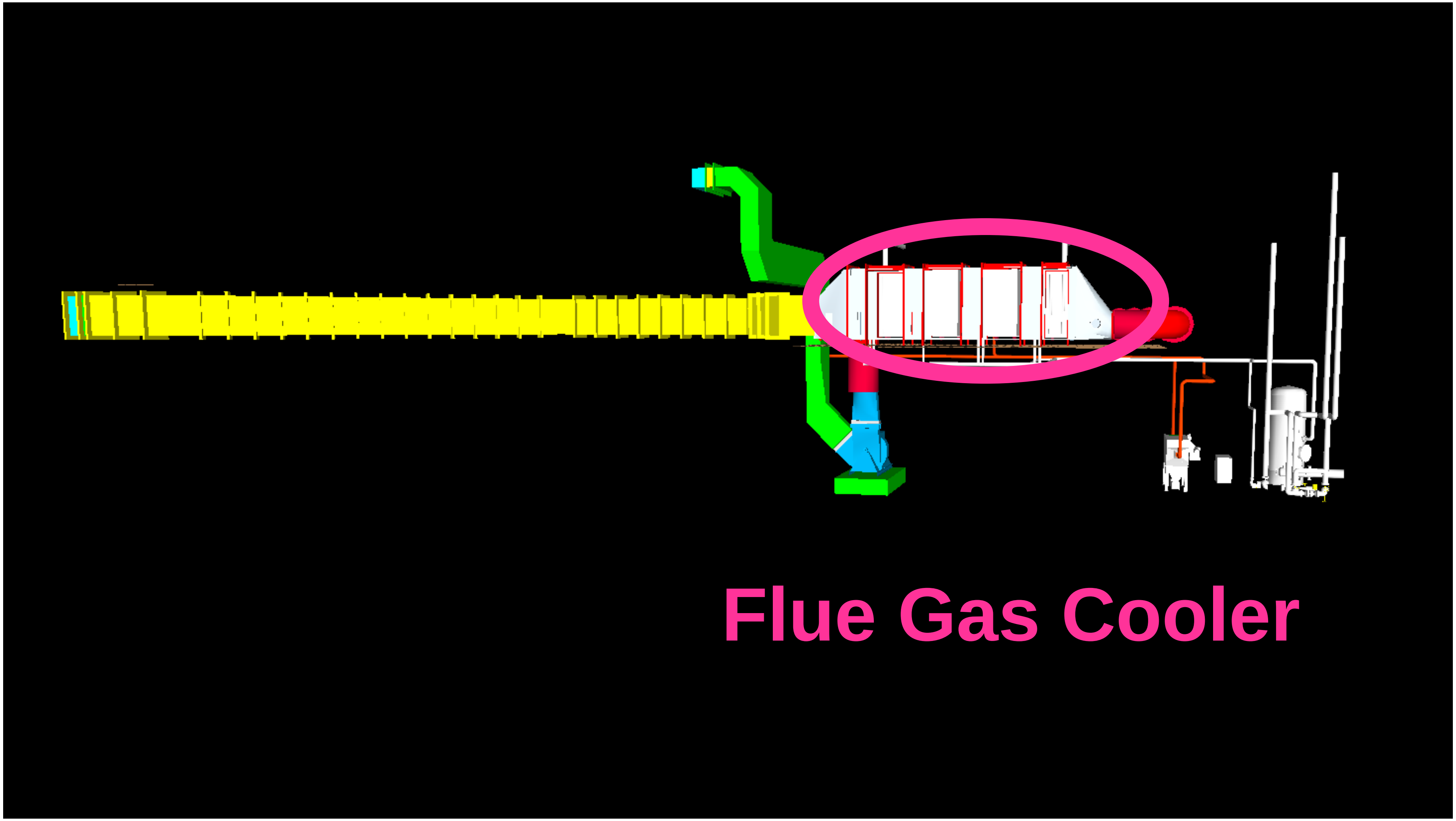


Flue Gas Cooler Area – Plan View



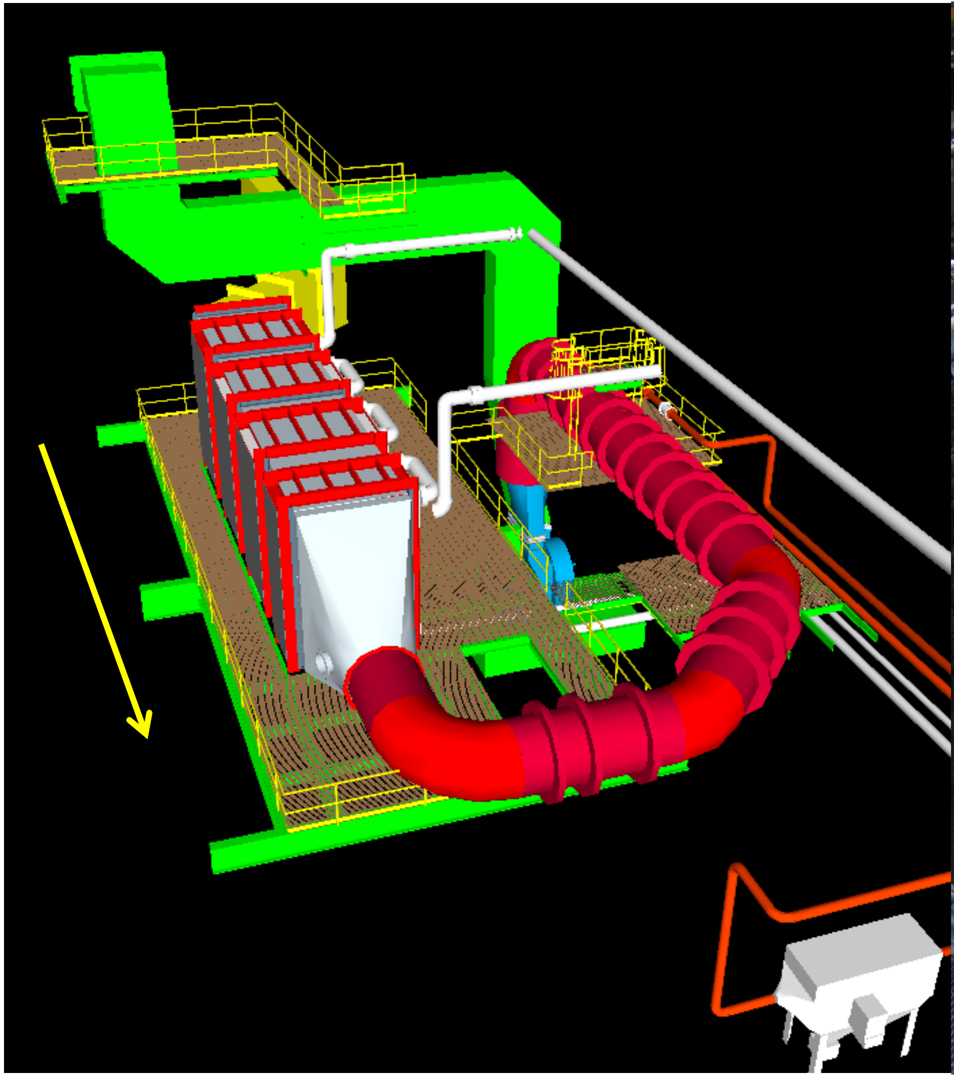
Flue gas dampers

Side View

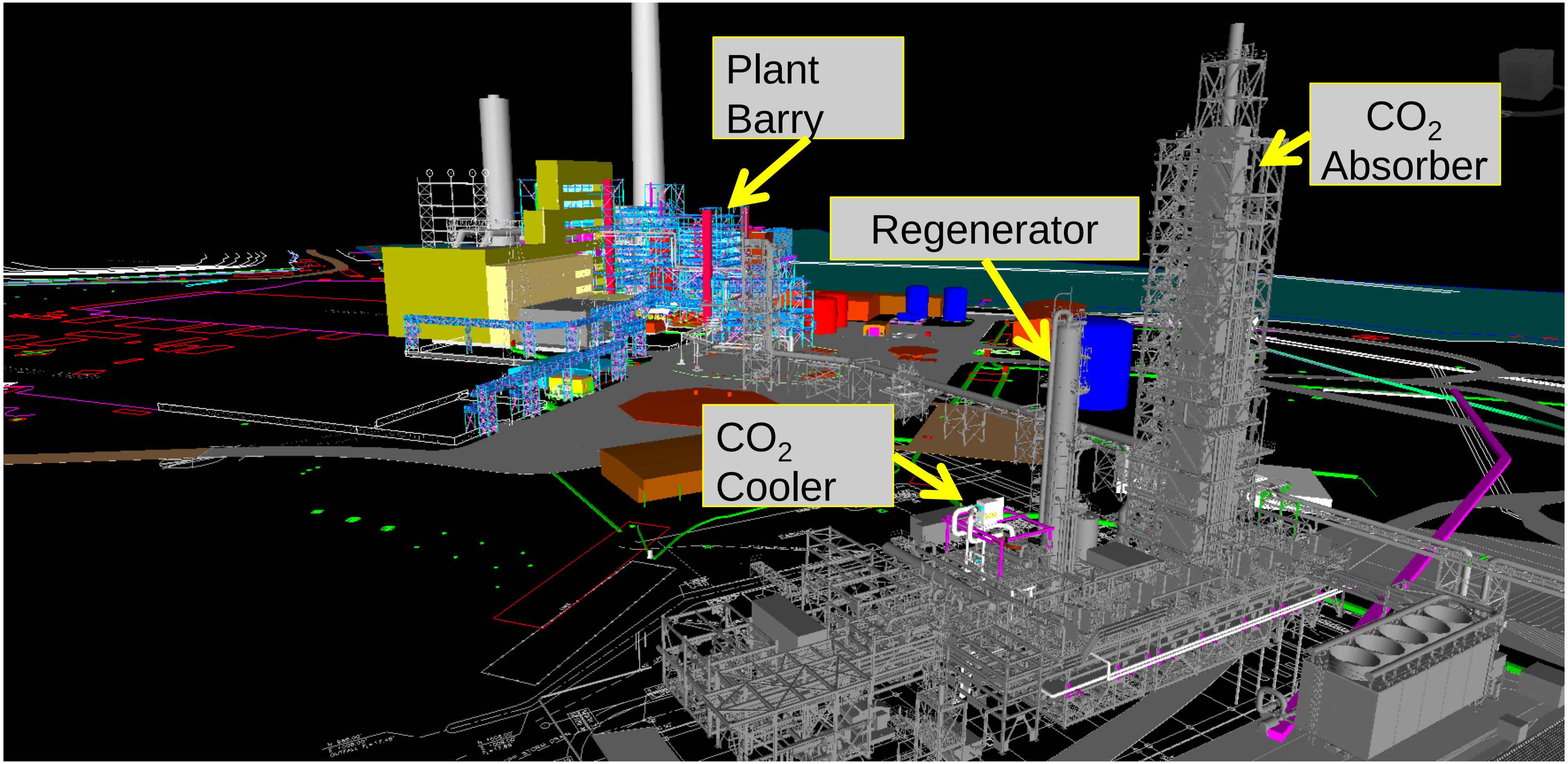


Flue Gas Cooler shell fabrication

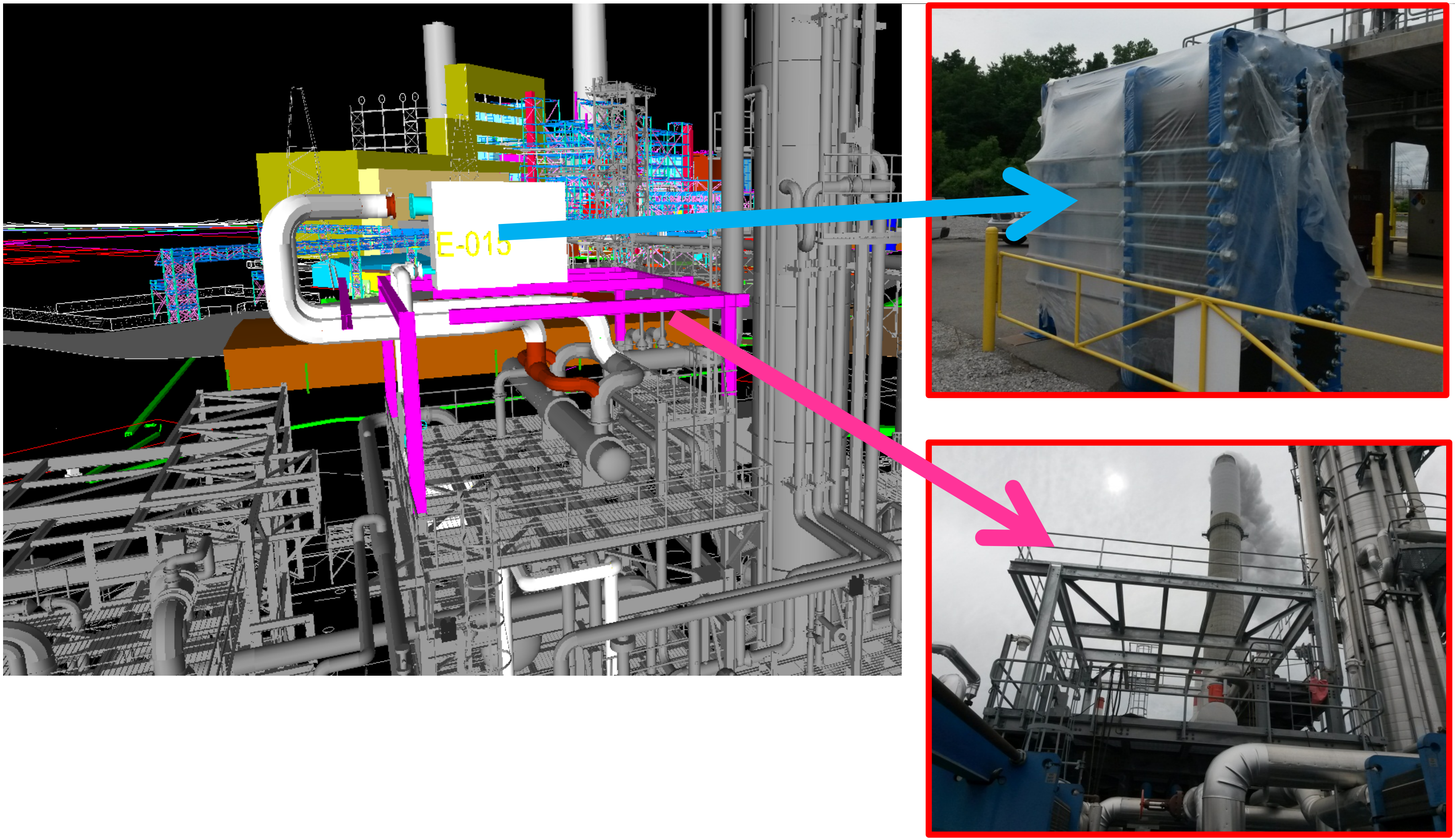
Flue Gas Cooler Installed



CO_2 Cooler General Arrangement



CO_2 Cooler & Platform Construction



CO_2 Cooler Installed

BP3 completes March 2016

BP1

- FEED and Target Cost Estimate
- Permitting

BP2

- Engineering, Procurement, Construction

BP3

- Operations
- Field Testing Analysis

Remaining project work

Complete Construction → **Commission** → **Operations and Testing**

Dec 2014 | **June 2015** | **June 2015 – Nov 2015**

- Verify efficiency
- Estimate reduction in FGD water use
- Measure corrosion, erosion
- Test water quality
- Measure SO_3, trace metal removal

Test Program

- Performance
  - Verify max heat recovery performance and controllability of TCV
  - Water consumption reduction to FGD, cooling water reduction to Quencher
  - Boiler condensate water quality and tube leak potential
  - Total economic evaluation
- Turndown Load Operation
  - Confirm heat recovery performance at turndown load (same items as above)
- Impurities Removal
  - Verify ESP performance (ash characteristics, trace metals removal, impact of Br injection)
- Long Term Durability
- Material Evaluation