FutureGen 2.0
Oxy-Coal Carbon Capture Plant with permanent CO_2 Storage

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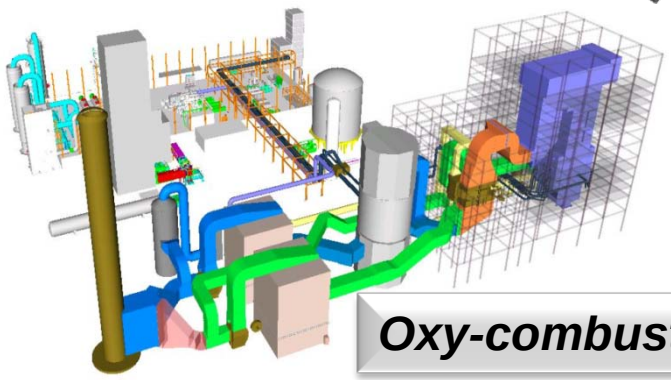
Advanced Technology

Solar Receivers

B&W mPower
a progressive energy solution

Biomass Systems



Oxy-combustion

Post-Combustion Capture

clean energy technologies

Project Participants

NETL
NATIONAL ENERGY TECHNOLOGY LABORATORY

Ameren
AIR LIQUIDE
B&W

FutureGen™
ALLIANCE

Power Generation & CO_2 Capture

CO_2 Transport and Storage

Summary of Funding – Oxy combustion large scale test

Project Cost Projection	**$737,000,000**
• **DOE Cost Share @ 80% =**	**$590,000,000**
• **Non-Government share @ 20% =**	**$147,000,000**

Project Schedule

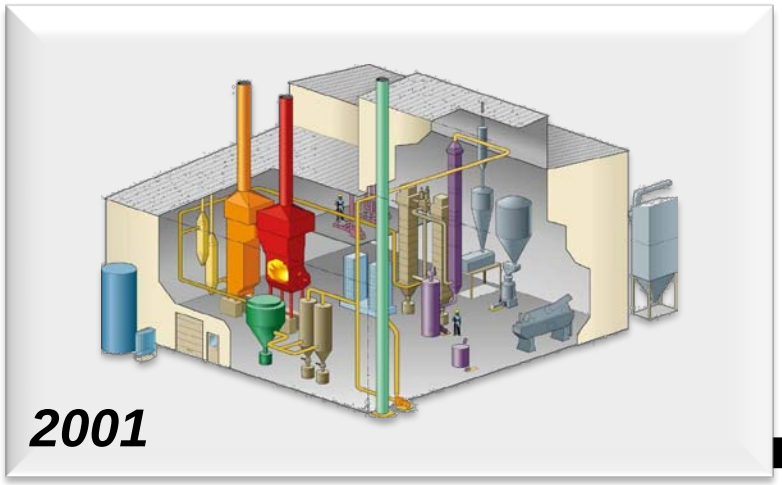
Task	*Complete*
• Cooperative Agreement -	September 2010
• Project Definition / Pre-FEED -	September 2011
• FEED, NEPA, Permitting -	October 2012
• Detail Engineering, Procurement, Construction, Start-up -	April 2016
• Testing -	December 2018

Project Objectives

Prove the Oxy-combustion process at commercial scale

- Establish a cost and schedule baseline for the technology
- Equipment Designs – Primarily Boiler
  - Reliability – component design, materials of construction
  - Maintainability – erosion, corrosion, outage cycles
  - Not designed for high efficiency – designed for flexibility & learning
  - Basic process and heat transfer data – can move to high efficiency, larger capacity w/o incremental steps
- Process Designs
  - Safety, Functionality, Operability
- Integrated operation of ASU – Boiler & AQCS – CPU – Storage
  - Start-up, Shutdown, Load Swing, Capacity Factor, System Dynamics

Oxy-combustion Development Path

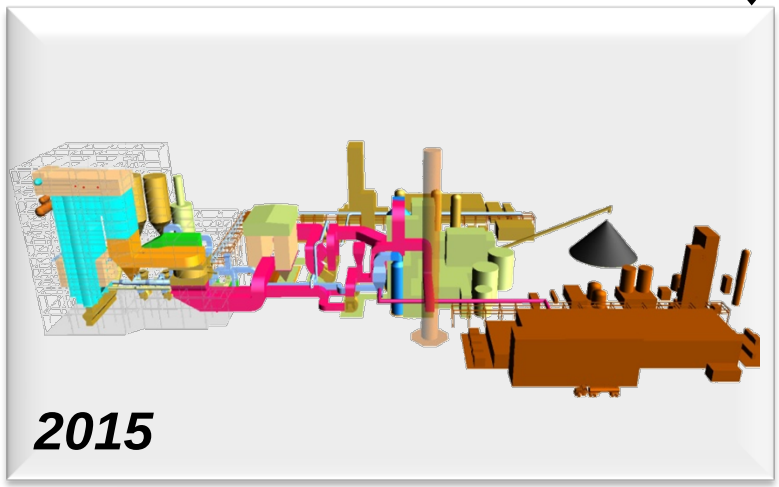


Small pilot 1.5 MWth

Large pilot 30 MWth

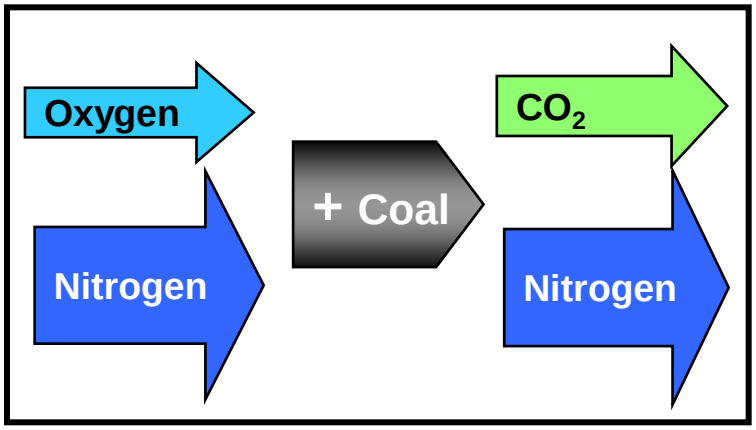
Oxy-coal Combustion Development

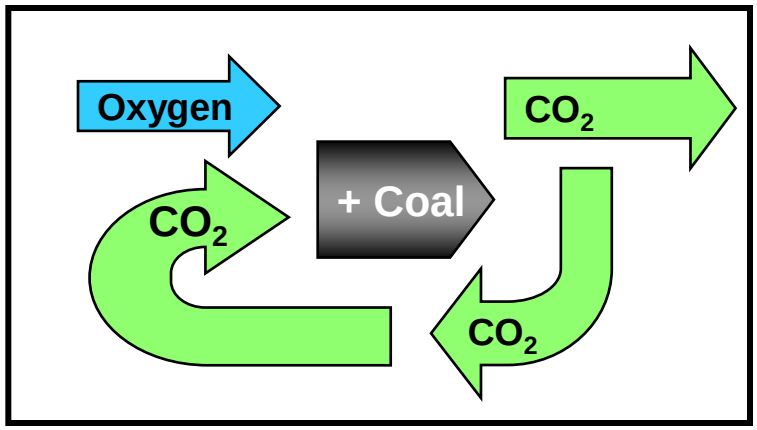
- Multiple Oxy Eng Studies, including ASU / CPU Optimization & Process Heat Integration completed
- Small & Large Scale Oxy Pilot testing, completed, Lacq Oxy-Gas & CPU test, Callide CPU test in progress
- Reference plant design complete at 680/450 MWe net SCPC
- Next step - FutureGen 2.0

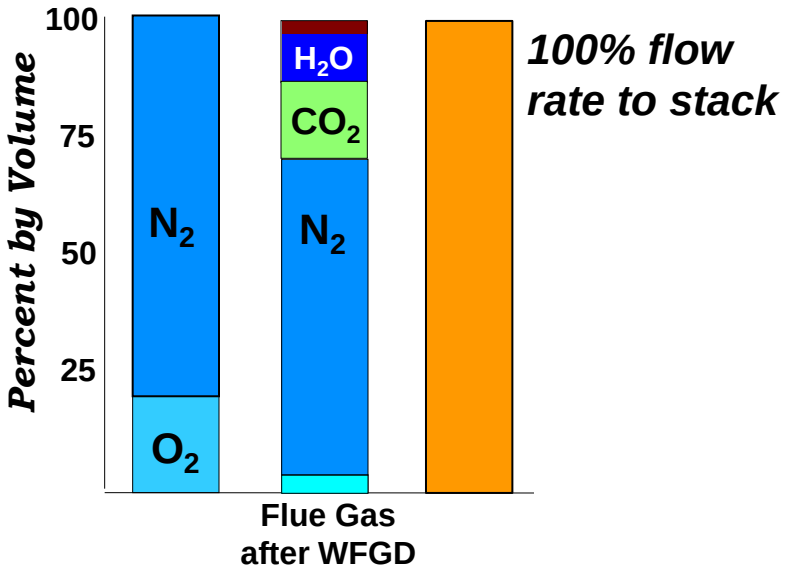


FutureGen 2.0 - 200MWe gross

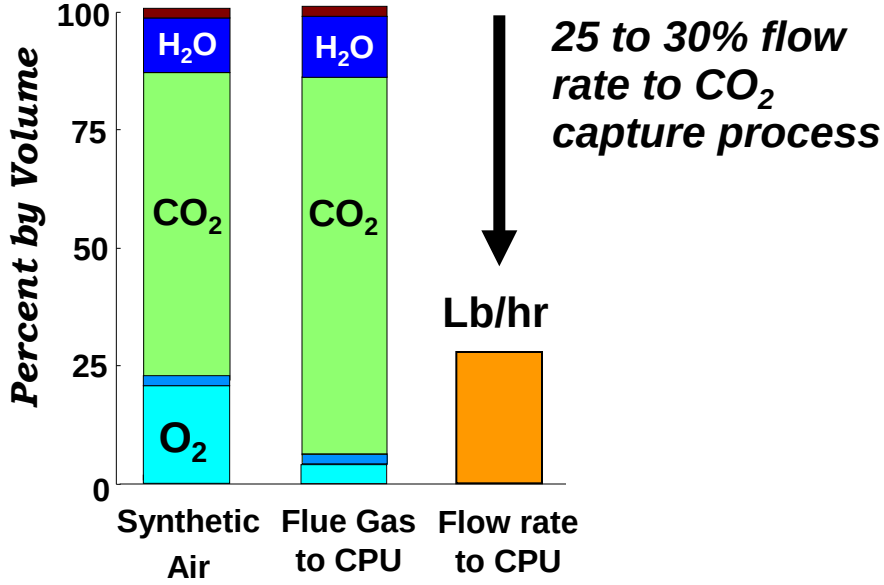
Oxy-Coal Combustion Principles





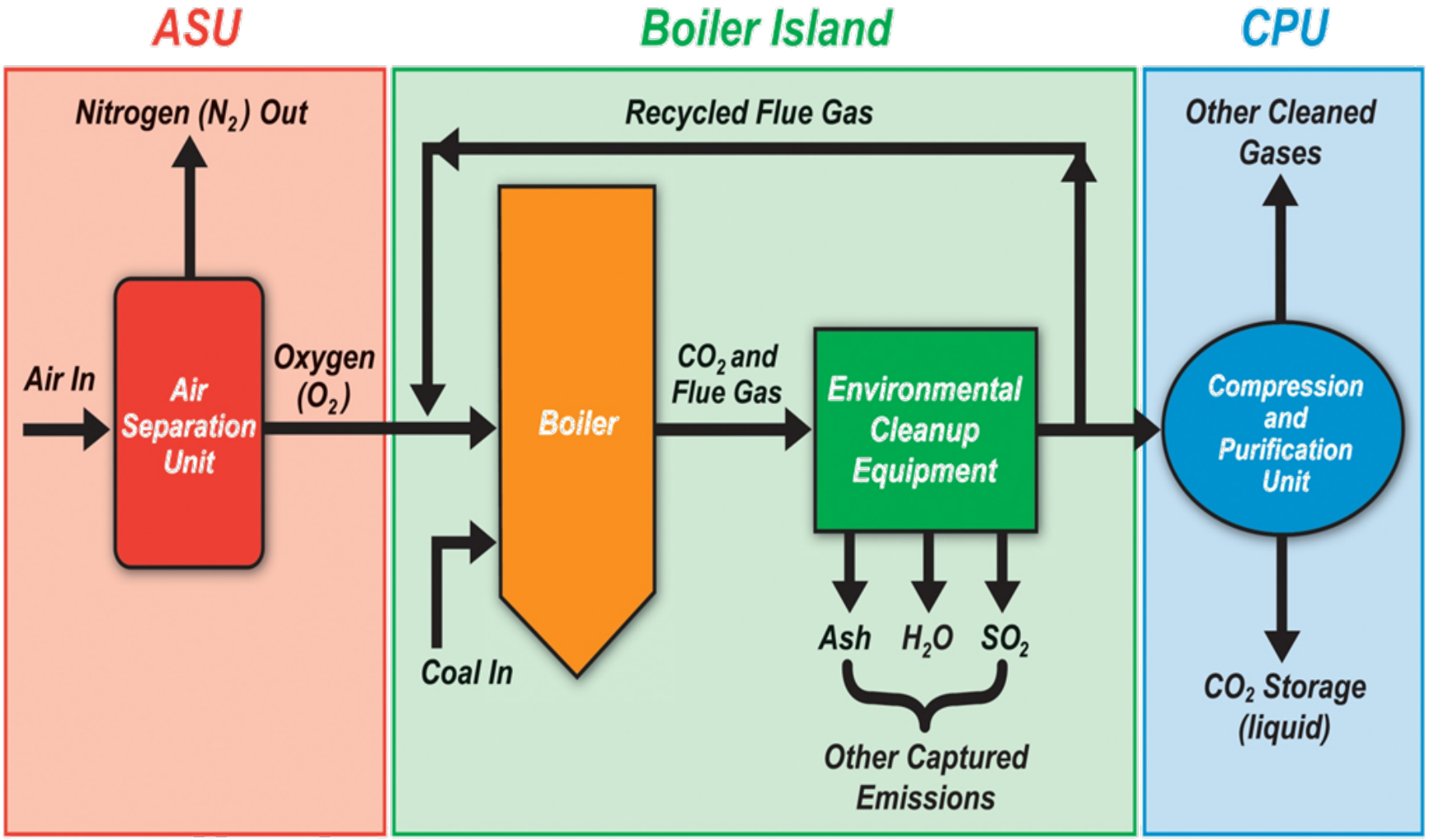


Conventional Combustion



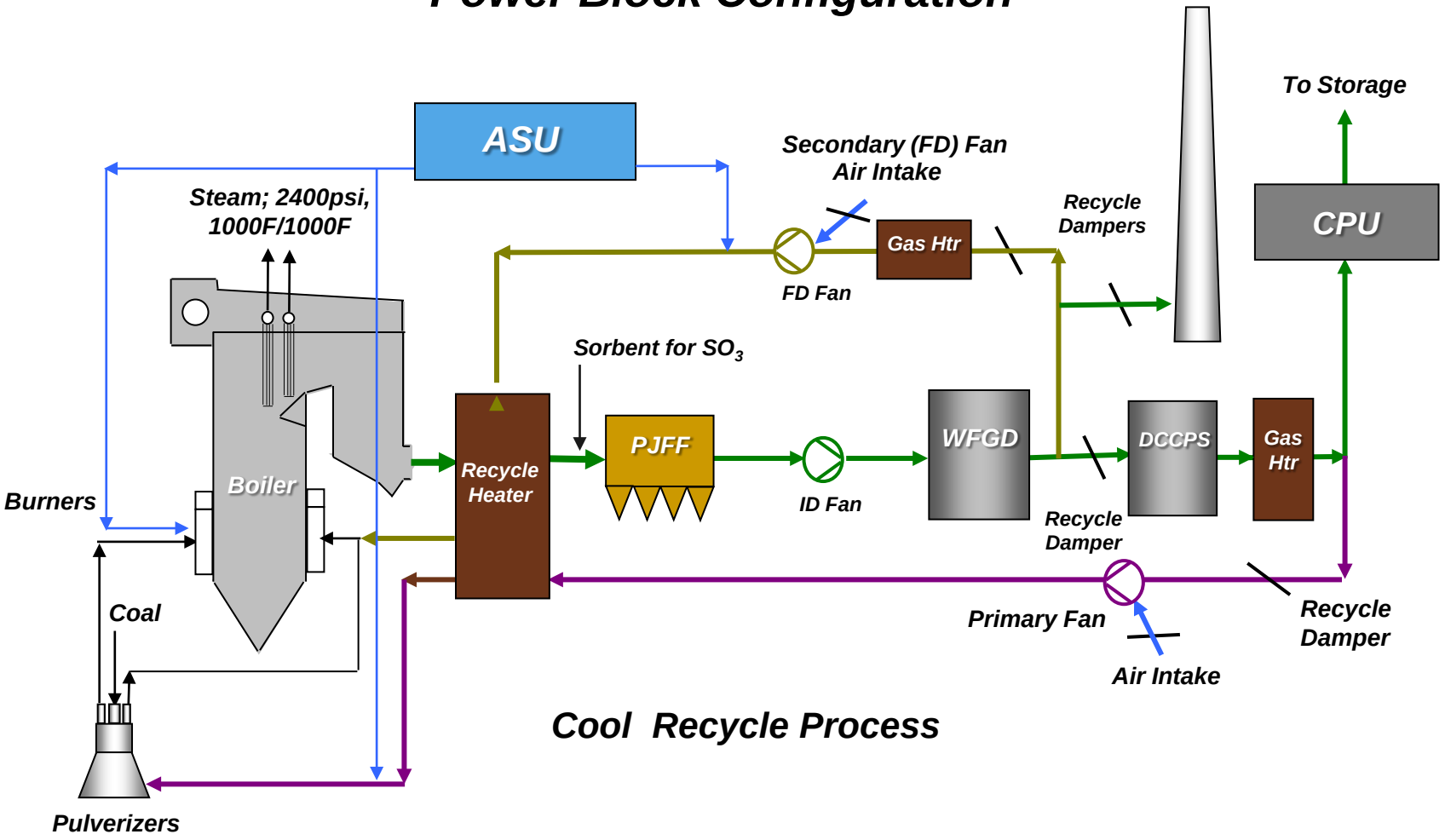
Oxy-Coal Combustion

Oxy-Combustion Process



FutureGen 2.0
Oxycombustion Carbon Capture Plant

Power Block Configuration

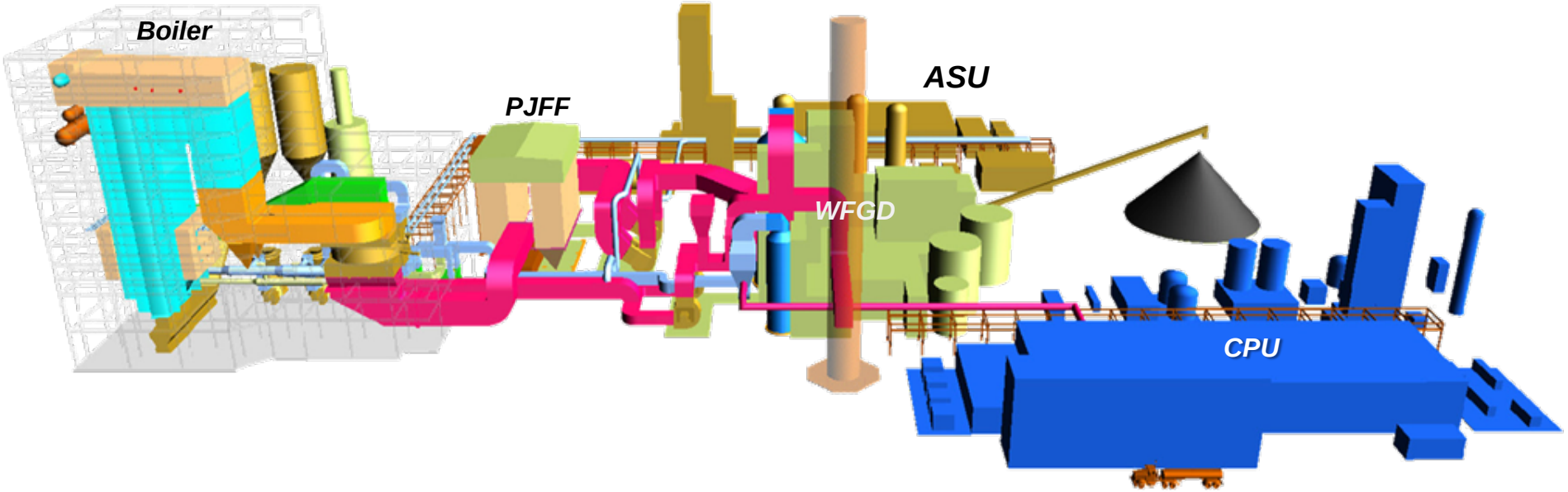


FutureGen 2.0 – Oxy-Combustion Project

Meredosia Plant

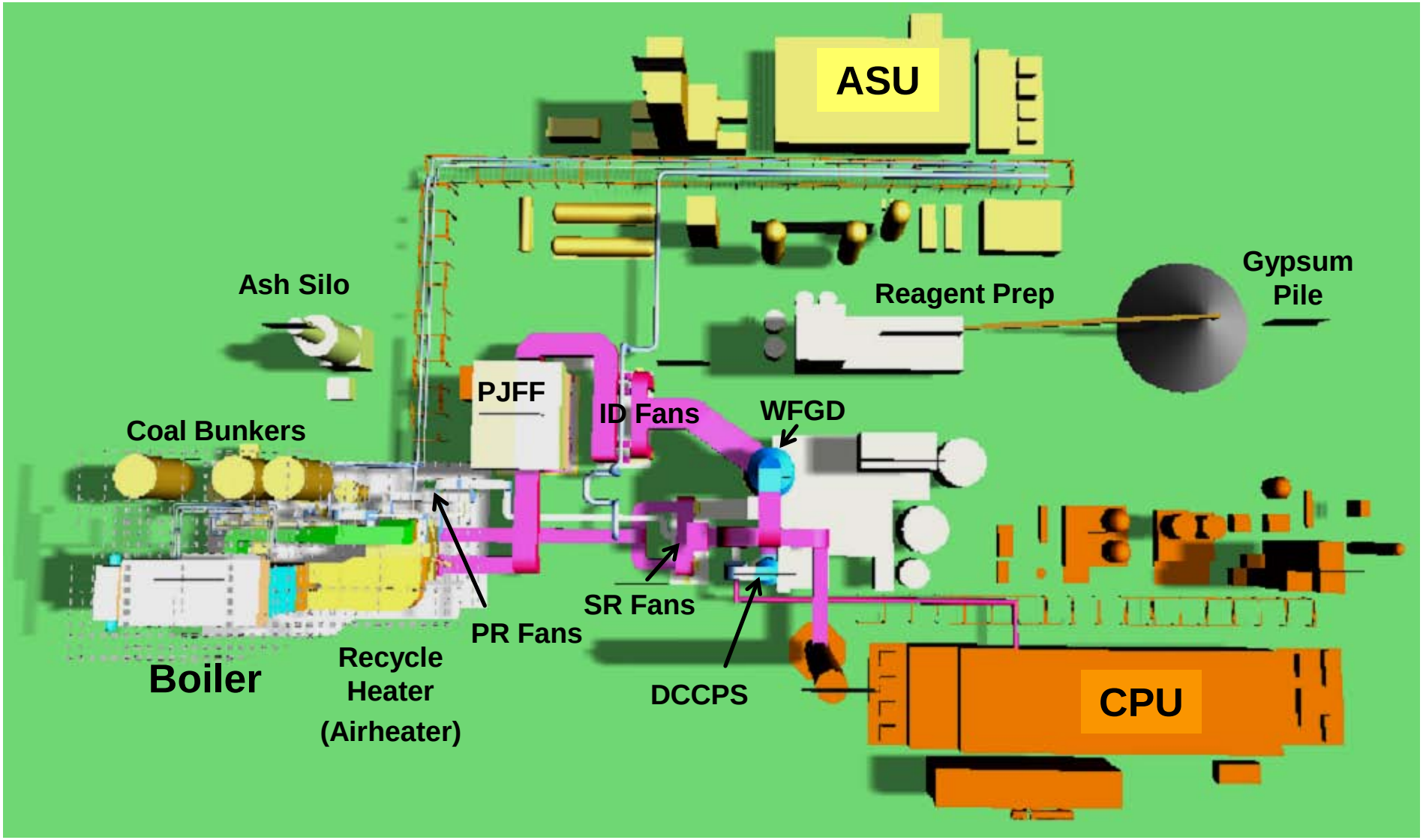
- **Meredosia, IL: Owned/operated by AER**
- **3-coal fired units (2 retired)**
- **Unit 4, 200 MWe oil-fired boiler built in 1975 2400 psig 1000 / 1000F Steam Cycle**
- ***3500 TPD CO_2 to Storage***

FG2.0 Oxy-Coal Capture Plant

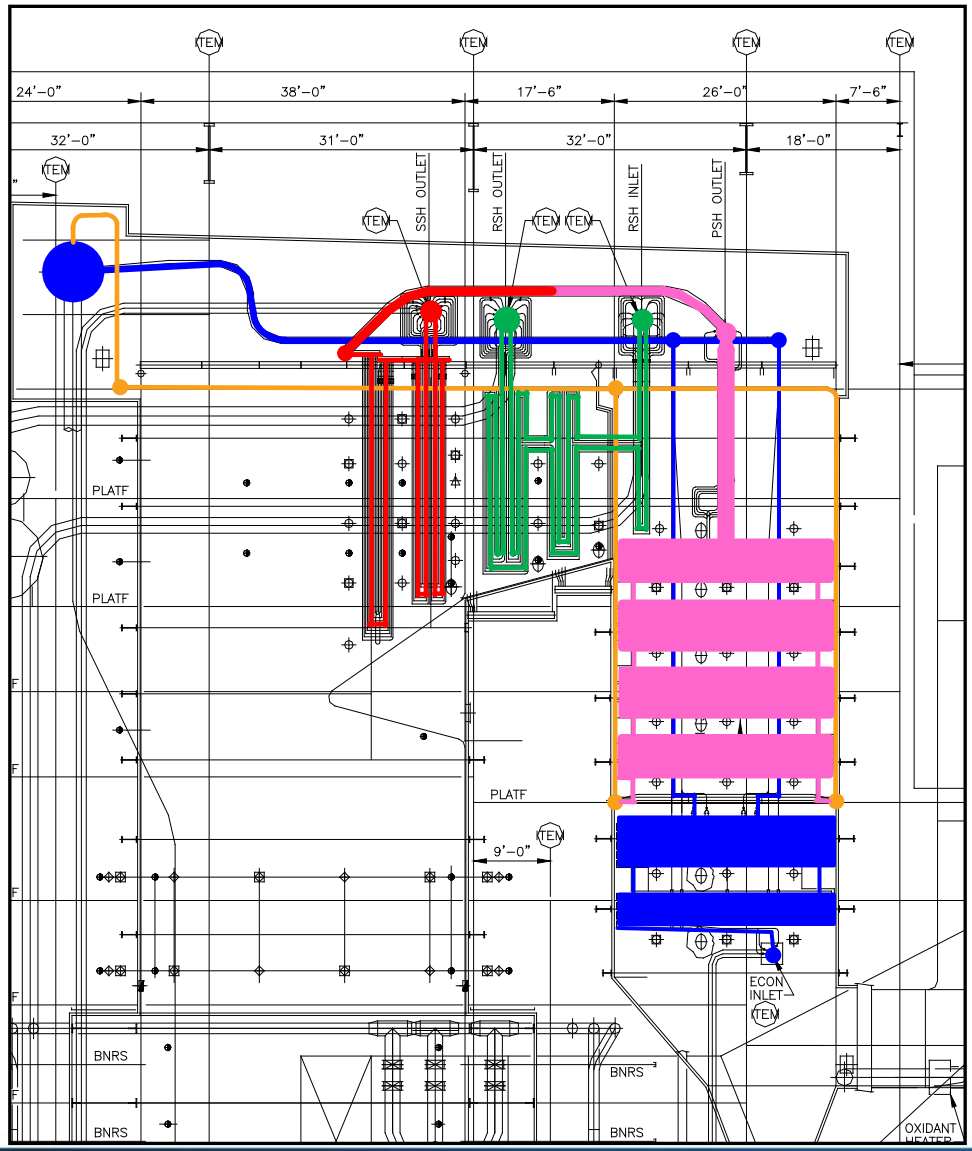


Not the optimal equipment arrangement for a new plant but the best possible in this case due to site space limitations. Will be a common occurrence with existing plant retrofits and repowerings

Plant Equipment Layout



Steam & Water Flow Path



Oxy-Combustion Pros

- **Boiler and AQCS equipment utilize conventional designs, materials of construction and arrangements. Combination of equipment and processes that are known to industry users**
- **The oxy system will look and operate like a conventional power plant. Pilot Testing indicated minimal impact to boiler combustion and little change to thermal performance. AQCS performance is unchanged**
  - **Furnace and Heating surface**
  - **Pulverizers**
  - **Burners**
  - **FGD Systems**
  - **Baghouse and ESP**
  - **Basic Process Controls unchanged**

Oxy-Combustion Pros Cont'd

- **Oxy process can utilize a wide variety of coals including lignite, sub-bituminous and bituminous fuels**
- **For retrofit or repowering less complex integration into the existing plant energy balance than PCC**
- **No new chemicals or waste streams introduced into the plant process. Bottom ash, fly ash, FGD waste streams unchanged.**
- **No major change to the plant water balance. For low rank fuels may be a positive water balance from condensation of water from the flue gas stream**

Oxy-Combustion Challenges

- **Cost – CAPEX and OPEX but no different than the other CCS technologies**
- **Auxiliary Power – same here Oxygen making and CO_2 Compression are still energy intensive**
- **Not a partial capture technology – all or nothing**
- **Need to prove the integrated operation of a large scale ASU – Boiler /AQCS – CPU Start-up, Shut-down, Load Swings, Upsets**

FG 2.0 Project Status– Pre-FEED Accomplishments to Date

- Owner's Engineer selected – URS
- Integrated Project Schedule, DOR, WBS, Project Cost Estimate
- Existing Plant Assessment
- Project LCOE model
- Federal and State government affairs, Illinois EPA efforts on-going
- Draft Phase 1 Decision Application in progress

- Boiler / GQCS design and performance
- GA's, plot plans
- Quotes for 85 % of major equipment
- Specifications and bid packages for BOP
- Preliminary P&ID's, PFD's, I&C architecture
- High level construction plan

- ASU and CPU design, GAs, plot plans
- Quotes for 70% of major equipment
- Specifications and bid packages for BOP
- PFDs, Control architecture, interface list
- High level construction plan

power generation group

"We are passionate about innovation and technology leadership"

clean energy technologies

Steve Moorman
Manager -Business Development
Advanced Technology