The Clean Coal Advantage

clean co_2al Project | SaskPower

Expert Meeting on Financing CCS Projects

London, England

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SaskPower

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Presentation Overview

- Background
- The Opportunity
- The Engineering
- The Project as Proposed

History Lesson

Fall 2005:

- Canada tables GHG regulations
- Canada requests proposals for GHG initiatives
- SaskPower engaged in option studies (internally and with others)

2006 - January

- SaskPower Assembles Clean Coal Team to prepare Commercial Proposal to be evaluated against other supply options
- Coal Exploration rigs into the field (-30C)

2006 - February

- Engineering Resources and Manufacturers Engaged
- EOR Operators Contacted
- Project Office Opened

2006 - September

- **Oxyfuel Technology Selected**

2006 - November

- Coal Negotiations Completed
- Site Selected

2007 - April

- Technical Proposal to SaskPower
- Project Guidelines for EIA Received
- Application for Water License Submitted

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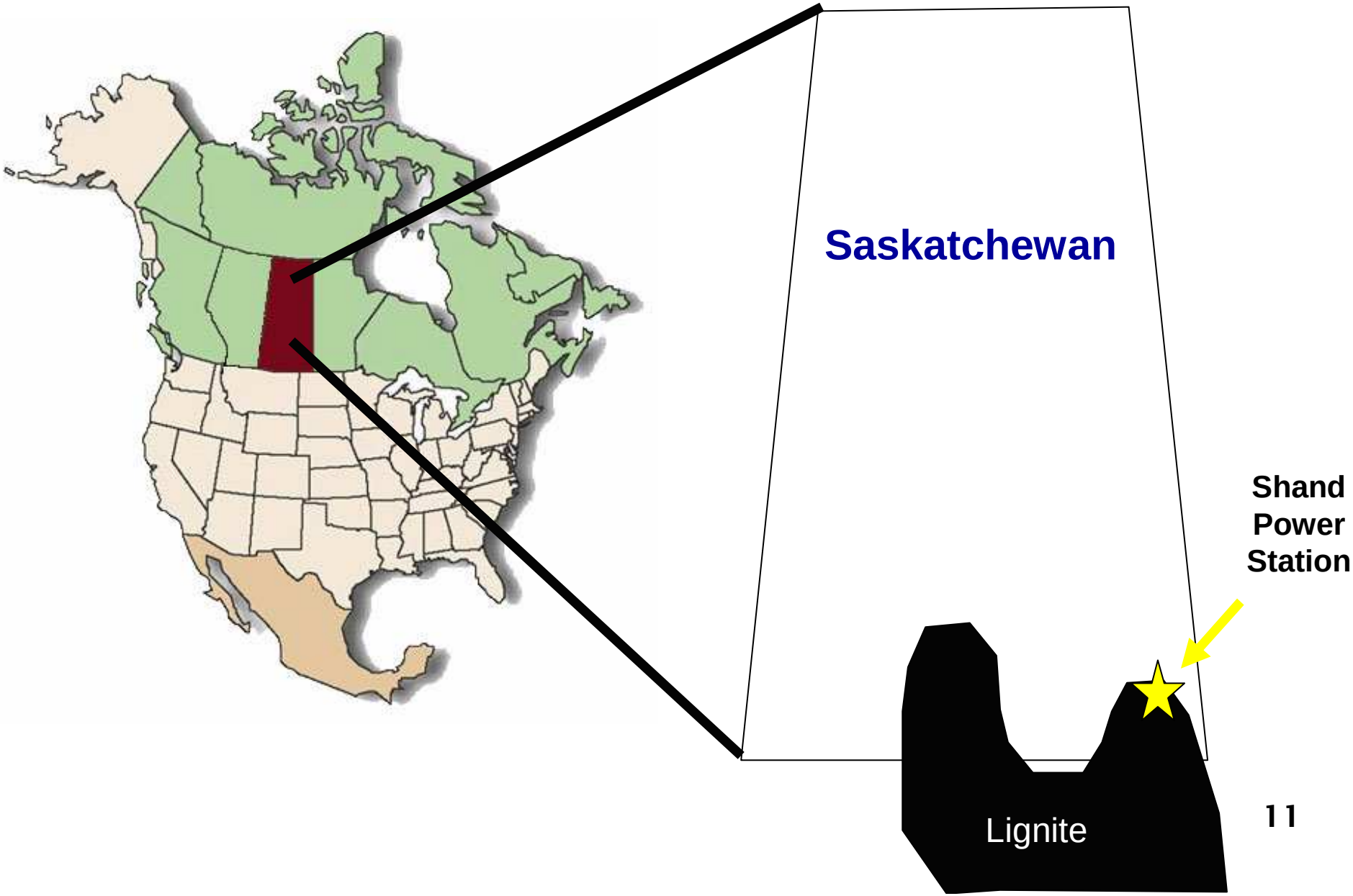
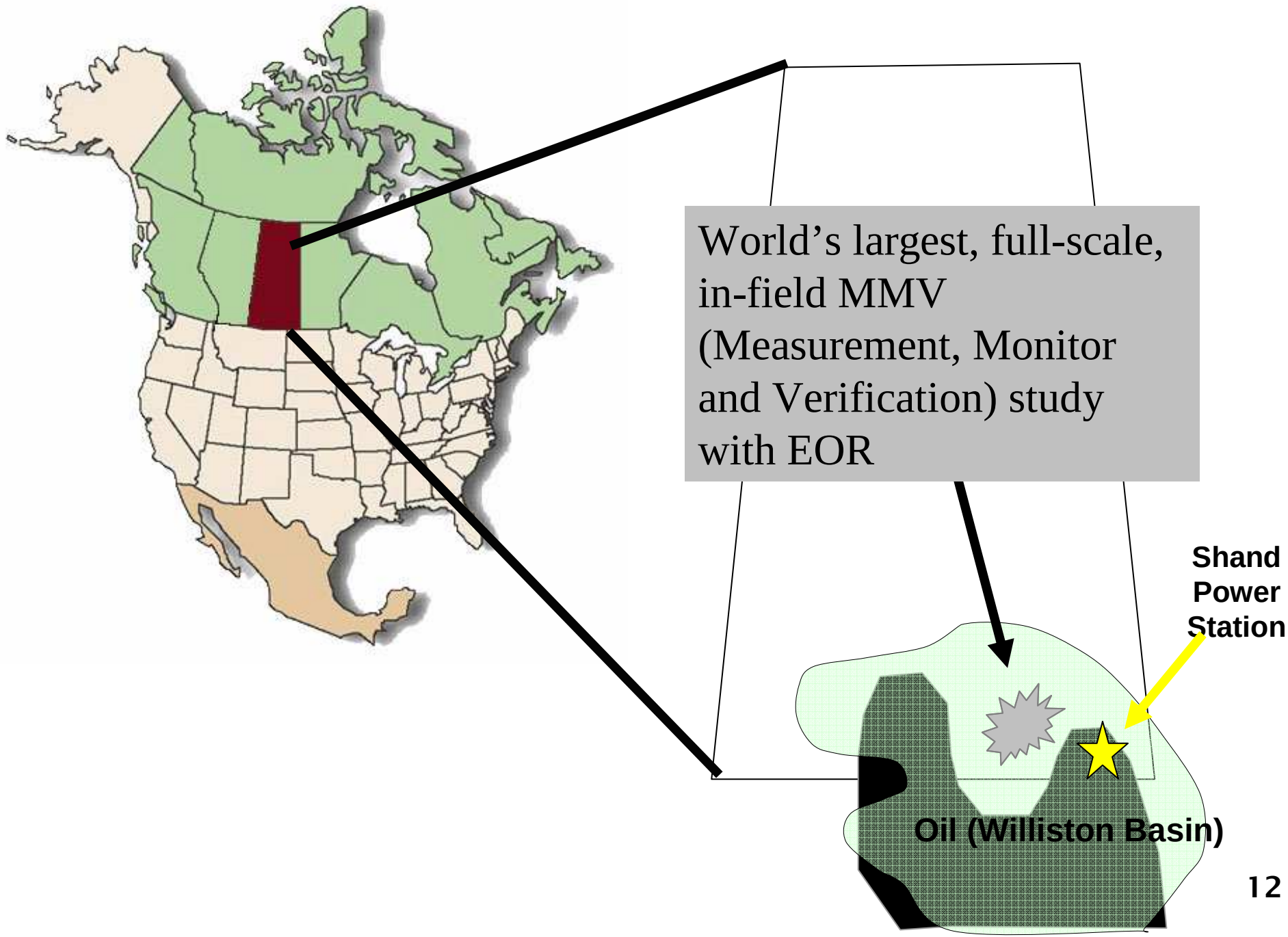
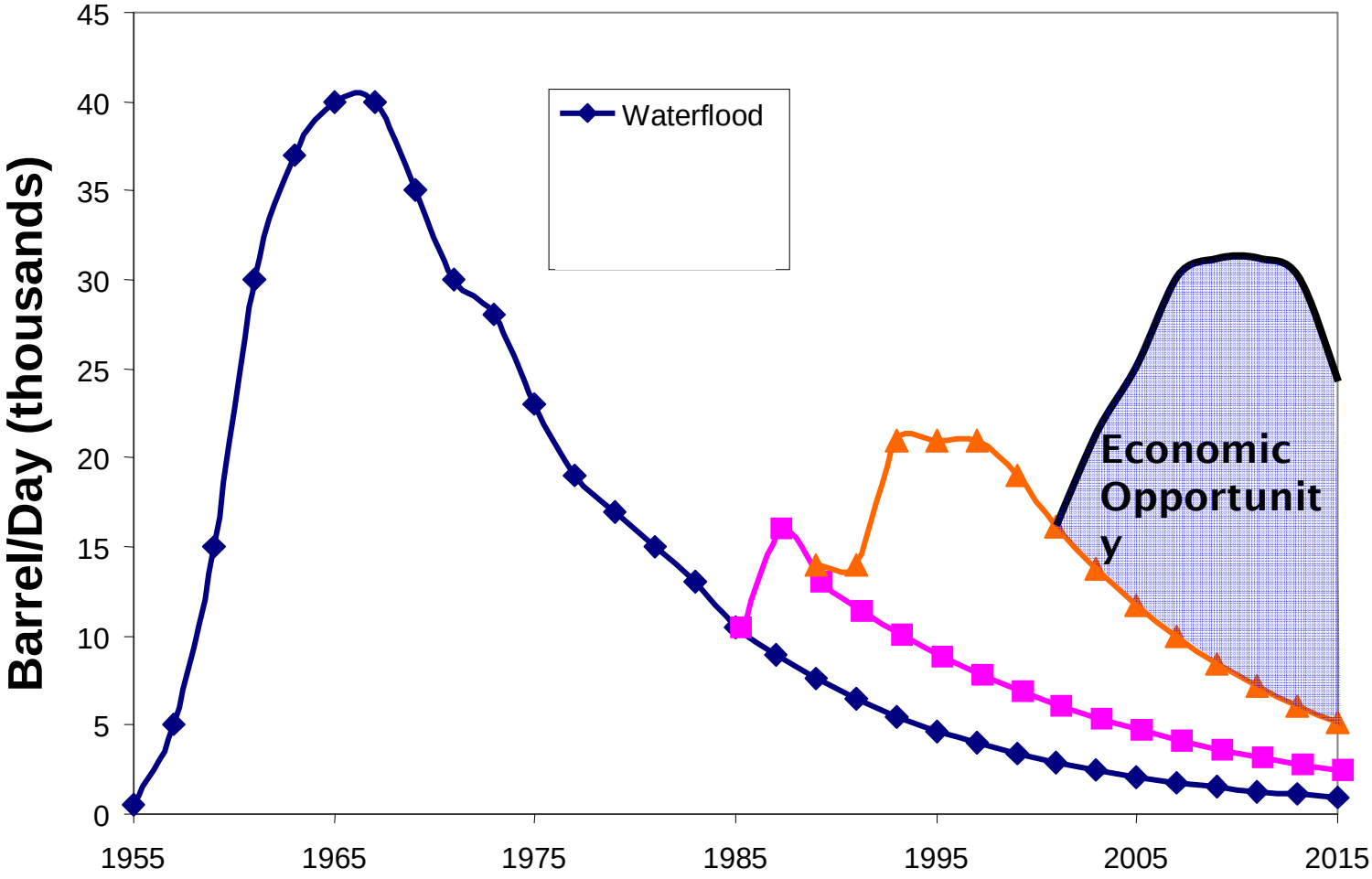
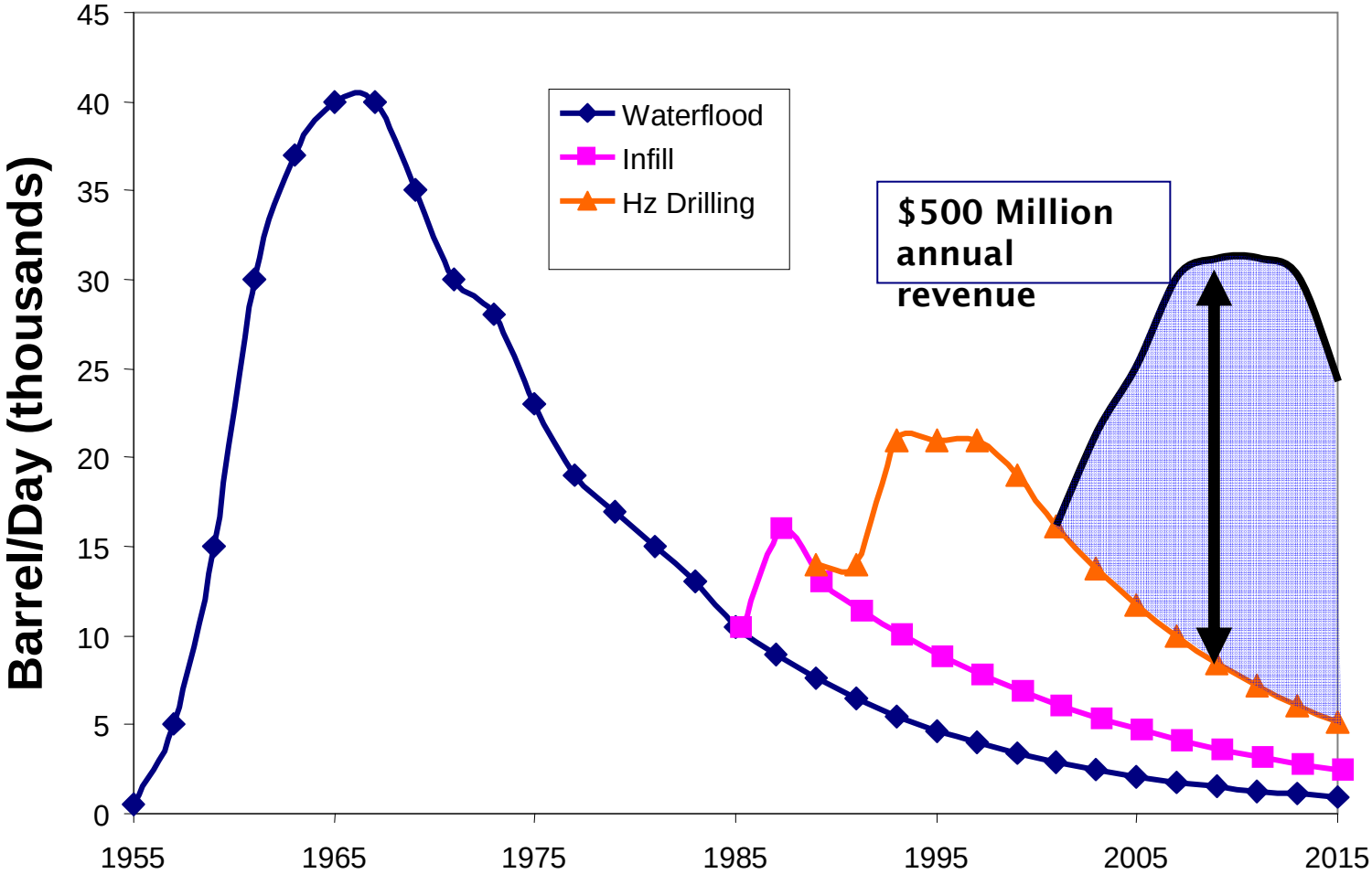

Saskatchewan
Shand
Power
Station
Lignite


World's largest, full-scale, in-field MMV (Measurement, Monitor and Verification) study with EOR
Shand Power Station
Oil (Williston Basin)

Weyburn Pool Production History

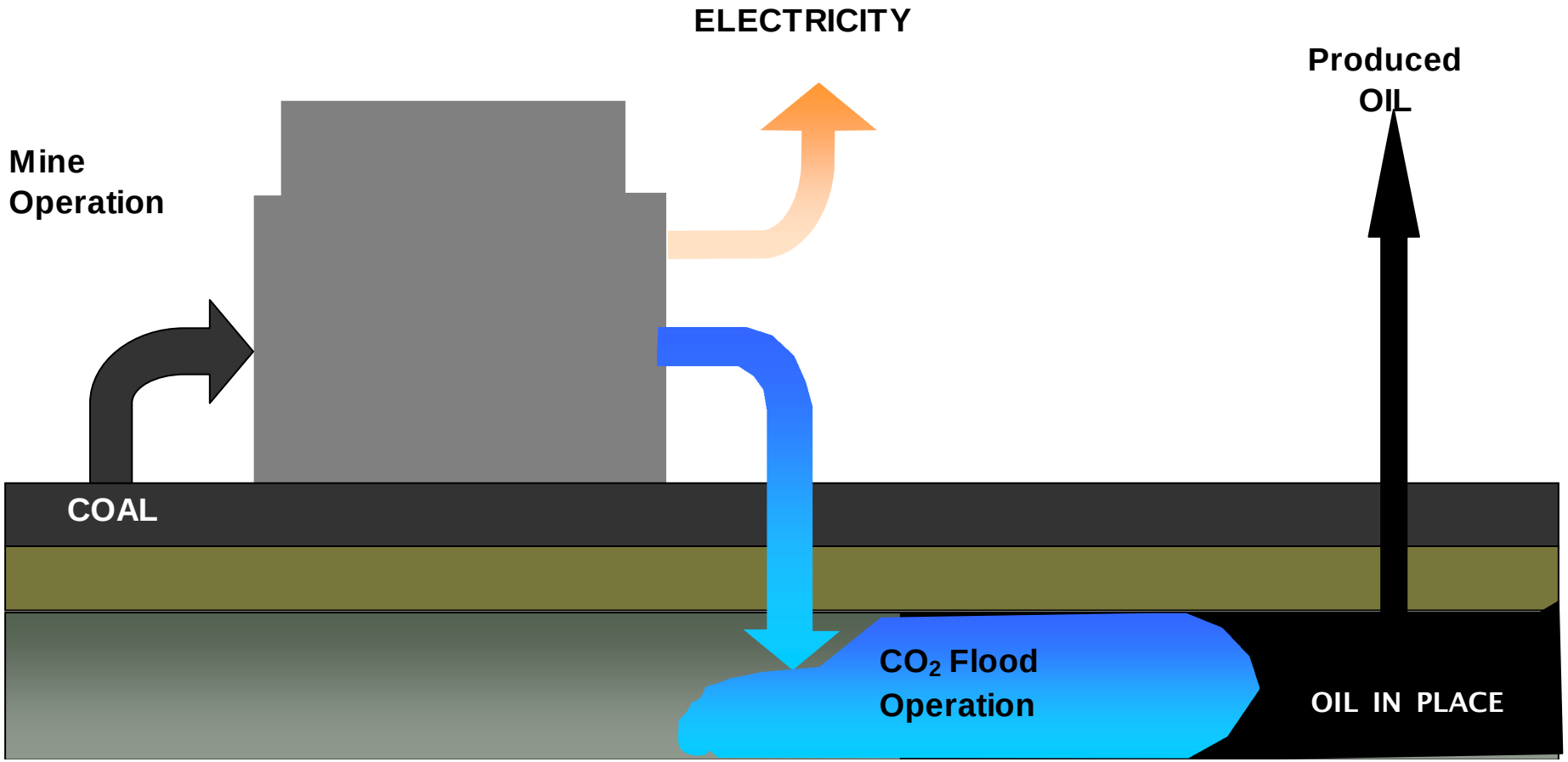


Weyburn Pool Production History



Overall COAL to OIL Process

1 Tonne Coal → Produces → **0.8 MWh + 2 to 10 barrels Oil**



Net Emissions Impact

Near Zero emissions electricity plus:

1 Barrel Weyburn Crude: Equivalent to 1.0 GHG unit

Offsets

1.3 to 1.4 GHG equivalents Middle East Oil

or

1.9 GHG equivalents Alberta Oil Sands

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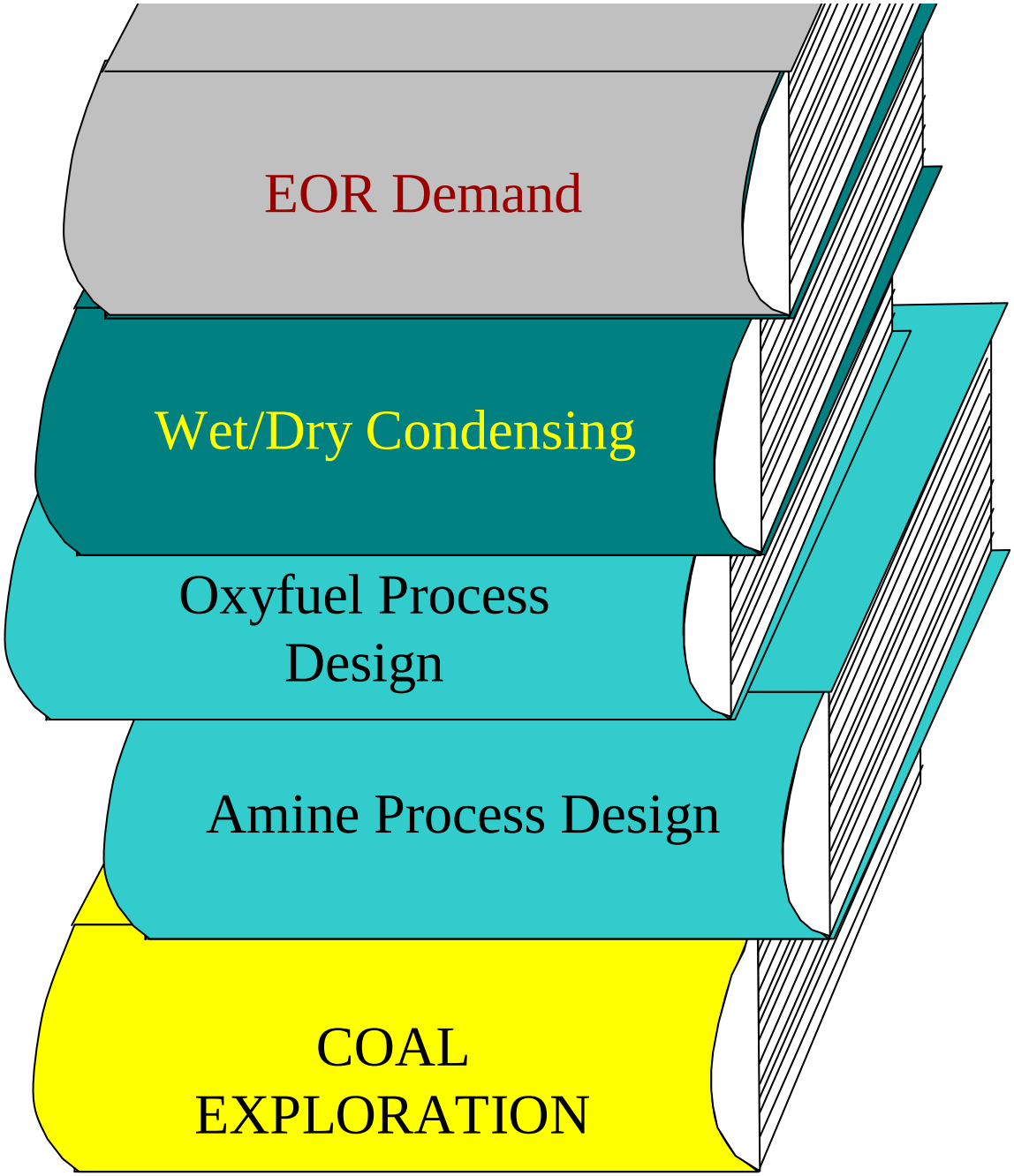
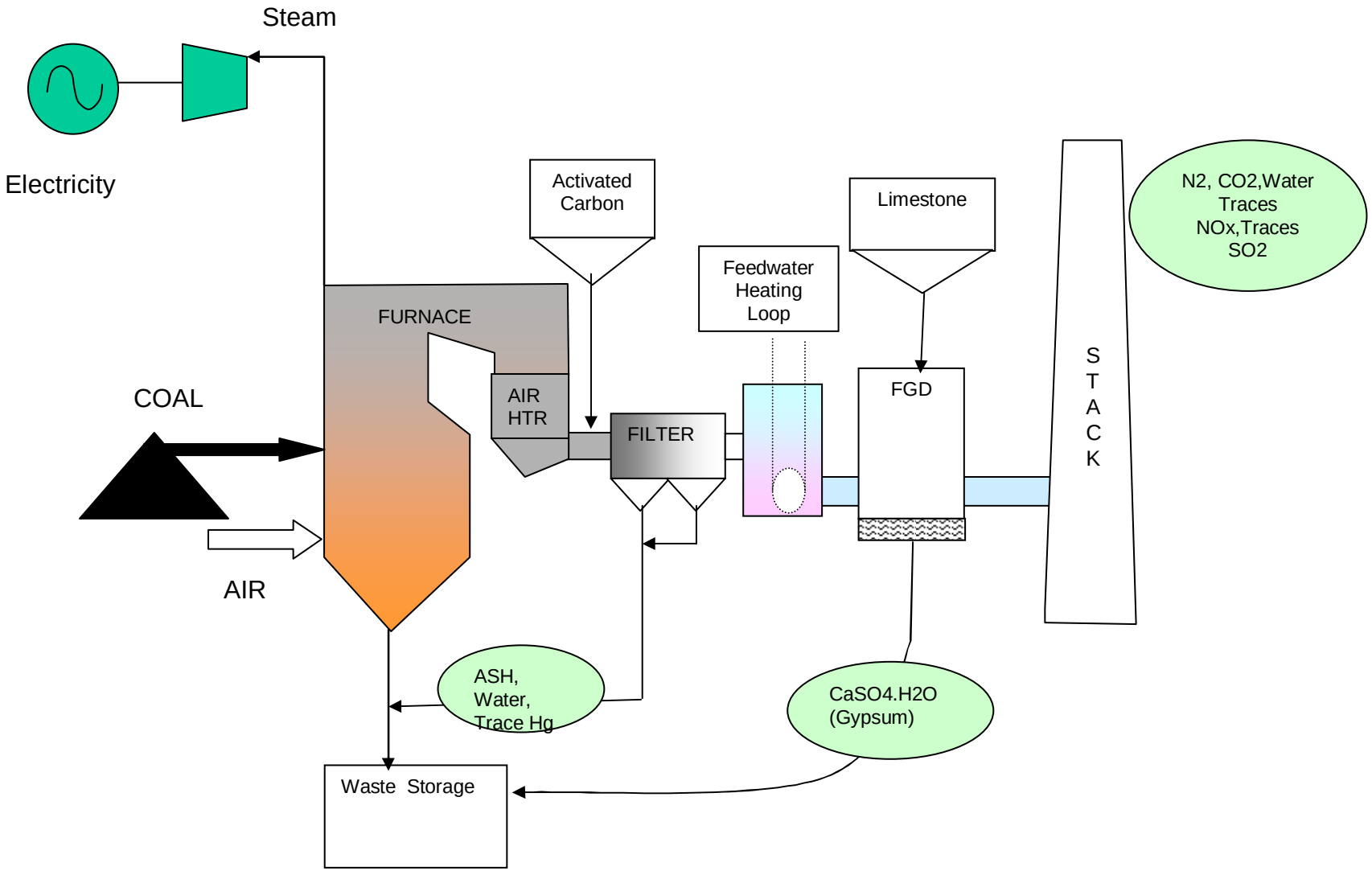

EOR Demand
Wet/Dry Condensing
Oxyfuel Process Design
Amine Process Design
COAL EXPLORATION

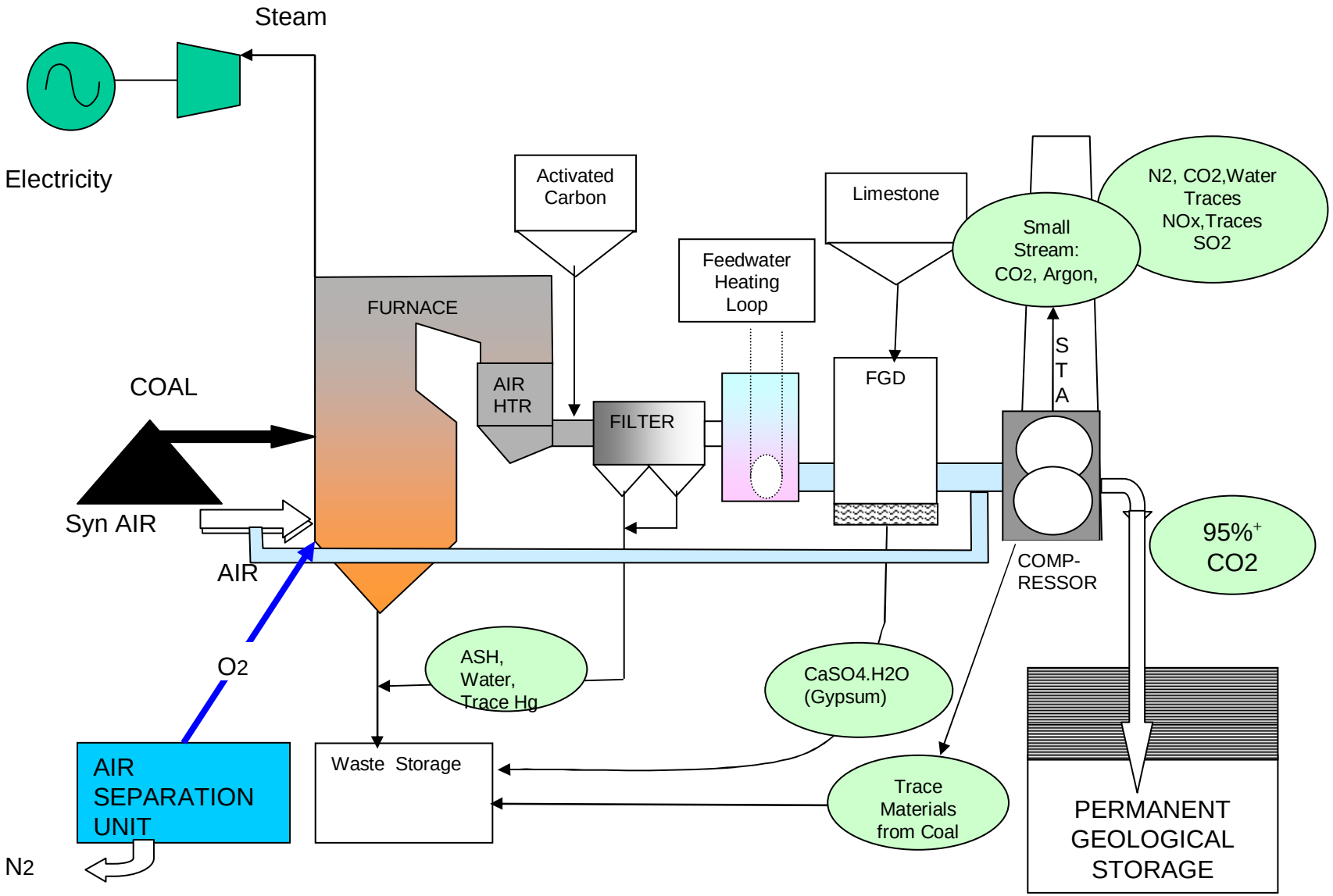
- 70 system design bases
- 32 process diagrams
- 23 Project Standards
- Single line diagrams, layout and arrangement drawings
- Full thermodynamic model (Gate cycle)
- Oxyfuel furnace CFD model (in production)
- (Roughly 100,000 engineering man-hours)

Engineered Deliverables

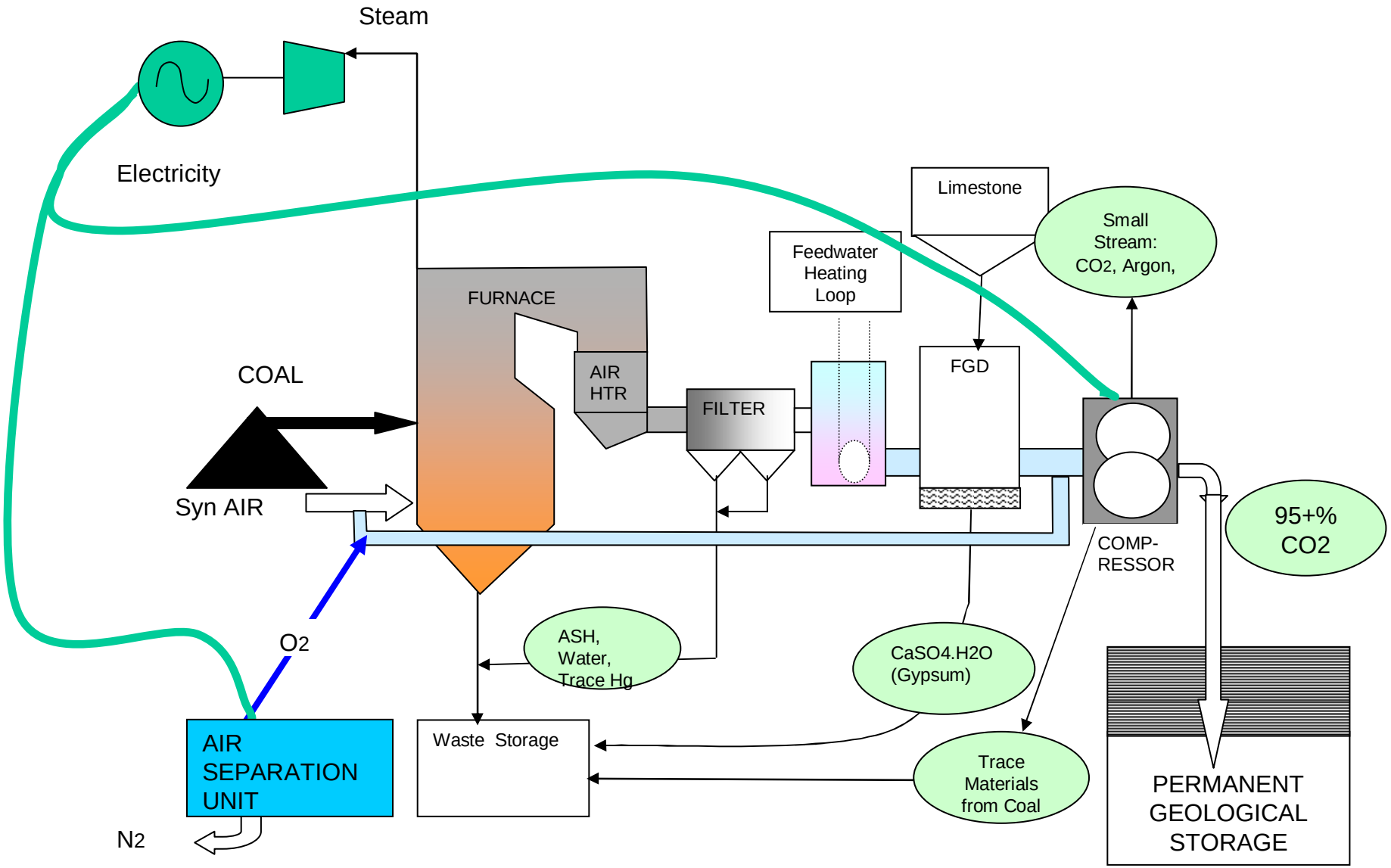
- Detailed plant design (two sites) for amine and oxyfuel with cost/performance comparison
- Detailed Oxyfuel design:
  - Full and part load
  - Air fired start up
  - Range of fuel characteristics
  - Range of ambient conditions
  - Work with available water resources
- Project Integrated Construction Schedule
- Hazop Analyses
- Structured Risk Analyses



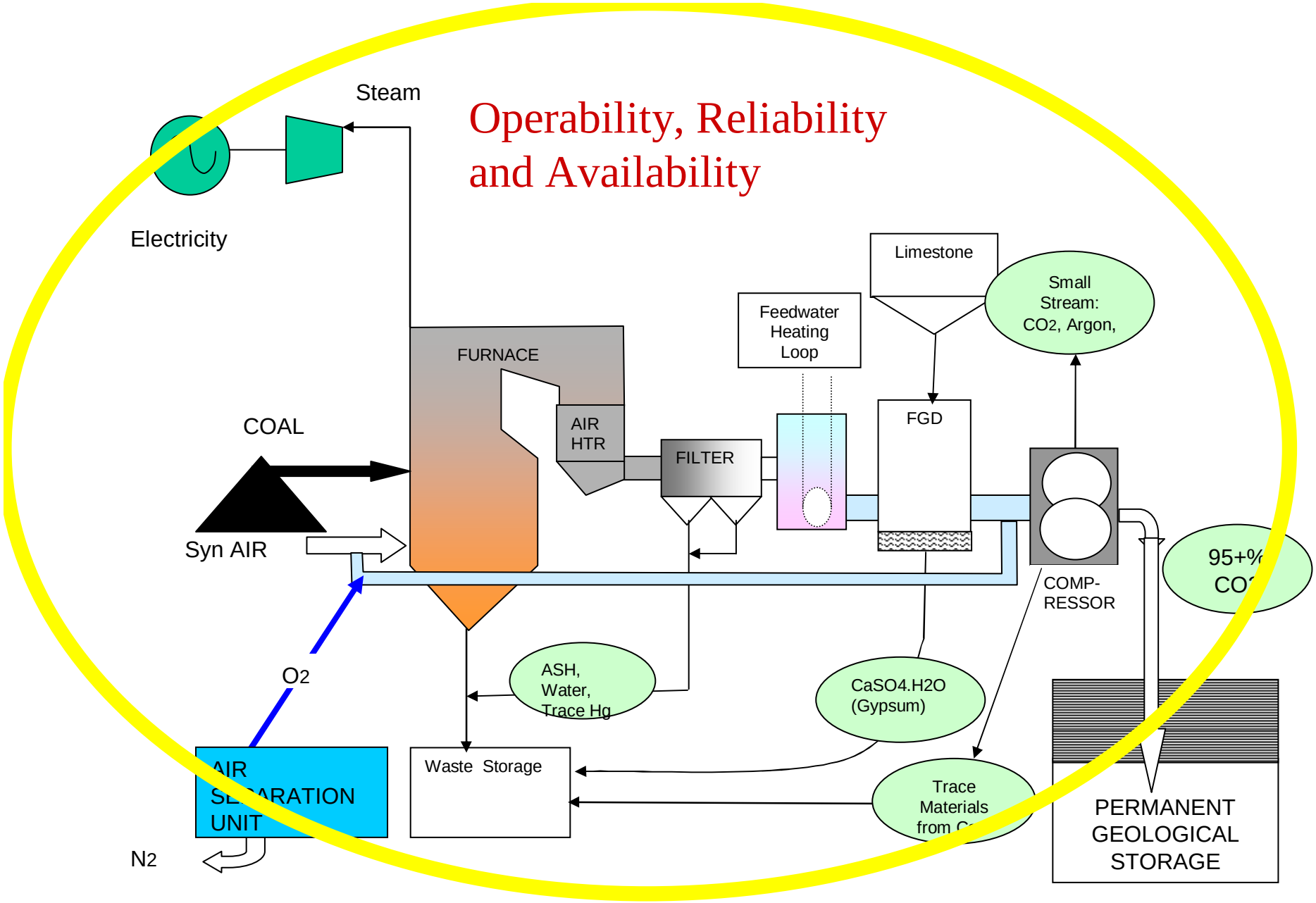
COMPLIANT COAL UNIT



SaskPower Oxyfuel Process



SaskPower Oxyfuel Process



SaskPower Oxyfuel Process

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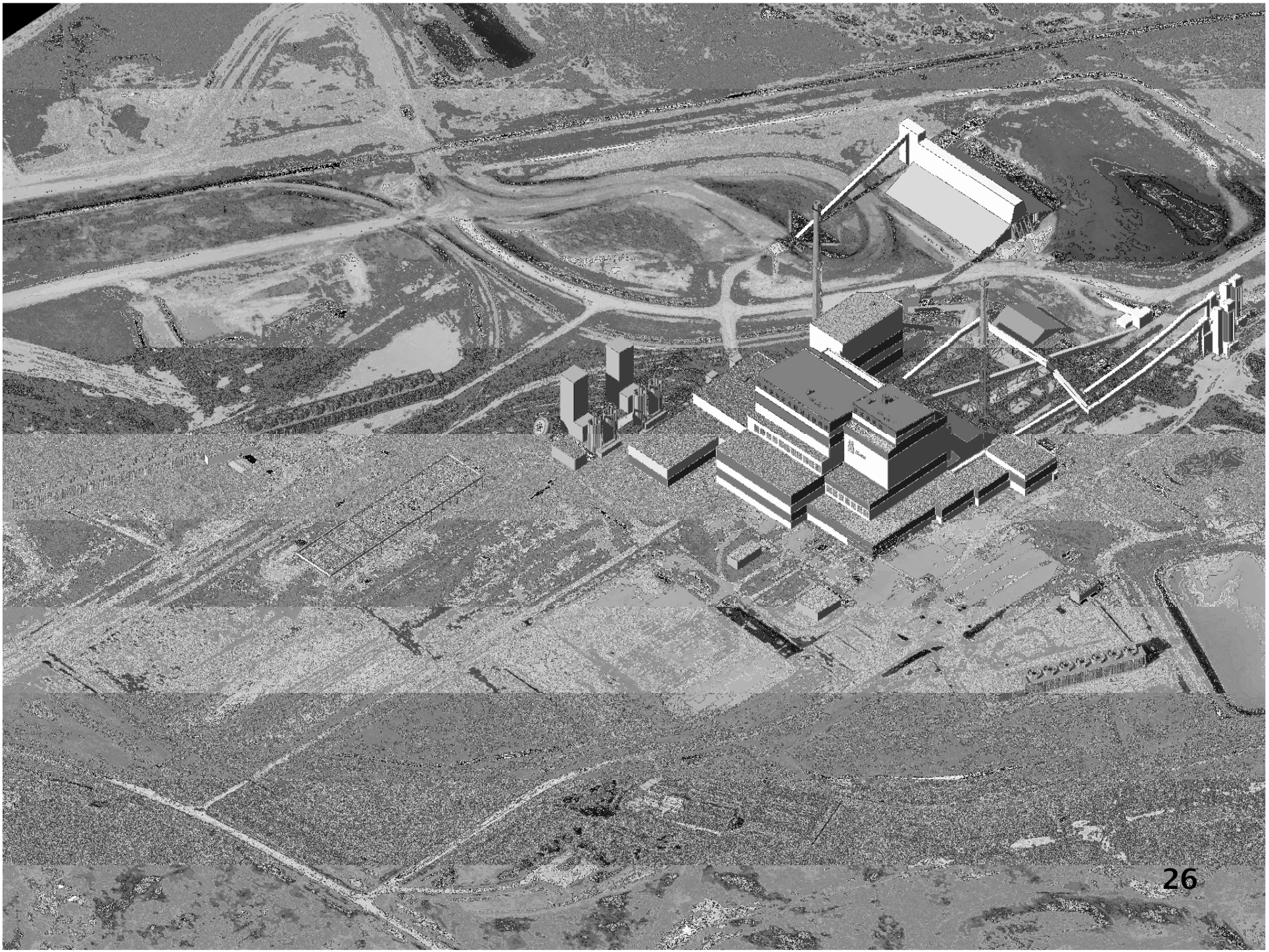
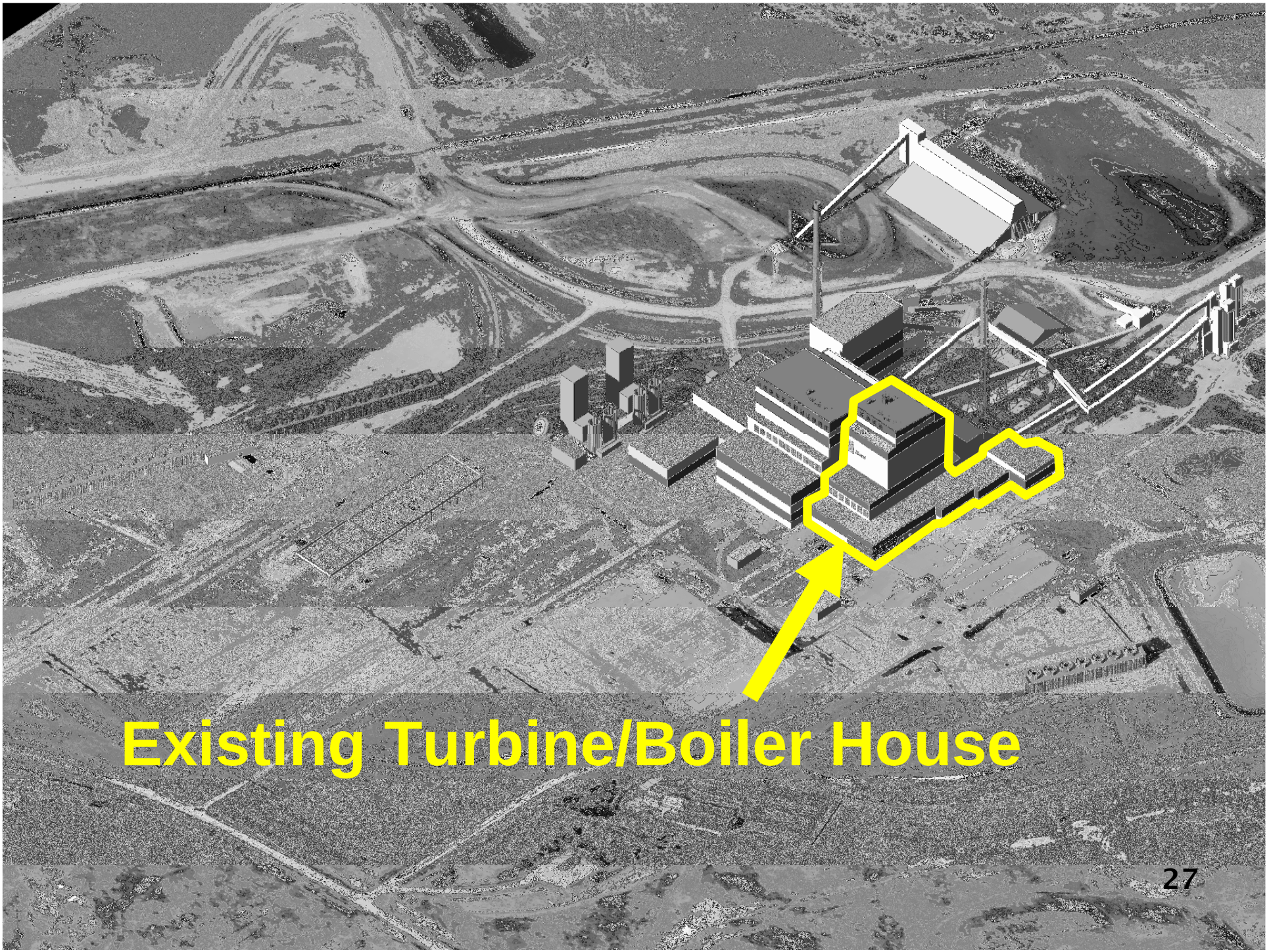
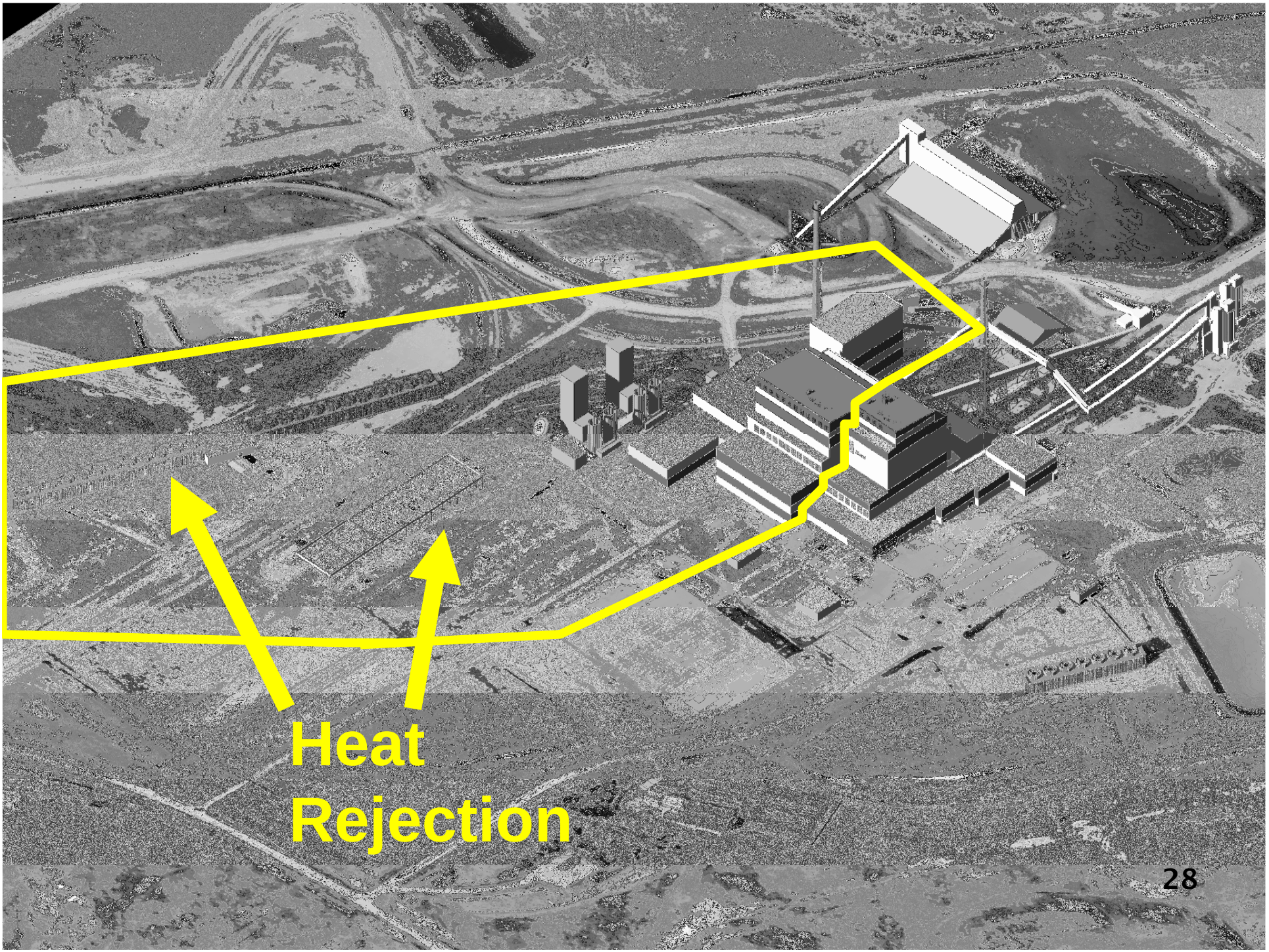
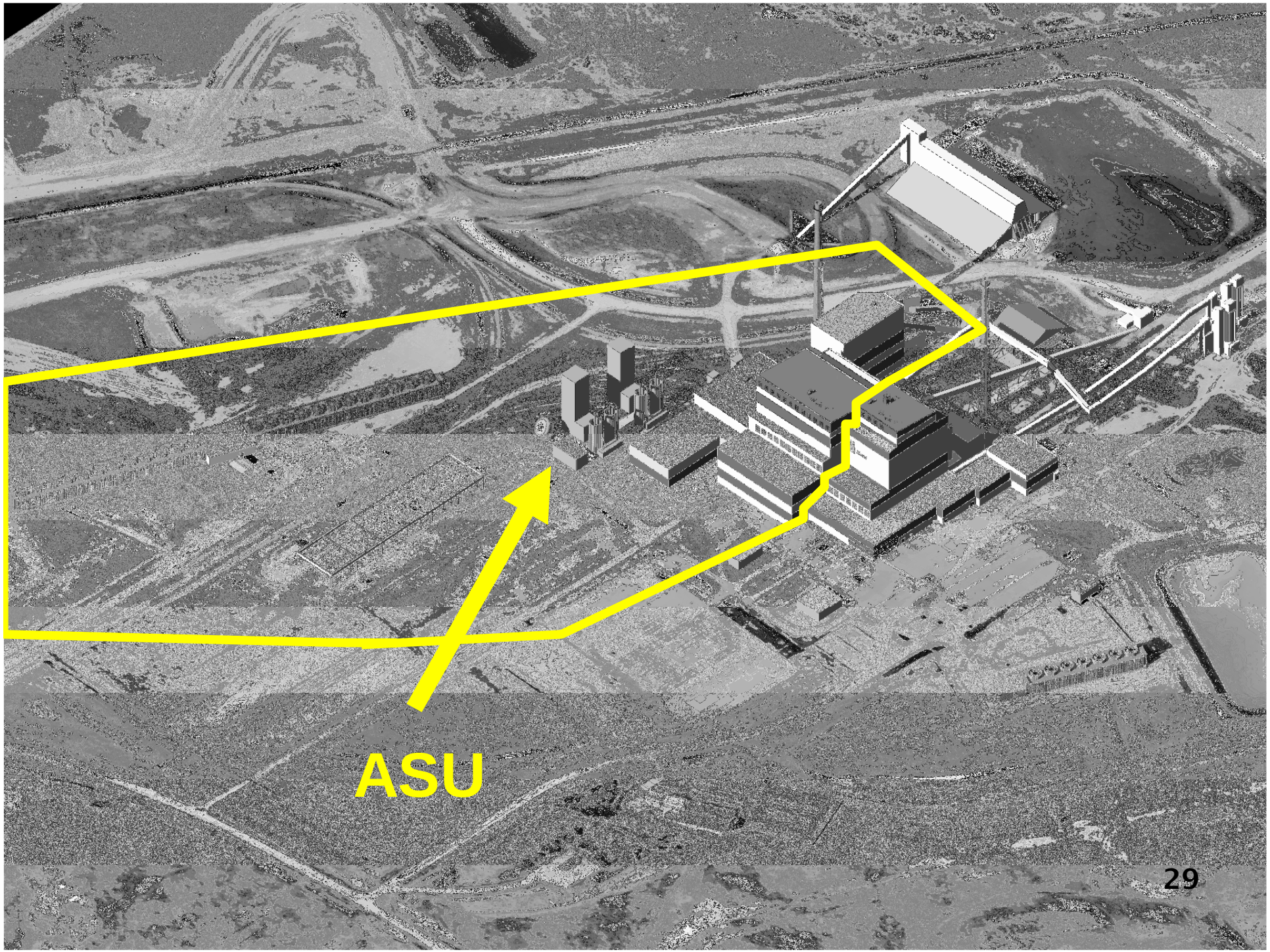
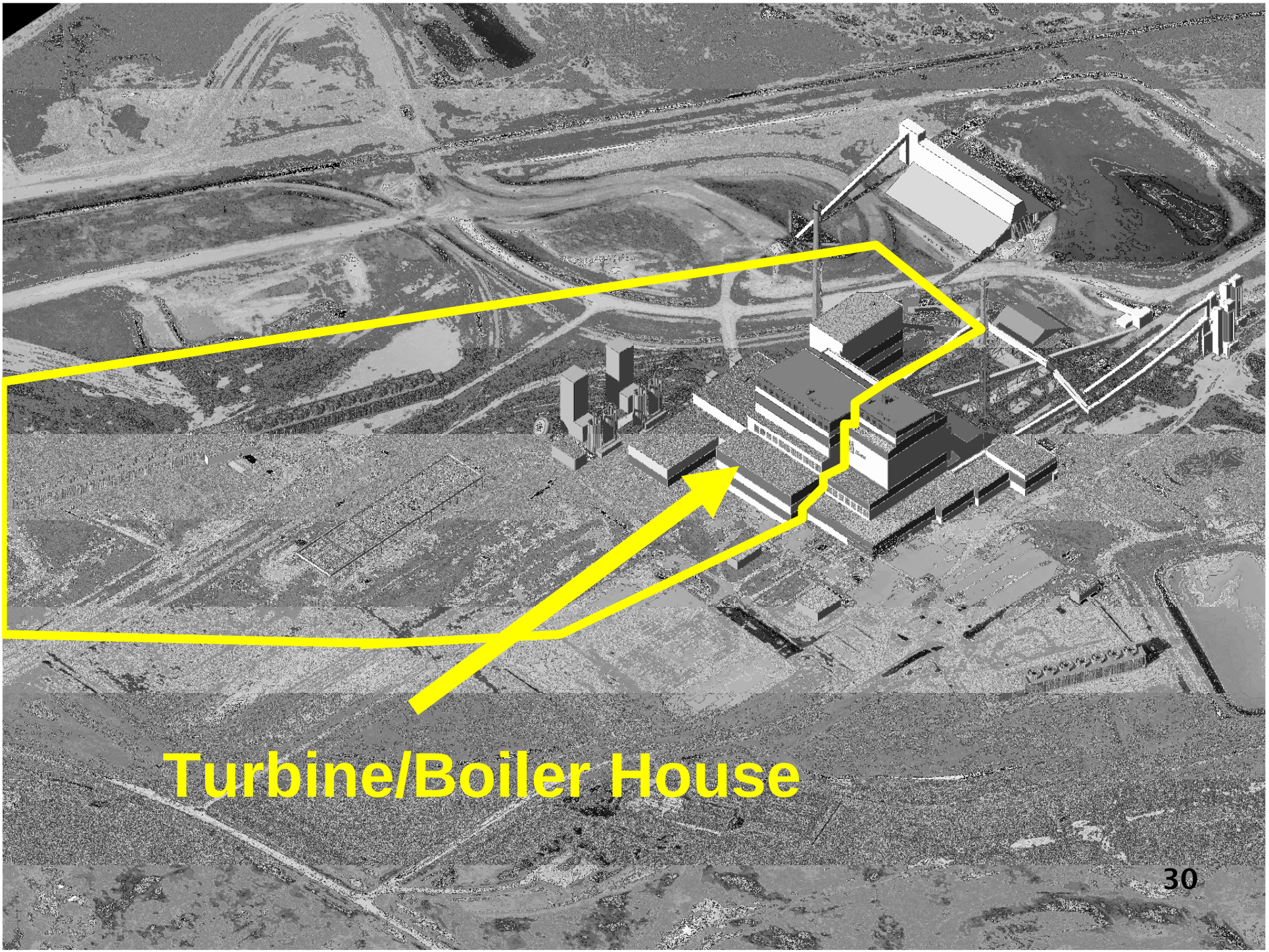
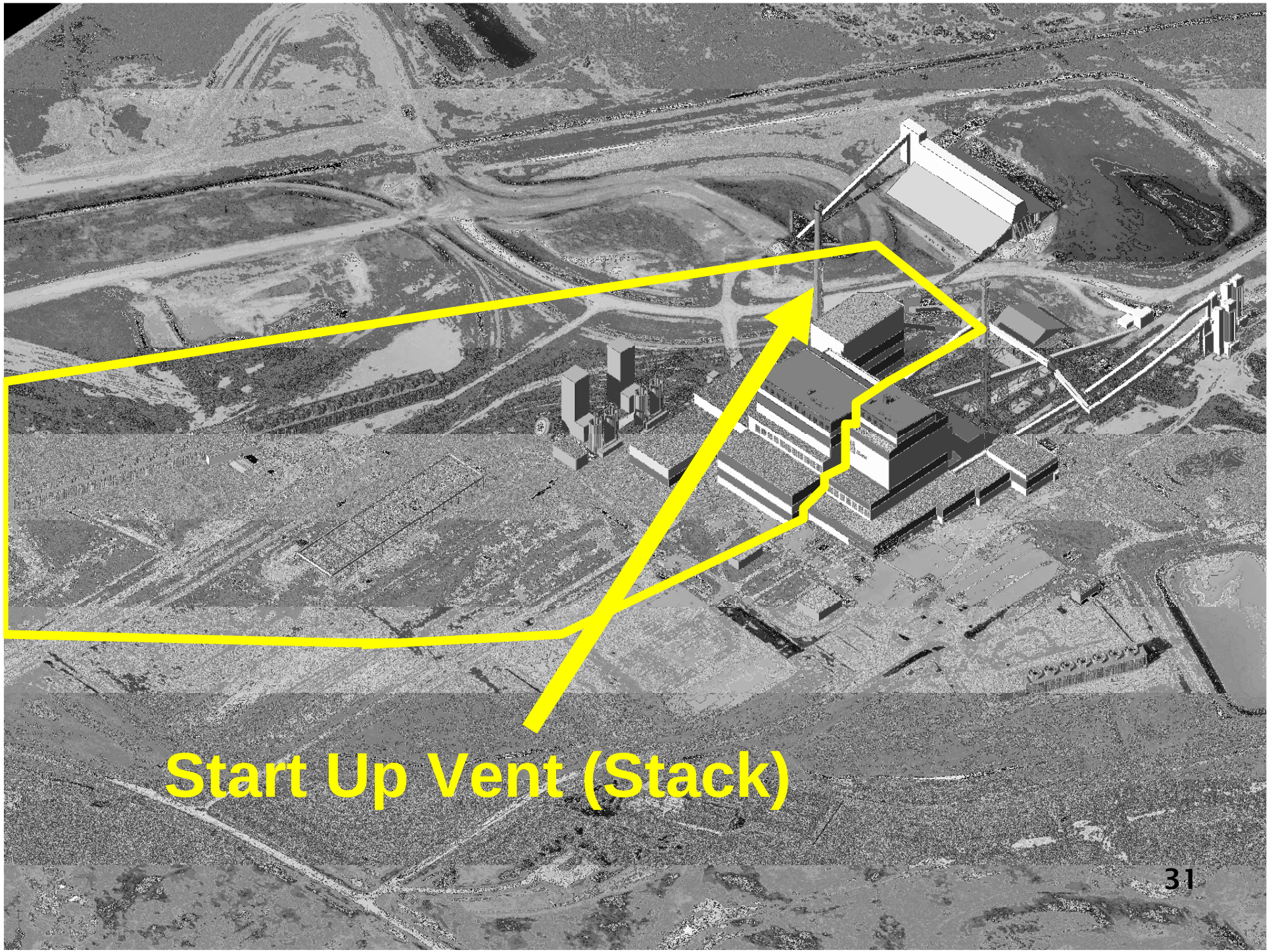


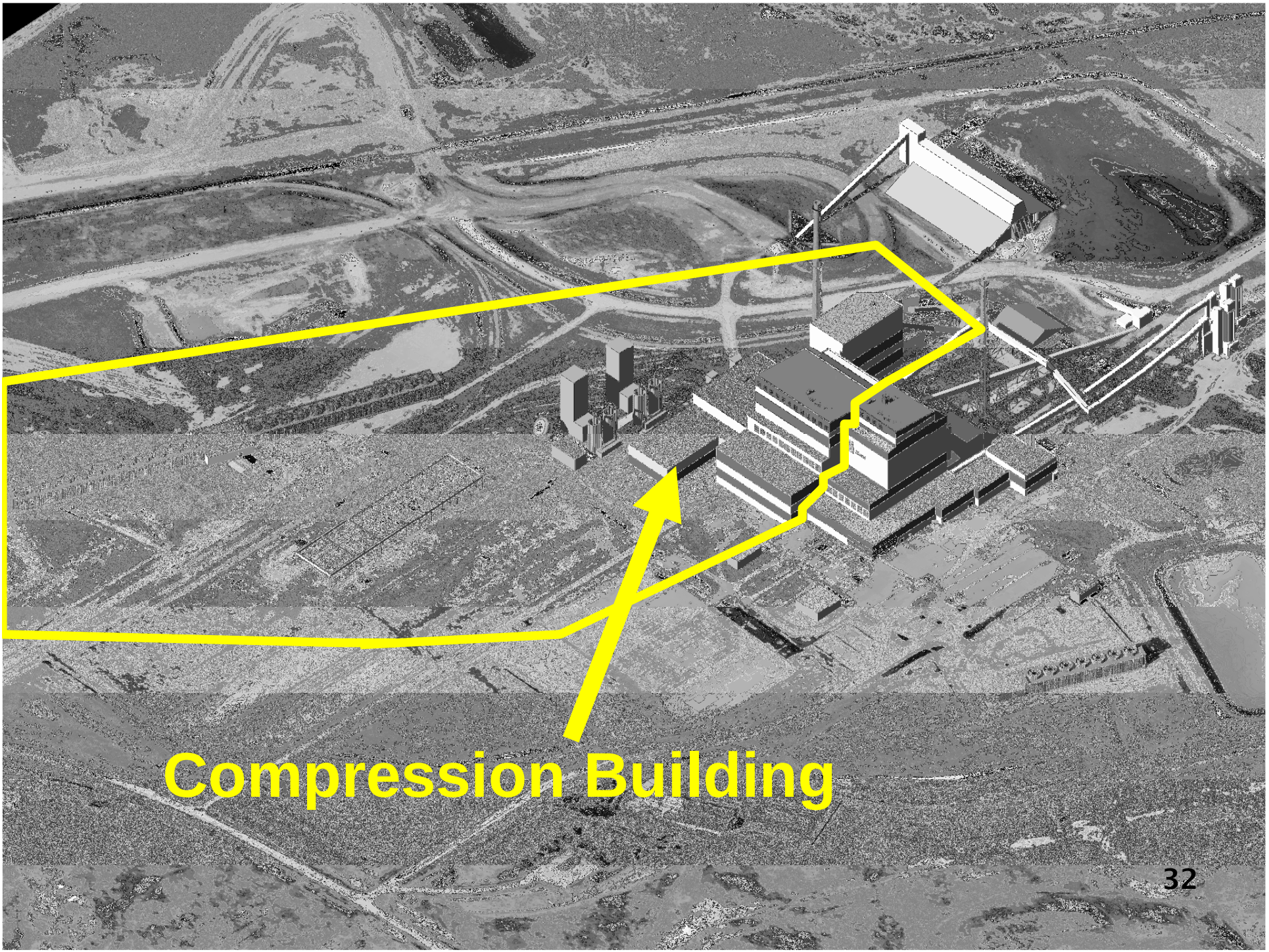

Existing Turbine/Boiler House


Heat
Rejection


ASU


Turbine/Boiler House


Start Up Vent (Stack)


Compression Building

Clean Coal Project – Technical Proposal: In-Service Date & Capacity Factor

- Air Fired Operation Date
  - March 1, 2012
- Oxyfuel In-Service Date
  - September 1, 2012
- Forecast Capacity Factor
  - 85%

Clean Coal Project – Technical Proposal: Operating Costs

- $26 million per year O&M cost
  - $18 million fixed cost
  - $3.80 variable cost/MWh
  - Life cycle capital costs also estimated
- Coal Requirements
  - 2.3 Mt per year
- Fuel Pricing
  - Fuel Supply has established coal price
  - Dragline pricing received

Clean Coal Project – Technical Proposal: CO_2 & Electrical Production

- Forecast Annual CO_2 For Sale
  - 3.15 million Mt per year - net
- Annual Electrical Production
  - 2.2 million MWh - net

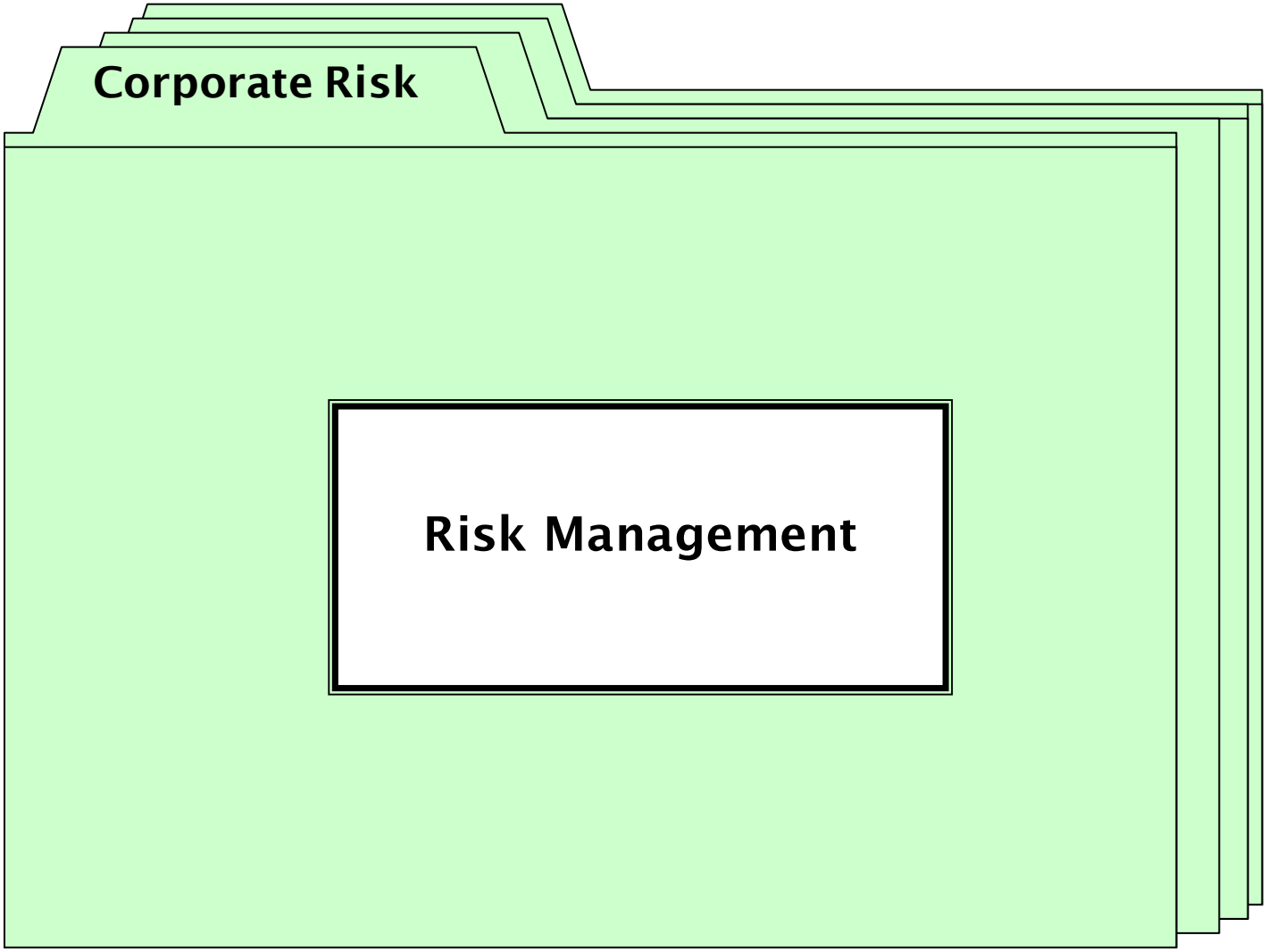
Atmospheric Emissions Performance Comparison

	2006 Compliance[1]	Conventional Unit (Approved 1988)	Clean Coal
SO_2, kg/MWh	2.9	2.86	~ 0 ✓
NO_x, kg/MWh	0.69	2.86	0.02 ✓
Particulate Matter, kg/MWh	0.095	0.49	~ 0 ✓
Mercury, kg/TWh	15.0	-	~ 0 ✓
CO_2, kg/MWh	1000 (unregulated)	1044.0	44.0 ✓

1. These compliant guidelines reflect the current guidelines issued as New Source Emission Guidelines of the Canadian Environment Protection Act (CEPA) for SOx, NOx and PM, and the Canadian Council of Ministers of The Environment (CCME) Canada Wide Standard for Mercury.

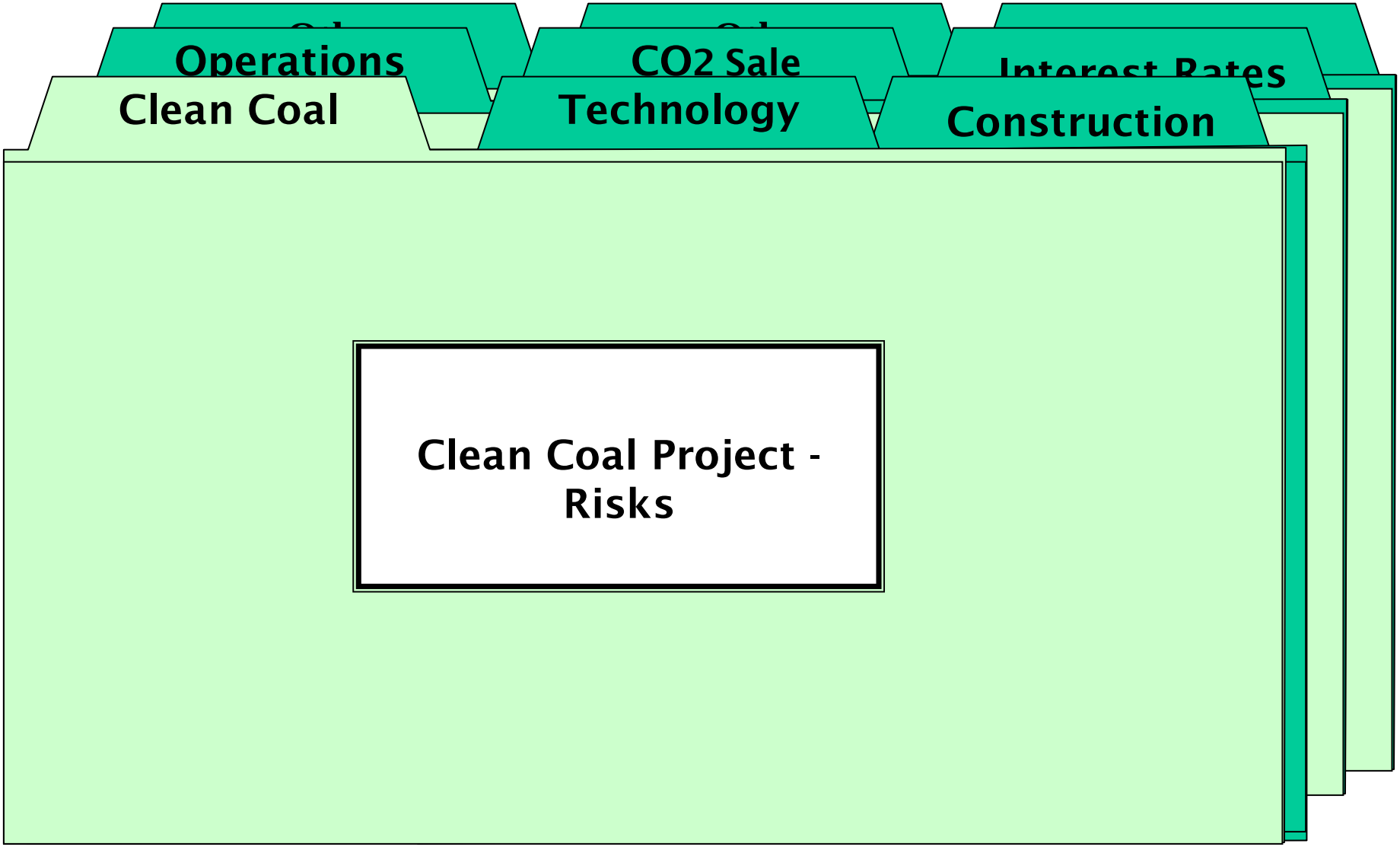
Environmental Issues

- Project is an addition to an existing site
- Site was approved as a two unit site in 1988
  - One unit built – on line in 1992
  - Second unit approved as IGCC in early 1990's – not built
- EIS being updated now to cover the proposed clean coal unit at this site
  - Need to update EIS to current standards


Corporate Risk
Risk Management

GHG Regulations

- Canada issued a “Regulatory Framework for Air Emissions” in April 2007
  - Will cover all air emissions, including CO2
  - Reductions in GHG intensity – 18% by 2010, 26% by 2015
  - $15/tonne beginning in 2010
  - $20/tonne in 2013
- Detailed regulations for a specific industry to be developed this year and issued spring of 2008
  - Several instruments being proposed
  - Still difficult to develop detailed plans


Operations
CO2 Sale
Interest Rates
Clean Coal
Technology
Construction
Clean Coal Project - Risks

Issues

- (Safety – managed through HAZOP)
- Oxyfuel Process
  - Flue Gas Cooling
  - Furnace Heat Transfer
  - Burner Performance
- CO_2 Compression & Clean Up
- Air Separation Unit
- Process Integration
- Waste Water Management
- ..more….

Conceptual Risk Assessment

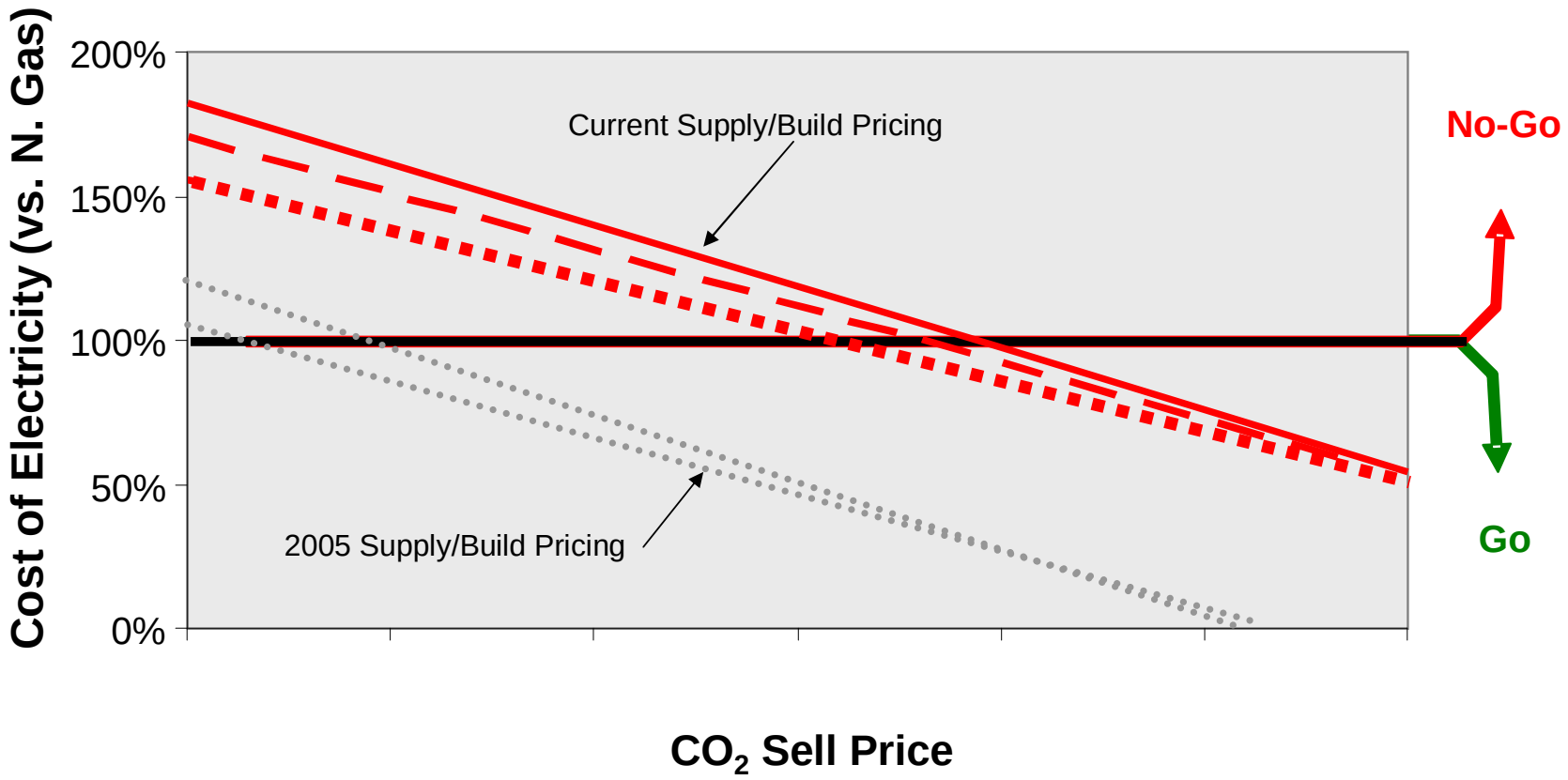
(Values are for demonstration only)

	Clean Coal		Compliant Coal	
Issue	**Expected Loss**	**Maximum Exposure**	**Expected Loss**	**Maximum Exposure**
Construction Labour	$ 55,000,000	$ 550,000,000	$ 38,465,250	$ 384,652,505
CO2 Sale Price	$ 96,000,000	$ 480,000,000	$ -	
Electricity Sale Price	$ 48,000,000	$ 240,000,000	$ 48,000,000	$ 240,000,000
Change in Interest Rates	$ 20,000,000	$ 200,000,000	$ 13,987,364	$ 139,873,638
Long Term OM&A Costs	$ 32,000,000	$ 160,000,000	$ 16,000,000	$ 80,000,000
Technical Risks - Oxyfuel	$ 34,375,000	$ 137,500,000	$ -	$ -
Material Price Risk	$ 25,000,000	$ 100,000,000	$ 17,484,205	$ 69,936,819
GHG Regulations			$ 240,000,000	$ 960,000,000
	$ 310,375,000	$ 550,000,000	$ 373,936,819	$ 960,000,000

?

GHG Exposure for Compliant Coal may offset the project execution risks around “First Of” Clean Coal

Shand #2 CO_2 Cogen Plant - 2007 Supply/Build Prices




QUESTIONS?