

Welcome



***Energy & Telecommunications
Interim Committee***

to

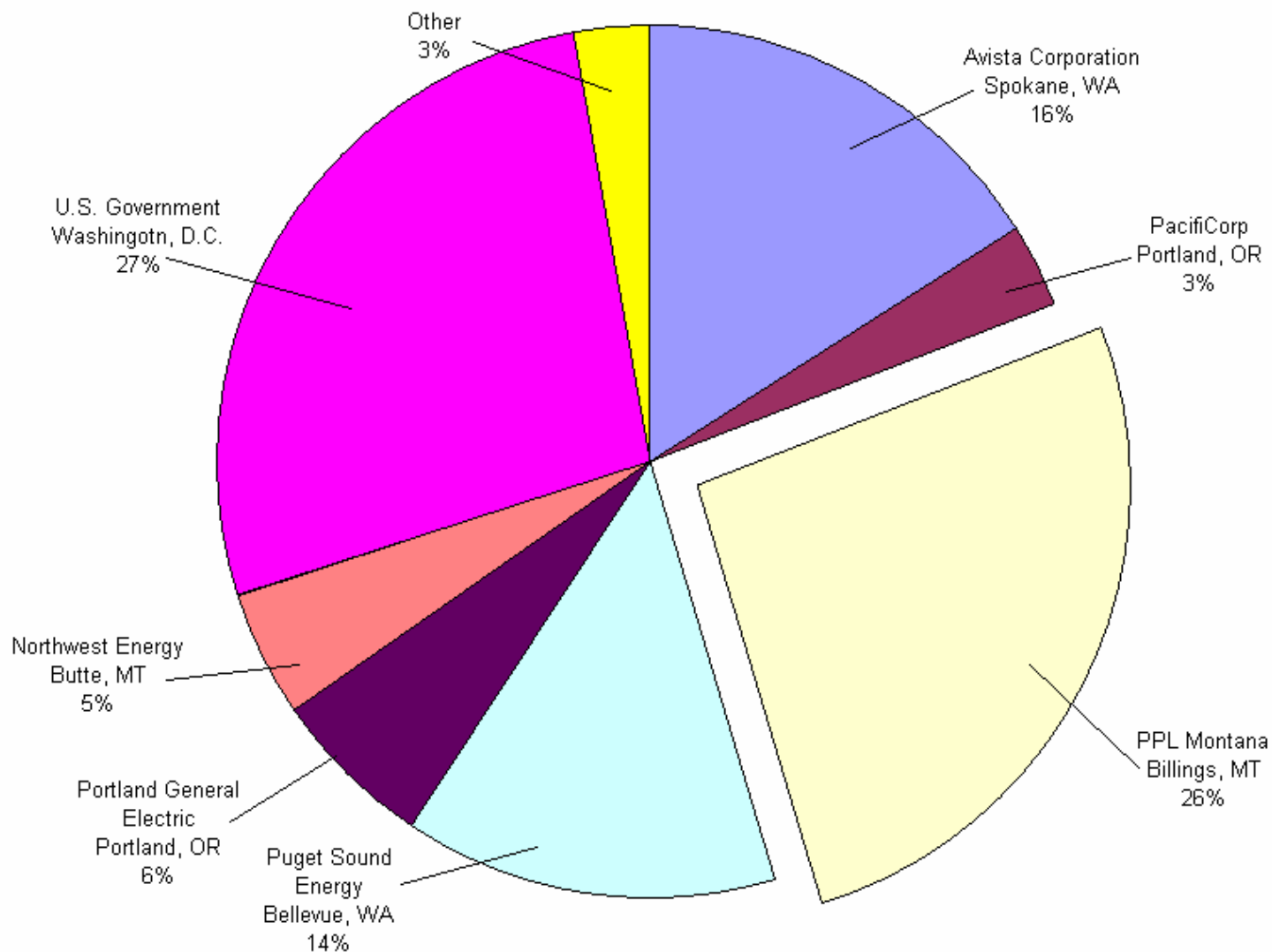
Colstrip SES



***VPP is a Journey,
not a Destination***



Electricity producers in Montana . . .



All generation capacity numbers based on summer capacity data for 2002 as published by the WECC.

PPL Montana Generation . . .



 Hydroelectric Plant	 Coal Fired Plant
---	--



PPL MONTANA™

PPL Montana Generation Resources



Hydro

11 Units; **577 MW**

Fossil (Coal)

2 Stations; **728 MW**

JUN 13 2002

Colstrip Ownership

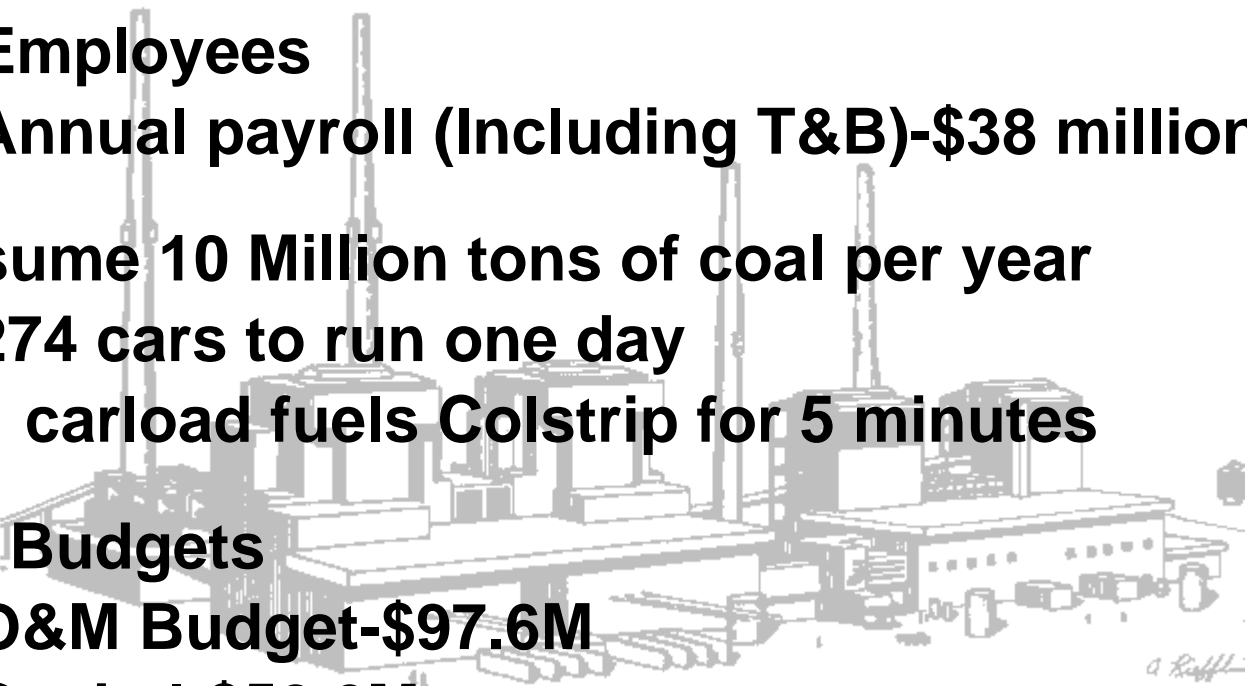


	<u>Unit 1&2</u>	<u>Unit 3&4</u>	<u>Total</u>	<u>Total MW</u>
■ <u>Puget</u>	50%	25%	32%	736 MW
■ <u>PPL</u>	50%	15%	25%	575 MW
■ <u>PGE</u>		20%	14%	322 MW
■ <u>NorthWestern Energy</u>		15%	11%	242 MW
■ <u>Avista</u>		15%	11%	242 MW
■ <u>PacifiCorp</u>		10%	7%	161 MW

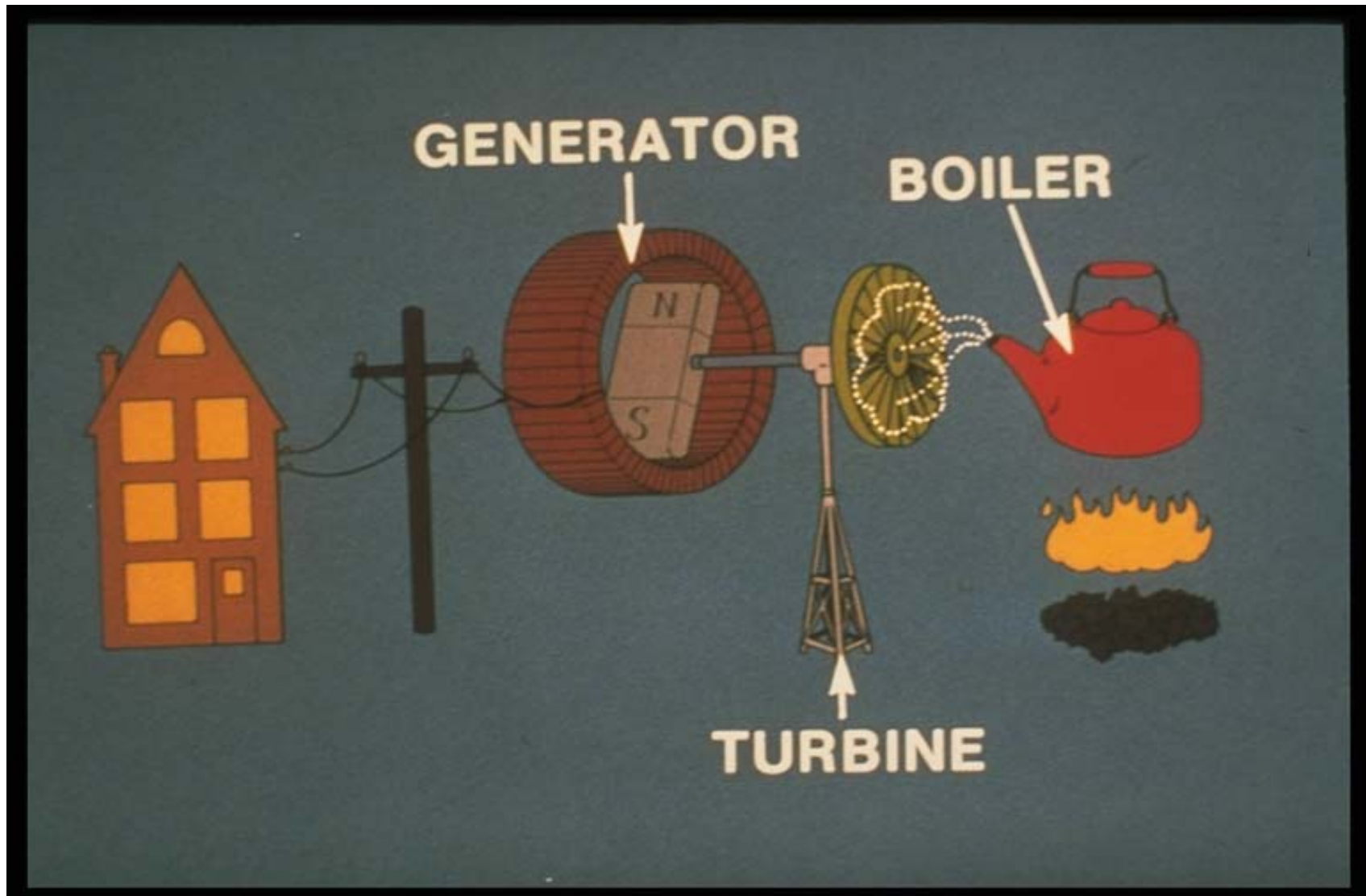
Colstrip Plant . . .



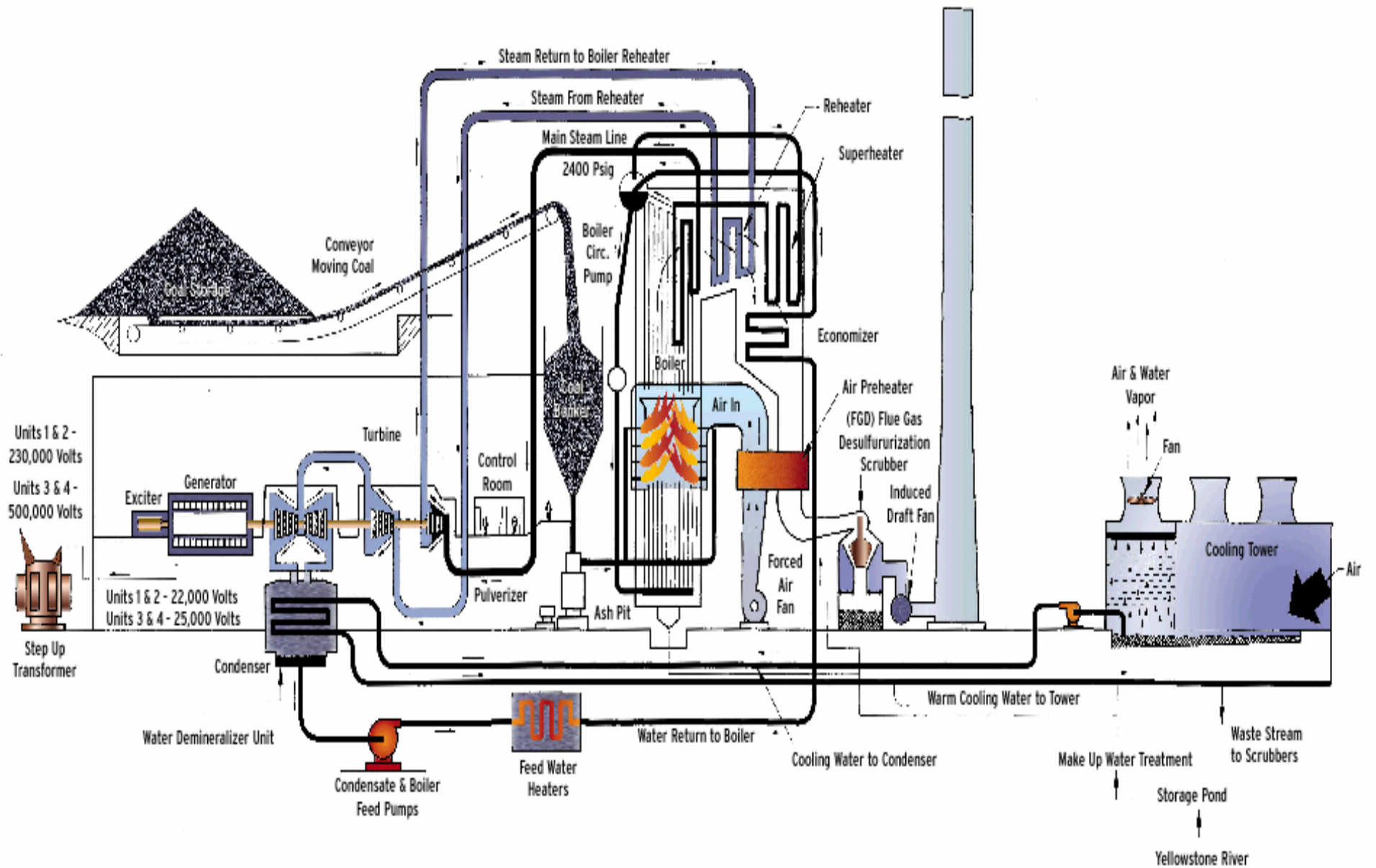
- **Total 2276 Megawatts**
- **350 Employees**
 - **Annual payroll (Including T&B)-\$38 million**
- **Consume 10 Million tons of coal per year**
 - **274 cars to run one day**
 - **1 carload fuels Colstrip for 5 minutes**
- **2007 Budgets**
 - **O&M Budget-\$97.6M**
 - **Capital-\$52.6M**



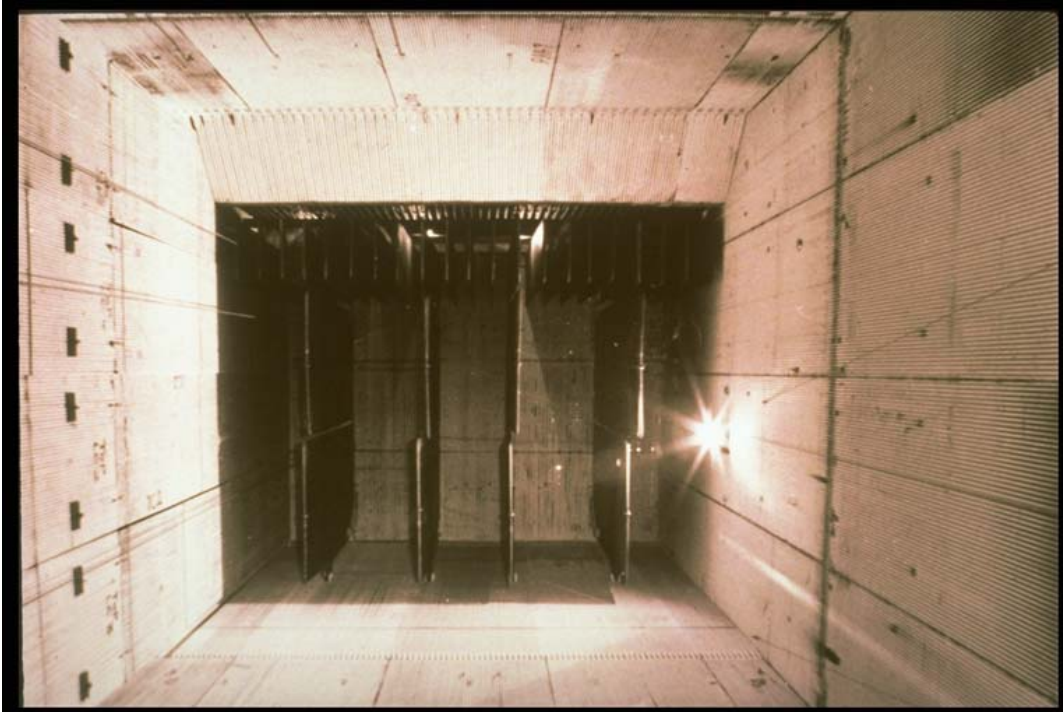
How Fossil Electricity is Generated



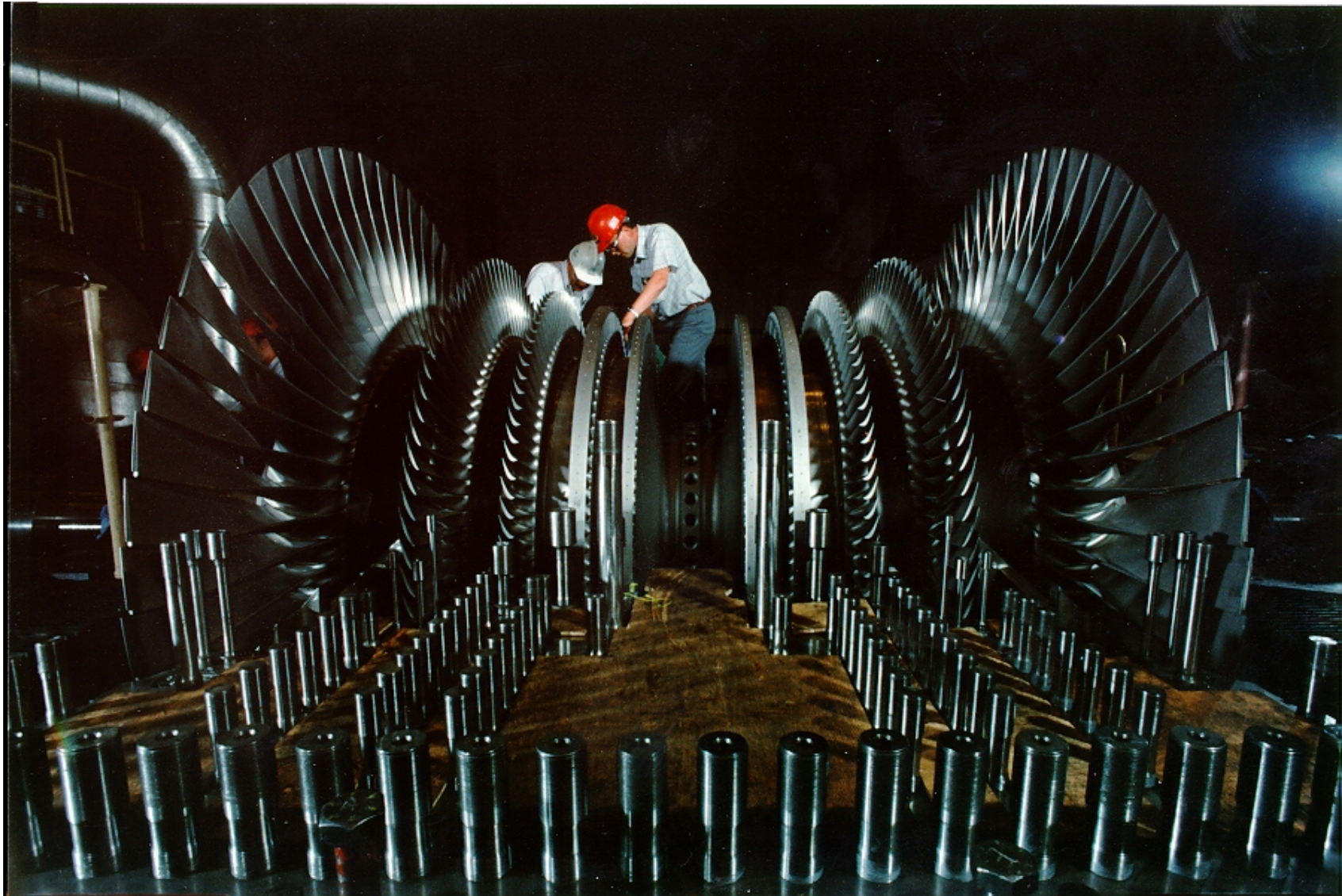
How Colstrip Generates Electricity



Tangential Fired Boiler



Steam Turbine



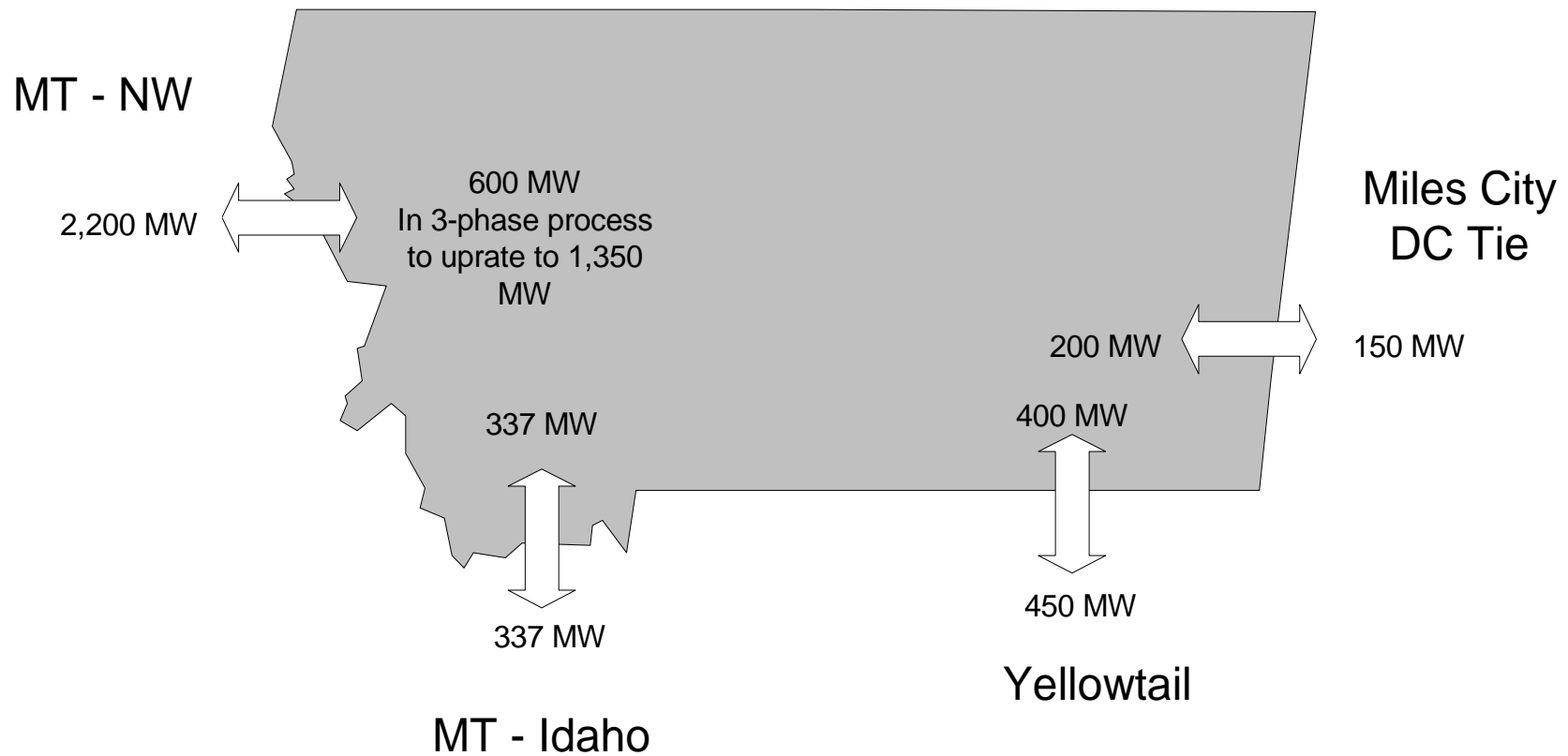
Generator



Transmission Capacity

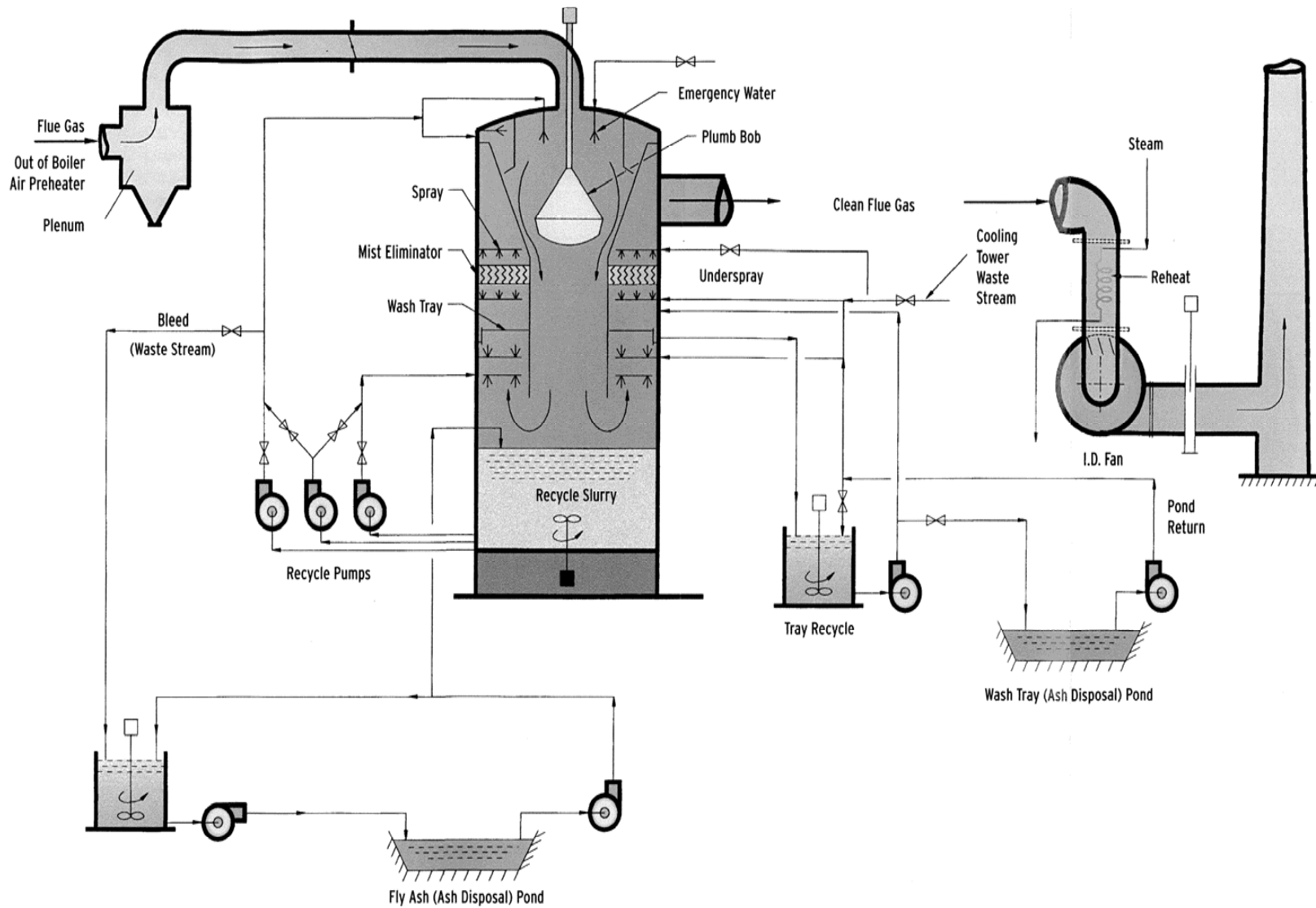


Transmission Interconnection



Simplified Flow Diagram

Scrubbers



Groundwater Protection



- Colstrip is a zero-discharge facility
- Wet scrubbers use surface impoundments for final disposal
- Ponds lined with clay, synthetic liners, or concrete wall
- Over 800 monitoring wells to help ensure protection of groundwater
- Current strategy to protect groundwater (~\$34 million)
 - Paste disposal process (90% reduction in seepage potential)
 - Double-lined clearwater ponds with leachate collection
 - Forced evaporation/wastewater treatment



SO₂ Control



■ Units 1&2 – limit of 1.2 lb/mmbtu

- Normal control efficiency of 65-75%
- Normal emission rate of 0.35 lb/mmbtu
- 38th cleanest coal-fired power plant in country (~350 plants)

■ Units 3&4 – limit of 0.10 lb/mmbtu

- Normal control efficiency of 95%
- Normal emission rate of 0.08 lb/mmbtu
- In 2006, 9th lowest SO₂ emissions from US coal-fired plants

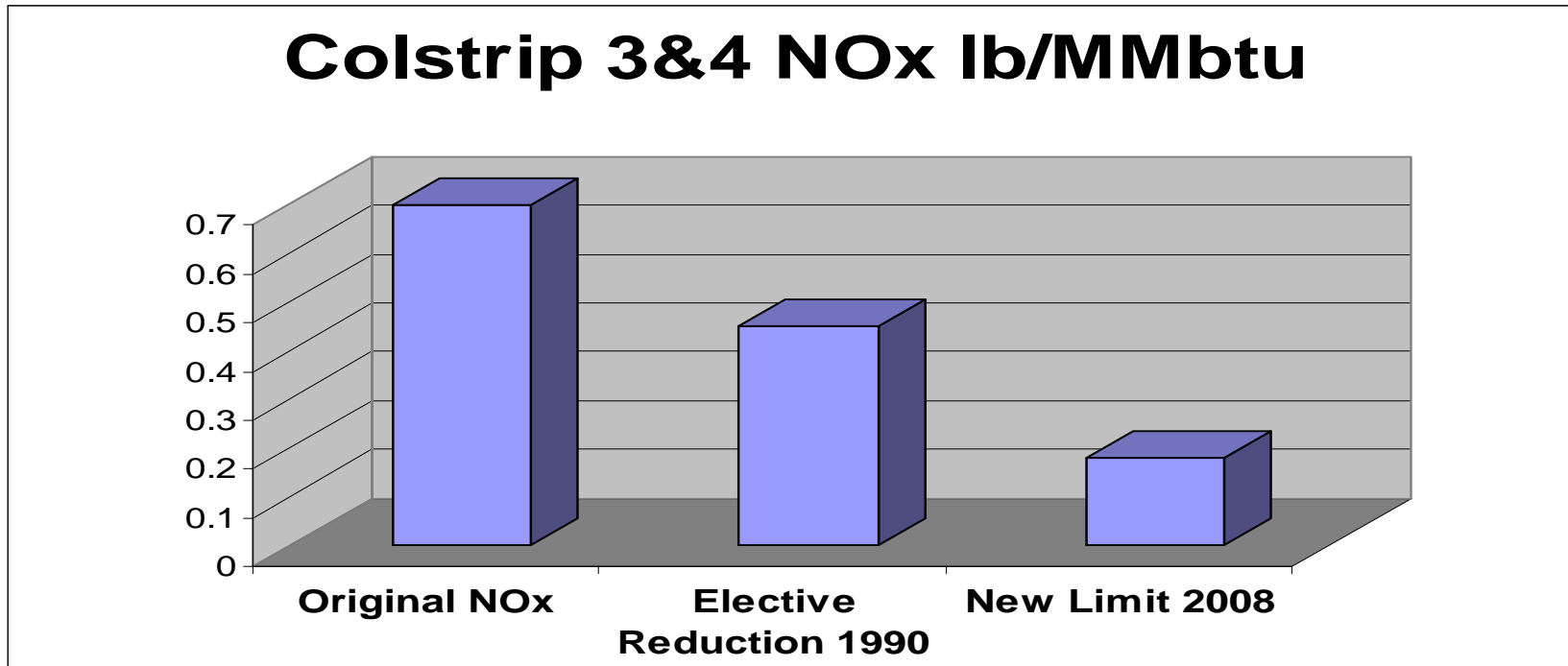
Particulate Control

- Units 1&2 particulate emission limit of 0.10 lb/mmbtu
 - Normal removal efficiency of 99.5%
 - Normal emission rate of 0.04 lb/mmbtu

- Units 3&4 particulate emission limit of 0.05 lb/mmbtu
 - Normal removal efficiency of 99.5%
 - Normal emission rate of 0.03 lb/mmbtu

- Continuous monitoring of Opacity to help ensure compliance with particulate emissions at all times

NOx Control



- 75% NOx reduction
- Low-NOx burners with a SOFA, \$20 million
- Unit 3 in 2007, Unit 4 in 2009
- 3&4 will rank ~60th out of 350 coal-fired power plants for NOx

Mercury Control



- EPA federal rule required 20% reduction by 2010 and 80% reduction by 2018
- 17 states have promulgated/proposed stricter limits than EPA Federal Rule
 - MT has second strictest rule (0.9 lb/Tbtu, 85-90% reduction by 2010)
- ~1% of mercury deposited in Montana is from Montana power plants, based on EPA models
- Colstrip currently emits 6-8 lb/Tbtu (use Astrodome analogy)
- Mercury control technology installed by 2010, ~\$16 million capital, ~\$4.5 million/yr O&M

Recent Mercury Control Testing on Unit 3



- In September, conducted tests involving addition of calcium bromide and treated activated carbon to remove mercury
- Preliminary results are encouraging
 - Achieved about 90% reduction and an emission rate of about 1 lb/Tbtu
- Additional testing in 2008 to fine tune process and evaluate balance of plant impacts



PPL Climate Change Strategy



- ✍ PPL generated 39 percent of its electricity from non-fossil fuel power plants in 2006.
- ✍ PPL participates in the beneficial reuse of ash which offsets greenhouse gas emissions from the cement industry.
- ✍ PPL is decommissioning two coal-fired power plants in 2007, which will reduce annual carbon dioxide emissions by about 1.3 million tons.
- ✍ PPL has developed 12 megawatts of renewable energy projects; plans to invest at least \$100 million in renewable energy projects over the next five years.
- ✍ PPL plans to expand generating capacity at existing nuclear and hydro plants

PPL Climate Change Strategy



✍ PPL is a member of the FutureGen Industrial Alliance, which is developing a near-zero emission power plant that can capture carbon dioxide for sequestration.

✍ PPL is a member of Big Sky Carbon Sequestration Partnership

✍ PPL participates in the Montana Governor's Climate Change Advisory Committee.

✍ PPL plans to participate in EPRI (Electric Power Research Institute) to evaluate technology options as they are developed, then support demonstration projects as appropriate at Colstrip

Colstrip CO2 Control – Opportunities?



- Colstrip SES emits ~18 million tons CO₂/yr
 - 18th largest power plant, rank ~50th for CO₂ emissions
- Current technologies are in developmental stage
- Possible control technologies
 - Amine scrubber w/sequestration
 - Chilled ammonia w/sequestration
 - GreenFuel's Algae-to-Biofuel



Amine Scrubber Process



■ Basis:

- Carbon capture from flue gas and geologic sequestration
- Current status 1200 tpd, Colstrip 40,000 tpd
- Study conducted on Wyodak power plant by Idaho National Laboratory, scaled up for Colstrip 1-4
- Current technology, no improvements
- Target 90% capture of CO₂

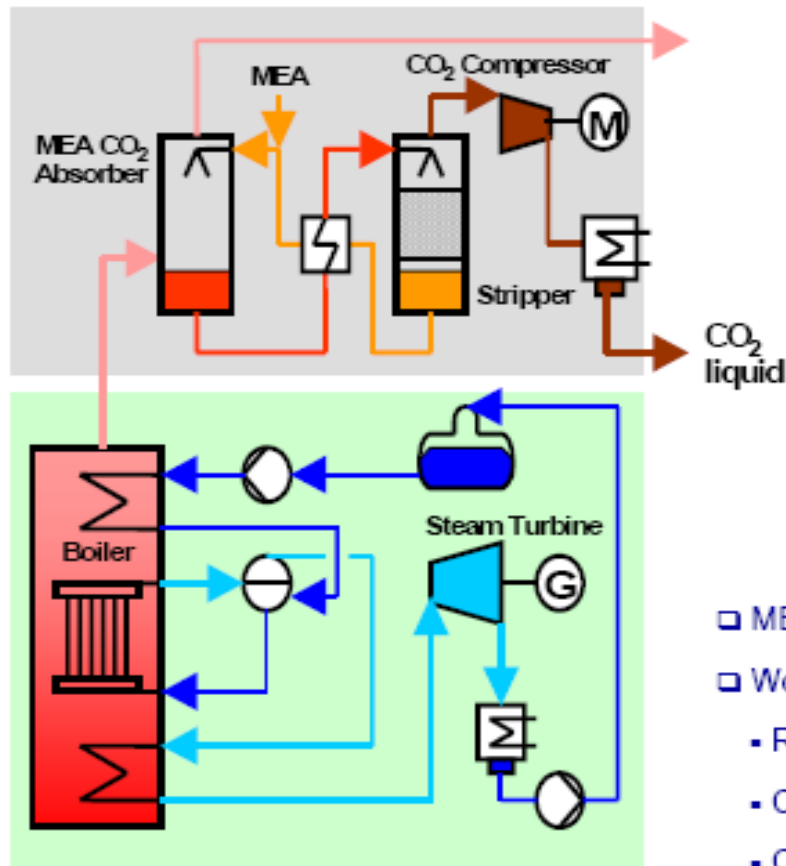
■ Following cost estimates are ballpark

- Capital Cost: \$430 Million
- O&M Annual Cost: \$900 Million
 - Includes “Energy Penalty” of 30% (625 MW)
 - CO₂ removal and sequestration cost per ton: \$53

Amine Scrubber Process



Amine-Based Absorption - CO₂ Capture



SHADY POINT, OKLAHOMA, USA
An AES CFB power plant with
MEA CO₂ separation

- MEA has demonstrated performance on coal based flue gas
- Work required to address:
 - Regeneration power
 - Compression ratio
 - Cost of solvent

Chilled Ammonia Process



■ Basis:

- Carbon capture from flue gas and geologic sequestration
- ALSTOM's 5mw pilot test at Pleasant Prairie
- Scaled up for Colstrip 1-4 (2276 mw)
- Target 90% capture of CO₂

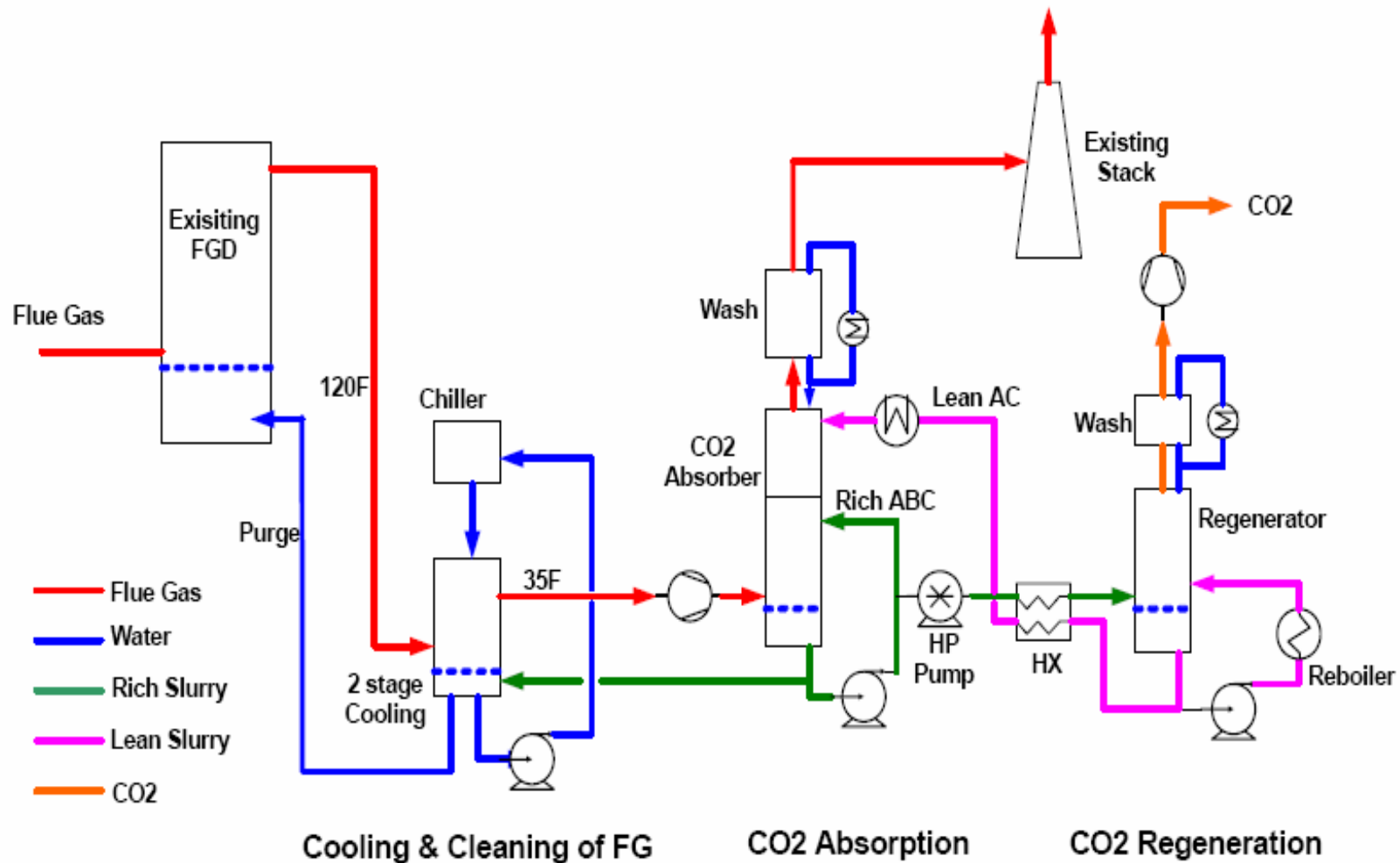
■ Following cost estimates are ballpark

- Capital Cost: \$430 Million
- O&M Cost: \$650 Million
 - Includes "Energy Penalty" of 9% (189 MW)
 - CO₂ removal and sequestration cost per ton: \$39

Source: Alstom Power, November, 2007

Chilled Ammonia Process

Schematic of commercial Ammonia-based CO2 capture system retrofitted downstream of the FGD



Green Fuels Algae-to-Biofuel



■ Basis:

- Flue gas to 'feed' algae, then convert to bio-fuel
- Use of Existing Technology without improvements
- 40% capture of CO₂
- Scaled up for Colstrip 1-4, 26 sq. miles of algae fields

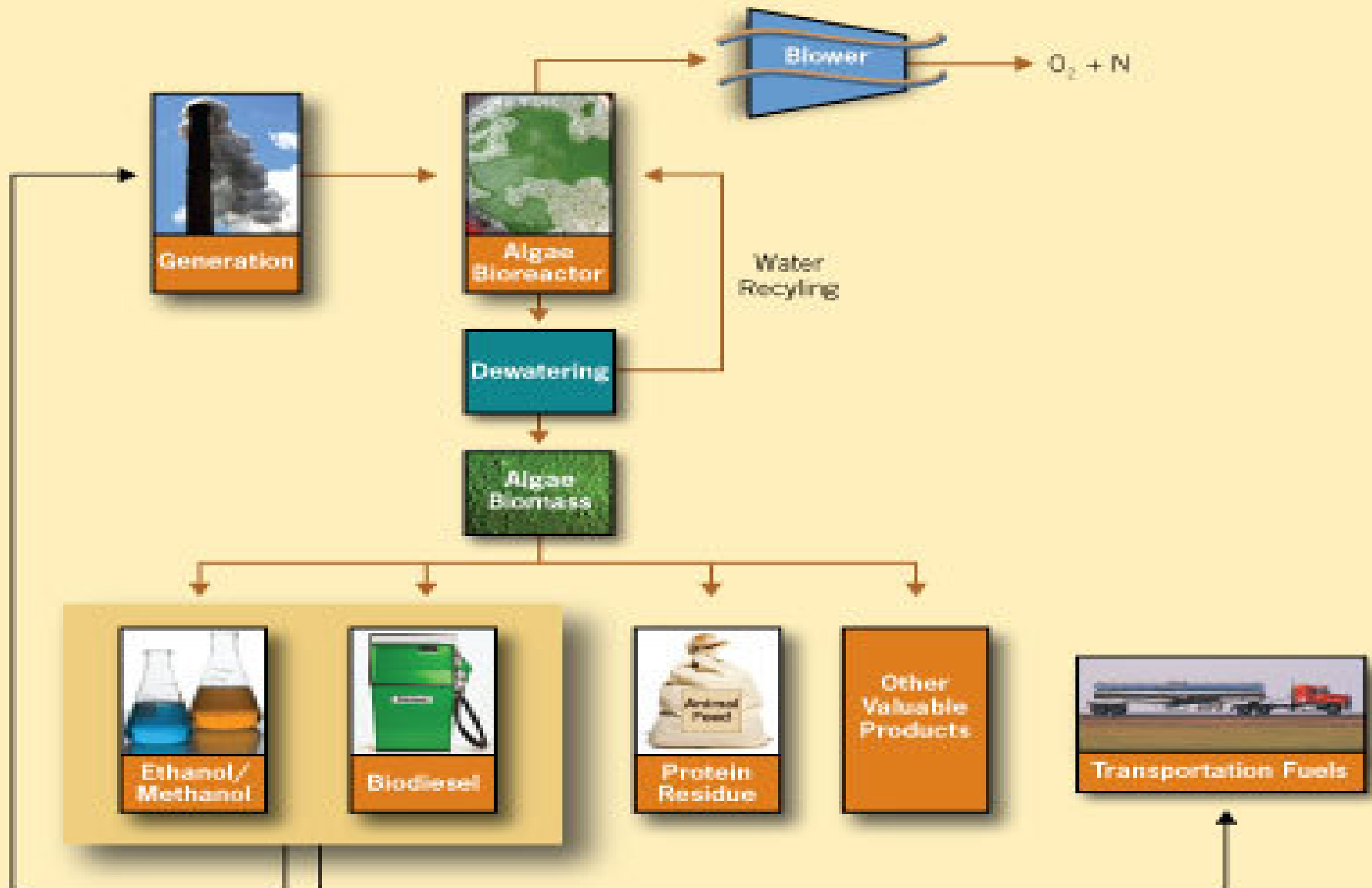
■ Following cost estimates are ballpark

- Capital Cost: \$1.7 Billion
- O&M Cost: \$417 Million
 - Revenue Potential is \$750 million

■ Recent setback w/bioreactor system results in layoff of half the 50 person staff

Green Fuels Algae to Biofuel

Process Flow



QUESTIONS?

