The Energy and Water Nexus: Carbon Capture and Water

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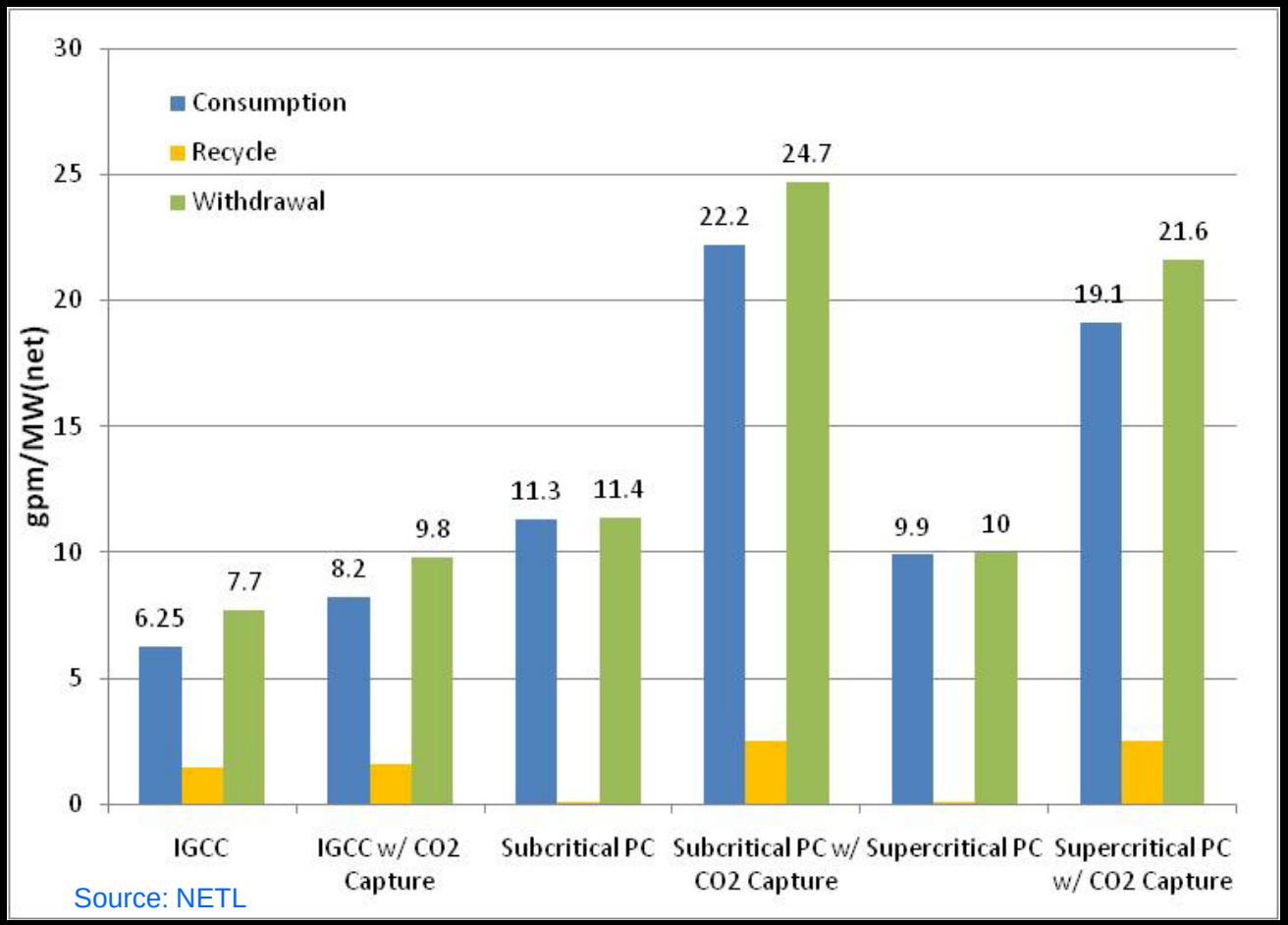
Power Plant Water Demand with and without Carbon Capture



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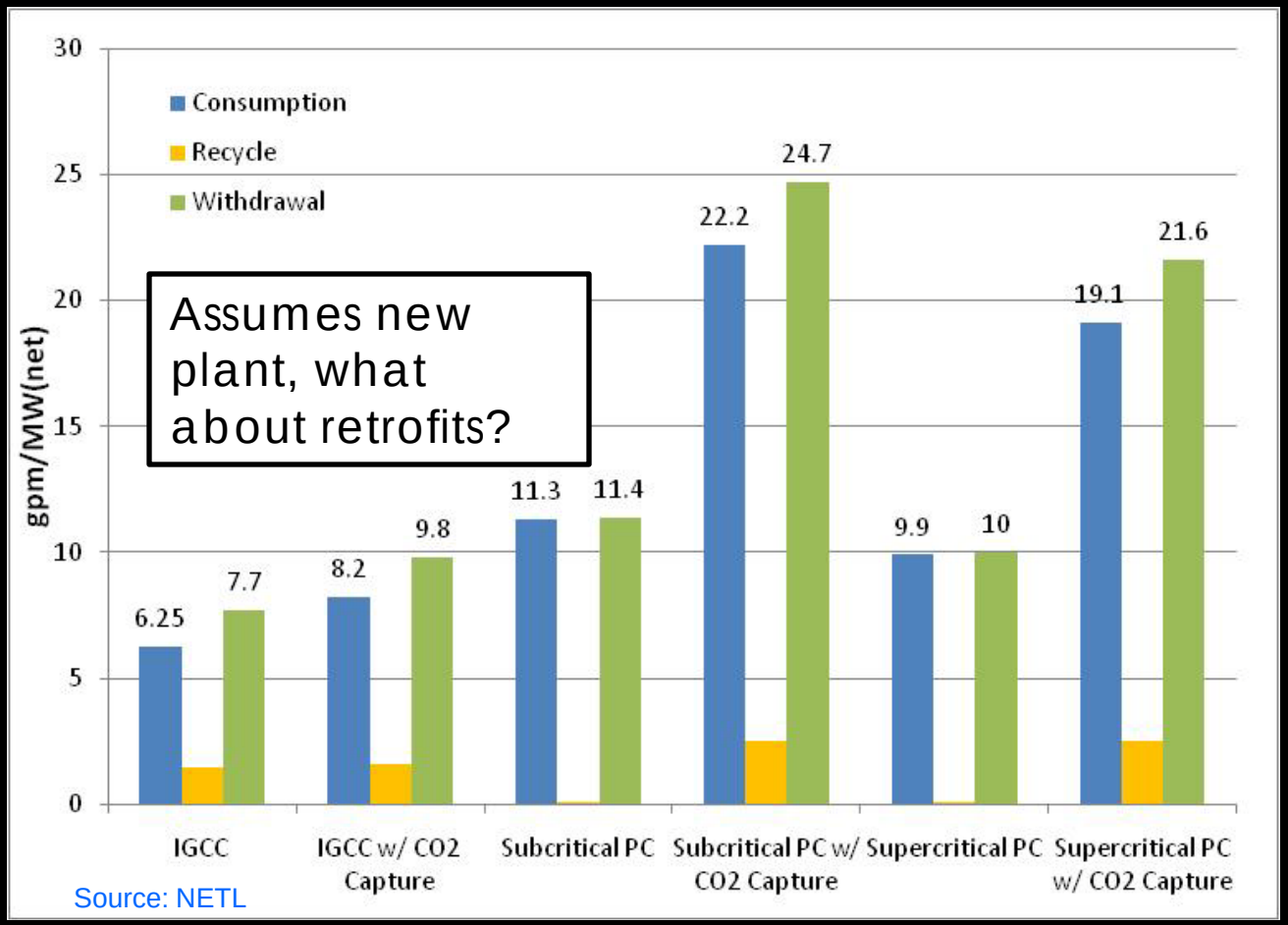

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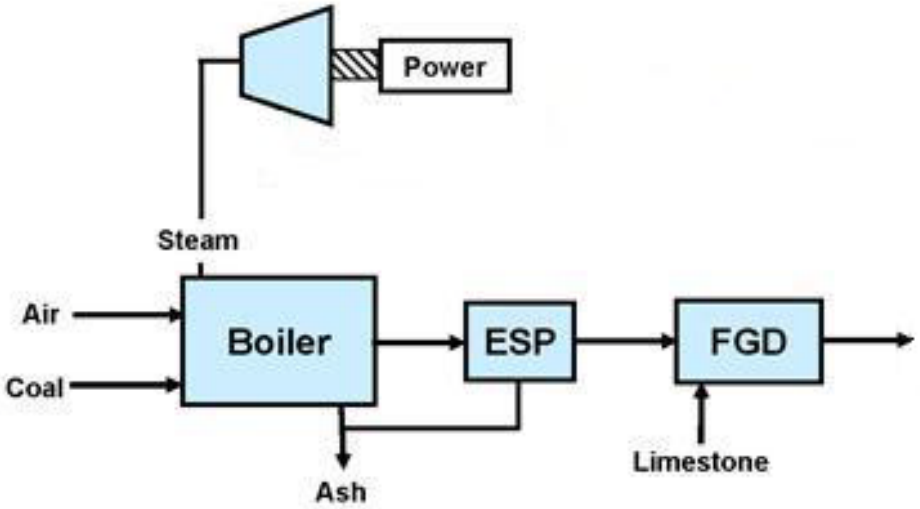
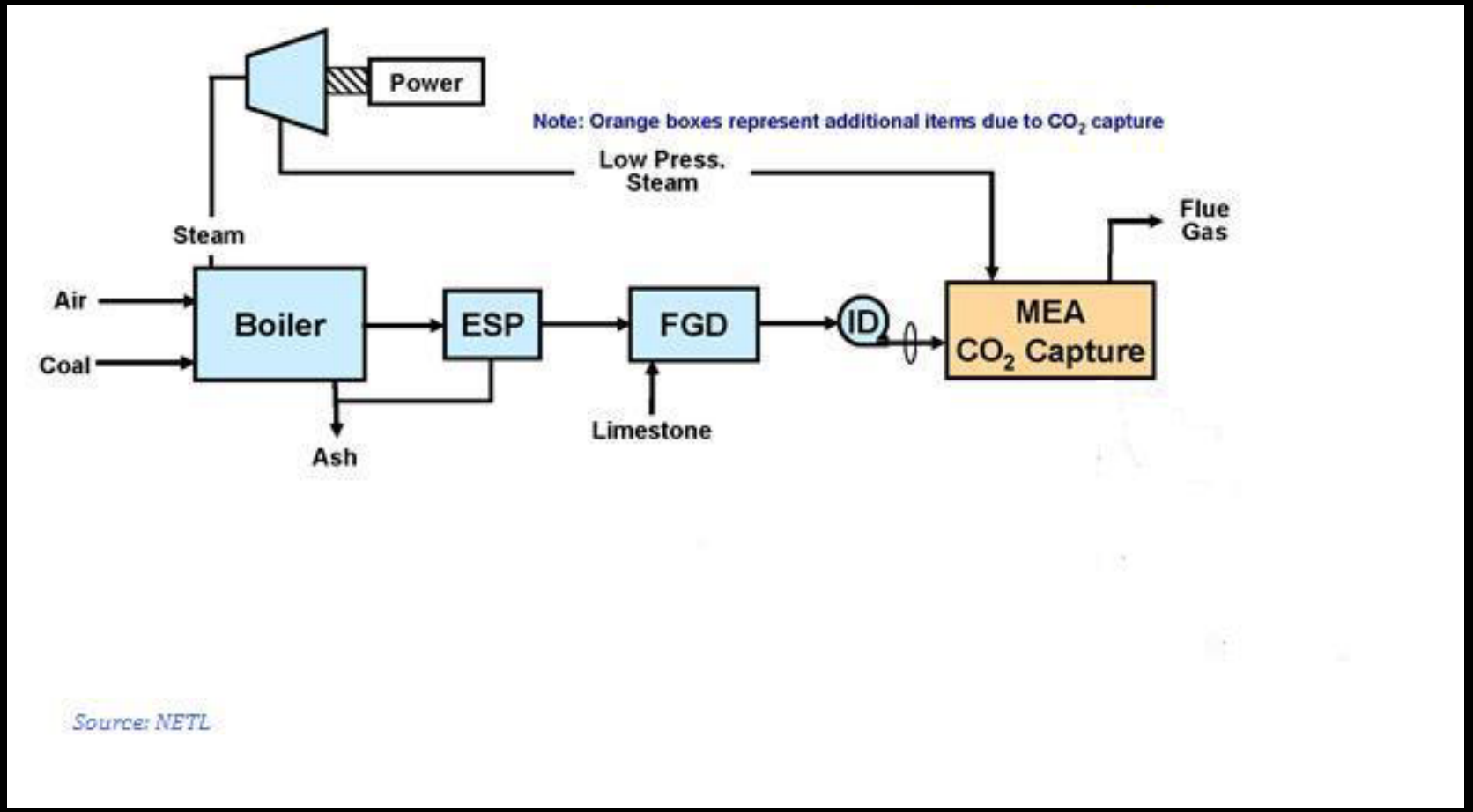
$$\text{Cooling Water Required (gpm)} = \text{Evaporative Loss} \cdot \frac{1}{1\text{-recycle ratio}}$$

Pulverized Coal Plant



Source: NETL

Pulverized Coal Plant with Post-Combustion Capture



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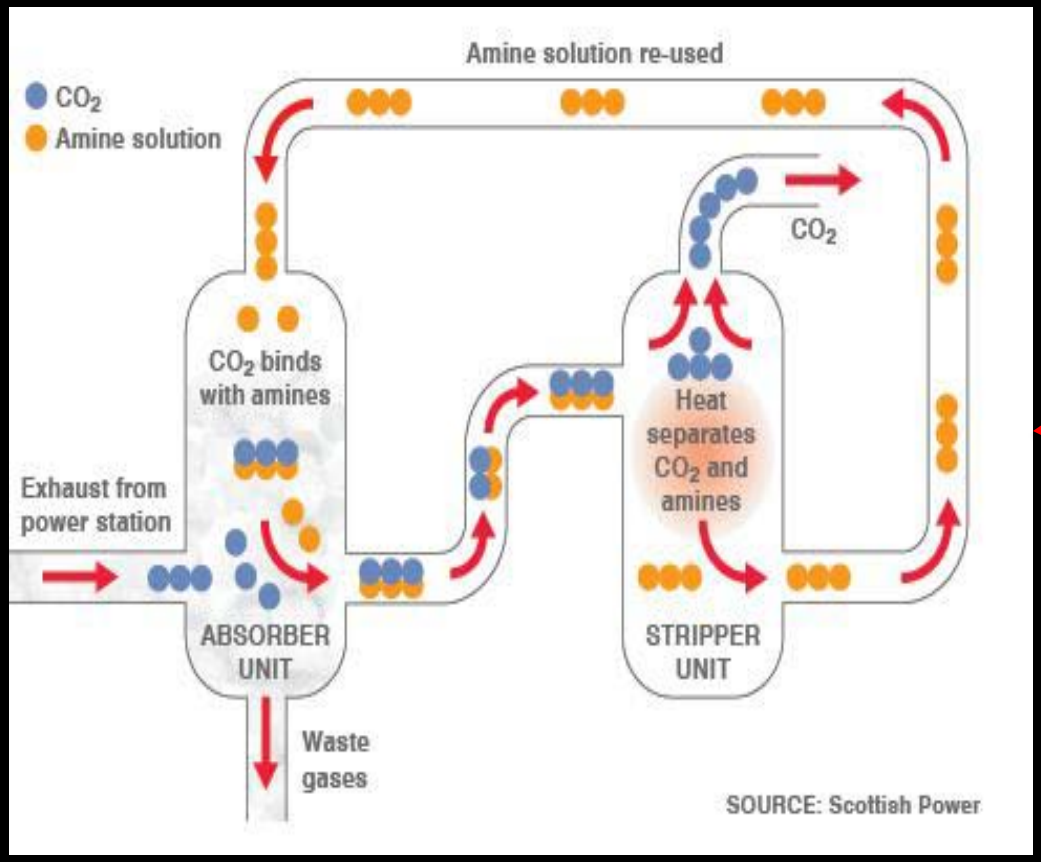

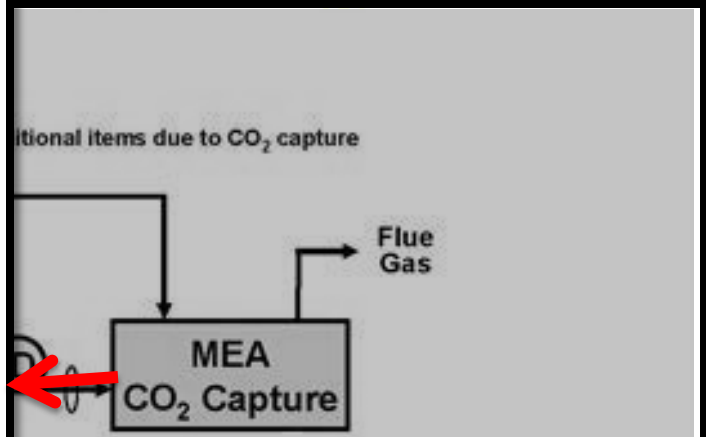

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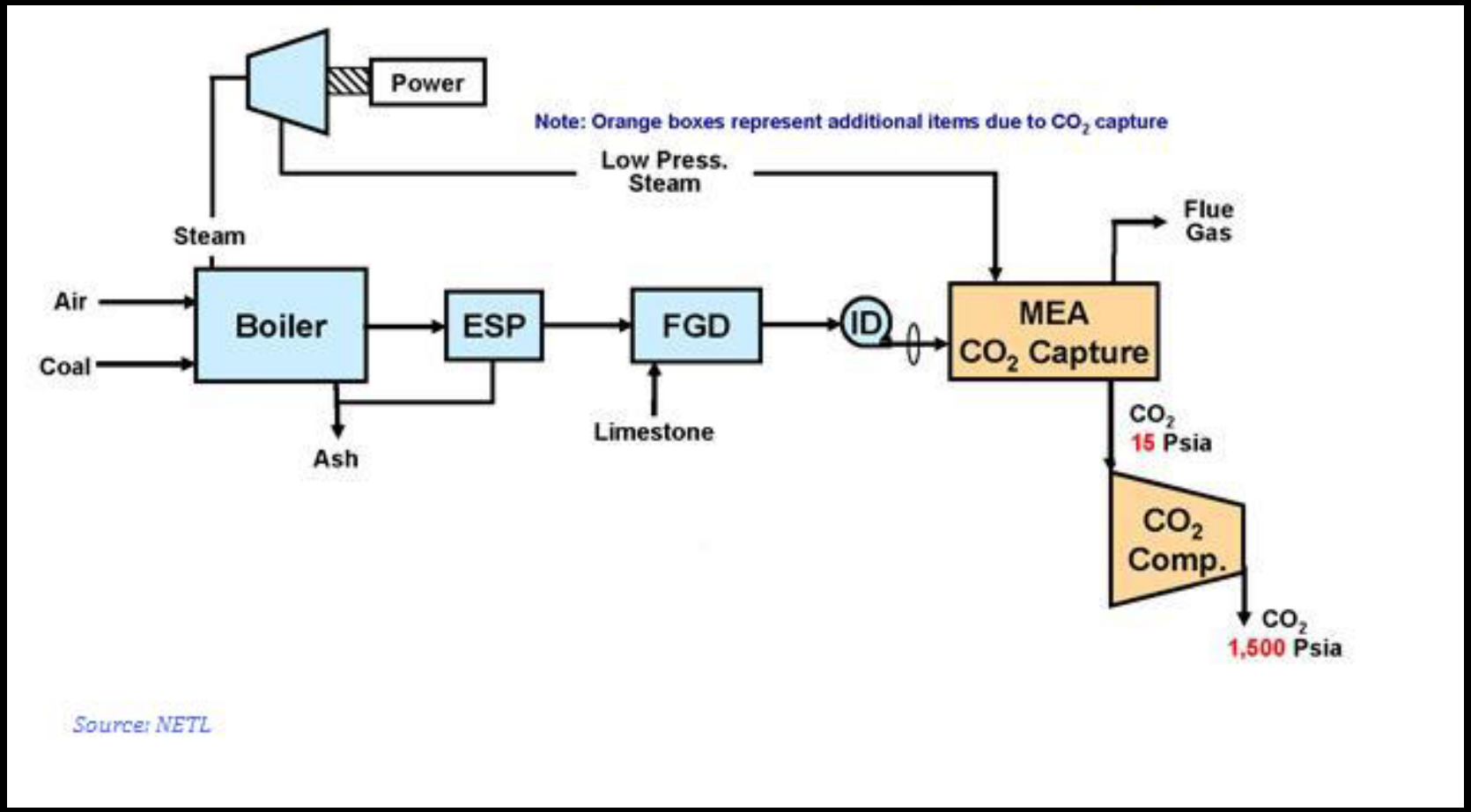

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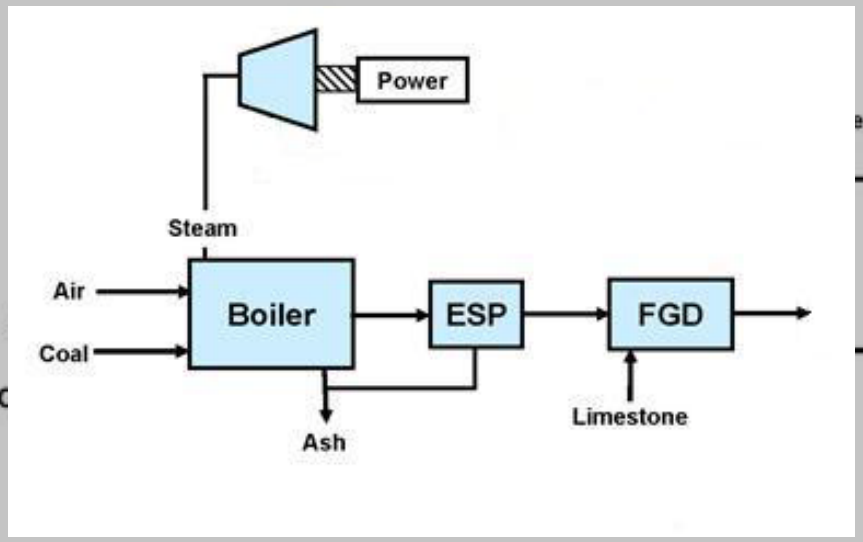

ent additional items due to CO_2 capture

Flue

Condenser Duty

ID

CO_2 Capture

CO_2 15 Psia

CO_2 Comp.

$_2$ Psia

$$\text{Condenser } \cancel{\text{Heat}} \text{ Duty} = 3414426 \cdot \text{Plant Capacity} \cdot \frac{\text{1-Efficiency}}{\text{Efficiency}}$$

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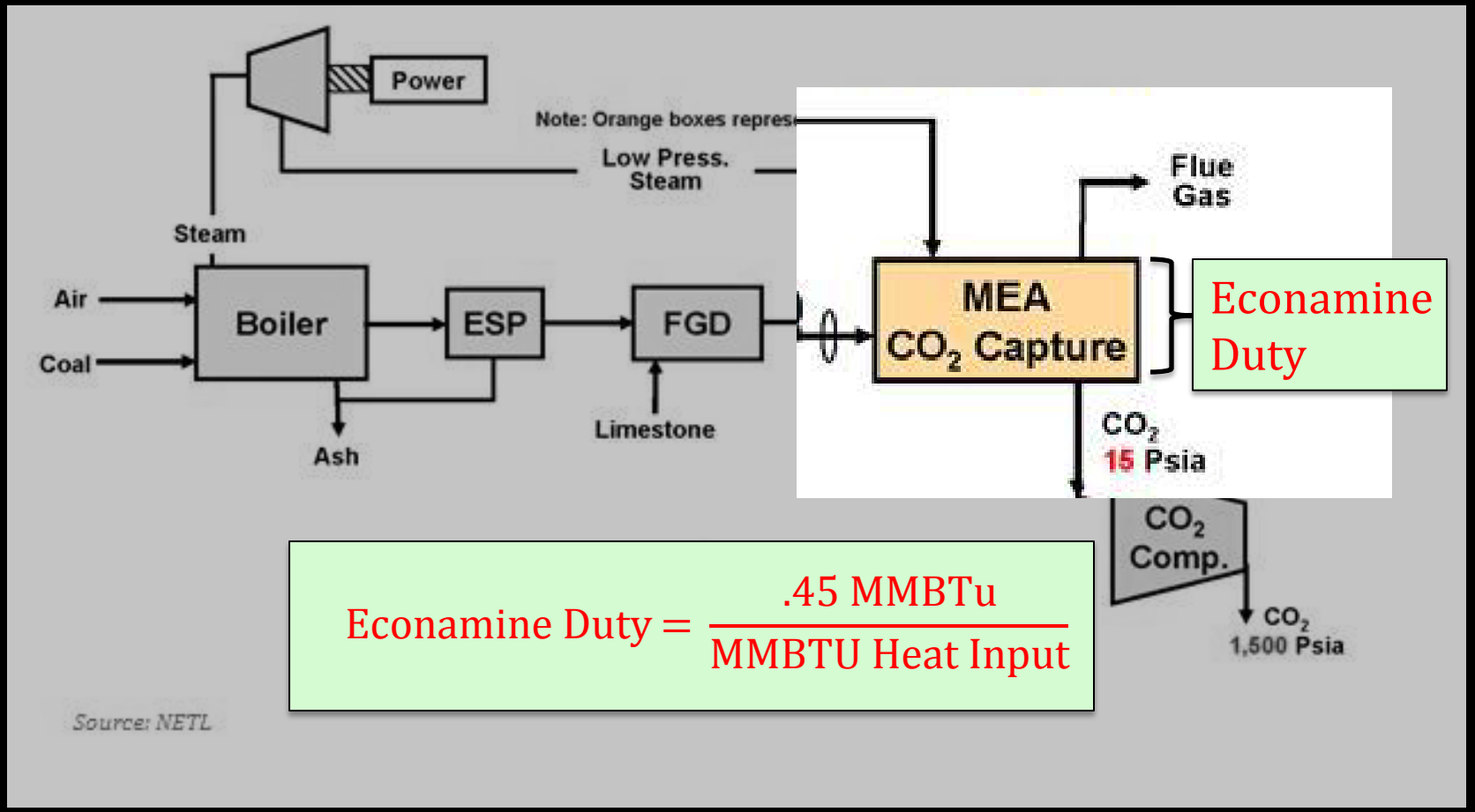

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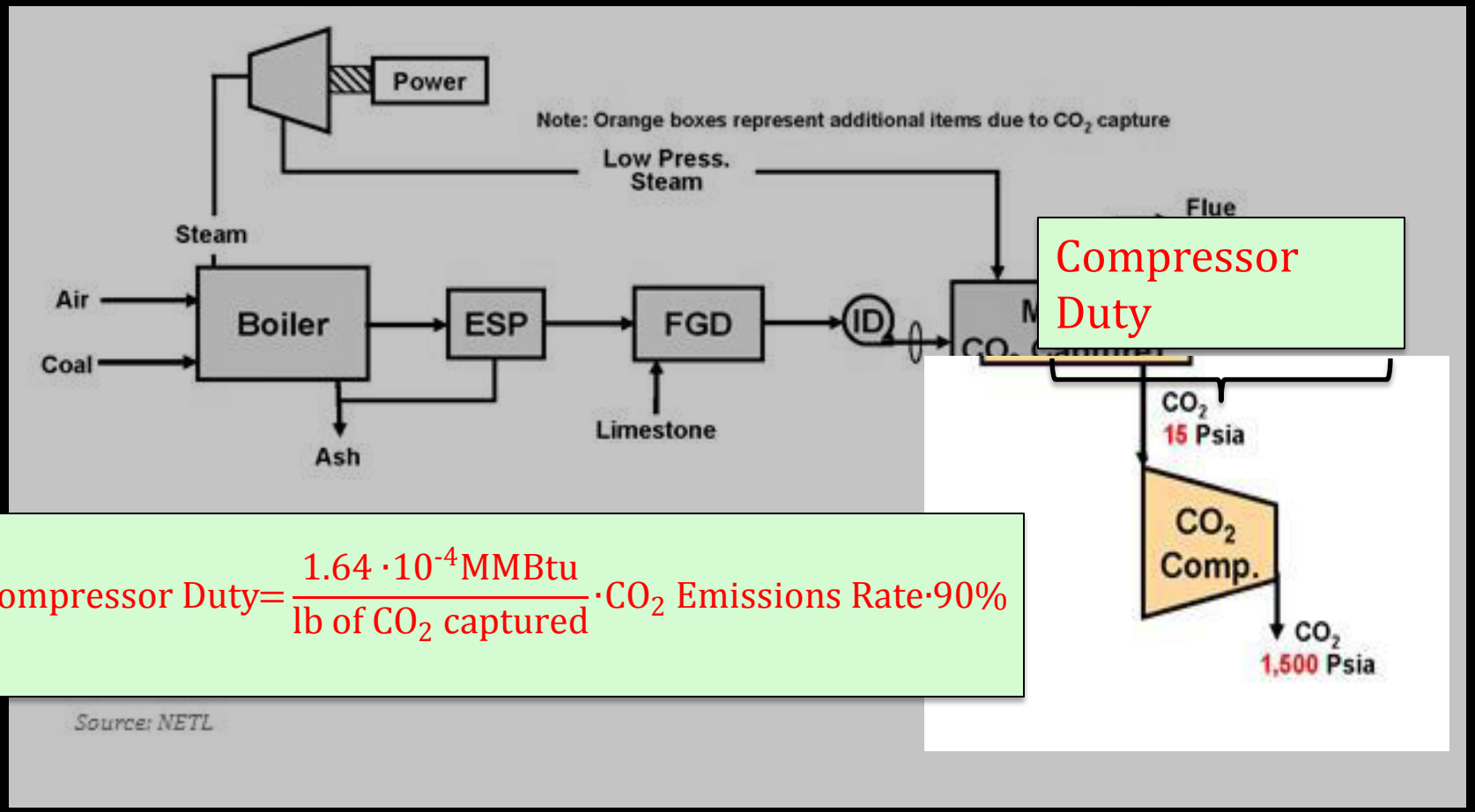


$$\text{Compressor Duty} = \frac{1.64 \cdot 10^{-4}\,\text{MMBtu}}{\text{lb of } CO_2 \text{ captured}} \cdot CO_2 \text{ Emissions Rate} \cdot 90\%$$

How well do equations estimate cooling water need?

	Condenser Water Requirement (gpm)	Econamine Water Requirement (gpm)	Compressor Water Requirement (gpm)	Total Water Requirement (gpm)	Process Model Requirement (gpm)
Subcritical PC	5,587	N/A	N/A	5,587	5,587
Subcritical PC w/ Capture	6,513	6,082	365	12,960	13,172
Supercritical PC	5,053	N/A	N/A	5,053	4,895
Supercritical PC w/ Capture	5,778	5,518	331	11,627	11,380

The UCRB and the "Law of the River"

- 10-year minimum of 82.3 million acre-feet past Lee's Ferry

Coal Plants in the UCRB

Assumptions

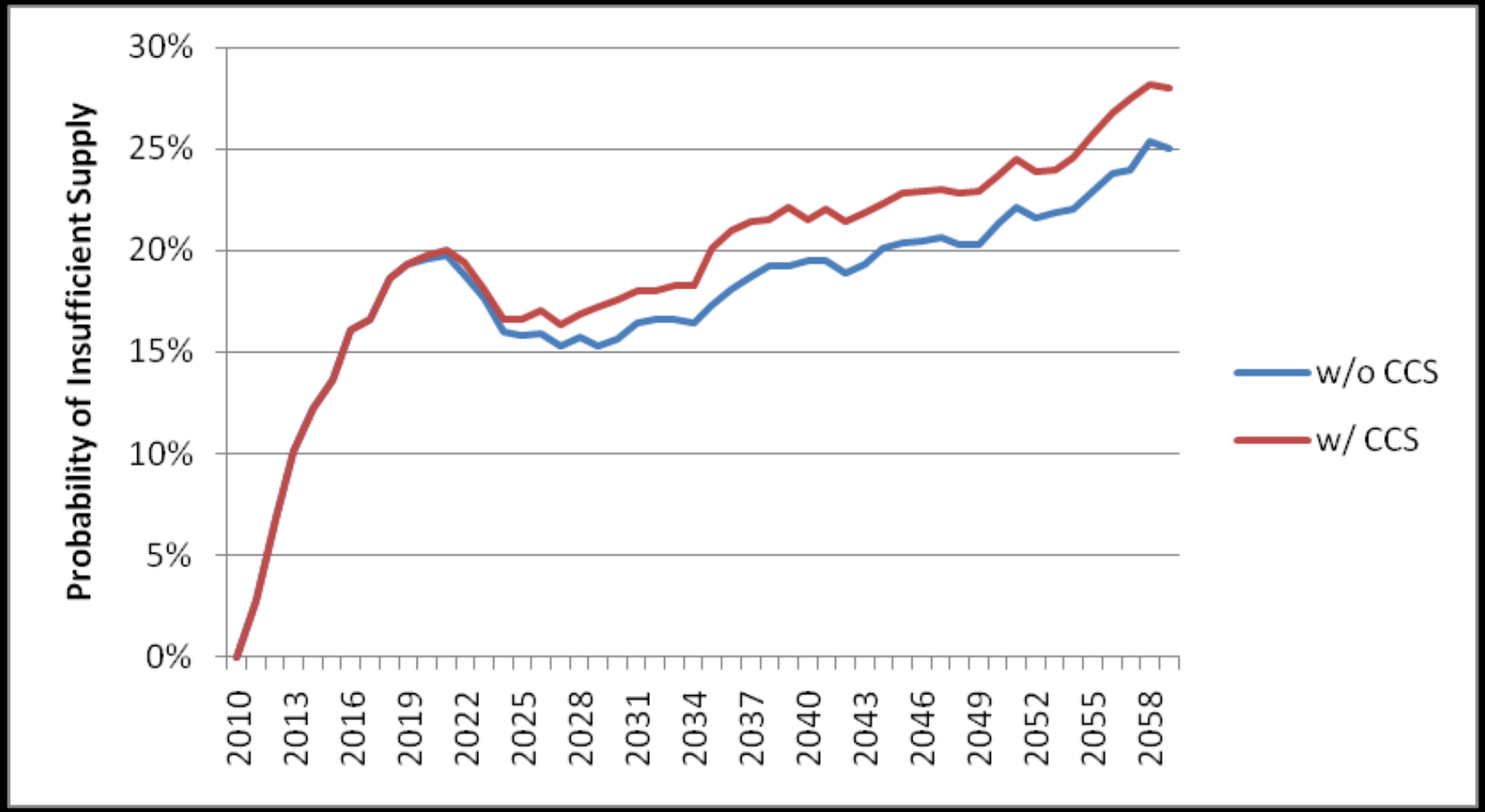
- Plants less than 500 MW not retrofitted
- Plant efficiency doesn't change
- Retrofit happens in 2020
- Additional water drawn from same source
  - All from Colorado River or its tributaries
- Only storage is in Lake Powell
- Additional use = 143,000 acre-feet/yr

Accounting for Water in the UCRB

$$\frac{\Delta \text{Storage}}{\text{year}} = \text{Natural Flow} - \text{Consumption} - \text{Evaporation} - \text{Flow Out}$$

- 1,000 natural flow scenarios from University of Colorado
- Consumption schedule from USBR
- Evaporation from USBR
- Flow out = 8.23 MAF subject to certain conditions

Results


Probability of Insufficient Supply
30%
25%
20%
15%
10%
5%
0%
2010
2013
2016
2019
2022
2025
2028
2031
2034
2037
2040
2043
2046
2049
2052
2055
2058
w/o CCS
w/ CCS

Questions?

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