

***Utility Mercury Air Toxics Rule:  
PM Control  
with WESP Technology***

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## *Outline of Presentation*

1. Proposed PM Standards for New & Existing Units
2. Focus of Discussion on Plants with WFGD
3. Conventional Wisdom = DSI + Fabric Filter
4. Possible Alternative = WFGD + Wet ESP
5. ICR Data
6. Issues with Fabric Filters
7. Pressure Drop comparison
8. Real Estate comparison
9. Maintenance comparison
10. Water Usage Comparison
11. Process Comparison
12. Capital Cost comparison
13. Summary

# PM Emissions Limits

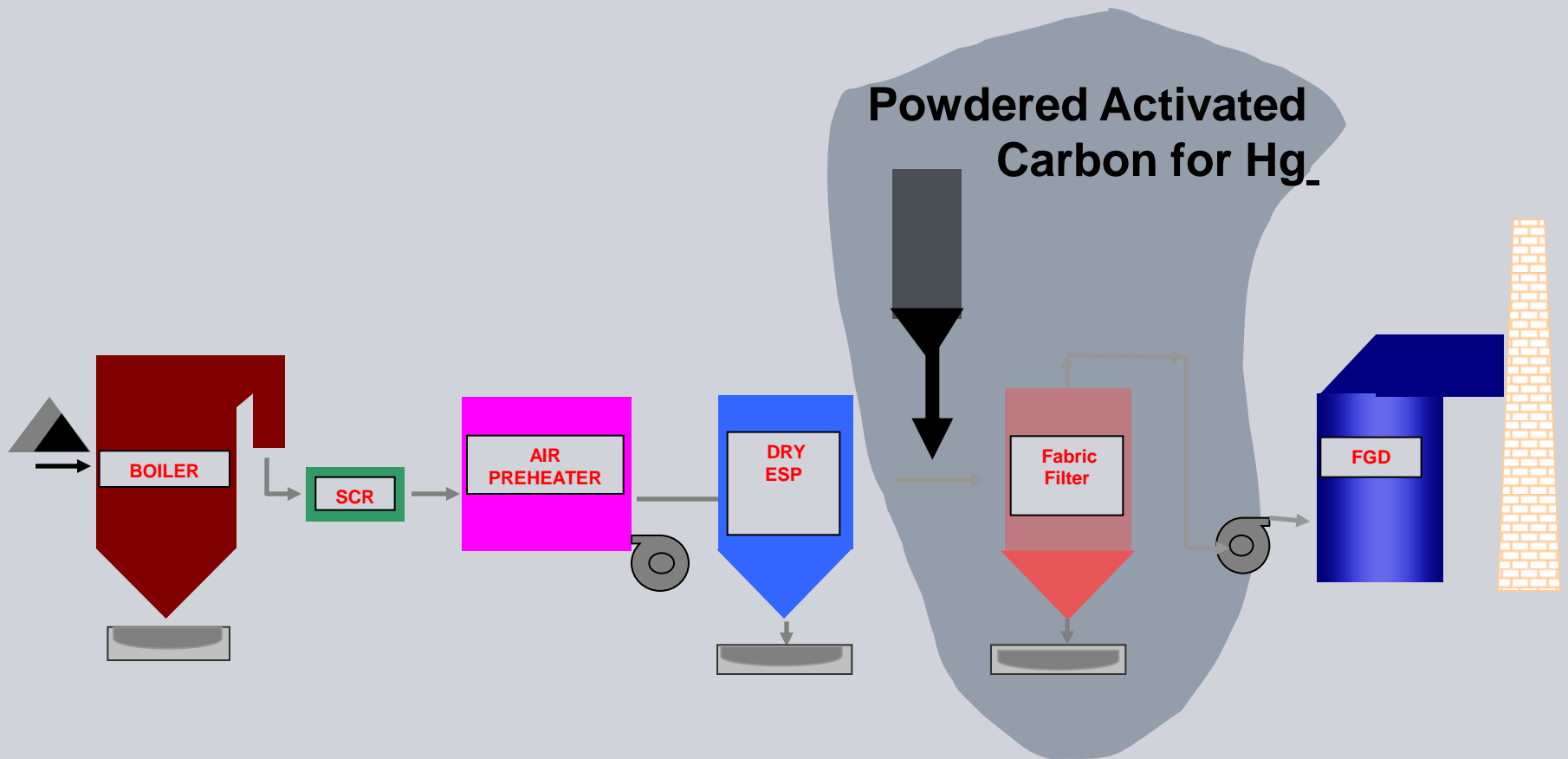
Utility Mercury Air Toxics Rule  
Emission Limits for Particulate

	Existing Coal-Fired Units		New Coal-Fired Units		
	Initial Proposed Rule (5/3/11)	Final Issued Rule (12/16/11)	Initial Proposed Rule (5/3/11)	Final Issued Rule (12/16/11)	in lb/MMBtu
PM <sub>filterable</sub>	-	0.03 lb/MMBtu or 0.3 lb/MMWh	-	0.007 lb/MWh	0.0007
PM <sub>Total</sub>	0.030 lb/MMBtu or 0.3 lb/MWh	-	0.05 lb/MWh	-	-
or					
Non-Hg Metals	0.00004 lb/MMBtu or 0.0004 lb/MWh	0.00005 lb/MMBtu or 0.5 lb/GWh	0.00004 lb/MWh	0.06 lb/GWh	0.0006
or					
Individual metals					
Antimony	0.8 lb/TBtu or 0.006 lb/GWh	0.8 lb/TBtu or 0.008 lb/GWh	0.00008 lb/GWh	0.008 lb/GWh	0.0008
Arsenic	2.0 lb/TBtu or 0.02 lb/GWh	1.1 lb/TBtu or 0.02 lb/GWh	0.0002 lb/GWh	0.003 lb/GWh	0.0004
Beryllium	0.2 lb/TBtu or 0.002 lb/GWh	0.2 lb/TBtu or 0.002 lb/GWh	0.00003 lb/GWh	0.0006 lb/GWh	0.00006
Cadmium	0.3 lb/TBtu or 0.003 lb/GWh	0.3 lb/TBtu or 0.003 lb/GWh	0.0004 lb/GWh	0.0004 lb/GWh	0.00004
Chromium	3.0 lb/TBtu or 0.03 lb/GWh	2.8 lb/TBtu or 0.03 lb/GWh	0.02 lb/GWh	0.007 lb/GWh	0.0007
Cobalt	0.8 lb/TBtu or 0.008 lb/GWh	0.8 lb/TBtu or 0.008 lb/GWh	0.0008 lb/GWh	0.002 lb/GWh	0.0002
Lead	2.0 lb/TBtu or 0.02 lb/GWh	1.2.0 lb/TBtu or 0.02 lb/GWh	0.0009 lb/GWh	0.002 lb/GWh	0.0002
Manganese	5.0 lb/TBtu or 0.05 lb/GWh	4.0 lb/TBtu or 0.05 lb/GWh	0.004 lb/GWh	0.004 lb/GWh	0.0004
Nickel	4.0 lb/TBtu or 0.04 lb/GWh	3.5 lb/TBtu or 0.04 lb/GWh	0.004 lb/GWh	0.04 lb/GWh	0.004
Selenium	6.0 lb/TBtu or 0.06 lb/GWh	5.0 lb/TBtu or 0.06 lb/GWh	0.03 lb/GWh	0.006 lb/GWh	0.0006

## *Focus of Discussion on Plants with WFGD*

- Plants that do not have a wet FGD system will likely remain with “dry” air pollution control solutions- ESP, FF, Spray Dryers, Sorbent Injection.
- However, those plants with ESPs and WFGD will likely need additional Hg & PM control due to sorbent injection and should consider a Wet ESP as an alternative to installing a fabric filter.

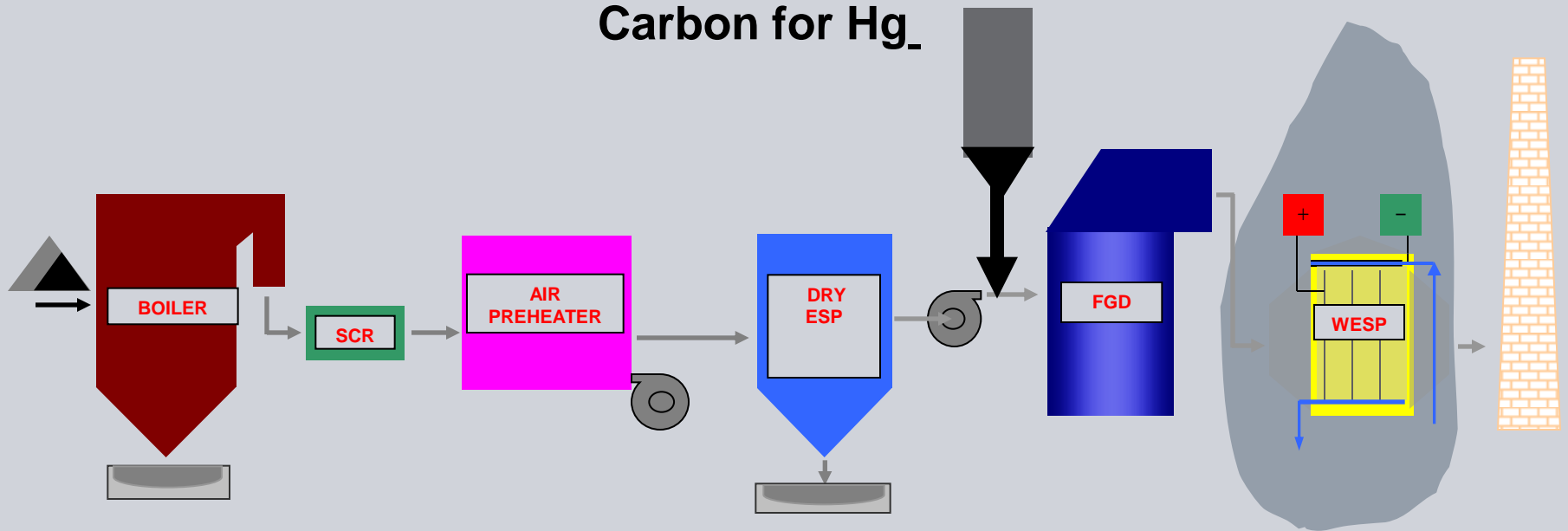
# Conventional Wisdom = PAC + Fabric Filter



## Possible Alternative = WFGD + Wet ESP

Powdered Activated Carbon for Hg<sub>2</sub>

Wet ESP alternative



# ICR DATA has 2 Plants with WESP

Microsoft Excel - Utility MACT Metals-PM database.xlsx

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Calibri 10

EA5 FF, WFGD

	A	B	C	D	E	EA	EB	EC	
	primary_fuel	ORIS code	Plant Name	physical_state	Unit Number	Control summary	control_group_1	control_type_1	inst
2									
3	coal	7790	Bonanza Power Plant	UT	1-1	FF, WFGD	PM control	Fabric Filter, reverse air	
4	coal	2554	Dunkirk Generating Plant	NV	1	SNCR, DSI, FF	NOx control	Selective Noncatalytic Reduction	
5	coal	492	Martin Drake	CO	Unit 5 - Coal	FF, WFGD	PM control	Fabric Filter, reverse air	
6	coal	568	Bridgeport Station	CT	BHSEMU3053-#2	ESP, ACI, FF	PM control	Electrostatic precipitator, cold side, w/o flue gas	
7	coal	2712	Roxboro Steam Electric Plant	NC	Rox_Cfg_2c	SCR, ESP, WFGD	NOx control	Selective Catalytic Reduction	
8	coal	8223	Springerville	AZ	4	SCR, DFGD, FF	NOx control	Selective Catalytic Reduction	
9	coal	891	Havana	IL	Boiler 9	ESP, SCR, ACI, DFGD, FF	PM control	Electrostatic precipitator, hot side, unspecified	
10	coal	2554	Dunkirk Generating Plant	NV	4	SNCR, DSI, FF	NOx control	Selective Noncatalytic Reduction	
11	coal	7097	J K Spruce	TX	1	FF, WFGD	PM control	Fabric Filter, reverse air	
12	coal	2324	Reid Gardner	NV	1	FF, WFGD	PM control	Fabric Filter, pulse	
13	coal	2451	San Juan	NM	Unit 3	ACI, FF, WFGD	Other control	Activated carbon injection	
14	coal	2712	Roxboro Steam Electric Plant	NC	Rox_Cfg_1b	SCR, ESP, WFGD	NOx control	Selective Catalytic Reduction	
15	coal	963	Dallman	IL	34	SCR, FF, WFGD, WESP	NOx control	Selective Catalytic Reduction	
83	coal	6041	H L Spurlock Station	KY	Unit 01	ESP, SCR, WFGD, WESP	PM control	Electrostatic precipitator, cold side, w/o flue gas	
84	coal	10343	Foster Wheeler Mt Carmel Cogen	PA	SG-101	FBC, FF	PM control	Fabric Filter, reverse air	
85	coal	6021	Craig	CO	C3	DFGD, FF	SO2 control	Dry FGD - Spray Dryer	
86	coal	2324	Reid Gardner	NV	3	FF, WFGD	PM control	Fabric Filter, pulse	
87	coal	6664	Louisa	IA	101	DFGD, FF	SO2 control	Dry FGD - Circulating Dry Scrubber	
88	coal	130	Cross	SC	C1	SCR, ESP, WFGD	NOx control	Selective Catalytic Reduction	
89	coal	6113	Gibson	IN	2-2007-FGDIN	SCR, ESP, WFGD	NOx control	Selective Catalytic Reduction	
90	coal	52071	Sandow Station	TX	5B	FBC, SNCR, ACI, DFGD, FF	NOx control	Selective Noncatalytic Reduction	
91	coal	4041	South Oak Creek	WI	OCPP-B8	ESP	PM control	Electrostatic precipitator, cold side, w/o flue gas	
92	coal	2324	Reid Gardner	NV	2	FF, WFGD	PM control	Fabric Filter, pulse	
93	coal	1710	Consumers Energy - J.H. Campbell	MI	JHC2-Conf	ESP	PM control	Electrostatic precipitator, cold side, w/ flue gas conditioning	
94	coal	1710	Consumers Energy - J.H. Campbell	MI	JHC1-Conf	ESP	PM control	Electrostatic precipitator, cold side, w/o flue gas	
95	coal	56224	TS Power Plant	NV	TSPower	SCR, ACI, DFGD, FF	NOx control	Selective Catalytic Reduction	
96	coal	4042	Valley	WI	VAPP-B3	FF	PM control	Fabric Filter, pulse	
97	coal	4042	Valley	WI	VAPP-B2	FF	PM control	Fabric Filter, pulse	
98	coal	6170	Pleasant Prairie	WI	PPPPB2	SCR, ESP, WFGD	NOx control	Selective Catalytic Reduction	
99	coal	8224	North Valmy	NV	2	DFGD, FF	SO2 control	Dry FGD - Spray Dryer	
100	coal	3138	New Castle Plant	PA	NC3-2	SNCR, ESP	NOx control	Selective Noncatalytic Reduction	

Summary / PM\_avg\_MMBtu / PM\_New\_MMBtu / PM\_coal\_MMBtu / PM\_avg\_MW / PM\_New\_MW / Total\_Metal\_avg\_MMBtu / Total\_Metal\_New\_MMBtu

Ready

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# Total PM Emissions ICR Data vs WESP Data

	# of Units	Ave PM <sub>f</sub> Lb/MMBtu
<b>PM<sub>f</sub> Limit</b>		<b>0.03</b>
<b>Top 12% mean</b>	130	0.0022
<b>Dallman Unit 3</b>	1	0.001
<b>HL Spurlock Unit 1</b>	1	0.0036



## New Coal Plant WESPs not in ICR Data

Facility	Unit Size (MW)	Fuel	APC Control Technology	Status
Elm Road	2 x 615	Pittsburgh #8	FF / WFGD / <b>WESP</b>	<b>Online</b>
Trimble County	750	Blend of Bituminous & Sub-bituminous	ESP / FF / WFGD / <b>WESP</b>	<b>Online 2011</b>
Prairie States	2 x 750	Southern IL Bituminous	ESP / WFGD / <b>WESP</b>	<b>Fall 2011 &amp; Spring 2012</b>

## *Fabric Filter Issues*

- Increased pressure drop
  - may require new larger fans
  
- More real estate for FF
  - is there enough room
  
- On-going bag replacement
  - cost + outage time
  
- Increased waste by-product
  - need to landfill

***Are all costs factored into an overall life cycle analysis?\_***

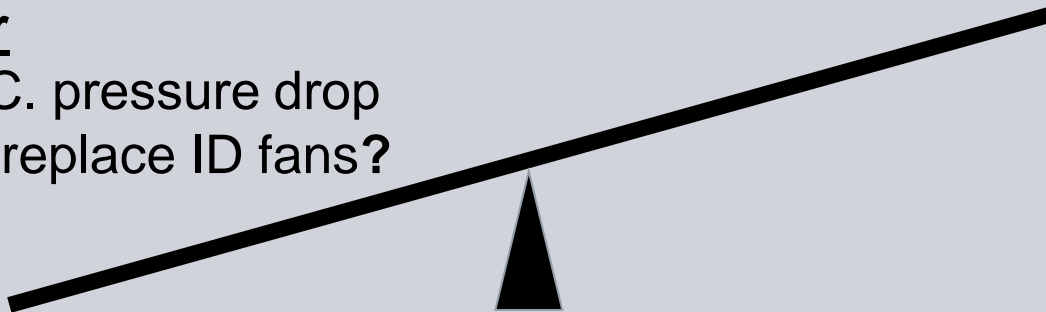
## Pressure Drop Comparison

### Wet ESP + duct

< 2" W.C. average pressure drop  
Existing ID Fans may be acceptable.

### Fabric Filter

= 7" - 10" W.C. pressure drop  
May require replace ID fans?



## *Real Estate comparison*

### **Fabric Filter**

Velocity = 4-6 fps

@ twice the size of a WESP

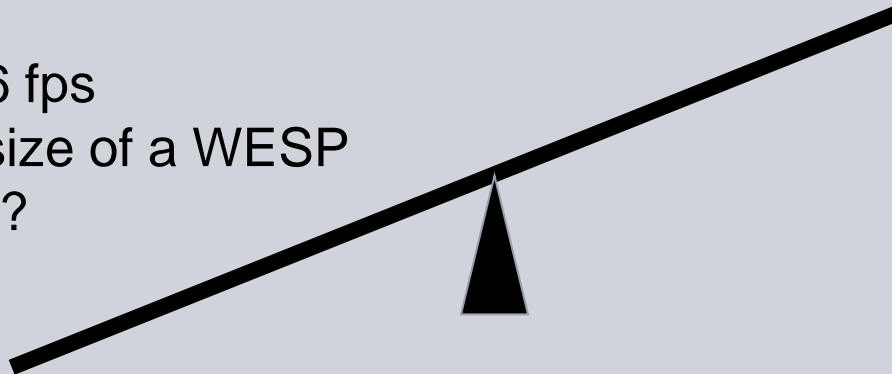
Is there room?

### **Wet ESP**

Velocity = 7-10 fps

@ Half the size of a FF

Use area between WFGD & stack.



***WESP installed after a WFGD***

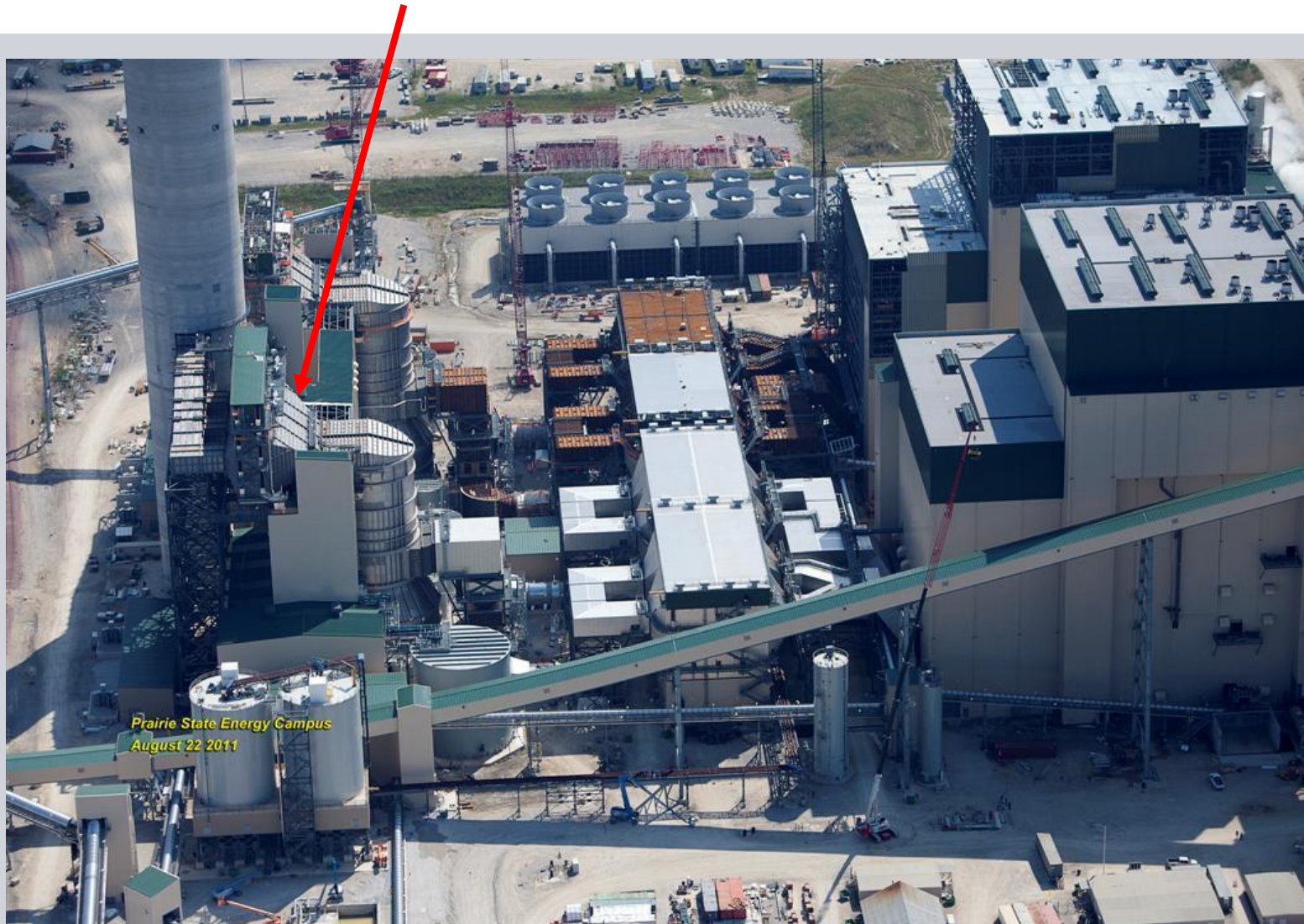


***FF / WFGD / WESP***





***DESP / WFGD / WESP***



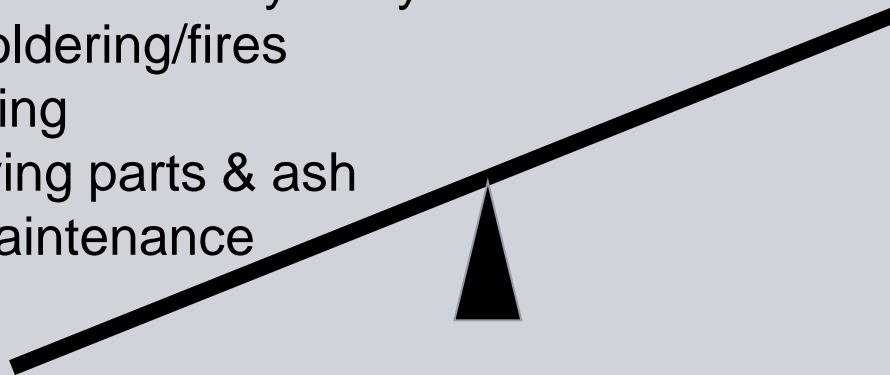
## Maintenance Comparison

### Fabric Filters

- Bag Replacement every 3-5 years
- Hopper smoldering/fires
- Ash conveying
- A lot of moving parts & ash
- Constant maintenance

### Wet ESP

Alloy internals - no replacements  
Everything is saturated & wet  
No moving parts & no ash  
Drain to WFGD  
Outage inspection & maintenance





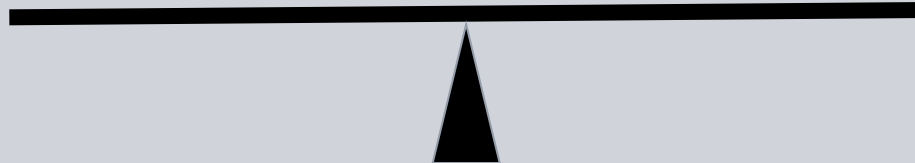
## Water Usage Comparison

### Fabric Filter

- No water used

### Wet ESP

- No additional burden
- First use of WFGD water
- Drain to WFGD



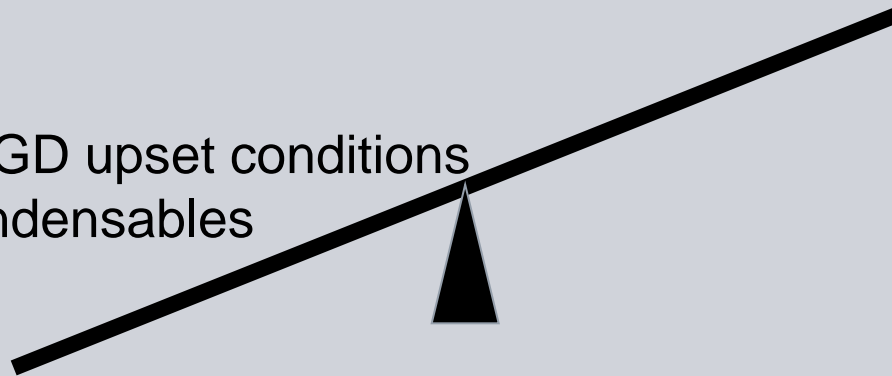
***Process Comparison***

**Fabric Filter**

Cannot handle WFGD upset conditions  
Cannot remove condensables

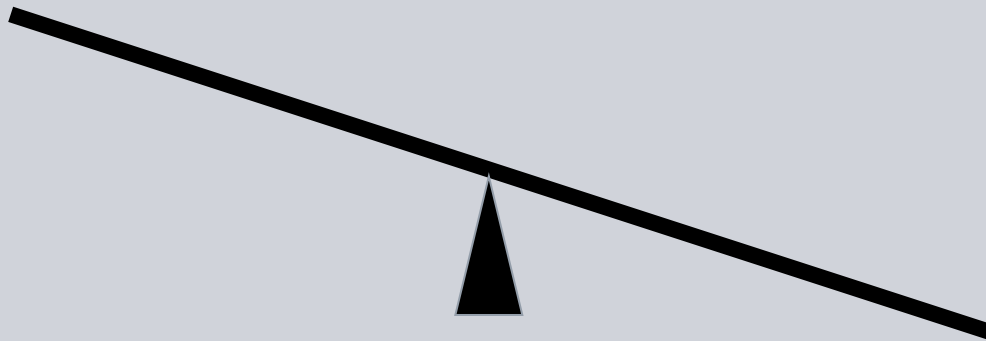
**Wet ESP**

Can handle WFGD upset conditions  
Can remove condensables



***Capital Cost comparison***

**Fabric Filter  
\$15- \$25 /kw**



**WESP  
\$40-\$70 /kw**

## Summary

- **Wet ESP after a WFGD offers**
  - Less pressure drop
  - Less maintenance
  - Less real estate
  - High removal (> 90%) of PM<sub>2.5</sub>, SO<sub>3</sub> and some Hg
- **Need to analyze the economic benefits of a WESP's lower operating costs vs higher capital cost than a Fabric Filter.**
- **Design /Build for worst case situation to avoid future add-ons**
  - Future PM regulations will likely include condensables – SO<sub>3</sub>
  - MATS limits will get more stringent – 5 year review
  - Look to limits for new coal plants–0.007 lb/MWh

***THANK YOU***

**SIEMENS**

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