NATIONAL ENERGY TECHNOLOGY LABORATORY

An Analysis of DSI's Impact on Dispatch Economics in PJM

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Identifying The Problem…

- **Acid Rain cap and trade program (1990's) gave compliance options:**
  1. Install FGD
  2. Buy emission allowances on open market
  3. Switch to low-sulfur coal (compliance coal)
- **CAIR resulted in deployment of FGD in the eastern U.S. but many existing coal units still unscrubbed**
- **Combination of MATS, ~~CSAPR~~[1] will likely result in all coal units being scrubbed**
- **Should existing coal units install dry sorbent injection (DSI) or FGD[2] for environmental compliance?**

1. *CSAPR remanded to EPA on 8-21-12 by D.C. Circuit, but will eventually be replaced*
2. *This analysis assumes dry FGD is the other candidate compliance technology*

Dry FGD vs. DSI

	Dry FGD	DSI
Capital Cost	High	Low
Operating Cost	Low	High
Installation Difficulty	High	Low
Experience Base[1]	Mature	Immature
Applicability	All coal types	Low S, Cl coals only

1. *Relative to HCl control – it is acknowledged that DSI is an established compliance strategy for SO_3 control*

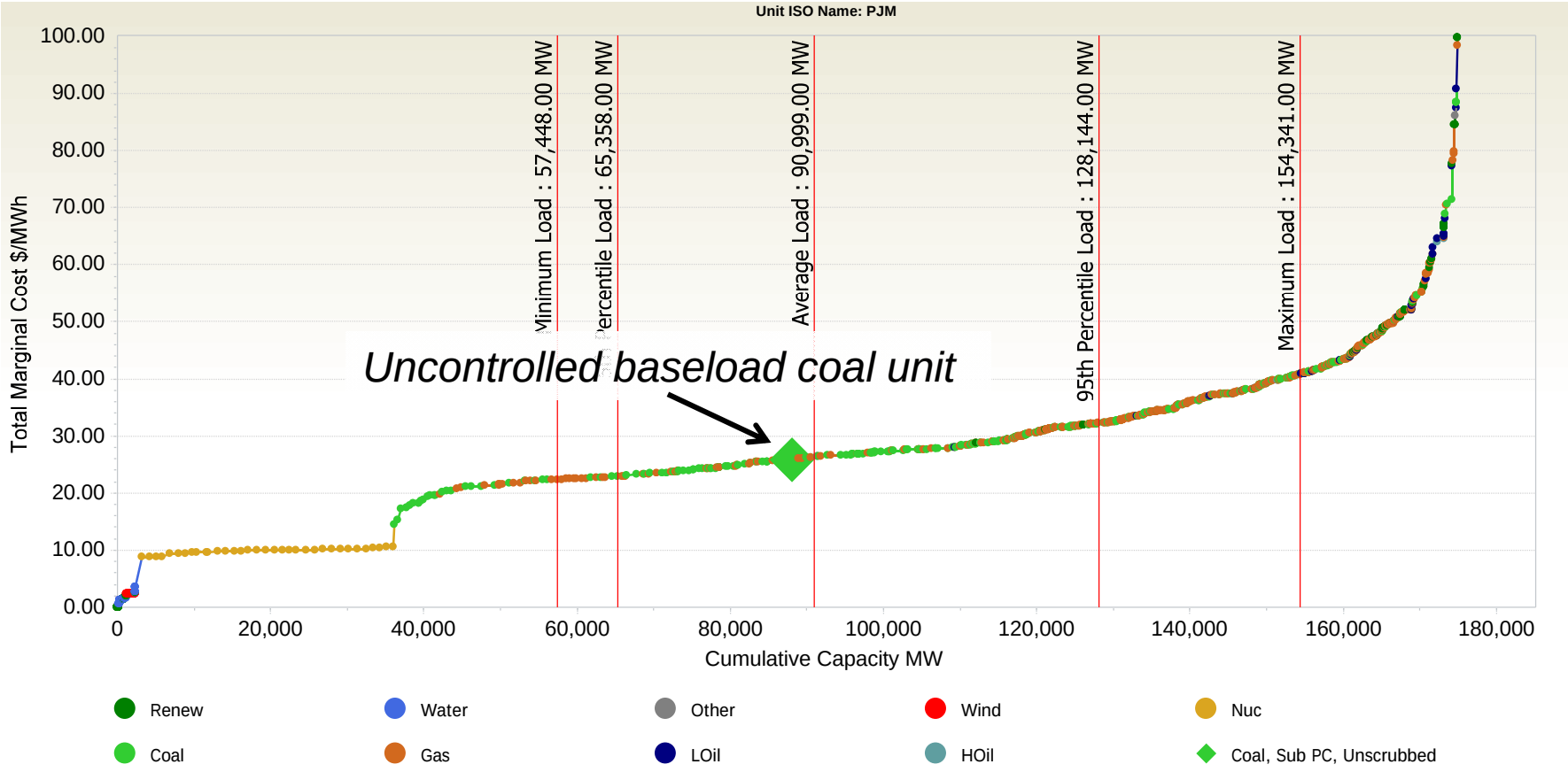
Dispatch Economics of MATS Compliance Options

- **How will the marginal cost of operation[1] change for an unscrubbed coal unit that installs dry FGD for MATS compliance in PJM?**
- **Will an existing, baseload coal unit that installs dry sorbent injection for MATS compliance maintain a reasonable capacity factor in PJM?**
  - DSI sorbents considered are hydrated lime, trona, and sodium bicarbonate

1. *Defined as the sum of fuel and variable O&M cost in $/MWh*

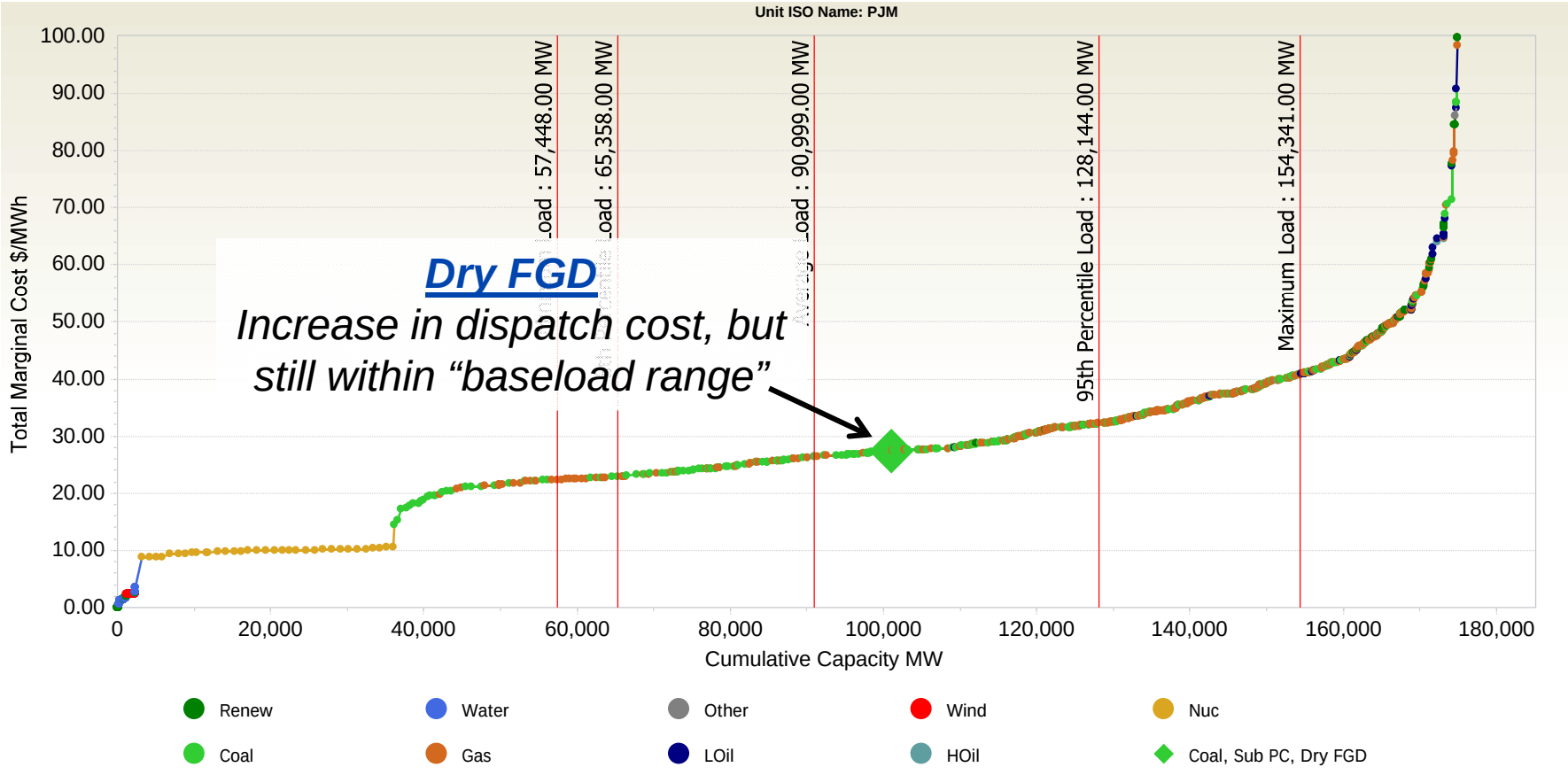
PJM Merit-Order Dispatch

Subcritical PC, Unscrubbed



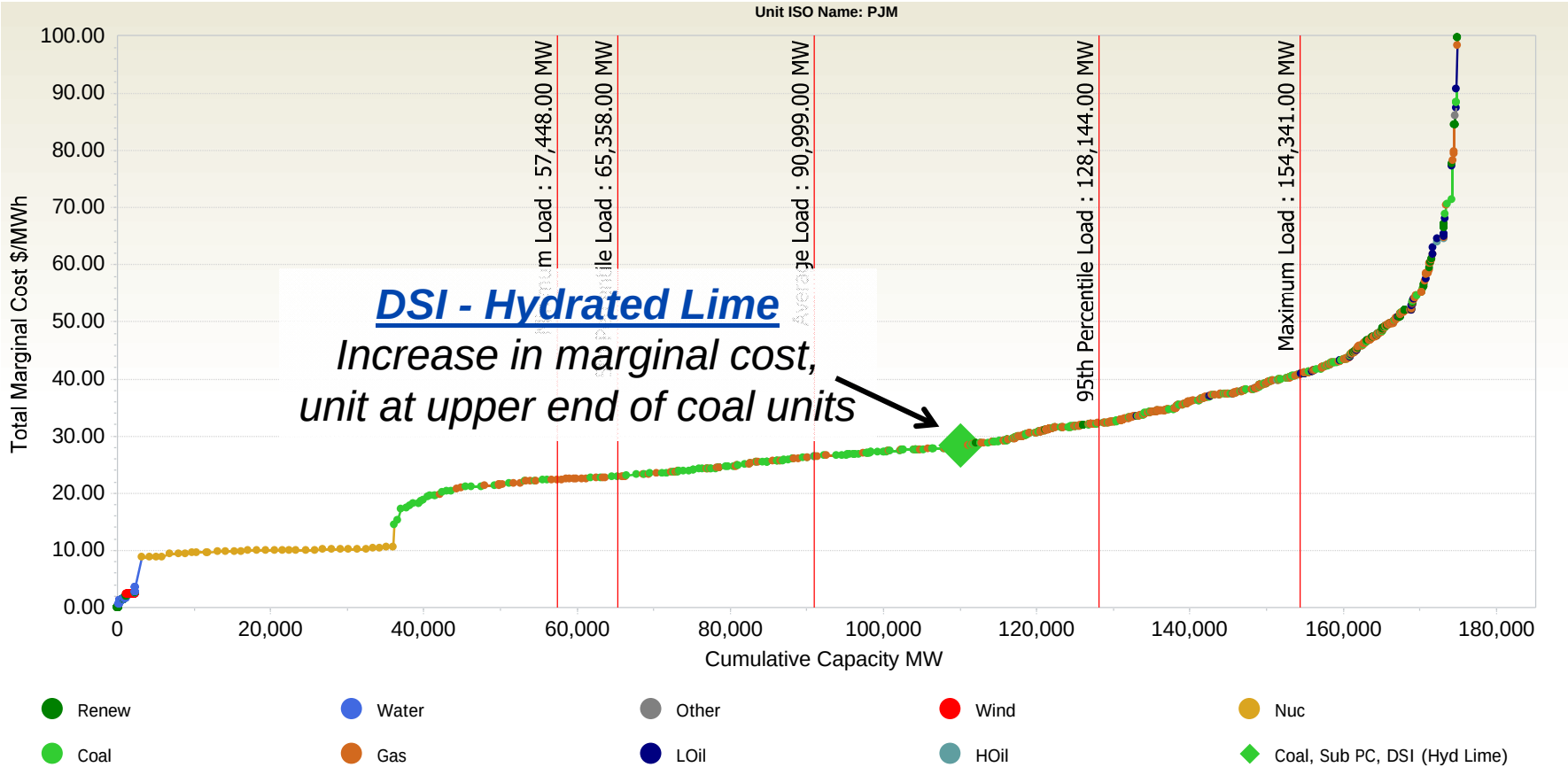
PJM Merit-Order Dispatch

Subcritical PC, Dry FGD



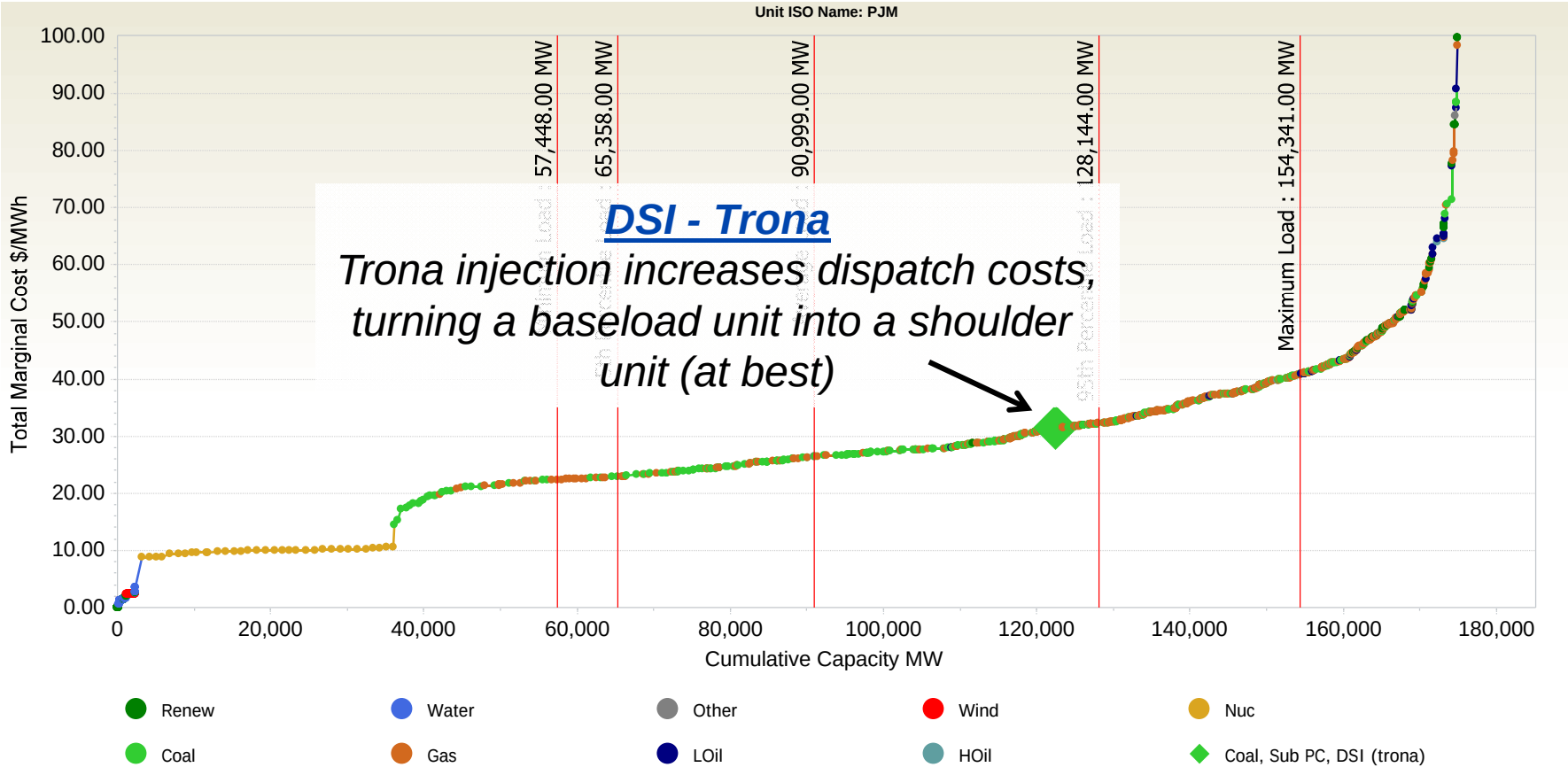
PJM Merit-Order Dispatch

Subcritical PC, DSI (Hydrated Lime)



PJM Merit-Order Dispatch

Subcritical PC, DSI (Trona)

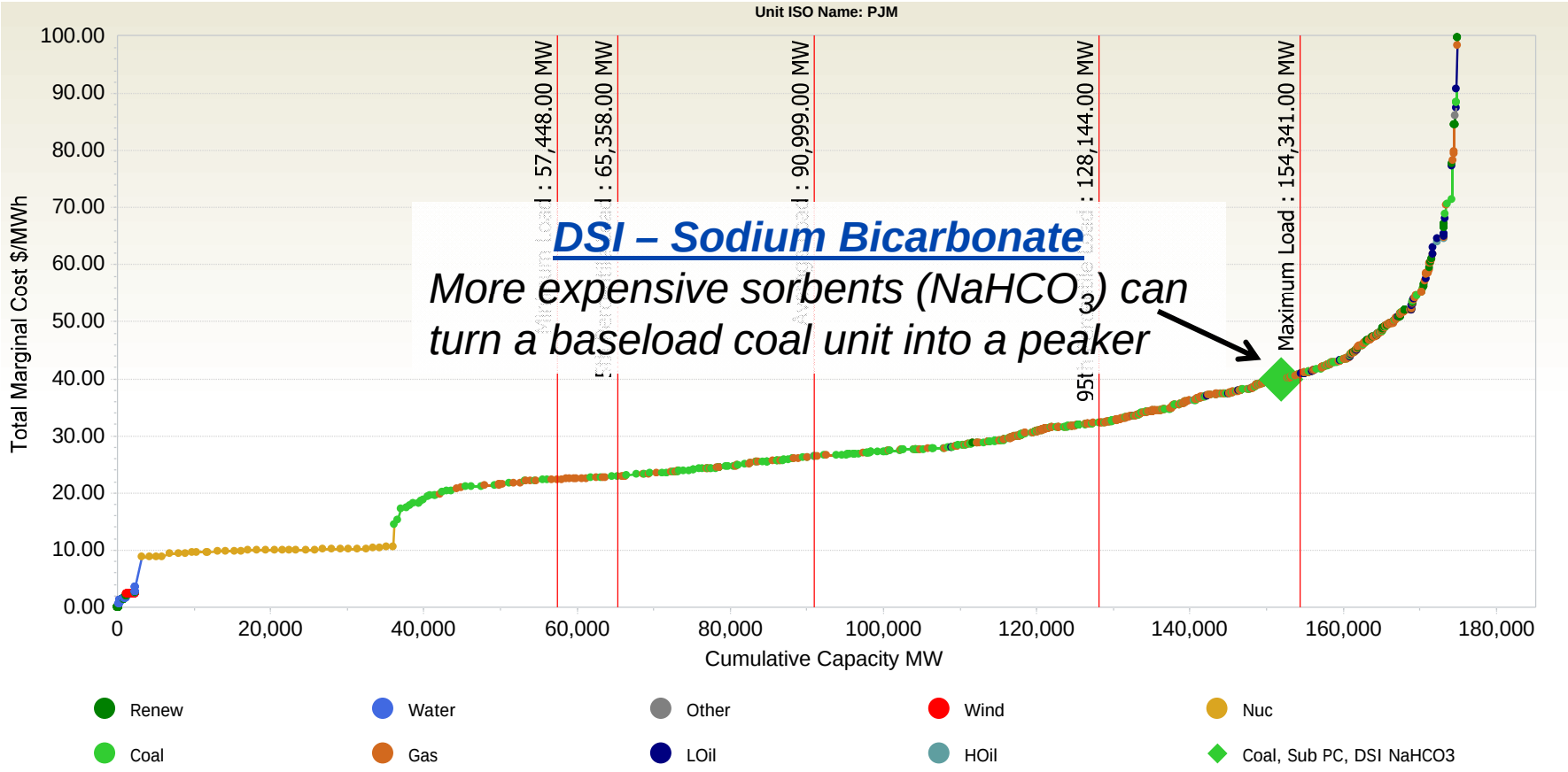


DSI - Trona

Trona injection increases dispatch costs, turning a baseload unit into a shoulder unit (at best)

PJM Merit-Order Dispatch

Subcritical PC, DSI (Sodium Bicarbonate)



DSI – Sodium Bicarbonate

More expensive sorbents ($NaHCO_3$) can turn a baseload coal unit into a peaker

Conclusions[1]

- **DSI increases the marginal cost of operation to a greater extent than a Dry FGD retrofit**
- **Hydrated lime injection has the least adverse impact on marginal cost of all DSI options evaluated**
- **Sodium-based sorbents (trona, sodium bicarbonate) are most expensive, turning baseload units into peakers**
- **Units installing sodium-based sorbents will see capacity factor decreases in markets like PJM, cutting profits**
- **Ash disposal impacts of sodium-based sorbents not considered. This could further increase costs for units using trona or sodium bicarbonate.**

1. These results are specific to units that have existing ESP's. Results may vary for units equipped with fabric filters. However since unscrubbed units burning low S coal with ESP's in PJM outnumber those with fabric filters by 12-to-1, these results are representative of the choices utilities in PJM face.
(Source: Ventyx, accessed September 7, 2012)

Design Basis

- **Existing 500 MW subcritical PC unit, 33% efficiency**
- **Unscrubbed, existing ESP**
- **Assumed Central Appalachian compliance coal**
  - $60/ton[1], 12,000 Btu/lb[2], 1% sulfur[2], 934 ppmw Cl[3]
- **Hydrated Lime: $90/ton[4], 3 Lb sorbent/Lb acid gas[3]**
- **Trona $110/ton[4], NSR = 2.5[5]**
- **$NaHCO_3$ $250/ton[4], NSR = 2.5[5]**
- **Assumed Dry FGD O&M costs: $1.56/MWh[6]**

1. http://www.eia.gov/coal/nymex/, accessed August 27, 2012
2. http://www.cmegroup.com/trading/energy/coal/central-appalachian-coal_contract_specifications.html
3. "*Results of Dry Sorbent Injection Testing to Reduce HCl,"* Laird et al, Paper #107, 2012 MEGA Symposium
4. "*Coal's Triple Challenge for Air Regulation Compliance"* Johnson et al, Paper #1, 2012 MEGA Symposium
5. "*Survey of Power Plants Using Dry Sorbent Injection for Acid Gas Control,"* Arambasick et al, Paper #92, 2012 MEGA Symposium
6. Energy Velocity, accessed August 27, 2012, Average O&M cost for coal units with Dry FGD in PJM