

Comparison of CEMS and Fuel Data for Heat Rate

Jim Staudt, Ph.D., Andover Technology Partners

*For questions: staudt@AndoverTechnology.com
(978) 683-9599*

EPRI CEMS Meeting

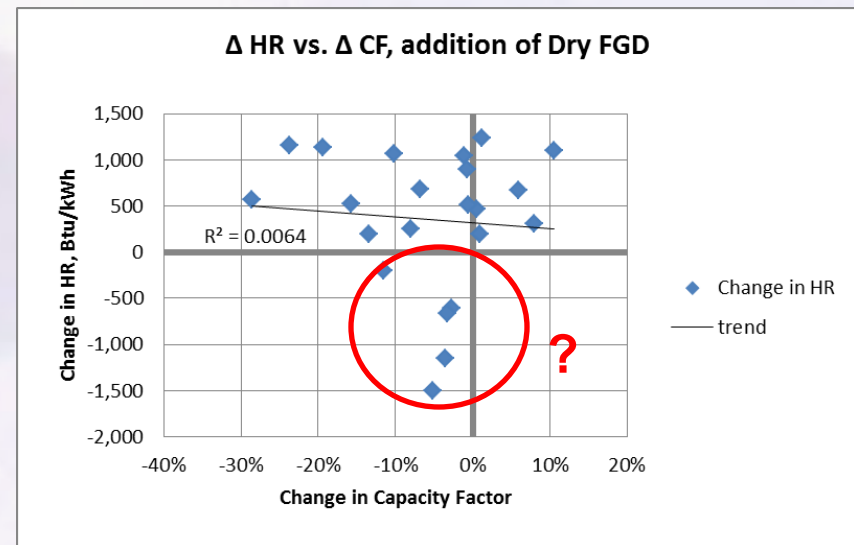
May 2-3, 2018

Public Sources of Heat Rate data

- EPA's National Electric Energy Data System (NEEDS)
 - Net heat rate uses heat rates developed by EIA from 3 year periods for Annual Energy Outlook examining fuel use and generation data
- Energy Information Administration (EIA) Form 923
 - Reported fuel use and generation data
- EPA's Air Markets Program Data (AMPD)
 - Heat input determined from exhaust parameters, gross generation reported
- EPA's eGRID (developed from AMPD)
- FERC Form 1 data (self reported)

NEEDS

- Examined effects of capacity, capacity factor, fuel, age, steam cycle and if scrubber was installed – results presented in 2014 MEGA Symposium
 - Most trends as expected
 - Capacity, age, steam cycle
 - Some unexpected
 - Likely due to noise in data



EPA's AMPD and EIA Form 923 Study

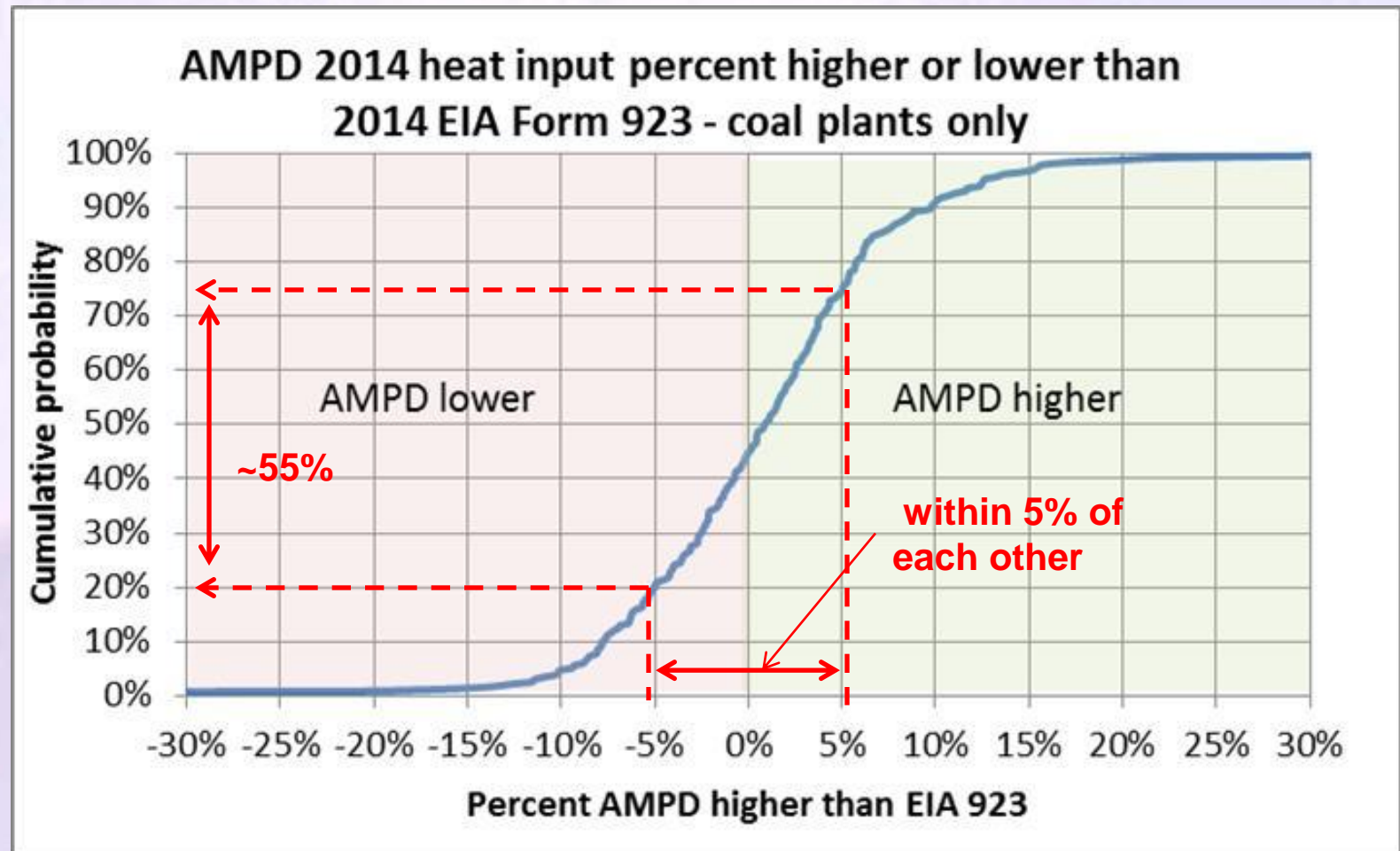
(also see paper in 2016 MEGA Symposium)

- Compare heat input data from EIA Form 923 and EPA's AMPD for coal plants and determine degree of consistency/inconsistency
- Examine the stability of the F factor relationship (flow versus heat input or CO₂ versus heat input) with different coals and the potential impact on “apparent” potential improvement in heat rate when performing heat rate variability analysis

Form 923 versus AMPD comparison

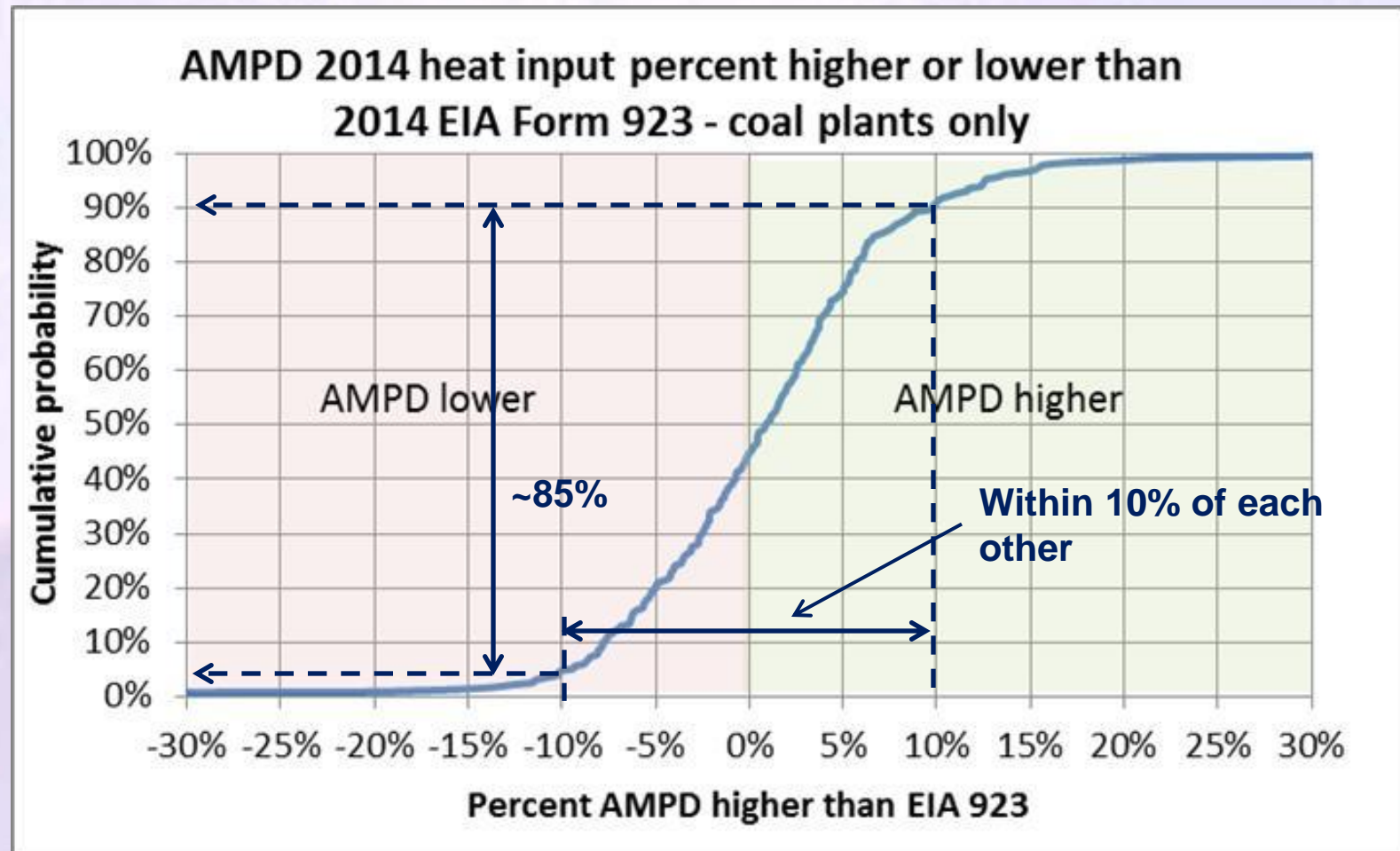
- Compared annual 2014 AMPD data and EIA Form 923 data for electric utility boilers
 - AMPD is from CEMS
 - EIA Form 923 from reported fuel use
- Compared total annual heat input for 232 plants that only have boilers with coal as primary fuel (no CTs or combined cycle on site)
- Also examined data for coal units with lowest CO₂ emission rate based upon AMPD and compared against EIA

Comparison of heat input – AMPD versus EIA Form 923 (see 2016 Mega paper)



Comparison of heat input – AMPD versus EIA Form 923

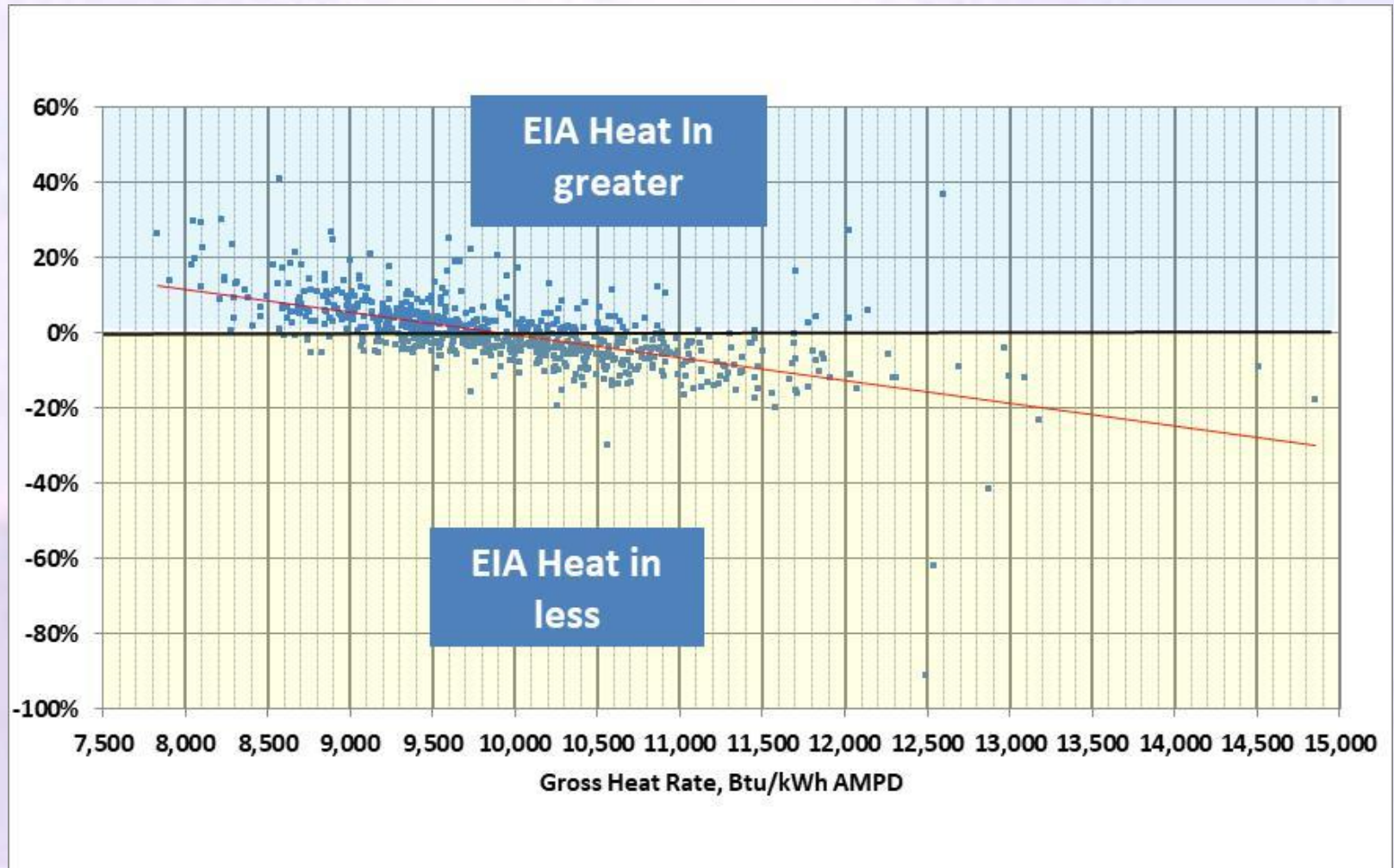
Form 923



Comparison of 2014 AMPD to EIA Form 923 Plant Heat Input

- AMPD heat input and heat input estimated from EIA Form 923 fuel use data are within 5% in only about 55% of the plants
- AMPD heat input and heat input estimated from EIA Form 923 fuel use data are within 10% in only about 85% of the plants
- The maximum amount that AMPD was lower than that determined by Form 923 was 100%.
- The maximum amount that AMPD was greater than that determined by EIA Form 923 was 34.3%

EIA Form 923 versus AMPD Heat Input – All coal units for 2014



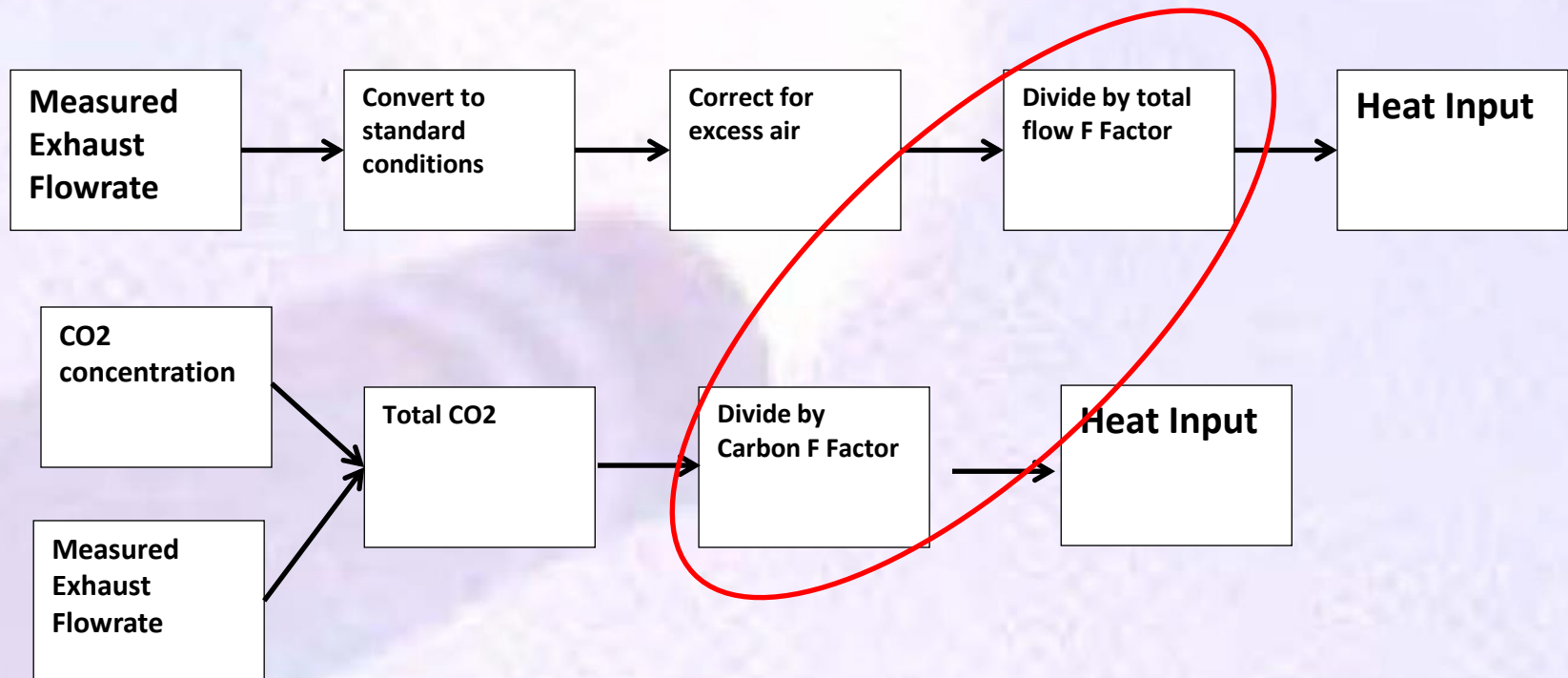
Conclusions – AMPD versus EIA

- Significant differences between heat input from AMPD data and EIA Form 923 fuel data
 - AMPD is based upon measured stack parameters while EIA Form 923 is based upon fuel use
- On a unit basis, as AMPD heat rate in drops, EIA heat in tends to be higher than AMPD and as AMPD heat rate in increases, EIA heat in tends to be lower than AMPD
- Similar trends for 2015 AMPD and EIA data

AMPD Inference of heat input from measured stack parameters

Heat input is assumed to be proportional to flowrate or CO2

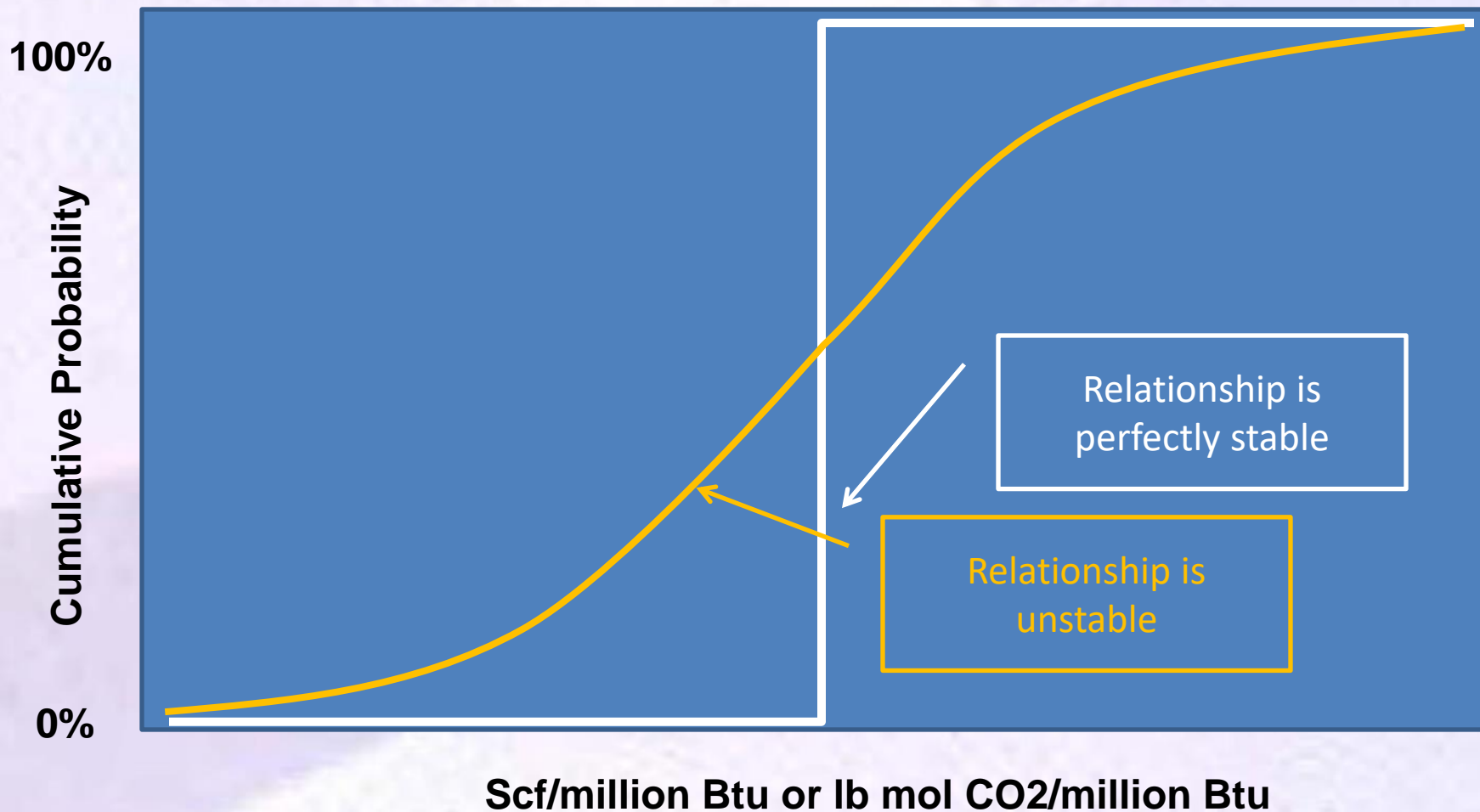
How stable is the "F factor" relationship?



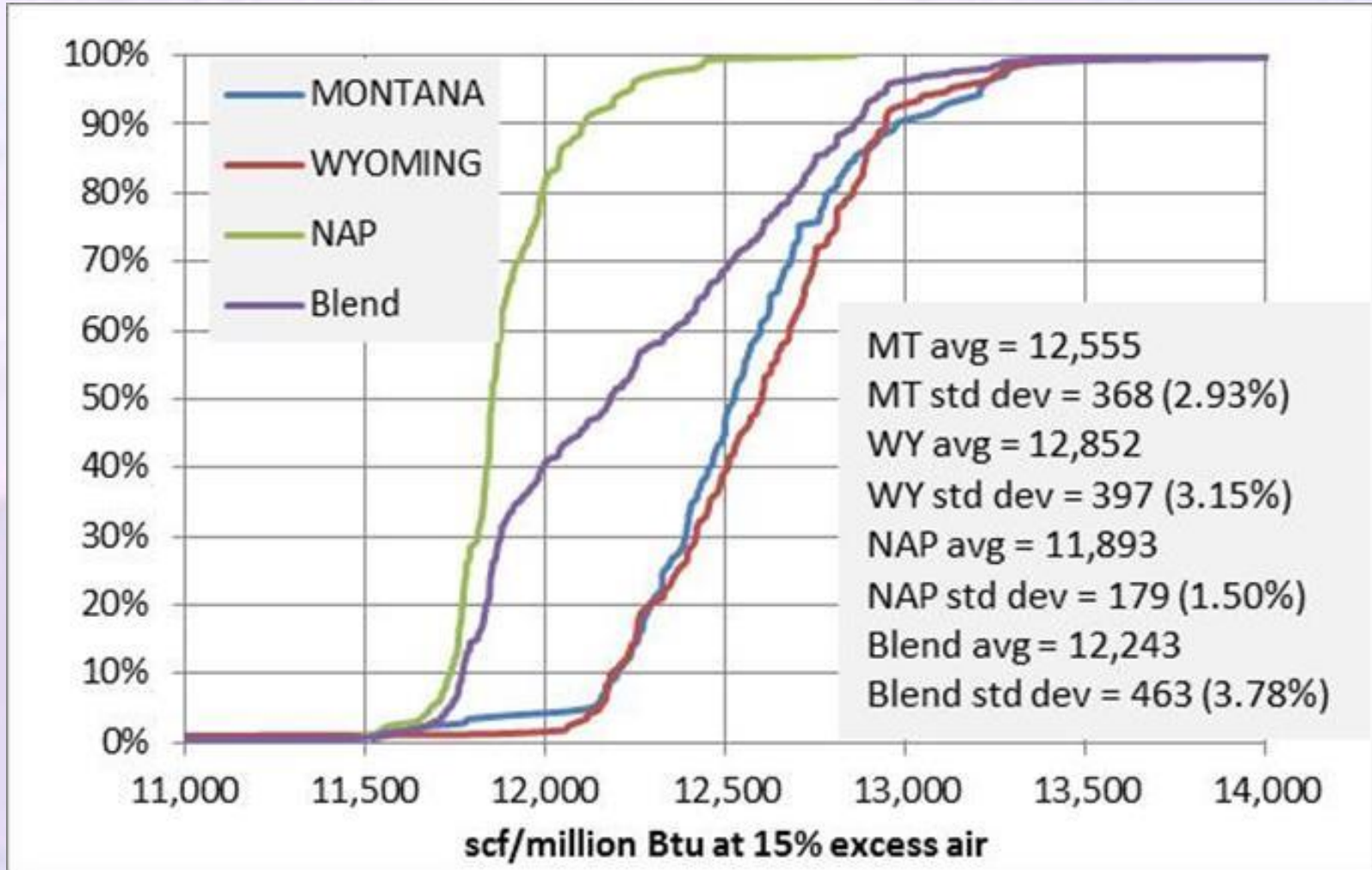
Examination of the stability in F factor relationship for different coals

- The actual relationship between flowrate and heat input is a function of coal characteristics.
- Used fuel data from USGS Coal Quality database
- For different coals performed calculations to determine exhaust flowrate per million Btu and lbmol CO₂ per million Btu
- Examined variability in relationship and potential impact on heat rate variability analysis
- **Assume “perfect” flow and CO₂ measurement**

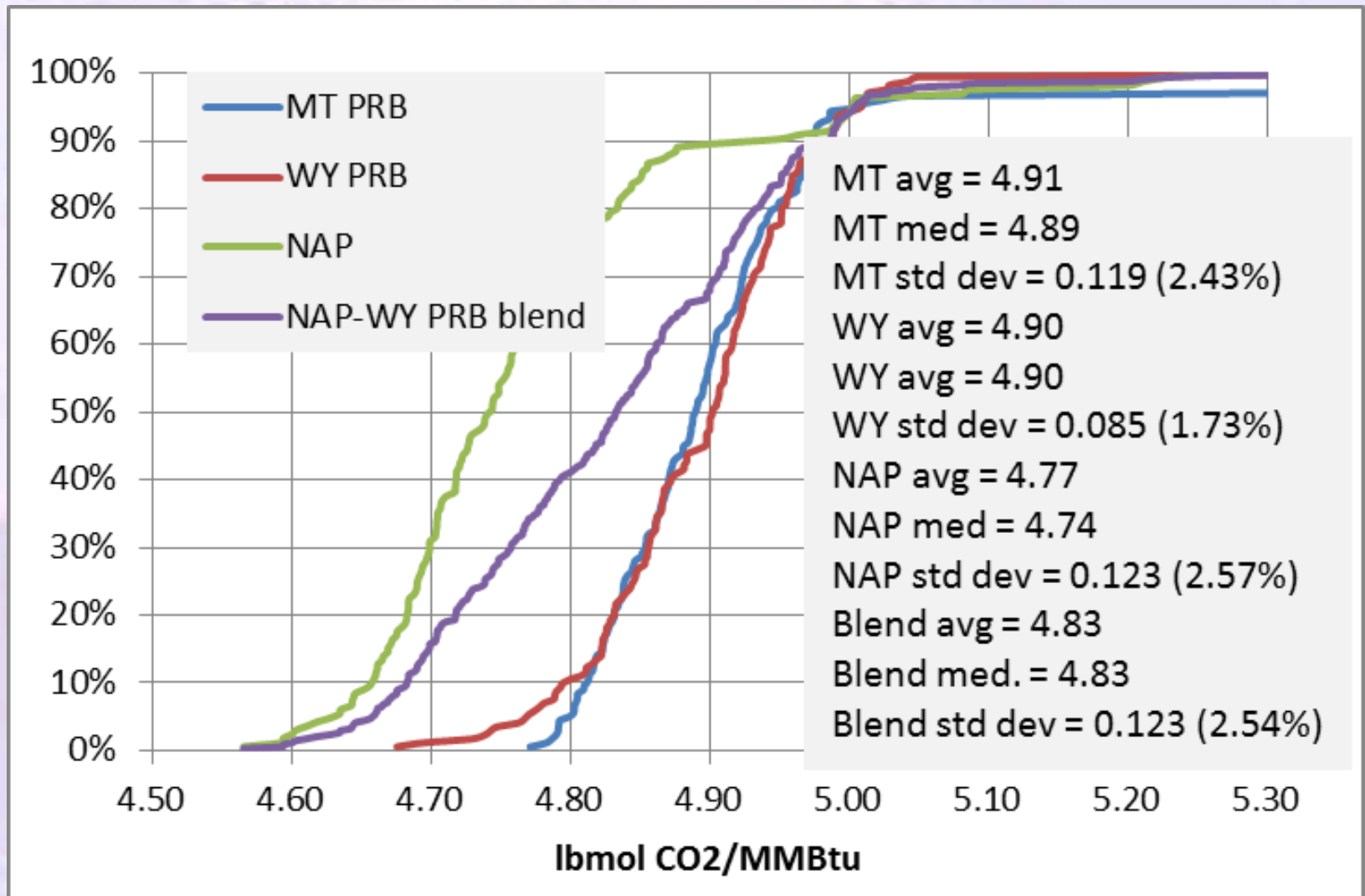
Examine relationship between flowrate and heat input and CO2 and heat input using samples of coals



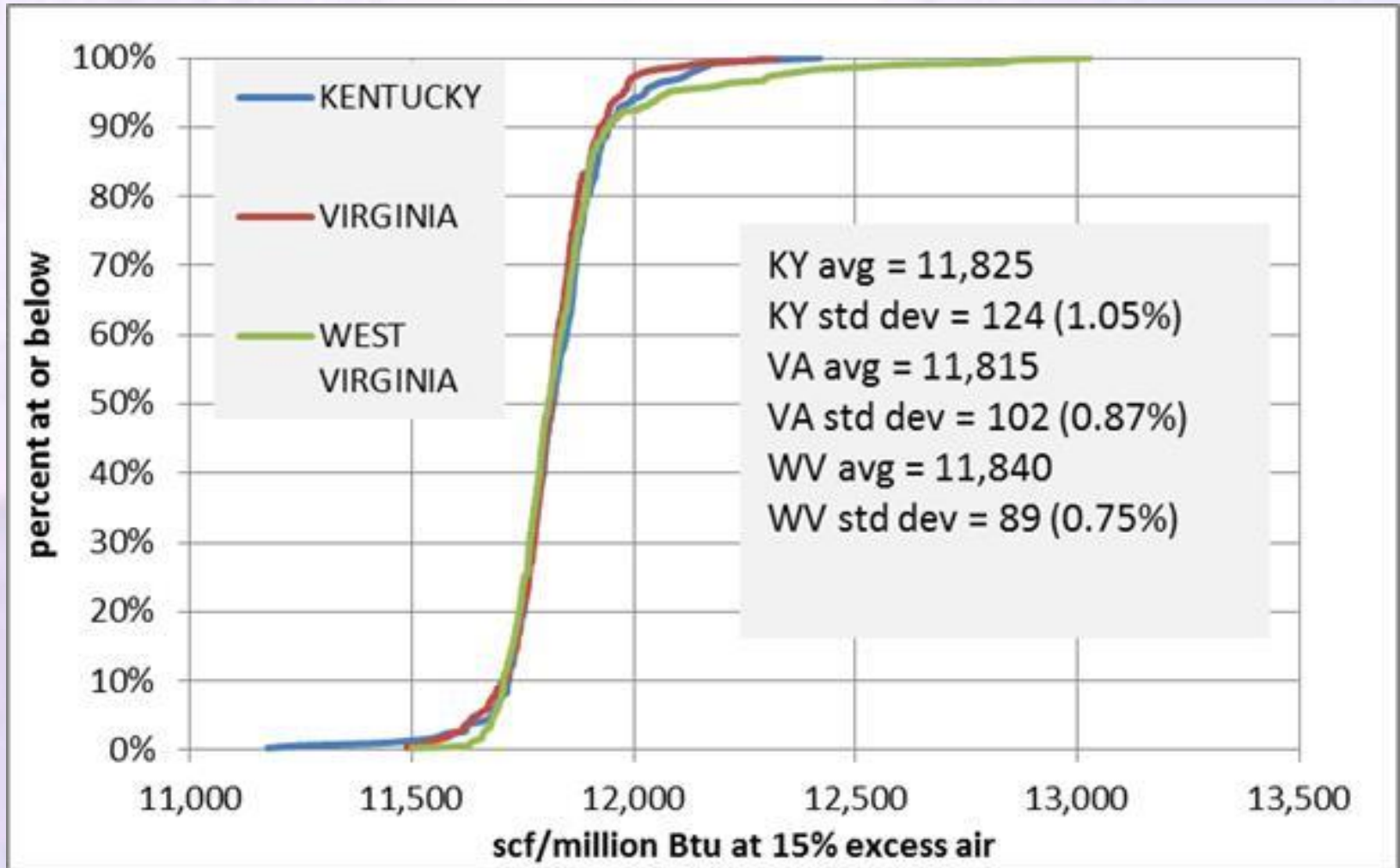
Cumulative probability of exhaust flow to heat input at 15% excess air for Montana PRB, Wyoming PRB, Northern Appalachian (NAP) coals and 50/50 blend of WY PRB and NAP



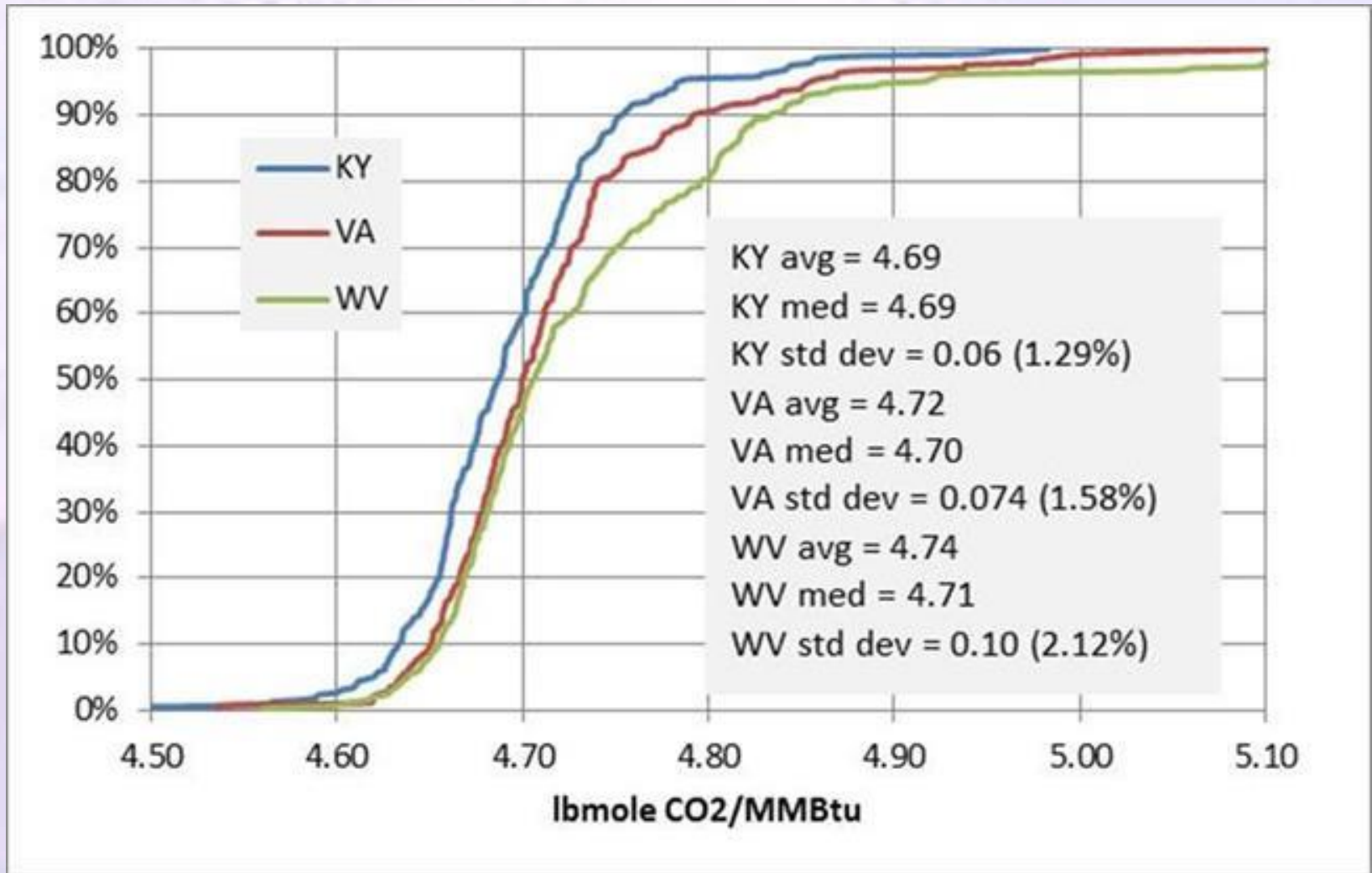
Cumulative probability of lbmol CO₂ to heat input for Montana PRB and Wyoming PRB



Cumulative probability of exhaust flow to heat input at 15% excess air for Kentucky, Virginia and West Virginia Central Appalachian coals



Cumulative probability of lbmol CO₂ to heat input for Central Appalachian coal

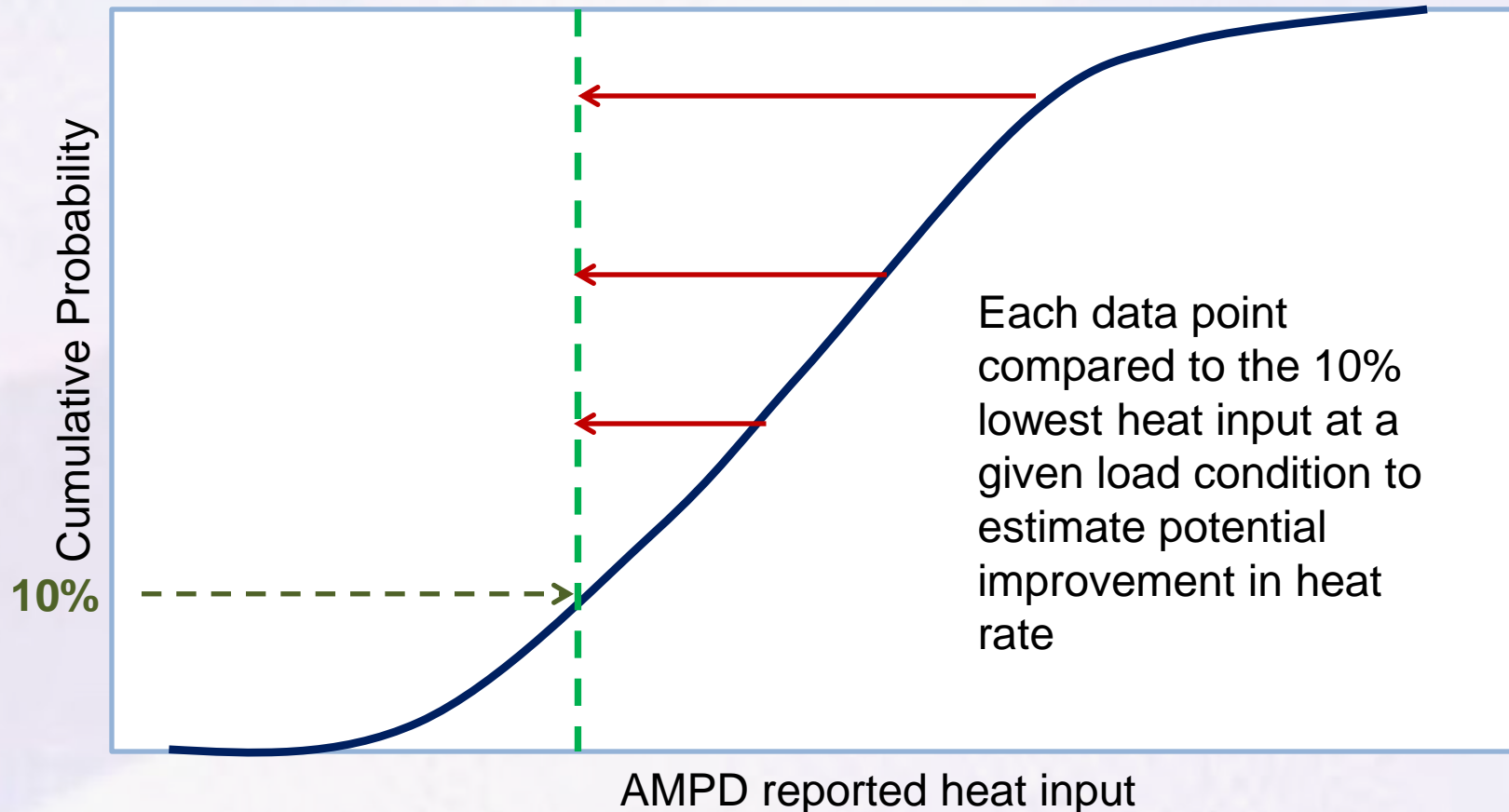


Apparent heat rate improvement opportunities

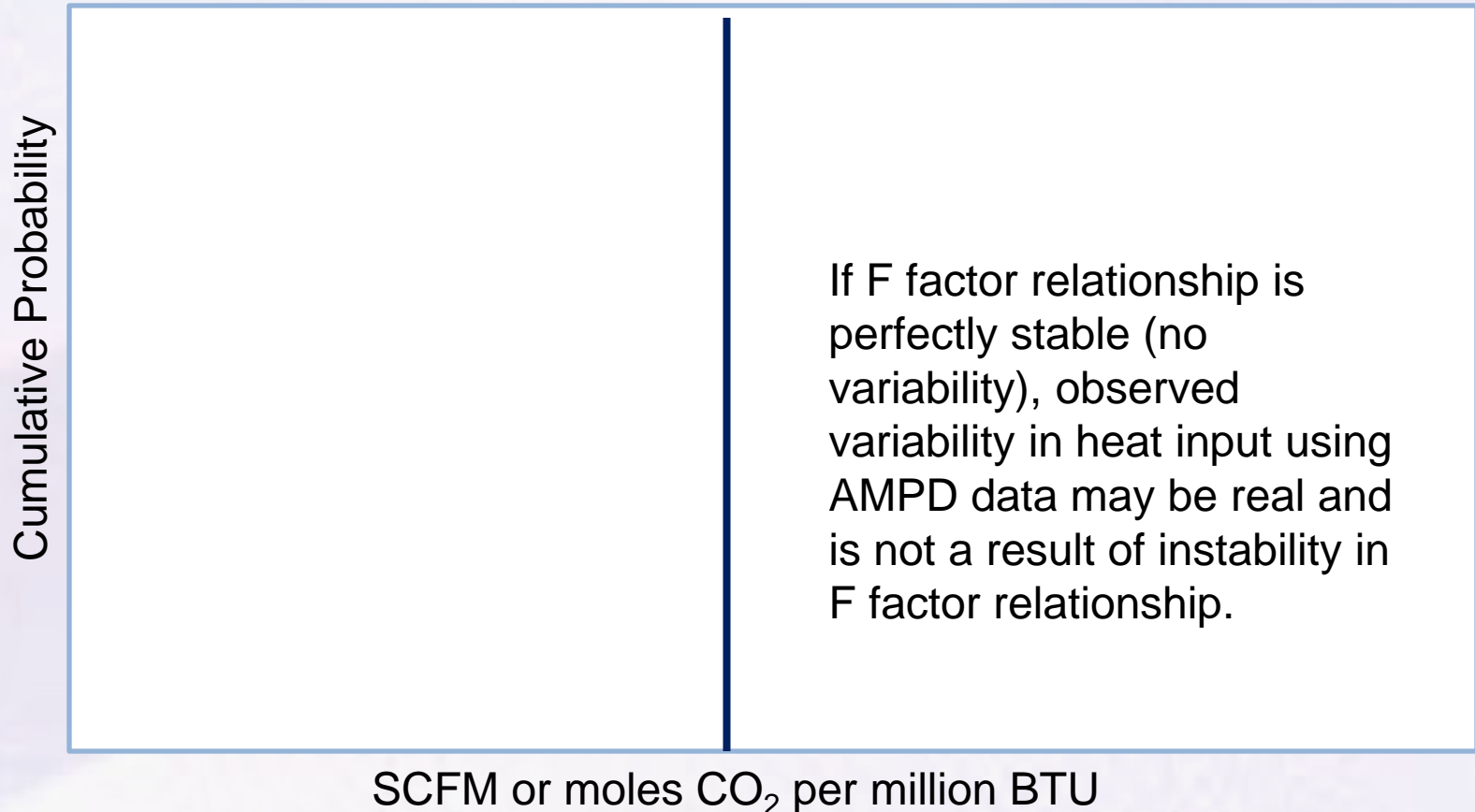
- If hourly heat rate calculated from AMPD appears to vary under a given condition that *may* indicate an opportunity to improve heat rate.
 - This was basis of EPA's Building Block One assessment
- What if the observed variability of inferred heat rate at a given condition is, in fact, due in part to instability of F factor relationship rather than actual change in heat rate?
 - How significant is this effect?

Heat Input Variation – EPA’s BB1 approach

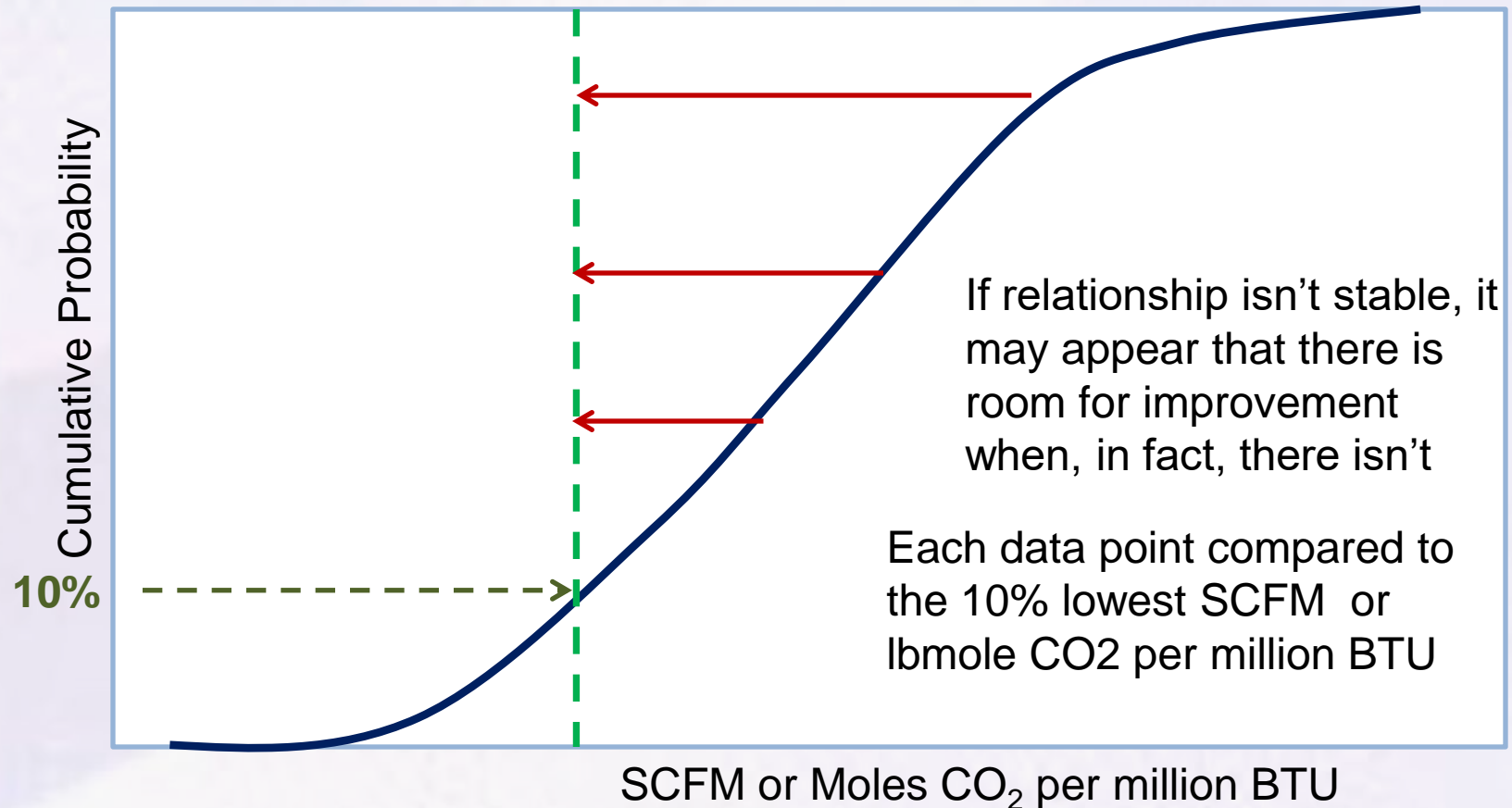
evaluation of heat input variation at specific load and ambient temperature conditions



“Apparent” improvement opportunity in heat input



“Apparent” opportunity for improvement in heat input from F factor instability



“Apparent” potential improvement in heat rate resulting from instability in the relationship between flowrate and heat input or CO2 emissions and heat input.

Method	MT PRB	WY PRB	NAP	WY PRB- NAP Blend	KY CAP	VA CAP	WV CAP
Flow	3.53%	3.95%	1.56%	4.43%	1.09%	1.11%	1.28%
CO2	2.16%	2.36%	2.93%	3.47%	1.48%	1.57%	1.90%

Conclusions – F factor stability

- F factor relationship used to determine heat input in AMPD does not appear to be stable for most coals some more or less stable than others
- Impacted by fuel type and whether or not there is blending. Blending will result in greater instability in the relationship.
- May have significant impact on “apparent” heat rate improvement when performing heat rate variability analysis in the manner performed by EPA for BB1
- *This does not factor in flow monitoring variability, which would increase the effect.*

Recommendations

- Need to better understand differences in the AMPD heat input and the EIA fuel use data
 - Hopefully make data more consistent
- Need to examine the issue of instability in F factor relationship and impact on apparent heat rate
 - Examine more plant coal data
 - Include the impacts of flow monitor performance variability

- For Questions or Comments
 - staudt@AndoverTechnology.com
 - (978) 683-9599 (office)
 - (978) 884-5510 (mobile)
 - Website: www.AndoverTechnology.com

