



ENERGY STAR® Data Center Infrastructure Rating Development Update

Web Conference
November 12, 2009



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Agenda



- Welcome
- Rating Development Timeline
- EPA Rating Overview
- Response to Industry Feedback
- Proposed Rating Model
- Next Steps

Rating Development Timeline



- October 2007 – March 2008
 - ◆ Consultations with industry stakeholders
- March 2008 – June 2009
 - ◆ Data collection, Updates to industry
- June – September 2009
 - ◆ Analysis & Preliminary rating development
- September 29, 2009
 - ◆ Preliminary results presented to industry (*Recording available*)
- October – November 2009
 - ◆ Analysis of industry feedback & Final rating development
- April 2010
 - ◆ Data center model scheduled for release

Rating Development Objective



- Build on existing ENERGY STAR methods and platforms
- Apply to stand-alone data centers and data centers housed within office or other buildings
- Assess performance at the building level to explain how a building performs, not why it performs a certain way
- Provide users with information and links to additional resources to aid in their efforts to determine next steps
- Offer the ENERGY STAR label to data centers with a rating of 75 or higher (performance in the top quartile)

Rating Development

EPA Methodology



- Express data center efficiency as an ENERGY STAR 1-to-100 rating
 - ◆ Each point on rating scale equals 1 percentile of data centers
- Adjust for operating constraints outside of the owner/operators control
 - ◆ Target efficiency will depend on operational constraints
- Factors for adjustment to be determined based on results of data collection and analysis

Preliminary EPA Findings Presented on September 29



- With over 100 data centers, EPA has identified that there will be adequate data to support a 1-to-100 Rating
- The EPA rating will incorporate power usage effectiveness (PUE)
 - ◆ Total Energy / UPS Energy
- The data show a strong correlation between PUE and total UPS energy; this effect will likely be included in the rating algorithm
- The data show a weaker correlation between PUE and Tier Level than anticipated; this effect is still being evaluated for inclusion in the rating algorithm
- Data centers do not exhibit a strong weather dependence

Industry Feedback



- Most comments received by EPA focused on:
 - ◆ Efficiency metric (PUE vs. EUE)
 - ◆ Source Energy
 - ◆ Use of UPS meter for IT Energy
 - ◆ Stand Alone vs. Enclosed Data Centers
 - ◆ Climate
 - ◆ Economizers
 - ◆ Tier level
 - ◆ Data Center Type (traditional, hosting, internet, etc.)
- Will provide more detail on each

Efficiency Metric: PUE vs. EUE



Issue: EUE proposed as data center efficiency metric

Industry Feedback: PUE preferred over EUE

- The name of the data center efficiency metric has been revised, but the value remains the same:

Power Usage Effectiveness (PUE) = Total Energy / UPS Energy

- Total Energy includes all fuels (electricity, natural gas, diesel, etc.)

Efficiency Metric: PUE vs. EUE



- Why change to PUE?
 - ◆ EPA prefers to use an existing standardized metric
 - ◆ The name Energy Usage Effectiveness (EUE) had been considered to distinguish Total Energy from Total Electricity load
 - ◆ The use of **Total Energy** is consistent with the methodology detailed in Green Grid's white papers
 - PUE can be calculated using either energy or power
- Why use Total Energy?
 - ◆ This is consistent with all EPA rating models
 - ◆ For buildings that are 100% electric (most cases), a total energy metric is identical to an electricity metric
 - ◆ In cases where fuel is used (e.g. to power generators regularly or for absorption chillers) it is important to capture this load
 - ◆ For data centers enclosed in other buildings, note that Total Energy is the energy for the data center space only

Source Energy



Issue: Source Energy required for rating calculations

Industry Feedback: Why is Source Energy necessary?

- Source Energy is used for all EPA rating models
- It is the most equitable unit of evaluation to compare buildings with a diverse mix of fuel types
- It represents the total amount of raw fuel required to operate the building, and incorporates all transmission, delivery, and production losses
- A detailed description is available on the ENERGY STAR Web site

www.energystar.gov/ia/business/evaluate_performance/site_source.pdf

UPS vs. PDU Data



Issue: IT Energy measured at UPS for rating model
Industry Feedback: Identified challenges that will require clear guidance

- Why will the rating model be based on UPS data?
 - ◆ EPA wants data centers to be able to use the rating - only 35% of facilities in the data collection effort had PDU data available
 - ◆ EPA did not have enough PDU data to develop a rating
 - ◆ Results show limited losses between UPS and PDU readings
 - ◆ EPA prefers to issue clear and simple instructions to avoid confusion, to the extent possible
- Where will UPS data be measured?
 - ◆ EPA will request measurements at the output of the UPS meter

UPS vs. PDU data



- What if a data center doesn't have a UPS meter?
 - ◆ EPA will allow IT Energy to be measured at the PDU meter or at a location closer to the racks
- What if a data center has other equipment on the UPS meter?
 - ◆ If a data center has more than 10% non-IT load on a UPS meter, it will be required to measure IT Energy at the PDU meter or a location closer to the racks, or it can sub-meter the non-IT load
- What if a data center prefers to measure IT Energy at the PDU meter?
 - ◆ EPA may allow tracking of IT Energy at both the UPS and PDU meters, but the rating will be based on UPS data, because the rating model was developed with UPS data

Stand Alone vs. Enclosed



Issue: EPA undecided on the use of Stand Alone facilities only vs. All data centers for model development

Industry Feedback: Confusion about applicability of model to Stand Alone vs. Enclosed data centers

- Mix of Stand Alone and Enclosed data centers collected
- EPA will use Stand Alone facilities to develop the rating regression model
 - ◆ Energy performance ratings are similar regardless of data used
 - ◆ Overall significance of models is higher
 - ◆ Similar to process used by EPA for other space types
 - ◆ Greater confidence in IT Energy measurements for Stand Alone
- Portfolio Manager will calculate ratings for both Stand Alone and Enclosed data centers

Climate



Issue: Climate variables not included in a rating model
Industry Feedback: Mixed response

- Some respondents agreed that energy consumption is dominated by internal loads, as opposed to climate
- Others provided theoretical reasons why climate should influence load
- EPA does not dispute the fact that climate can have an impact on energy consumption
 - ◆ This impact is not significant enough to show up in the regression analyses that form the basis of EPA models
 - ◆ Variability in PUE as related to climate is less significant than variability caused by other factors (IT Energy, management, etc)
- EPA ratings must reflect **observed** relationships

Economizers



Issue: Data shows little savings from economizers

Industry Feedback: The rating model should reward data centers that use economizers properly

- The rating model will reward data centers that use economizers properly
- EPA models normalize for operational characteristics outside of an operator's control
- EPA models do not normalize for efficiency measures
- Buildings utilizing "efficiency measures" use less energy, and therefore receive higher ratings



Economizer Rating Example

- Two example buildings
 - Same UPS Energy, Size, Climate
 - Same Predicted PUE
 - Facility with economizer has lower Total Energy and Actual PUE
 - Different ratings

	No Economizer	With Economizer
UPS Energy (MBtu)	220,000	220,000
Total Energy (MBtu)	380,000	360,000
Predicted PUE	1.87	1.87
Actual PUE	1.73	1.64
Rating	60	70

Tier



Issue: Tier under consideration for inclusion in a model

Industry Feedback: Tier should not be included

- Facilities can have multiple Tiers within one data center
- Facilities may have unnecessarily high Tier levels thinking greater redundancy is better, even if it is not required for all components in the data center
- Normalizing for Tier level provides a disincentive for efficient design
- Based on industry feedback, Tier will not be included in the final model

Data Center Type



Issue: Type expected to be excluded from model

Industry Feedback: General agreement

- Many different categories of data center and even multiple categories within certain centers
- Operators agreed that the data (average PUE values, regression results) do not support the inclusion of data center type in a model
- Type will not be included in the final model



Model Recommendation

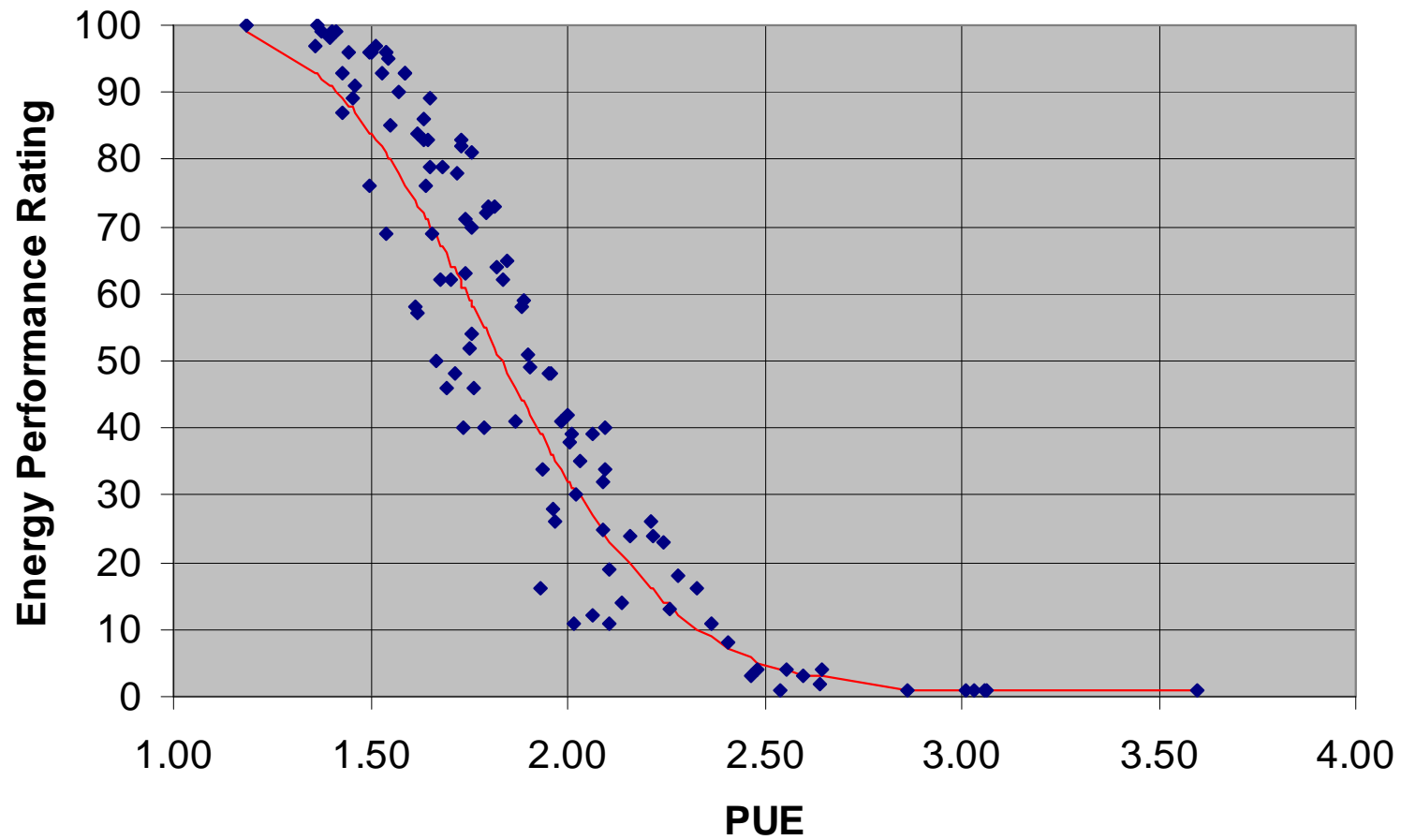
- Data: 61 Stand Alone Data Centers collected by EPA
- Dependent Variable: PUE
- Independent Variable: UPS Energy
- Overall Model Statistics
 - ◆ R-squared values are low (0.10) for a PUE model because UPS Energy explains a large percentage of Total Energy
 - ◆ R-squared values for a Total Energy model would be > 0.90
 - ◆ F-statistic: 7.56
 - ◆ P-level: .0079
- Individual Variable Statistics
 - ◆ The adjustment for UPS Energy is significant with 99% confidence
 - ◆ T-statistic is 2.75

Model Performance

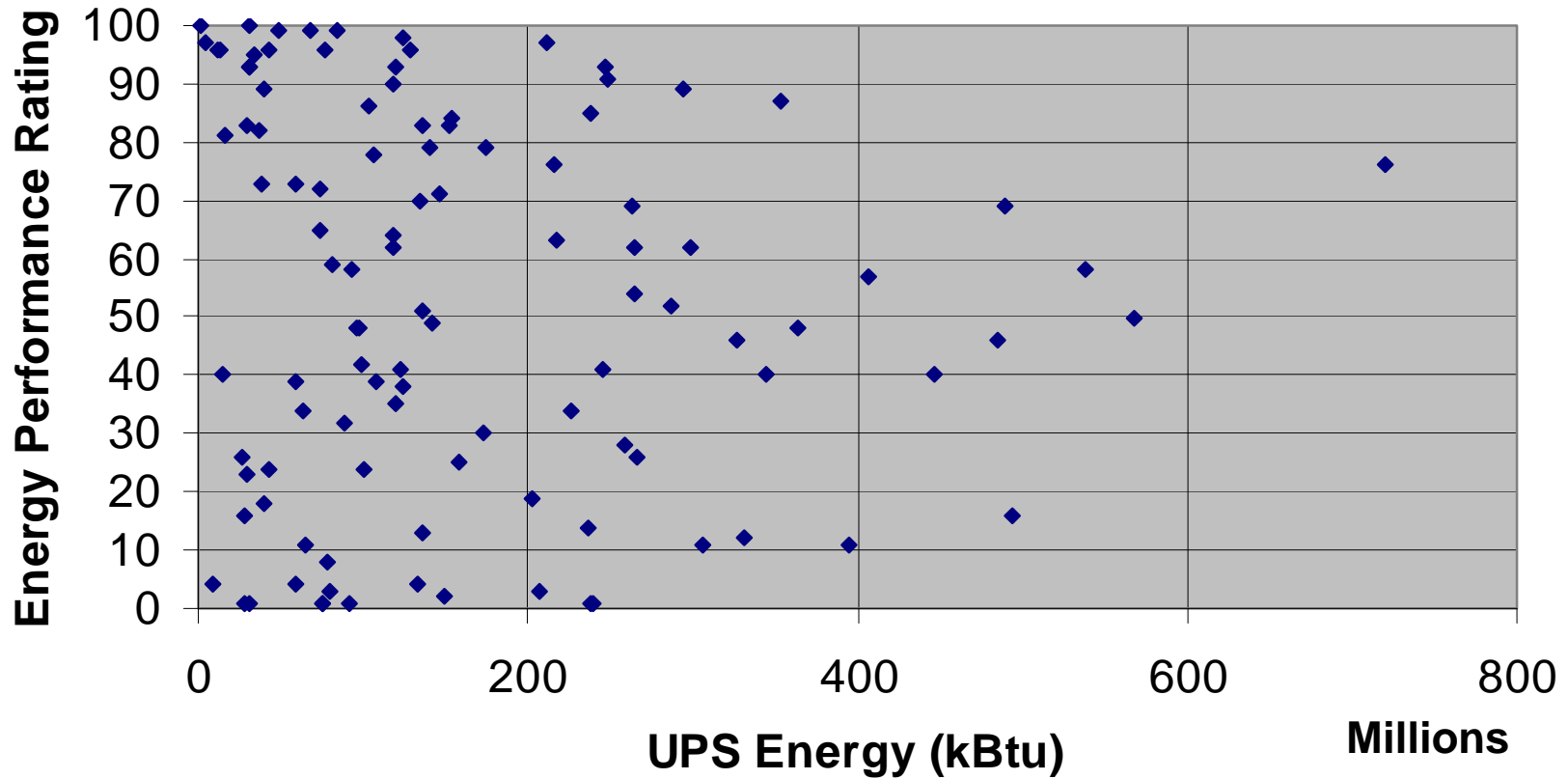


- Model produces appropriate ratings
 - ◆ Average Rating: 49
 - ◆ Percent Rating > 75: 23%
- Model produces a uniform distribution
 - ◆ Approximately 10% of the population falls within each 10 point rating bin
- Residual plots exhibit random scatter
 - ◆ Buildings with particular operating parameters do not have systematically higher (or lower) ratings
 - ◆ Buildings in different climates do not have systematically higher (or lower) ratings
- Strong model
 - ◆ Based on these results, the model appears robust

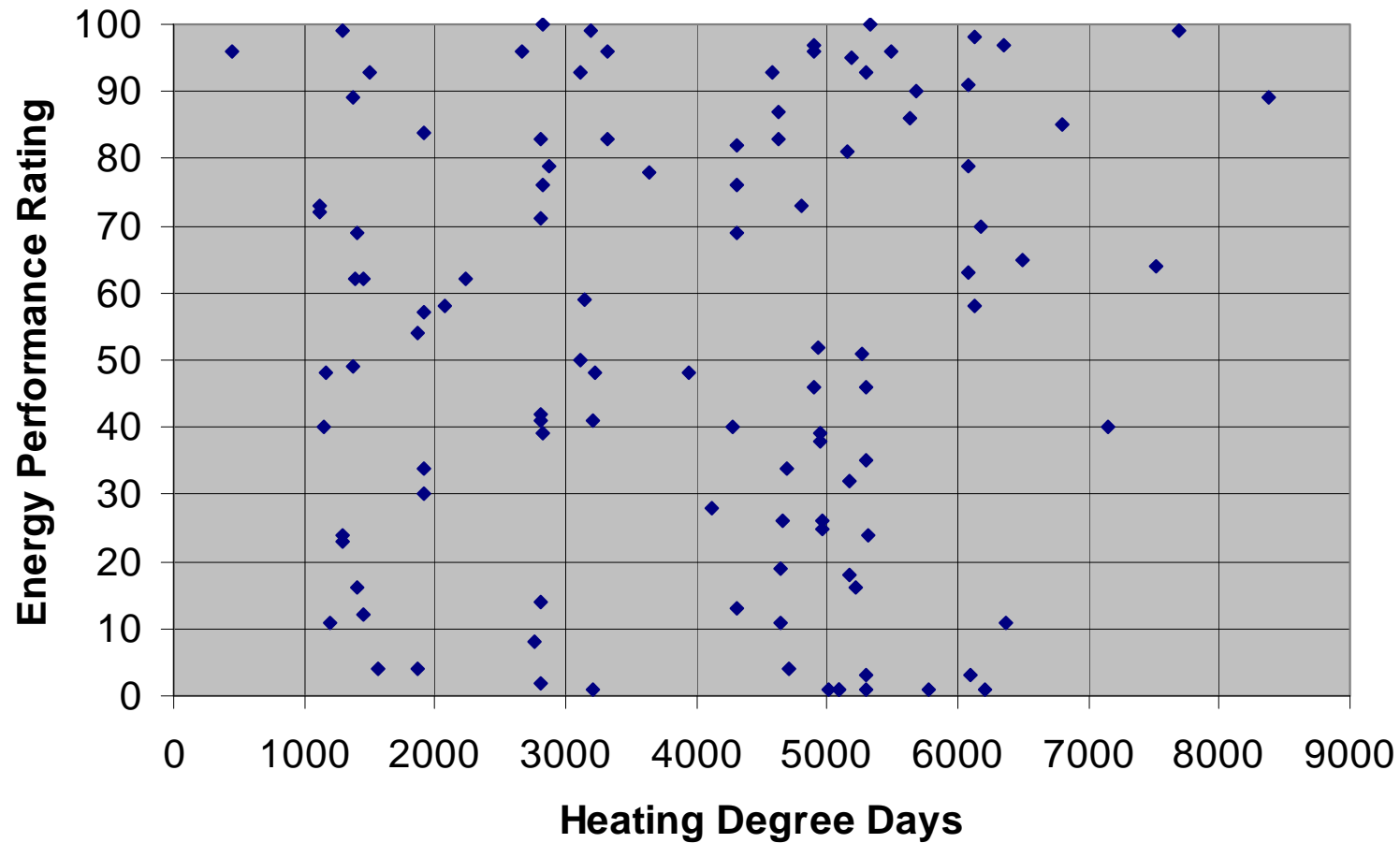
Rating vs. PUE



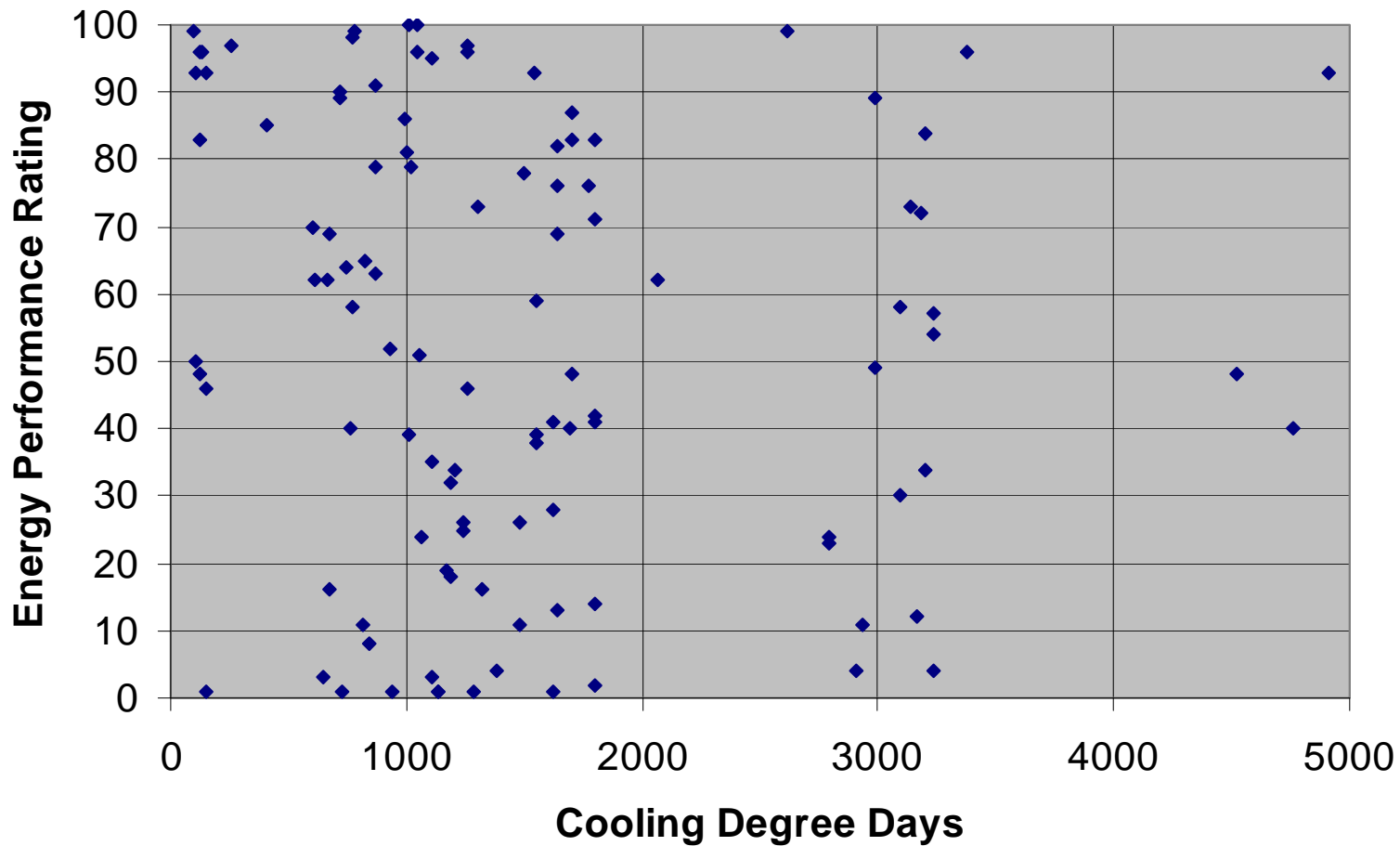
Rating vs. UPS Energy



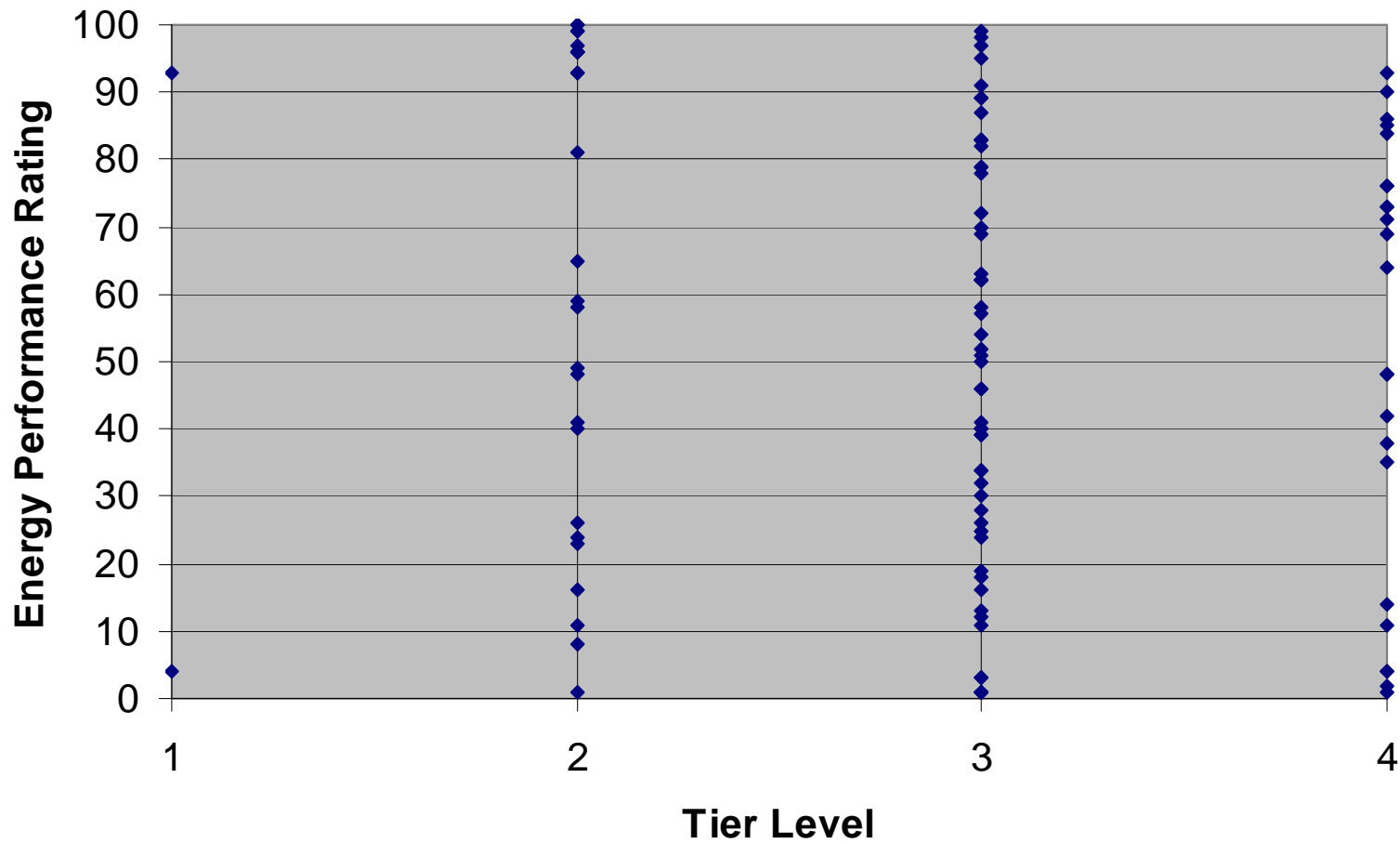
Rating vs. HDD



Rating vs. CDD



Rating vs. Tier



Summary



- Data collection
 - ◆ Developed data collection elements through a series of webinars with industry
 - ◆ Opened participation to any interested facilities
- Model development
 - ◆ Performed a thorough analysis of collected data – included a wide variety of operational parameters
- Solicited your feedback
 - ◆ Valuable insight into data center operations
 - Reasons why Tier and Type may not be significant
 - Observations about performance with respect to UPS and Climate
 - ◆ Incorporated your observations into final model variable decisions
- New model recommendation
 - ◆ Regression on PUE
 - Independent variable is UPS Energy
 - ◆ Good statistical properties
 - ◆ Equitable ratings for facilities in data collection

Next Steps



- By November 20, 2009
 - ◆ Submit comments regarding the results presented today
- November – December 2009
 - ◆ Final model selection
 - ◆ Preparation of software specifications
- January – March 2010
 - ◆ Software programming
 - ◆ Portfolio Manager training to prepare operators for model launch
- April 2010
 - ◆ Data center model scheduled for release



For More Information



Please send questions to:

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Check the ENERGY STAR Web site for updates:

www.energystar.gov/datacenters