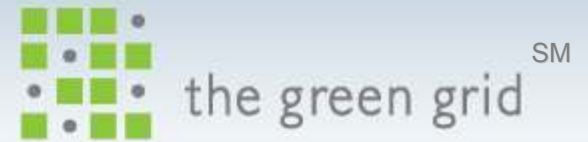


Rating Data Centers for Energy Efficiency Panel

Moderator
Roger Tipley, Hewlett-Packard Company
A Director, The Green Grid Association

Panel

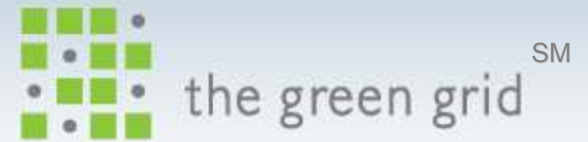


- Paul Scheihing, U.S. Department of Energy
 - EERE Industrial Technologies, *Save Energy Now*
- Michael Zatz, U.S. Environmental Protection Agency
 - Energy Star for Commercial Buildings
- Jan Viegand, Danish Electricity Saving Trust
 - European Commission Data Center Code of Conduct
 - Danish Energy Authority
- Ray Pfeifer, Silicon Valley Leadership Group
 - Datacenter 21, LEED-DC
- Paul Roggensack, California Energy Commission
 - PIER programs
- Bill Tschudi, U.S. Department of Energy
 - Lawrence Berkeley National Laboratory

Rating System for Operational Data Center Infrastructure Energy Efficiency

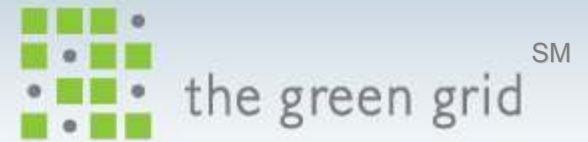
Roger Tiple, Hewlett-Packard Company
A Director, The Green Grid Association

Data Center Energy Issues



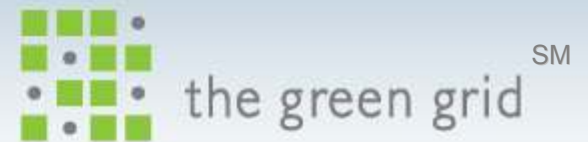
- Exploring the creation of a data center rating system based upon metrics from The Green Grid
- Three basic requirements
 - Instrument a data center for measuring DCiE or PUE
 - Better DCiE and PUE scores receive higher ratings
 - Track long term data center energy use
 - Reductions in annual energy use may increase a rating
- Confidentially report measurements and scores

Rating System Proposal



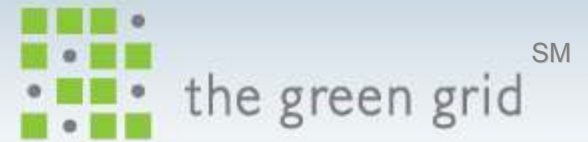
| Rating | Data Center Requirements |
|--------------------------|---|
| Green Grid Recognized | <ol style="list-style-type: none"> 1. Implement <i>DCiE</i> measurement methodologies 2. Report data center type (i.e. Tier I, II, III, IV data center) 3. Report the elapsed time of the <i>Assessment Period</i> 4. Report the <i>Mean Source Load</i> for the <i>Assessment Period</i> 5. Report a <i>Mean DCiE</i> score $\geq 40\%$ 6. Report the <i>Highest Daily DCiE</i> score occurring during the <i>Assessment Period</i> 7. Report the <i>Lowest Daily DCiE</i> score occurring during the <i>Assessment Period</i> |
| Green Grid Bronze | <p><i>Recognized</i> requirements plus: Report a <i>Mean DCiE</i> score $\geq 50\%$ minus <i>Bronze Adjustments</i></p> |
| Green Grid Silver | <p><i>Recognized</i> requirements plus: Report a <i>Mean DCiE</i> score $\geq 60\%$ minus <i>Silver Adjustments</i></p> |
| Green Grid Gold | <p><i>Recognized</i> requirements plus: Report a <i>Mean DCiE</i> score $\geq 70\%$ minus <i>Gold Adjustments</i></p> |
| Green Grid Platinum | <p><i>Recognized</i> requirements plus: Report a <i>Mean DCiE</i> score $\geq 80\%$ minus <i>Platinum Adjustments</i></p> |

Adjustments



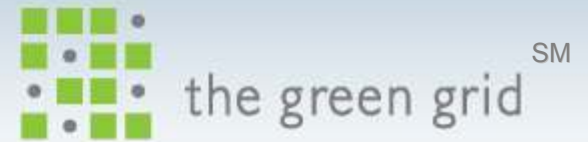
- Bonus points for redundancy
 - Propose accommodations for Tier III and IV data centers
- Bonus points if the past year's total energy consumption is less than the previous year's energy consumption
 - May increase DCiE and PUE rating at most by one level
 - Credit for installing more efficient IT equipment
 - Credit for consolidation projects
 - Extra credit for improving infrastructure efficiency
- Confidentially report measurements and scores

Adjustments Proposed



| Adjustments | Bronze | Silver | Gold | Platinum |
|---------------------------------|--|--|--|--|
| Tier I | 0 | 0 | 0 | 0 |
| Tier II | 0 | 0 | 5% | 5% |
| Tier III | 0 | 5% | 10% | 10% |
| Tier IV | 0 | 5% | 10% | 10% |
| Source Energy Reductions | % decrease in Mean Source Power (not to exceed 10%) | % decrease in Mean Source Power (not to exceed 10%) | % decrease in Mean Source Power (not to exceed 10%) | % decrease in Mean Source Power (not to exceed 10%) |

Panel



- Paul Scheihing, U.S. Department of Energy
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 - Lawrence Berkeley National Laboratory



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The Value of Rating Data Centers

Paul Scheihing, U.S. Department of Energy

Developing a Rating System for Data Center Energy Efficiency



Six important questions:

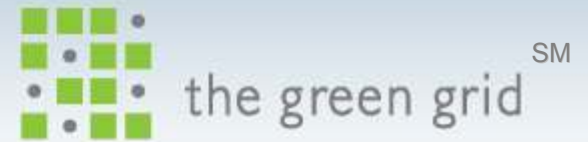
1. What are the desired outcomes?
2. What program resources are already available?
3. What are the benefits for data centers?
4. What are the ingredients to move data centers to greater energy efficiency?
5. What are some possible new rating systems or concepts?
6. What rating system(s) will help give greater clarity and credibility to the term “green” data center?

What are the Desired Outcomes?



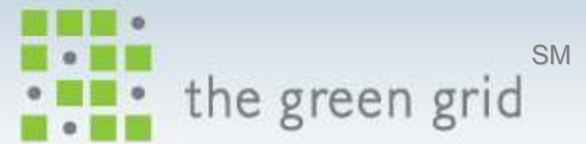
- Develop a recognizable standard of quality for energy efficiency for new construction and existing data centers (operations, systems, IT and facilities)
 - Rating method: data center meets a certain level of best practice
- Validate energy efficiency improvements to policy makers, incentive providers, regulatory bodies, carbon markets and the public
 - Rating method: demonstrate that energy intensity is improving; validate energy saved and carbon reduced
- Use as internal management tool
 - Rating method: performance based relative benchmark scoring to understand how overall data center and/or subsystems are performing relative to other similar data centers or subsystems
- **Overall outcome: accelerate energy efficiency improvements in data centers by “raising the bar”**

What Program Resources are Already Available?



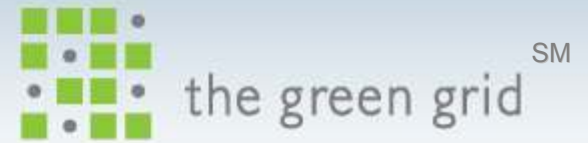
- For new construction
 - LEED® - New Construction
 - Relates to building envelope only, not data center energy use
 - Total of 17 points are “energy-related” out of 69 maximum; considers other environmental and sustainability factors
- For existing buildings
 - ENERGY STAR - applies to whole buildings and equipment
 - LEED - Existing buildings - applies to whole buildings and operations
 - Requires prerequisite of ENERGY STAR score of 69 (2 points credited) and up to 13 extra points are credited for score above 69
 - Another 15 points for “energy-related” activities (commissioning, performance measurement, renewable energy, refrigerant management, and emission reduction reporting)
 - Total of 30 points are “energy related” out of 92 maximum; considers other environmental and sustainability factors

What Program Resources are Under Development?



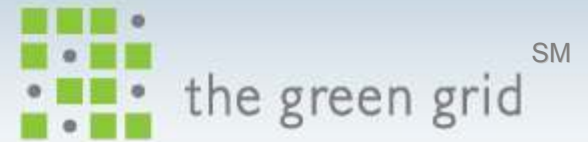
- For new construction
 - “LEED-type” Environmental Performance Criteria for Data Centers (LBNL, CEC, Uptime Institute, The Green Grid, ASHRAE, SVLG)
- For existing buildings
 - ENERGY STAR for whole data center
 - ENERGY STAR for data center IT equipment (starting with server, possibly other IT equipment)
 - ANSI-accredited certification for energy efficiency – applies to buildings, equipment and operations

What are the Benefits of Energy Performance Rating Systems?



- Lower the total cost of ownership
- Better utilization of equipment assets
- Ability to benchmark (and measure improved) performance
- Ability to demonstrate continuous improvement and superior performance for energy efficiency:
 - Achieve market distinction as a **TRULY** “green” facility
 - Receive the transparency and validation required for participation in carbon markets, incentive programs
 - Satisfy requirements of supply chain customers

Ingredients for Data Center Energy Efficiency



Start Right

- Apply “Best-in-Class” design practices standards and guidelines
- Demonstrate energy efficiency through commissioning

Continually Improve

- Benchmark data center
- Assess for energy saving opportunities
- Implement energy efficient best practices
- Adopt latest technology

Manage Energy

Create and apply energy management plan and standards considering system flexibility and reliability required

Data Center Energy Efficiency

Achieve Superior Performance

Elements of Rating Systems



| Stage | Rating System | Value |
|--|--|--|
| <p>Start Right: New Construction</p> | <p>Point based rating process using energy and environmental performance criteria</p> | <p>Recognized as sustainable new data center design. High emphasis on energy efficiency but consider other factors such as environmental and reliability</p> |
| <p>Continually Improve: Upgrade data center with best practices and best-available technology</p> | <p>Energy efficiency certification of data centers based on standards approach used in industrial facilities</p> | <ul style="list-style-type: none"> - Recognition of continual improvement via energy management program - Assessment and implementation of best practices and new technology - M & V of energy savings - 3rd party validation and certification - Recertified periodically (e.g., 3 years) |
| <p>Achieve Superior Energy Performance: Benchmark performance</p> | <p>Performance-based rating of entire data center to compare performance against peers and to identify top performing facilities</p> | <p>Recognized for point in time over a define time period (e.g., 1 year)</p> |

Summary



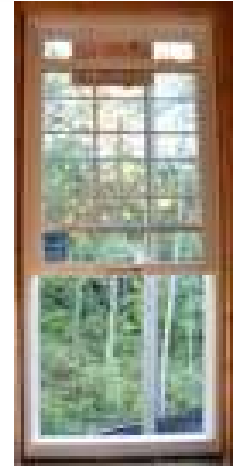
New rating systems will require:

- A variety of industry standards to guide new construction and existing data centers to adopt best practices and best-available technology
- Data center operator companies embrace an energy management strategy and standard
- A robust energy performance benchmarking system; need participation of data center operators to data collection effort
- Support from “C-Level” managers for data center operation staff to invest in energy efficiency and improve towards superior energy performance
- External rewards and incentives for energy efficiency

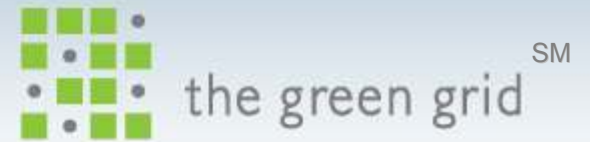
ENERGY STAR® Data Center Energy Performance Rating Development

Michael Zatz, U.S. Environmental Protection Agency
(EPA)

ENERGY STAR



Also ENERGY STAR



500 Boylston St.
Boston, MA



Albuquerque Indian Hospital
Albuquerque, NM



LL&E Tower
New Orleans, LA



Westin San Francisco Airport
Millbrae, CA



Parkside Elementary School
Buffalo, MN



Blue Earth County Courthouse
Mankato, MN

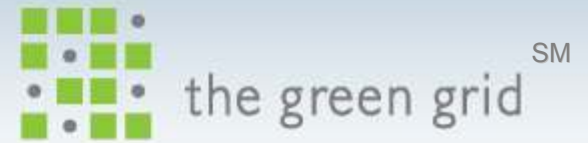
The Green Grid Technical Forum

What is ENERGY STAR for Buildings?



- U.S. government energy management program providing proven solutions to help public and private sector building owners and managers reduce their energy consumption
- Over 1,700 partners operating more than 11 billion square feet of space (nearly 20% of space in the U.S.)
- Over 70,000 buildings measure and track their energy performance using ENERGY STAR's Portfolio Manager online tool

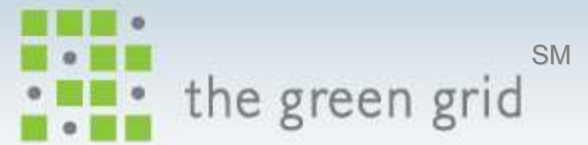
The ENERGY STAR for Buildings



- ENERGY STAR labeled buildings use 35 percent less energy than average buildings
- Nearly 4,000 buildings have earned the ENERGY STAR label for energy efficiency

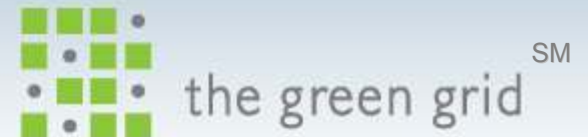


EPA's Energy Performance Rating System



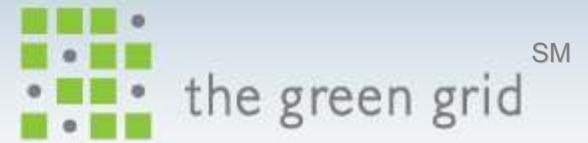
- Based on actual as-billed energy data
- Serves as a whole building indicator
 - Captures the interactions of building systems not individual equipment efficiency
 - Tracks energy use accounting for weather and operational changes over time
- Allows for peer group comparison
 - Compares a building's energy performance to its national peer group – not other buildings in Portfolio Manager
 - Tracks how changes at the building level alter the building's standing relative to its peer group

EPA's Energy Performance Rating System – Technical Foundation



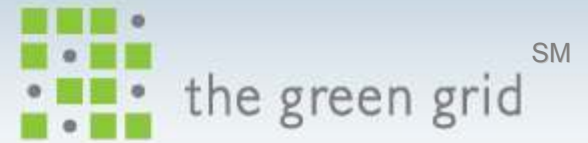
- Analyze national survey data
 - Energy Information Administration's Commercial Building Energy Consumption Survey (CBECS) for most building types
- Develop regression models to predict energy use for specific building types based on operations
- Create scoring lookup table
 - Ratings based on the distribution of energy use for a given building type and expressed on a 1-to-100 scale where one point represents one percentile of buildings
 - A rating of 50 indicates that the building performs better than 50% of all similar buildings nationwide
 - A rating of 75 indicates that the building performs better than 75% of all similar buildings and can earn the ENERGY STAR label

Goals for ENERGY STAR Data Center Rating



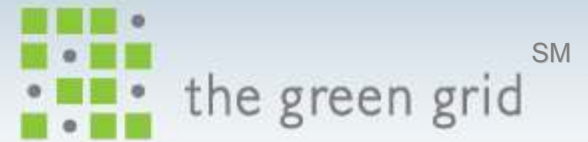
- Usable for both whole-building data centers, as well as data centers housed within office or other buildings
 - Methodology similar to existing ratings (1-100 scale)
- Allows users to compare the energy performance of one data center against others and against a national average
 - Assess performance at the building level
 - Explains how a building performs (does not explain why)
- Provides users with information and links to additional resources to aid in their efforts to determine next steps after receiving an energy performance rating for their building
- EPA plans to offer the ENERGY STAR label to data centers with a rating of 75 or higher (performance in the top quartile)
- Builds on existing ENERGY STAR methods and platforms

Goals for ENERGY STAR Data Center Rating



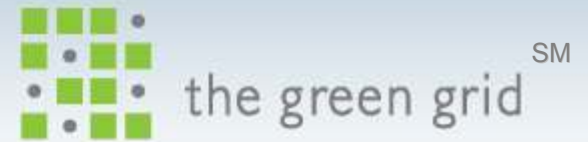
- Ideal high level metric: kBtu / useful work
- Challenge: how to measure “useful work” - teraflop or other alternative
- Next steps to meet metric goals
 - Agree on “useful work” – challenge industry to reach consensus
 - Implement working metrics for end users while industry discusses definition of “useful work”

ENERGY STAR Rating for Data Center Infrastructure



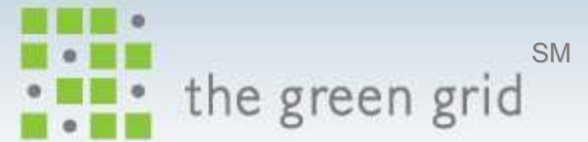
- Unit of Analysis: IT Energy / total energy
- What: measure of infrastructure efficiency
 - Captures impact of cooling and support systems
 - Does not capture IT equipment efficiency
- Why: the best available whole building measure
 - Important start for tracking, measuring, and improving
 - Industry still developing ways to understand and measure IT output and efficiency
- How: express ratio (IT/Total) as an ENERGY STAR 1-to-100 rating
 - Percentile of performance
 - Ratio value adjusted for: climate, tier level, other key factors

Developing the ENERGY STAR Rating for Data Center Infrastructure



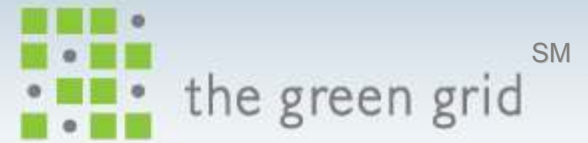
- ENERGY STAR ratings are based on representative data sample
- Collect data on key characteristics
 - **Need** characteristics that define *what* the data center does (i.e. redundancy level, climate zone)
 - **Do not need** characteristics that define *how/why* the data center operates a certain way (i.e. hot aisle/cold aisle configuration or presence of an economizer)
- Analyze data
 - Characterize the distribution of performance among data centers
 - Normalize for key operating characteristics

Progress to Date



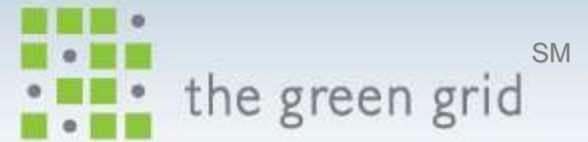
- Held numerous discussions with industry stakeholders, including associations and data center operators
- Presented data center rating development plan, including proposed data elements to be collected, to nearly 100 industry representatives during December 18 webinar
- Received and incorporated feedback from industry stakeholders
- Developed draft data collection template – to be shared with industry during webinar in mid-February

Data Elements Needed to Build Rating



- EPA will survey data center operators to obtain a variety of information, including the following elements that are critical to the development of a statistically valid rating model:
 - Climate zone (zip code)
 - Type of data center
 - Reliability (Tier Level)
 - Total IT plug energy
 - Total facility energy usage (all fuels)

Next Steps and Timeline



- Rating development meetings – Winter 2008
- Data collection – Spring 2008
- Data review and analysis – Summer 2008
- Share individual rating results – Fall 2008
- Industry rating results meeting – Fall 2008
- Target launch of rating in Portfolio Manager – January 2009

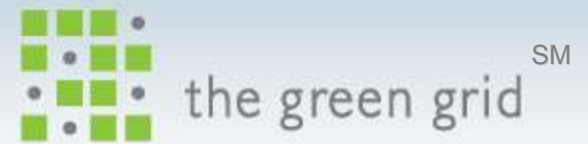


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European Union Code of Conduct on Energy Efficiency of Data Centers

Jan Viegand, Danish Energy Authority and
Danish Electricity Saving Trust

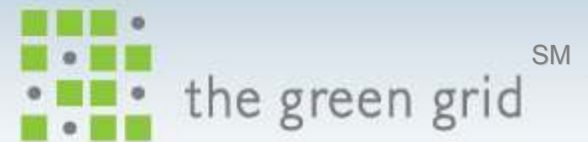
Why Energy Metrics?



Data centers need to be more efficient
Energy metrics is one of the instruments

- Tool for data centers: measures improvements
- Part of informative labeling directed at data center clients
 - Energy metrics as purchasing requirement?
- Part of CSR to document energy efficiency
- Energy benchmarking between data centers
- Basis for voluntary agreement and government regulation

Types of Energy Metrics



- No use of total metric if you only operate part of data center
- Metrics for each type of responsibility area:
 - Operator of facility and all equipment > Total data center metric
 - Operator of facility > Infrastructure metric
 - Operator of cooling system > Cooling metric
 - User controlling own IT equipment > IT metric
 - Etc.

European Union Code of Conduct



- Metrics as a tool for data center owners, operators and users
- Target for energy efficiency improvements by data centers
 - e.g. 10% improvement per year
- Indicative targets depending on data center types, etc.
- CoC, version 1, 2008: metric for efficiency of infrastructure and of cooling (simple)
- CoC, version 2, 2009: add metric for efficiency of main IT equipment (advanced)
- Energy Star for servers, when ready

Infrastructure and Cooling Metric

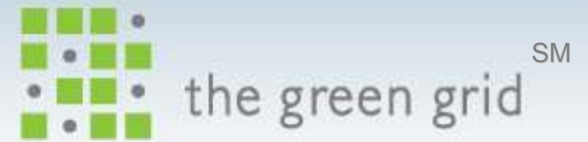


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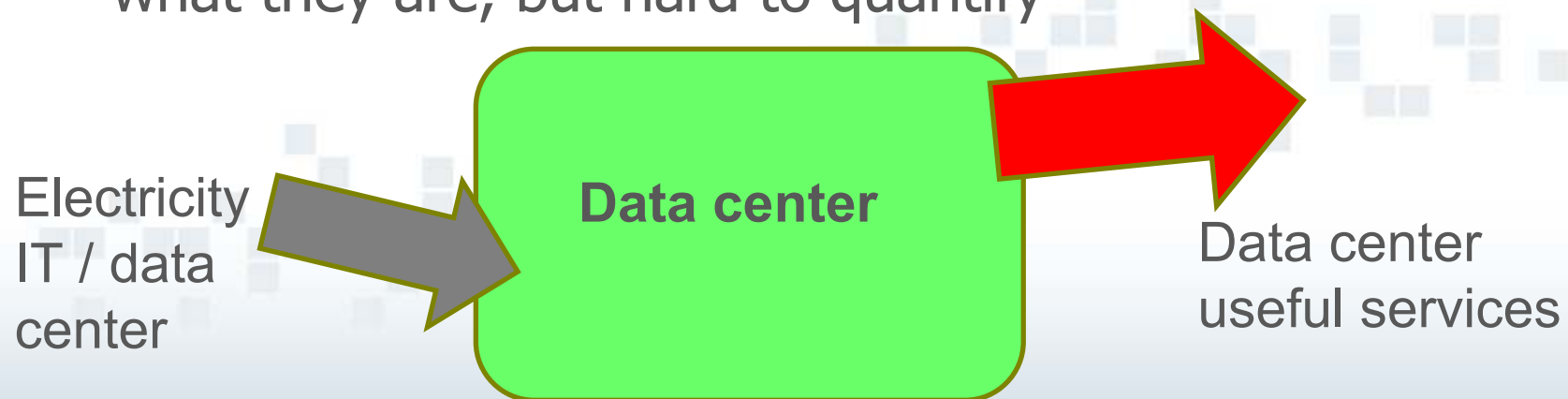
- Infrastructure metric: energy consumption of total facility divided by energy consumption of main IT equipment
- Cooling metric: energy consumption of cooling system divided by energy consumption of main IT equipment

So far, simple. But now ...

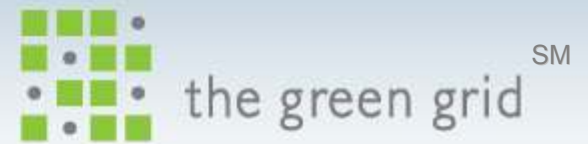
IT and Total Data Center Metrics



- Indicator of the energy efficiency of the IT equipment by relating the energy consumption of the IT equipment to the useful IT services
- Similar for total data center metric: total data center consumption ...
- Useful IT services: three simple words. We all know what they are, but hard to quantify

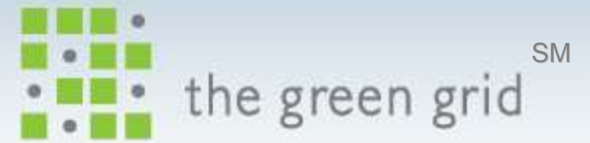


To quantify useful services



- Weighted sum of user activities, e.g.:
 - Users on mail server
 - Users on file server
 - Pages shown from web server
 - Transactions database server
 - Terminal server
- Dedicated software for logging indicators of user activities
- Logged data of server activities
 - CPU use, busy disk times, memory usage, etc.
- Food for thought, but let us be pragmatic and keep it simple

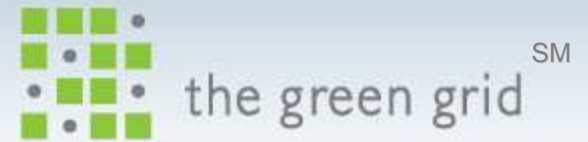
Not easy, but ...



Is possible if:

- Combining efforts
- Do it step by step, can be improved over time
- Accept that very precise results are not required

Collaboration



We support close collaboration with all stakeholders including:

- Energy Star
- U.S. Department of Energy
- The Green Grid
- National and state activities
- Research institutions (Uptime Institute, LBNL etc.)
- Individual companies
- Others

Conclusion



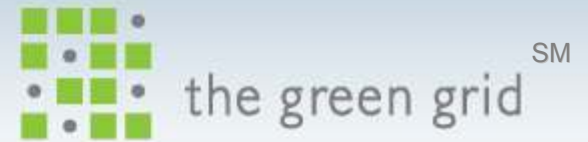
- New EU Code of Conduct for data centers in 2008
- Simple infrastructure metrics in first version
- We want to include a real metric including IT useful services (2009)
- We think it is possible
- We want to collaborate with all of you

Thanks

Datacenters EPC

Ray Pfeifer
Chair, Silicon Valley Leadership Group DCDP
and Datacenters EPC

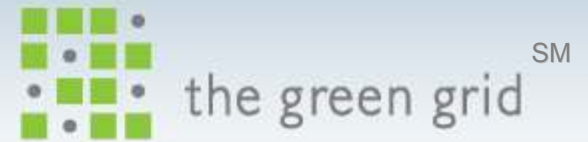
SVLG Energy Efficient DCDP



- The Leadership Group represents 230 member companies. Members employ more than 250,000 people in Silicon Valley
- Or 1 in 4 private sector jobs
- Member companies generate more than \$1 trillion in revenue
- Or approximately 8X as large as CA's State Budget

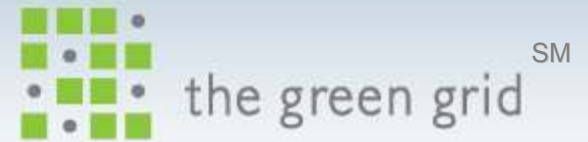


SVLG Energy Efficient DCDP



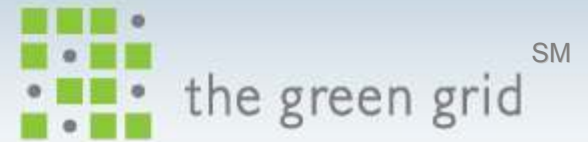
- Why is this needed?
 - Encourage publishing of energy efficiency case studies
 - Facilitate proof-of-concept and emerging technology demonstrations
 - Integrated forum for both IT and critical infrastructure teams
 - Lead public-private collaboration to accelerate change
 - Advocate for well intended energy efficiency public policy
- Project goals
 - CEC, LBNL, PG&E and SVP sponsored project
 - Collaborate with DOE on development of DC assessment tool
 - Complete and publish data center environmental and energy assessments
 - Publish case studies with before/after energy/GHG savings achieved by best practices and design measures outlined in EPA report
 - Re-run EPA model using actual data to validate 3 model scenarios PUE
 - Publish summary report with revised baseline and trend graphs
 - Develop and publish SVLG State of art scenario
- Scope and timing
 - ~20 demonstration projects
 - SVLG Data Center Event, June 2008

Data Centers EPC



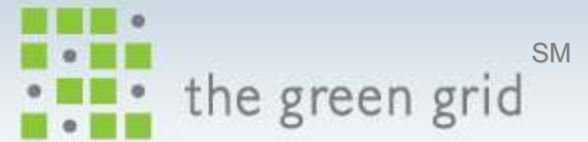
- Why is this needed?
 - Marketplace void for data center specific green building tool
 - Bridge data center infrastructure design and IT computing needs
 - Spur private sector to remove barriers and advance action
- Project goals
 - California Energy Commission sponsored project
 - Develop data center Environmental Performance Criteria
 - Core content transfer from existing tools (e.g., LEED®)
 - Collaboration and consensus with key industry groups
 - Voluntary, consensus-based standard for high performance energy efficient datacenter development
 - Industry group adoption and certification process for members
 - Submit to USGBC for LEED-Datacenters standard

Data Centers EPC



- Who's involved?
 - Led by LBNL Environmental Energy Technologies Team
 - Industry groups:
 - ASHRAE TC 9.9
 - Critical Facilities Round Table
 - The Green Grid
 - The Uptime Institute
 - 24X7
 - Silicon Valley Leadership Group
- Timing?
 - EPC will be completed and published in August 2008

Data Centers EPC Format



- Follow LEED™ Version 2.1
 - Sustainable sites
 - Water efficiency
 - Energy and atmosphere
 - Materials and resources
 - Indoor environmental quality
 - Innovation in design
- Similar approach to Labs21 EPC
 - Focus on additional credits as well as modifications to credits
 - Recommend threshold values for silver, gold and platinum ratings
 - Leave development of certification process to industry groups
- Highlights
 - Consider emissions impact of site selection and climate
 - Adopt metrics that enable data center assessment by type
 - Energy efficiency metrics – both infrastructure and “useful work”

If you would like to volunteer to assist in the development of the
Environmental Performance Criteria for Datacenters for the 21st Century

Send an email with your contact information, indicating your interest in participating on the following topics:

Sustainable sites

Water efficiency

Energy and atmosphere

A: Credits pertaining to energy supply emissions, efficiency, renewable energy, on-site generation, etc.

B: Credits pertaining to energy efficiency performance, measurement, verification and commissioning

C: Credits pertaining to datacenter infrastructure and IT equipment efficiency

Materials and resources

Indoor environmental quality

Innovation in design

Or for more information on the SVLG DCDP initiative please contact me at:

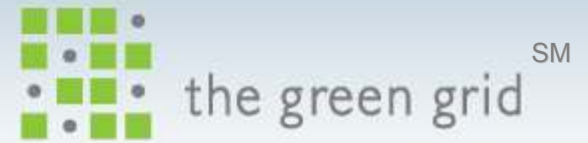
rpfeifer@svlg.net

Thank you for attending
The Green Grid Technical Forum

Public Interest Energy Research Role in Data Center Energy Efficiency

Paul Roggensack, California Energy Commission

California's Primary Energy Agency



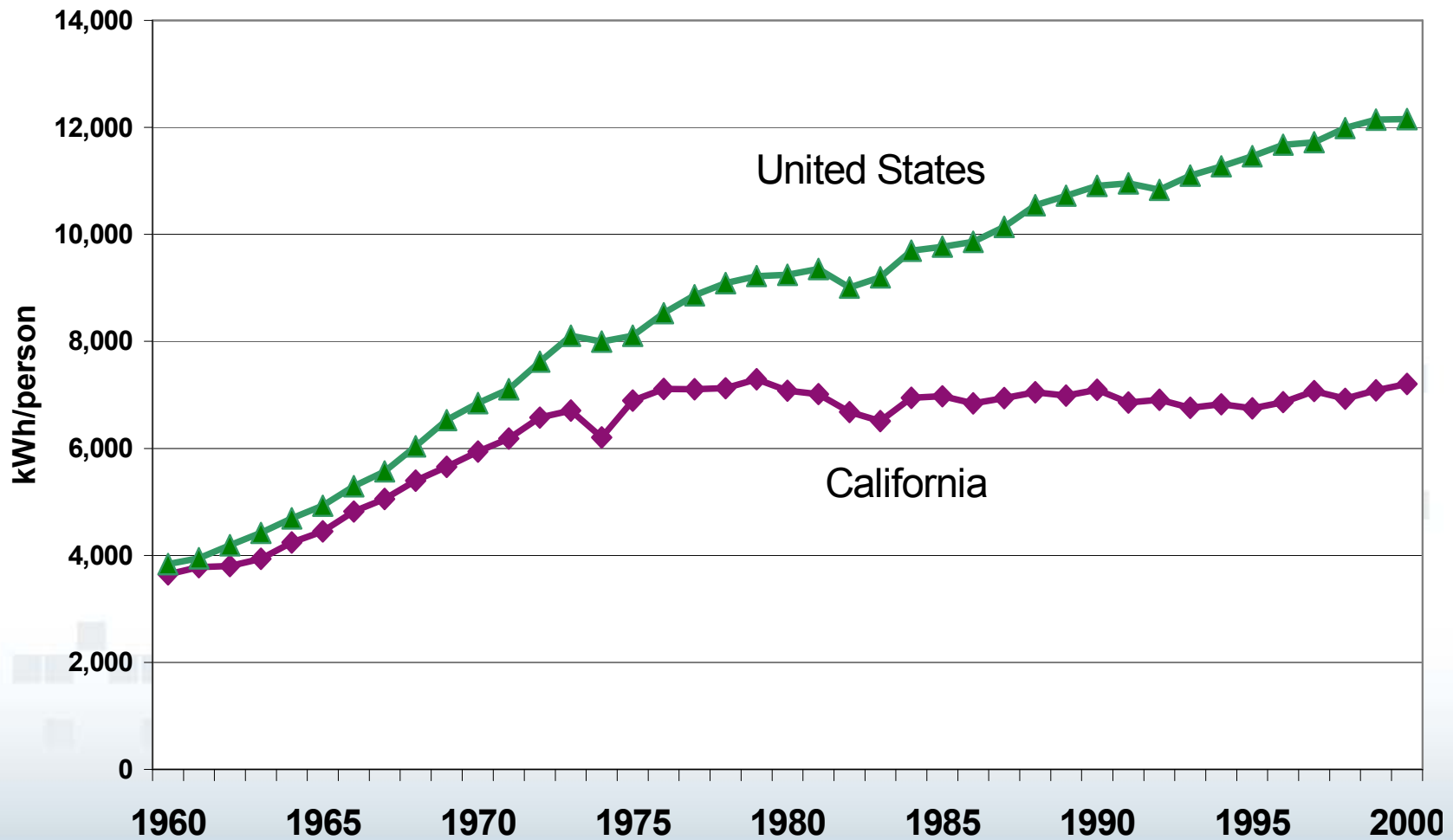
- License thermal power plants 50 MW and larger
- Adopt appliance and building energy efficiency standards
- Forecast state energy use
- Maintain energy information and performing analysis
- Propose to the Governor integrated state energy policies
- Conduct public interest energy research

Per Capita Electricity Consumption

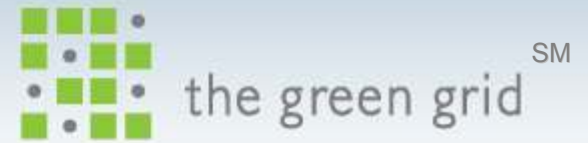


Per Capita Electricity Consumption

Source: http://www.eia.doe.gov/emeu/states/sep_use/total/csv/use_csv.html



Energy Picture



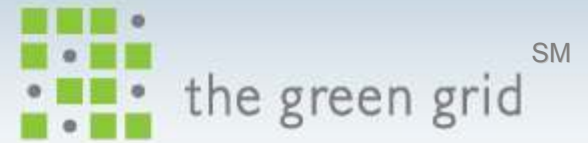
- 2004 population: *34 million, 1.1% growth per year*
- 2004 electricity use: *262,000 GWH*
- 2004 peak demand: *54,500 MW*
- Annual energy growth:
Consumption - 1.4%
Peak - 1.65%

PIER Program



- Established in California by legislation in 1996
- \$62.5 million collected annually from investor-owned electricity utility ratepayers for “public interest” energy research, development and demonstration (RD&D) projects

PIER Focus Areas



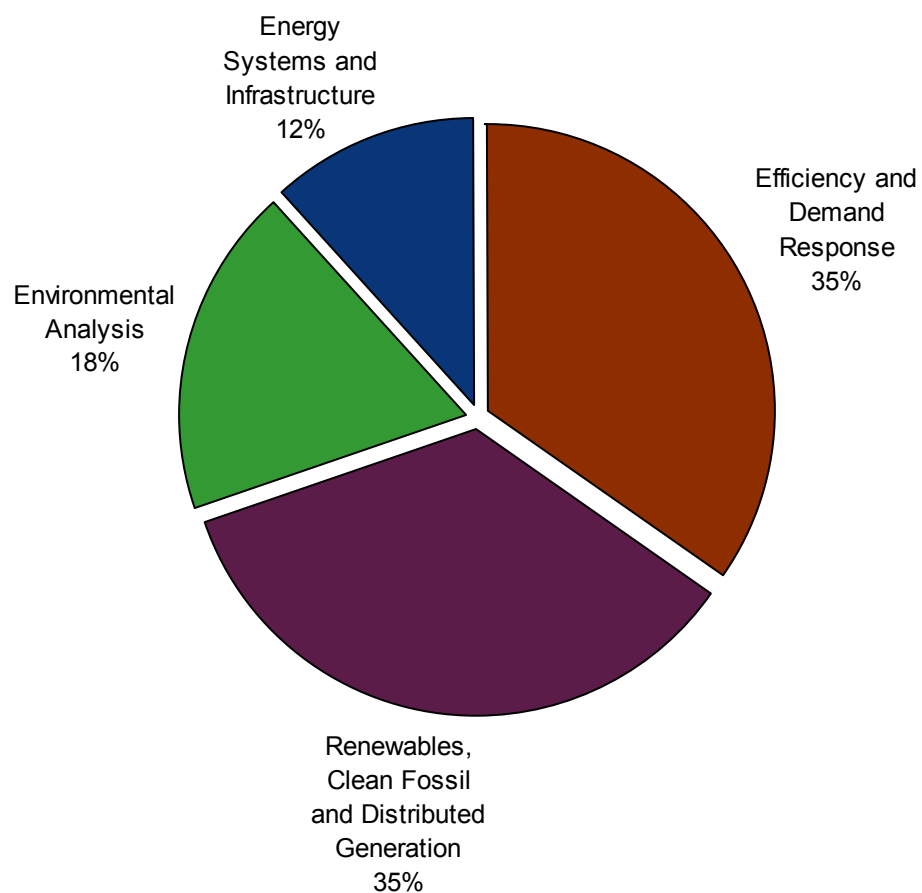
- Building end-use energy efficiency
- Energy-related environmental research
- Energy systems integration
- Environmentally-preferred advanced generation
- Industrial/agricultural/water end-use energy efficiency
- Renewable energy technologies
- Climate change program
- Transportation research

PIER “Rating System”

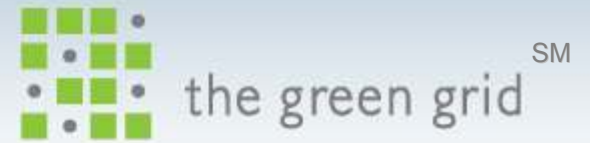


- Improve energy cost/value
- Improve environment, public health, and safety
- Improve electricity reliability/quality/sufficiency
- Strengthen the economy
- Provide consumer choice
- Address research gaps

PIER Funding by Research Areas for 2001-2005

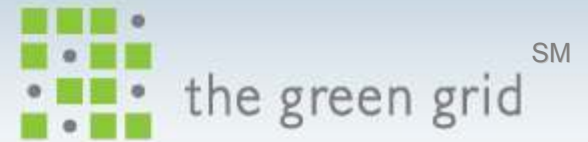


Reasons Data Centers were Funded (2001)



- Expected strain on the grid
- Press reports on strong growth

Over \$3.5 Million Funded on Data Centers Since 2001



- Benchmarking studies
- Research roadmap
- Self-benchmarking protocol
- Identify best practices
- Uninterruptible power supplies
- Computing and energy performance metrics
- Energy efficient power supplies
- DC architecture demonstration
- LEED certification
- Develop modular and scalable cooling system concepts
- Investigate air economizers in data centers
- Guidelines and training manual on low pressure drop systems
- Updated best practices
- Investigate strategies to promote best practices commissioning
- Promote the use of DC power in data centers
- Demonstrate the use of liquid cooling technologies
- Wireless control systems
- <http://hightech.lbl.gov>

Consistently Rating Data Centers

William Tschudi, Lawrence Berkeley National Laboratory
(LBNL)

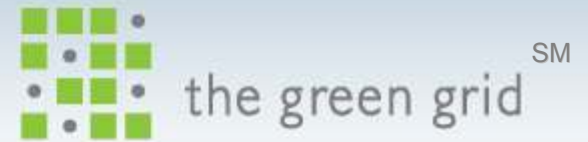
Common Assessment Protocol



It is important to collect like data

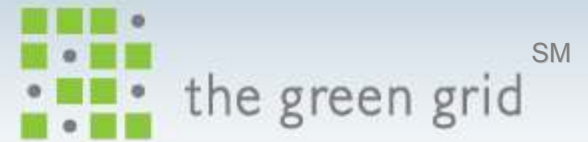
- Regardless of rating criteria, consistent data is needed
 - Measure similar systems in operating centers
 - Design targets for similar systems in new centers
 - Clearly define the data to collect
- Easier said than done. Examples:
 - Centers in office buildings
 - Chilled water serving data center and campus
 - Mixed systems
 - Centers built out over time
 - Lack of electric metering
 - Less than full occupancy
 - Limited building management systems
 - Accuracy of measured data

Challenges



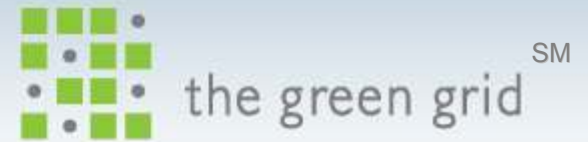
- Data centers serve different missions in different locations
 - Many different configurations/systems can affect efficiency
 - Record details of systems
 - Record mission of center
 - Record operational parameters
- Geographical location (weather) affects performance
- In God we trust – all others bring data
 - Measured data is better than design values, manufacturers claims, guesswork, or assumptions
 - Measured data can also be inaccurate
 - Suggest using best available data and refine over time

DOE Save Energy Now Assessment Tools



- LBNL is collaborating with The Green Grid and industry stakeholders to develop assessment tools
- Starting point is profiling tool – DC Pro
 - Metrics
 - Actions – pointers to more detailed assessments
 - Savings
- Additional assessment tools
 - Electrical
 - HVAC
 - IT equipment
 - Chilled water plant

Software Tool Suite



Tools to define baseline energy use and identify key energy-saving opportunities

- Determine general performance of the data center
- Benchmark subsystems
- Assess energy savings potential
- Track energy intensity improvement
- Provide quantification of key metrics including cost (\$), primary energy (Btu), and carbon



Energy Profiling Tool: Key Elements



Data Center Performance

- Overall energy performance (baseline)
- Performance of IT and infrastructure subsystems compared to benchmarks
- Potential areas for efficiency improvement
- Energy cost (\$), source energy (Btu), and carbon emissions (Mtons)

IT

- Servers
- Storage & networking hardware
- Software

Cooling

- Chillers
- Air handlers
- Cooling towers
- Pumps
- chiller, fan, and pumping energy

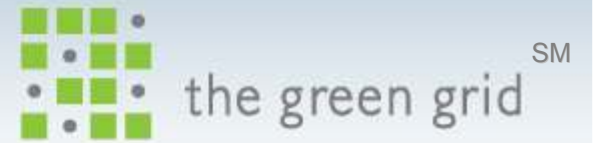
Power Systems

- UPS/power conversions
- Distribution schemes

Energy Source

- Source of power
- Distributed generation
- Cost per kWh
- Backup power

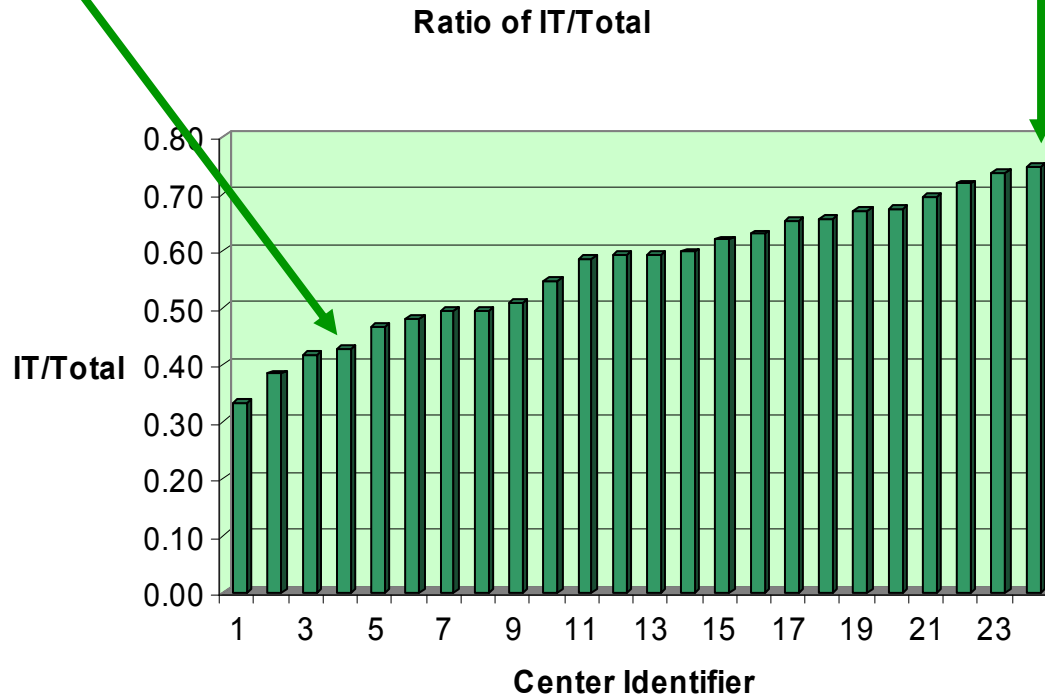
DC Pro



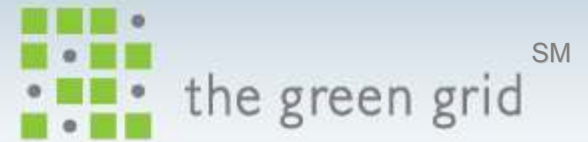
Energy performance level

Comparison to all

Where you could be



DC Pro



Data Center Assessment Inputs: Features and Metrics

DRAFT 1-15-08

Notes:

1. Each assessment area has two types of inputs: features and metrics
2. The features checklist can be used for stage 1 assessment (prior to site visit), and to prioritize metrics for stage 2 assessment
3. Input fields are shaded in blue - defaults are provided for priorities
4. Priority levels for metrics: 1 - Must have; 2 - Important, subject to ease of data collection; 3 - collect only if easily available
5. Use 'Data Collection' worksheet to plan and collect data required for metrics

Metrics, actions, and potential energy savings

| 1. Overall Energy Management | | | | |
|--|------------------|---|----------|-------|
| Has an audit or commissioning been conducted within the last 2 years? | | | | |
| Is there a written energy management plan? | | | | |
| Are there staff with explicit energy management responsibility? | | | | |
| What is the redundancy level for Electrical systems? (N, N+x, 2N) | | | | |
| What is the redundancy level for HVAC systems? (N, N+x, 2N) | | | | |
| What is the current usage factor? (% of space?) | | | | |
| Metrics | Unit | Data Required | Priority | Value |
| Overall Energy Effectiveness (IT energy use / total energy use) | - | IT Equipment Energy Use Total DC Energy Use (Site) | 1 | |
| Site Energy Use Intensity | Site BTU/sf-yr | Total DC Energy Use (Site) DC Floor Area | 2 | |
| Source Energy Use Intensity | Source BTU/sf-yr | Total DC Energy Use (Source) DC Floor Area | 3 | |
| Purchased Energy Cost Intensity | Energy \$/sf-yr | Total DC Energy Cost DC Floor Area | 2 | |
| Peak Electrical Load Intensity | Peak W/sf | Total DC Peak Elec Demand DC Floor Area | 2 | |
| 2. Environmental Conditions | | | | |
| What are the temperature setpoints (specify range)? | | | | |
| What are the humidity setpoints (specify range)? | | | | |
| Recommended and allowable intake temperatures and humidity (specify ranges)? | | | | |
| What is the temperature and humidity control sequence? | | | | |
| Do CRAC/CRAH units have centralized or distributed controls? | | | | |
| Are there humidity controls and does the data center need humidity control? | | | | |
| Are there procedures and personnel/cable grounding equipment to prevent ESD? | | | | |
| Are unit controls fighting each other (for example, simultaneously humidifying and dehumidifying)? | | | | |
| Does system have capability of taking slope and offset for sensor recalibration? | | | | |
| Metrics | Unit | Data Required | Priority | Value |
| Average Heat Density | W/sf | Heat Dissipation DC Floor Area | 1 | |
| Ratio Max Density to Average Heat Density | None | Max Heat Density Average Heat Density | 2 | |
| Actual Dew-Point Temperature | F | Data Center Dewpoint Temperature | 1 | |
| Climate Data | F | TMY/TRY/WYEC data | 1 | |
| Temperature and humidity sensor calibration | Slope and offset | Reference sensor reading | 1 | |
| 3. Air Management, CRAC/CRAH/AHU | | | | |

Inputs - Metrics

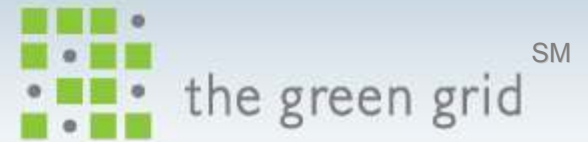
– Electrical Example



| Data Center Assessment Inputs: Features and Metrics | | | | |
|--|-------------|--|-----------------|--------------|
| 6. IT Equipment Power Chain | | | | |
| <i>Metrics</i> | <i>Unit</i> | <i>Data Required</i> | <i>Priority</i> | <i>Value</i> |
| 6A: UPS load capacity | kVA/kW | UPS rating | 1 | |
| 6B: UPS System Efficiency | % | UPS Output kW/UPS Input kW | 1 | |
| 6C: UPS input current THD | % | UPS THD measure at Input | 1 | |
| 6D: UPS input power factor | PF | UPS Power Factor measure at Input | 1 | |
| 6E: Transformer (upstream UPS system) Efficiency | % | XFMR Output kW/XFMR Transformer Input | 1 | |
| 6F: PDU (with built-in transformer) System Efficiency | % | PDU Output kW/ PDU Input kW | 1 | |
| 6G: STS efficiency | % | STS Output kW /STS Input kW | 2 | |
| 6H: IT Peak Power Density (actual) | W/sf | IT Peak Power (actual) / DC Floor Area | 1 | |
| 6I: IT Peak Power Density (design) | W/sf | IT Peak Power (design) / DC Floor Area | 2 | |
| 6J: IT Rack Power Density (actual) | kW/rack | IT Peak Power (actual) / rack quantity | 1 | |
| 6K: IT Rack Power Density (design) | kW/rack | IT Peak Power (design) / rack quantity | 1 | |

Data Collection

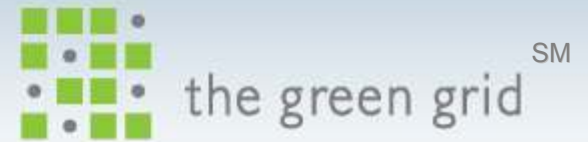
– Electrical Example



| Data Centers: Data Collection worksheet | | | | | | | |
|--|-----------------------------------|-------------|-----------------|------------------------|------------------------------|------------------------------|-----------------|
| ID | Data | Unit | Priority | Source / Method | Measurement Frequency | Measurement Equipment | Guidance |
| IT Equipment Power Data | | | | | | | |
| P1 | IT Equipment Energy Use | kWh | | | | | |
| P2 | IT Peak Power: Actual | kW | 1 | | | | Use P4 or P5 |
| P3 | IT Peak Power: Design | kW | 1 | | | | |
| P4 | UPS Input | kW | 1 | | | | |
| P5 | UPS Output | kW | 1 | | | | |
| P6 | UPS Rating | kVA / kW | 1 | | | | |
| P7 | UPS Input current THD | THD % | 1 | | | | |
| P8 | UPS Input Power factor | PF | 1 | | | | |
| P9 | Transformer (upstream UPS) input | kW | 1 | | | | |
| P10 | Transformer (upstream UPS) output | kW | 1 | | | | |
| P11 | Transformer rating | kVA | 1 | | | | |
| P12 | PDU Input | kW | 1 | | | | |
| P13 | PDU Output | kW | 1 | | | | |
| P14 | PDU Rating | kVA | 1 | | | | |

Actions

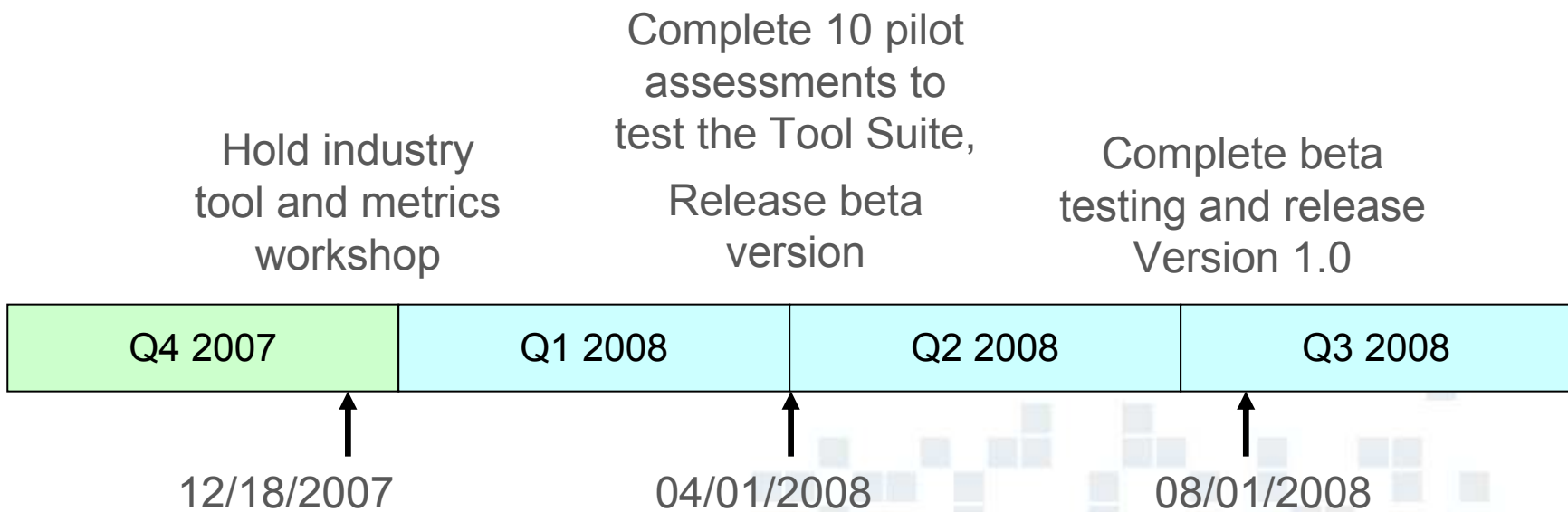
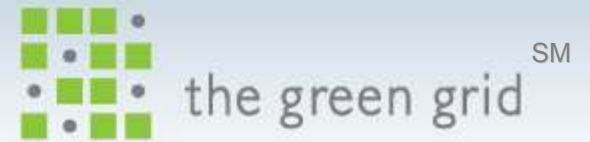
– Electrical Example



Data Centers Assessment: Efficiency Actions

| Actions | Criteria to Determine Applicability of Actions (using metrics and features) | Algorithm to Determine Potential Savings (using metrics and features) |
|--|--|---|
| 6. IT Equipment Power Chain | | |
| Maximize UPS load capacity: <ul style="list-style-type: none"> - UPS types / topologies (DB Con/DLT Con/Rotary) - Redundant configuration not to exceed (N+1) or 2 N. - Use modular UPS - Shutting down modules when the redundancy level is high enough | Applicability Criteria: <ul style="list-style-type: none"> < 30% for N+x configuration < 40% for N configuration Evaluate / Retrofit UPS topologies for more efficient ones. Y / N Shutting down UPS modules. Y / N Modular type UPS system. Y / N | based on typical UPS types - Rotary, Delta Conversion, Double Conversion, and Flywheel types. (see UPS efficiency Tab) Overall Energy Effectiveness is high. |
| Consider high efficient UPS types / topologies. | Use high efficient UPS types / topologies. Y/N | Y: Will increase UPS efficiency by 5-15%. N: 0% New UPS topologies offer high efficiency at load capacity below 40%. Overall Energy Effectiveness is high. |
| | | |

Software Tool Suite Timeline



Projected Timeline

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For more information please go to
www.thegreengrid.org



the green gridSM

get connected to efficient IT

