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New Trends in Data Center Metrics

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Critical Infrastructure of the Cable Industry

"Critical Infrastructure" can encompass a number of different types of facilities

- Data Centers
- Head-ends
- Hub sites

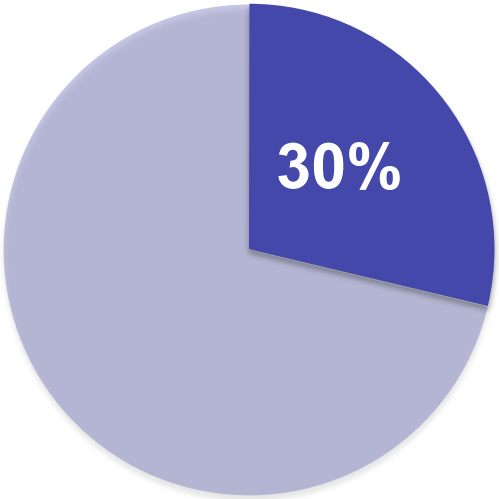
CHALLENGE:

Identify meaningful Data Center Metrics that can be gathered cost effectively and used in all critical infrastructure sites

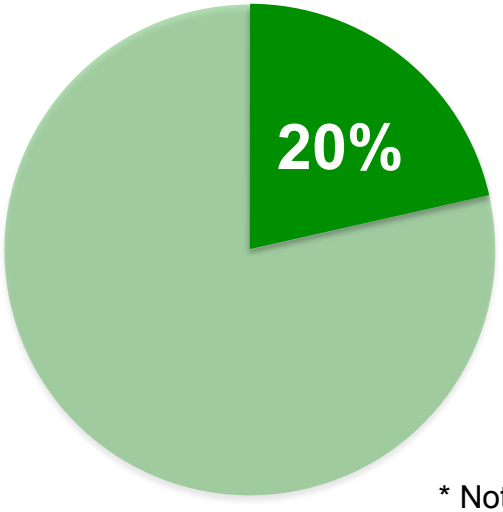
Why Do We Need Metrics?

- Cable Operators have large Power and Carbon footprints
- Critical Infrastructure is a meaningful contributor

% of Total Electricity Use of Typical MSO



% of Total Carbon Emissions of Typical MSO*



* Not including CPE

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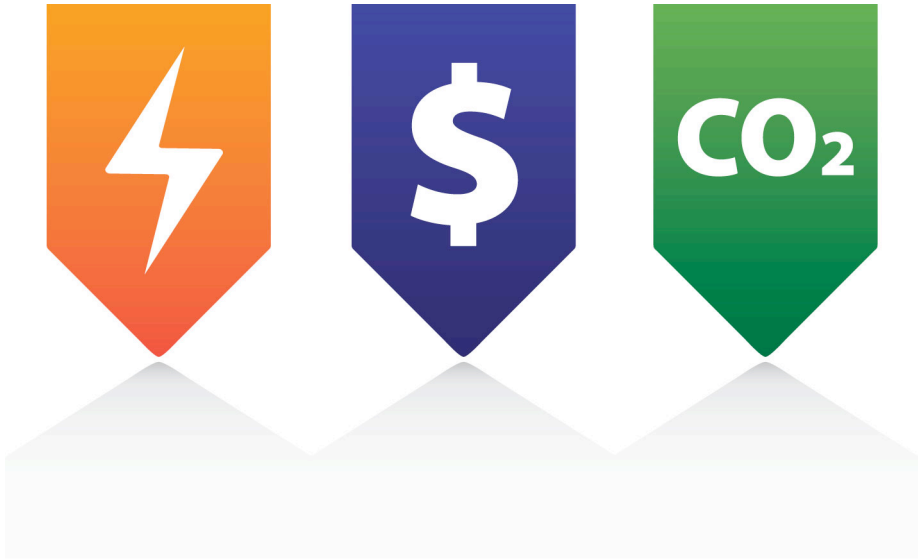
Why Do We Need Metrics?

There is growing interest in reducing power consumption and carbon emissions through energy efficiency and carbon abatement strategies.

- Metrics provide an initial benchmark
- Effectiveness of any initiative can be measured against this benchmark



The World of Data Center Energy Efficiency Metrics

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- Many industry bodies and organizations around the world are examining this issue:
  - US DoE through “Save Energy Now” Program
  - US EPA through Energy Star
  - Green Grid
  - European Commission Joint research Centre
  - METI (Japan)
  - SCTE SEMI
  - Green IT Promotion Council (Japan)
- Initially independent—now many working together to harmonize metrics

KEY TAKEAWAY:

Cable industry can benefit from the work of these groups

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Critical Infrastructure Dashboard

Most Cable Operators do not include energy efficiency or carbon emissions reduction in their KPIs or Dashboards.

Since energy is a large cost to the business, this should change.

Photo credit: NeoSpire via Flickr CC

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Data Center Dashboard:

Power Utilization Effectiveness (PUE)

- Power Utilization Effectiveness (PUE) is defined as a simple ratio of

$$\text{PUE} = \frac{\text{Total Power needed for Facility}}{\text{Total Power needed to run just IT equipment in Facility}}$$

- PUE is the most measured and recognized Data Center metric
- Fairly straight-forward to measure
  - Total power is measured at building power source
  - Equipment power best measured as close to equipment as possible
  - Generally accepted to measure equipment power at UPS
- Target to get as close to 1 as possible
  - **1.2** = best in class measurements
  - **1.8–2.2** = typical industry measurements

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Data Center Dashboard:

Power Utilization Effectiveness (PUE)

Examples

	Average Demand (kW)	Critical (IT) Power	PUE
Building 1	52.3	33.2	1.58
Building 2	13.8	8.0	1.73
Building 3	25.7	13.4	1.92
Building 4	27.5	13.2	2.08
Building 5	61.1	28.6	2.14
Building 6	38.4	22.8	1.68

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Data Center Dashboard:

Power Utilization Effectiveness (PUE)

Comparing PUE between companies and industries is difficult:

- All data centers are not equal
- Base PUE varies depending on certain factors
- PUE varies based on time of year and geography

PUE is more useful as a benchmark

- Benchmark should capture a full year of data
- Effectiveness of energy efficiency or carbon abatement work can be assessed

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Data Center Dashboard:

Power Utilization Effectiveness (PUE)

PUE is a widely accepted metric for data center because it tells an operator the effectiveness of HVAC efficiency in relation to IT equipment.

PUE is mentioned as potential metric to be tracked in SCTE SMS Work

However, it is not perfect:

- Does not help operators understand how efficiently IT equipment is being utilized from an energy perspective
- Does not help understanding how efficient the operator is at turning energy into productivity

OPPORTUNITY:

Integrate metrics that benchmark these energy efficiencies

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Data Center Dashboard:

Equipment Utilization Reporting

FACT: It is more energy efficient to run a smaller number of fully loaded pieces of equipment, then it is to meet the same demand using a larger number of lightly loaded units.

- IT Equipment Utilization (ITEU) is defined as a measure of how close the equipment runs to its rated capacity

$$\text{ITEU} = \frac{\text{Total Measured Power of Equipment}}{\text{Total Rated Power of Equipment}}$$

KEY TAKEAWAY:

Focus operators on fully using existing capacity of before creating more useable equipment space

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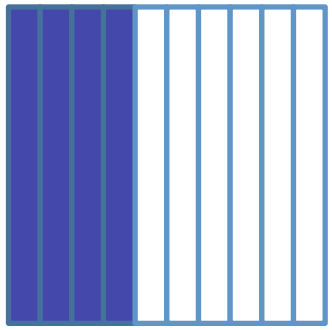
Data Center Dashboard:

Equipment Utilization Reporting

EXAMPLE: For an individual shelf



Total Shelf Rated Power = 2250W

Measured Power with Common Cards and minimal service cards = 1000W

$$\textbf{ITEU} = \frac{1000\text{W}}{2250\text{W}} = \textbf{44.4\%}$$

- ITEU = total measured IT Power divided by sum of all rated powers in data center

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Data Center Dashboard:

Equipment Utilization Reporting

Application of ITEU in Data Centers

- Initial targets could be around equipment capacity targets (75-80%)
- Total IT equipment power measured for PUE – just need to add tracking of Equipment Rating
- Benefits from tracking this measurement separately
  - ITEU not seen directly in PUE tracking
  - Improving ITEU should improve PUE (in theory)
  - Brings equipment engineers into the work associated with improving energy efficiency

KEY TAKEAWAY:

- ITEU data and use is still in its early days
- SMS 003 work should be good industry forum to discuss way forward
- ITEU can drive better and more efficient use of space and equipment

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Data Center Dashboard:

Equipment Efficiency Reporting

FACT: Running equipment with smaller and/or lesser “capacity” wastes energy and space.

- PUE does not capture this waste—power used is still considered equipment power for utilization purposes. Measure of equipment productivity per unit power is called IT Equipment Efficiency:

$$\text{ITEE} = \frac{\text{Total Capacity of the Equipment in Place}}{\text{Total Rated Power of Equipment}}$$

KEY TAKEAWAY:

- Focus operator on driving greatest productivity from used floor space

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Data Center Dashboard:

Equipment Efficiency Reporting

EXAMPLE: Edge QAM

	QAM Capacity	Rated Power	ITEE (QAM's/W)
Product 1	64 Streams	400W	0.160
Product 2	480 Streams	2250W	0.213
Product 3	72 Streams	450W	0.160
Product 4	48 Streams	192W	0.25

But could calculate per MB/s, etc.

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Data Center Dashboard:

Equipment Efficiency Reporting

CHALLENGES:

- Difficult to calculate—equipment has different types of “productivity”
- Lacks a standard unit of productivity
  - “Bits per watt” for standard Data Centers
  - What about video equipment? Ad-insertion equipment?

OPPORTUNITIES:

- Similar in concept to Green Grid DCeP
- Work with suppliers to improve the energy efficiency of equipment per unit of productivity
- SMS 003 could be a catalyst for improving productivity of equipment per unit energy

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Data Center Dashboard:

Carbon Reporting

FACT: Carbon is the common method for energy “accounting”, allowing one to add together all different types of energy usage into a common “currency”

- Carbon and carbon reporting is increasingly relevant for Operators
- Carbon Usage Effectiveness (CUE) is the total carbon footprint of the data center in metric tons of carbon dioxide equivalent ($kgCO_2e$) divided by the power consumed by the IT equipment only:

$$\text{CUE} = \frac{\text{kgCO2e Carbon for Data Center}}{\text{Total IT Only Power of Equipment}}$$

- CUE has a unit of Kilogram Carbon Dioxide Equivalent ($kgCO_2e$) per kilowatt*hour, or $kgCO_2e$ /kWh

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Data Center Dashboard:

Carbon Reporting

- Similar concept to Green Grid CUE
- As with PUE, mentioned as potential metric to track in SCTE SMS work
- Relatively straight-forward and simple to calculate
- Target to get as close to 0 as possible
- CUE and PUE are related

	TOTAL kg CO2e Emissions	IT Equipment Energy	CUE	PUE
Building 1	1,265,535.0	1,871,424.2	0.68	2.01
Building 2	2,487,550.0	1,310,438.9	1.90	2.21

OPPORTUNITY:

Lower Carbon implies more stable and available energy source long term

CUE helps Operators to think about how and where they source energy

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Data Center Dashboard:

Green Energy Co-Efficient

FACT: The amount of green energy a company uses is not directly part of PUE or CUE

- Green Energy Co-Efficient (GEC) is a simple measure of how much power is being used from Green Sources:

$$\text{GEC} = \frac{\text{Total Green Power Used for Electricity (Scope 2)}}{\text{Total Power Consumption in Facility}}$$

OPPORTUNITY:

Introducing renewable energy source(s) does improve carbon footprint

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Data Center Dashboard:

Green Energy Co-Efficient

CHALLENGES:

- Loose definition—suggest classifying as “renewable” energy
- Calculation is a function of obtaining percentage of power from renewable sources from utility company
- Plus, any onsite-generated power, like PV or wind
- Target will range from 0-1, with 1 being best
- Initially this measure may not vary much, and will correlate inversely with CUE

OPPORTUNITY:

- Renewable energy sources provide long term benefit as non-renewable sources become costly and/or scarce
- Becomes a catalyst for capital planning for the right projects to reduce cost, and reduce overall carbon footprint

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Data Center Dashboard:

Other Reporting Ideas

Break down non-IT power elements

- HVAC
- Measuring UPS/DC in, and UPS/DC out
- Measure Convenience and Lighting (if lighting and convenience outlets greater than 3% of power used, there is an issue)

CHALLENGE:

- Additional measurements require additional measurement points
- May be problematic in Head-ends and Hub sites

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Data Center Dashboard:

Breakdown of PUE Elements

Examples

	Average Demand (kW)	Critical (IT) Power	Losses, Lighting, Aux, etc.	Average HVAC Power	PUE
Building 1	52.3	33.2	3.7	15.4	1.58
Building 2	13.8	8.0	1.4	4.4	1.73
Building 3	25.7	13.4	3.2	9.0	1.92
Building 4	27.5	13.2	2.5	11.8	2.08
Building 5	61.1	28.6	5.0	27.5	2.14
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Data Center Dashboard:

Other Reporting Ideas

MEASURING COST OF POWER USAGE:

- Inefficiency manifests itself as cost
- Benchmark cost of power and use as an incentive
- Develop as a metric (i.e. $/sq ft) for potential comparison purposes

MEASURING POWER LOAD FLUCTUATIONS

- Power load in cable Data Centers is fairly constant through-out the day
- May be useful to understand periodically what the power load as a function of time of day
- In today's CI environment, fluctuations are not typically great
- Useful in a future SMS 003 environment where power draw adjusts

Conclusions

- Data Center energy efficiency and carbon emissions are becoming important topics for Operators
- New metrics are being developed for the industry to use
  - Simple to measure and use
  - Applicable to all Cable Operator Critical Infrastructure

- More work still needs to be done to better understand, implement, and effectively use these measurement to reduce Data Center energy usage and impact on the environment

