Energy Macro Measurement in Broadband Cable Industry

Energy Measurement for Cable

A Technical Paper prepared for the Society of Cable Telecommunications Engineers
By

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Overview

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EXECUTIVE SUMMARY

Many industries have benchmarks, key performance indicators and measurements to determine how something has changed in relationship to something of value to that sector or industry. The cable industry as of fall 2014 does not have a single metric to outline performance in relation to energy. This paper looks to cover parallel examples of metrics, the cable difference warranting its own metric and ultimately a proposed metric that all cable providers could use to determine how their products and services stand in terms of energy consumption.

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WHY TALK ABOUT ENERGY?

Energy and our modern world are almost inseparable. It is hard to consider a world without a supply of electricity. You could argue leveraging the examples of extreme storms causing extended power outages, the fabric of society is rooted in the availability of reliable power (above the foundational necessities of food, water, shelter and clothing). The second tier of "societal normalcy" would be communication and access to information (also enabled by access to reliable power). Looking at cable (the terms cable and broadband will be used interchangeably throughout this paper) and the services the industry provides, the third tier of normalcy has been accelerated via the millions of connections to homes around the world.

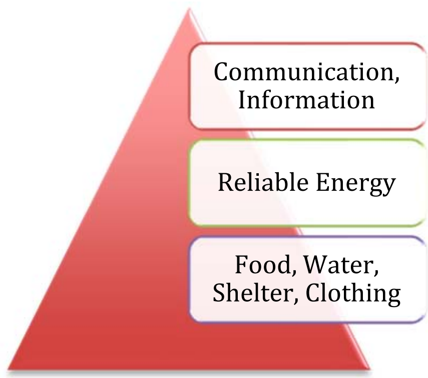

FIGURE 1: SOCIETAL NORMALCY PYRAMID

Before beginning to discuss metrics, it is important to define the question – "why do we need a metric in the first place?" A metric will help measure how well products, financials, or company as a whole is performing over a period of time in relation to its energy consumption. Having such a figure will help determine impacts of product change on energy efficiency, where to spend money, where energy could be saved and address public concerns over energy responsibility and environmental impacts of doing business. Cable's customers are becoming more acute to the global responsibilities of many industries not just cable. This awareness and access to information can influence how consumers choose products and services.

Metrics help emphasize importance. Solidly defined metrics help companies motivate employees by giving a target to aim for and a path for improvement. Overall, clearly defined metrics will help tell the cable story by outlining where the company has been, where it wants to go, measure if there is something wrong and provide indicators of success.

FINANCIAL REASONS

What about the financial perspective? Knowing the customer and ultimately the society that the operator is a part of, why should the business care about how it is consuming energy? It comes down to just that – business. Operators have done a great job in becoming more operationally efficient though call management, troubleshooting prior to truck rolls, proactive maintenance, and isolation of issues to exact locations on the network (to name just a few). What is the next operational and maybe the last cost savings advantage destination – the efficient management of energy. No longer can utility bills be "rubber stamped approved" by detached, non-vested parties distant from the equipment responsible for the services and power consumption. The solution to a power problem needs to have systematic examination and not simply an attitude of either this is the way things have always been or we will simply pour more money towards the problem.

If we look at the utility grid as a resource and understand its current challenges with aging infrastructure, pressure from Government to modernize through smart grid, and migrate from carbon heavy sources such as legacy coal fired power plants, there is no doubt that the cost per kilowatt hour will need to go up to cover this anticipated upgrade. If we look at an article posted on Gizmodo, the author sites the state of California (who has traditionally been ahead of the energy change curve) as an example of what we will likely be faced with. She paints a picture of a fine dance between new energy production embracing solar, wind, and other renewable sources in conjunction with heavier taxation on legacy sources of power. Based on estimated extrapolation of cable industry energy estimated cost of over $1 billion dollars annually, the quoted 47% increase would be a hefty price to pay literally. This cost increase in grid produced power is a good opportunity for cable to look at self-generation via fuel cell, micro turbine, or supplement with solar/wind technologies.

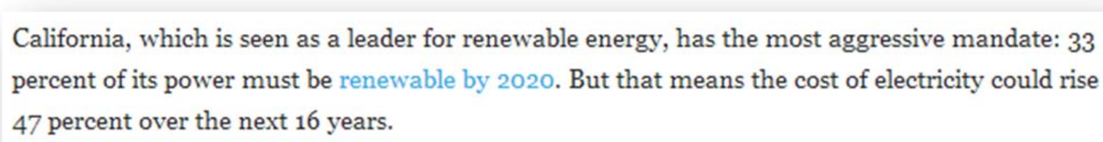
California, which is seen as a leader for renewable energy, has the most aggressive mandate: 33 percent of its power must be renewable by 2020. But that means the cost of electricity could rise 47 percent over the next 16 years.

FIGURE 2: GIZMODO ENERGY PRICE QUOTE

COMPETITIVE OPERATIONAL ADVANTAGE

We have seen over the last few years a stronger push to a more IP centric core product video service. What does this push to an all IP world for products mean for our industry? Creative competitive advantages need to be continually sought. As mentioned earlier, one such competitive advantage (beyond access to superior content) will be how well we continue to manage operations. Creative business opportunity exists to provide proactive network monitoring for partnerships with local utilities to provide insight into power outage patterns to help expedite restoration are already beginning to take shape. NOC (network operations center) systems of customers and alerts can paint powerful power outage maps via millions of set top boxes, gateways and cable modems. Utility providers could purchase this up to the minute information as a service to better determine strategic restoration of power. This two way communication in a developed relationship between cable operator and local utility provider is a win-win in the support of the reduction of customer outage.

Another opportunity is the shift to energy accounting at the engineering phase which is becoming even more important than ever. The energy ecosystem including the electronic components, critical spaces, where and what kind of power is sourced and even the core efficiencies of the customer products themselves will all be factors in the new all IP world. Many people have asked, "What is a more energy efficient means of video delivery - IP or QAM video delivery?" The converged network must have energy value at the facility level by not needing to support multiple types of equipment. Hints of the all IP based world surfaced with the adoption and roll out of VoIP services, video is the next major leap. Finally, remembering that 1 kW of equipment power will also require cooling accounting thus increasing energy spend.

SERVICE OFFERINGS LANDSCAPE CHANGE

What was only a dream 20 years ago (voice and data) is now cable's core services generating billions of dollars in revenue. What are today's hints at the expanded cable service future: home security and automation, telemedicine support, automotive telemetry/smart transportation, and even wholesaling of power. Power and cable share the same poles and pass the same customers; why not add value via resale of power? In March 2014 it was reported that Comcast is an energy reseller (http://www.greentechmedia.com/articles/read/comcast-and-energy-plus-launch-electricity-bundle-in-pa) in the deregulated state of Pennsylvania in a partnership with NRG. The power of number of customers served is something cable has as a tremendous asset. The numbers alone can speak for themselves as referenced in MultiChannel News http://multichannel.com/news/cable-operators/top-20-multichannel-providers/326351. The ability to get past the front door, the utility meter, health monitor or even refrigerator (think Internet of Things) is a great value. At the foundation of all of the future cable services/products will continue to be energy.

CABLE ARCHITECTURE

HFC

Let's pause and review hybrid fiber coax (HFC) deployment as it relates to energy demand. At the tail end of the cable plant, the energy load is light. As we migrate up the coax and hit power supplies, the average load begins to increase to 2kW. From the power supply reaching the hub, loads will vary but on average the first facility stop in the service will be anywhere from 2kW to 500kW. At the larger headends loads get bigger, 200kW to 1MW. Finally reaching the largest facility, the datacenter or master/national media center, loads can reach 1 plus MW in nature.

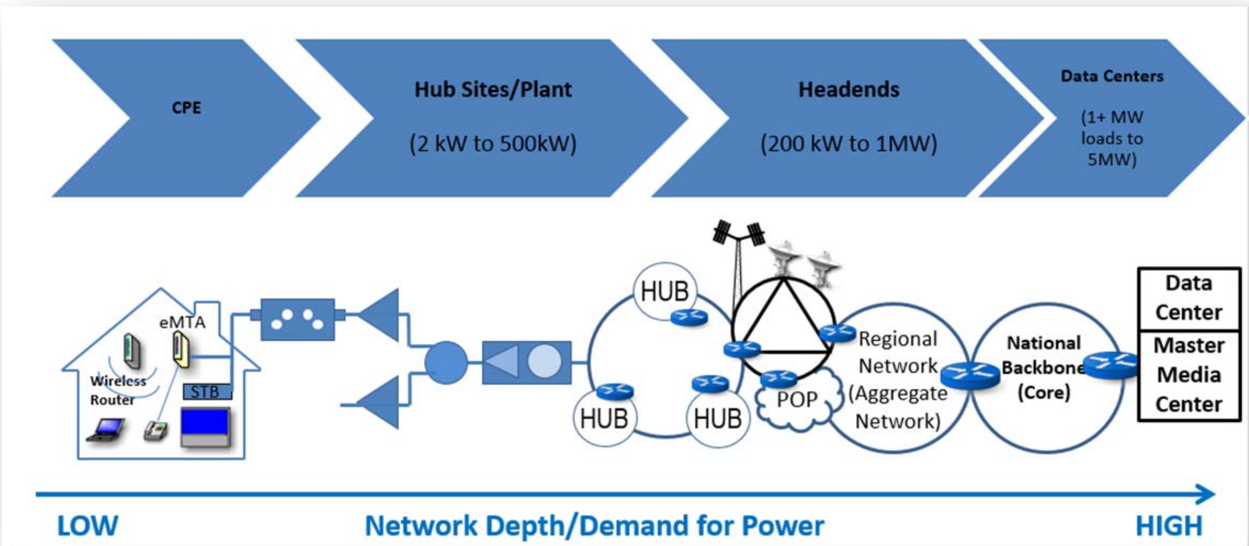

Figure 3: HFC and Power Flow Relationship

How does this relate to our proposed macro energy measurement metric? We need to define the boundary of where an operator should measure. This is not to define how (as in place clamp on meter at service point X) but it is an attempt to define the locations. Ideally, an operator should be able to leverage the generally accepted accounting practices (GAAP) in the financial departments to be able to pull the energy spend in kWh. However, this information is not likely to exist in the financial systems as cash flow is tracked not energy flow by accountants. The operator should capture total kWh from the last amplifier in the outside plant all the way back to the data center or master head end (i.e. end to end energy network spend measurement). The CPE side of the equation is a bit of a challenge since they are powered in the customers home, and should not be equated into this measurement. A parallel (although not perfect) example to why the operator should not be responsible for this kWh measure is the cell phone industry. Each consumer is responsible for the charging and recharging of their cell phone and the carrier does not supply power or equate that requirement into their network operations (although the power draw is of a different scale). One takeaway from this exercise is the need for delegating a responsible party for the tracking of the energy consumption across this defined kWh domain space.

IMPACT OF MORE CUSTOMER FACING FIBER

Looking at architecture, there are a few examples of embracing fiber delivery. Armstrong outlined its cost savings benefits in terms of both energy and support. It was documented that there was a 50% cost savings (not including operational efficiency gains) for fiber to the home delivery verses traditional HFC support. This was over 4,000 homes passed and more than 153 miles of plant. Verizon FiOS and the new Google Fiber project have embraced the deployment of fiber as the pipe of choice for these competitive players in the communication space. As cable continues to embrace the deployment of Fiber based services, we should expect to see a continued drop of power needs for the support of outside plant in this new landscape paradigm.

PARALLEL INDUSTRY METRICS EXAMPLES

CLOUD OR "X AS A SERVICE" PROVIDER INFRASTRUCTURE

When discussing cloud providers, names such as Google, Amazon, and Rack Space often come to mind. Unlike cable's products, these providers "products" are not distributed in nature but are heavily rooted in large datacenters. These datacenters will be billions of dollars of combined investment and hundred plus megawatts in power cumulatively. The customers on the Internet need to get access to these facilities and the facilities are connected to one another via high speed fiber links. This makes an "apples to apples" comparison a bit difficult. Cable is responsible for getting the customer to these very services and enabling this connection back to the cloud, requires a distributed "product" as described in the previous section. That being said, it is still worth a moment to pause and examine a few examples of metrics published by non-cable companies.

VERIZON EXAMPLE

Out of all the examples presented, Verizon may be closest to cable's business model offering voice, data and even video over a distributed network infrastructure. Why not simply recognize and adopt the same metric? The primary reason is cable's product is simply not movement of terabytes of data. RF based video is not the equivalent of data packets therefore, until cable's products are all IP wouldn't make sense adopt this and gain an accurate figure. The other challenge with the Verizon metric "tons of carbon/terabytes of traffic" model is that its objective is to measure sustainability projects impact and not overall energy performance changes. If considered an energy measure, additional information on how and where exactly data was collected for the electricity, building fuels and vehicle fuels quoted in the release as sources for the metrics ton measurement was collected. Remember carbon and energy usage are not mutually exclusive.

> The metric is derived by first combining Verizon's total carbon emissions (in metric tons) from the electricity, building fuels and vehicle fuels used to run the company's business. Then, that total is divided by the number of terabytes of data that the company transports across its network. (One terabyte equals about 300 feature-length movies.) Verizon transported 78.6 million terabytes across its global network in 2010 - an increase of about 16 percent, compared with 2009.

FIGURE 4: VERIZON PRESS RELEASE APRIL 28

MICROSOFT EXAMPLE

Microsoft has many products, operating system software, productivity software, gaming console, and cloud hosting platform (Windows Azure). Like the Verizon example, Microsoft's metric is heavily rooted in carbon intensity and not energy. They pledge carbon neutrality. They have recognized that energy consumption is a primary source of carbon emissions from internal operations (including data centers). Without close access to business to technology alignment, it would be difficult to separate customer facing data center and business support data center energy consumption. However in the Microsoft "Becoming Carbon Neutral 2013" report, a few metrics were recognized including popular PUE or power usage effectiveness.

> Our average power usage effectiveness (PUE, a measure of energy efficiency) in 2011 was 1.40 across all of our cloud infrastructure properties, compared with an estimated industry average of 2.0 (the theoretical best achievable PUE is 1.0). Our goal by the end of 2012 is to construct new data centers that average 1.125 PUE and use 30–50 percent less energy than traditional industry data centers.

FIGURE 5: MICROSOFT QUOTE FROM BECOMING CARBON NEUTRAL 2013

PUE is the ratio of power consumed by the IT equipment of the data center, versus the entire power consumed by the data center (lighting, cooling, security etc.). One big problem with PUE is it doesn't take into consideration the value of the IT equipment and its productivity. In other words, if a company wanted to produce a better PUE ratio, additional physical servers could be turned up, let idle and because the IT load has increased the PUE will appear to get better. PUE is not rooted in energy effectiveness.

AT&T EXAMPLE

If the AT&T example is closely reviewed, their energy metric approach is similar to Verizon however, AT&T also recognizes a second metric. The common theme of better for business, environment and servicing customer is claimed in their executive summary. AT&T, like Verizon, provides similar products to cable service: voice, video and data. The metrics at AT&T have been baselined as of 2008 and claim it is relative to data growth. The first metric AT&T is recognizing is similar to Verizon except it isn't rooted in energy to carbon conversion and cuts right to the chase:

Energy intensity (KWh electricity/Terabyte network traffic)

AND

Energy intensity (MWh electricity/$ billion revenue)

FIGURE 6: AT&T 2012 KEY ENERGY PERFORMANCE INDICATOR

The first metric closely resembles Verizon except it relies on energy consumption and not carbon. This helps keep the figure a bit more transparent and would not require a solid understanding of how the company collected the data used to report its carbon value. The second metric has a lot of merit especially for a publically traded company. This metric will help benchmark energy to financials, an important value, but still falls a bit short when looking for how well the product being delivered is performing in terms of energy consumption.

PROPOSED METRIC AND REASONING

CABLE'S ANSWER

What is right for cable? Let us revisit the purpose of a metric. We should strive for something useful that can be used to make intelligent business decisions and gain insight into how well a facility is performing. Taking this into consideration, some items that should play a role in the metric are time (duration of the measurement – month, quarter, year) and the importance of gathering a baseline measurement of power. Given the rate of change in the industry utilizing a years' worth of data would be a solid foundation of information to use in our equation. This would account for seasonal impacts based on both weather and human consumption patterns based on societal events (Super Bowl, holidays, business trends, etc.). Note that how to establish a baseline is out of the scope of this paper.

Time Warner Cable presenting at a Datacenter Dynamics conference in New York City in spring of 2014 outlined some solid metrics to consider. Any given metric should contain a measurement in the numerator based on useful calculation divided by meaningful "barometric value" that would hold meaning for the business managers conducting the exercise. Beginning with the numerator value, there are several items an operator should measure at any given site when putting together our metric: total critical load in kW and total critical load capacity. The critical load in kW should be measured at the UPS and the DC plant levels.

For the proposed metric, PUE can be determined since the calculation of the load was calculated in kW and collecting total power to the facility. This however, is not our final destination but added bonus and really only illustrates how much power as a percentage is going to support the "non-product load" such as lighting, security, cooling, airflow management and employee support needs. With this, metric as mentioned earlier, it best illustrates needs of concern for the support systems.

We need to move beyond PUE. What should our denominator be? In cable's case, as discussed in the Time Warner Cable example, it should be customer count. A customer should be defined as an entity receiving service. If we dive a bit deeper, the entity can be referred as a "primary service unit, which is further defined as the total of all discrete video, high speed data and voice subscriptions, in essence revenue generating units (RGUs). For example, a single household buying voice, broadband and video would represent three primary service units. This would take into account large service receivers such as hotels that may pay a single bill. The customer figure is a solid denominator to get the ratio of power at equipment to customers served. This will provide the "performance cost" of the equipment.

However, a deeper look into this calculation may be required as cable continues to secure business customers. A correlation between what types of service based on a point system may be required to help tally the totals. For example, a "traditional" triple play customer could be worth three points; whereas a fiber based business customer with both telephone and high speed data service could be worth 10 points. Defining the sliding point scale will be important as the metric will be impacted based on a jump in the denominator. The sliding scale should correlate based on energy utilization associated with the given RGU. Following the network signal flow, repeat the calculation and add the numbers to determine the "energy cost" of service. Obtaining a daily average of watts for the site over the month/year duration will help alleviate any "one off days" that an operator could experience. Also, utility grade meters are generally not present at the necessary granularity necessary to calculate kilowatt hours per point of measurement (such as IT load, UPS, or DC plant rectifiers). Operators report their customers served on a regular basis and modern monitoring equipment will allow for data collection on any interval. The same time frames should be used with capturing both figures. For example, if the critical load was for the month of March, the number of customers billed for the month of March should be used as well. If we put the two figures together our ratio would be:

$$\frac{\text{Total Critical Load W}}{\text{Total Customer Served}}$$

FIGURE 7: PROPOSED CABLE METRIC

Once all the facilities data is collected, the business decisions can be made to where new equipment should have priority for replacement compared to other facilities. The exercise should be done in totality to get a value view into how the sites are performing, one compared to another. If the exercise is only performed across a partial number of sites, the operator will not have a good picture into the total landscape. This activity could be regionalized to facilitate quicker wins into the business intelligence process and then aggregated up. Why not take the building total kW load into account and focus on the critical load? One answer is a facility may not have all of its space occupied thus skewing the excess overhead into the equation. Another reason is the facility may be mixed space and not exclusively reserved for product delivery (e.g. a hubsite with people space embedded in the building). In the example below (assuming a very small operator having three facilities) it is illustrated that example 3 has a higher than average watts per customer ratio. Investigation could be done to see about cooling efficiency optimization, equipment lifecycle analysis or even site consolidation.

	Total Critical Load kW/Month	Customer Count/Month	Watt/Customer Ratio
Example 1	70	62000	1.13
Example 2	86	90000	0.96
Example 3	50	12000	4.17

FIGURE 8: EXAMPLE CABLE METRIC VALUES

Why would the ratio be so radically different from site to site? One reason could be legacy vs. green field build outs. Legacy technology often times will not be as energy efficient as the latest solutions; or the legacy facility has received an overload of equipment to keep pace with competition in that market (broadband speeds for example) and the demands in that building have pushed the limits from a powering perspective. Possessing additional information from the facility manager will help determine the true root cause for the ratio spike as compared to the others in examination providing necessary information to make intelligent, energy related business decisions.

Some additional information an operator may want to collect, is the average age of equipment at a given site. Having the age across the total footprint and the new metric for each site could help an operator develop their own operational efficiency and replacement strategies based on performance in markets that have excessive per kWh costs. Another add-on data point to consider collecting is what percent of a facility supports commercial vs. residential customers. This trend could help establish customer energy accounting when bidding on new commercial builds.

Diving into Example 3 a little deeper, let's assume that there was a legacy building that prior to a fiber competitor moving into the region had a power rating of 18kW. Converting the kW to W would make our numerator 18,000W and the denominator 12,000. Dividing that number, we measure 1.5 W/customer. With the need to quadruple the bandwidth and provide five times the high definition television programming to add value to the customer base, the upgrade wound up costing the operator 32,000W to maintain competitiveness.

Finally, what about the outside plant, where should power be measured and cost of service determined for plant? The outside plant is slightly different than the critical facility example examined earlier. The diversity and geographic scale of the outside plant covering large distances requiring power amplifiers, repeaters and now even WiFi devices "paints" a different energy landscape. Instead of a megawatt facility, there are hundreds of power supplies attached to the network. This segment of the service network represents a calculation of scale when looking at power. This different picture may warrant a different definition of calculating the denominator. At this point in the service delivery network, the concern or count should be less about RGU and more about invoiced subscribers.

Looking at all of the power supplies and meters feeding these supplies are a logical source of data in determining the numerator. Once this figure is calculated, the segment of the network can be mapped to the customers served via that segment. If an operator had the need, a global service footprint could be calculated by adding up all the watts from the individual parts exercise and total customers served over time to determine total cost of service. However, this project may not bring as much value as the individual pieces since the objective is to create an inventory of performance to determine strategic need for modification. Finally, a component of the outside plant requires the same diligence of detailed metric analysis that facilities has traditionally. A consideration for incorporating the fleet component of "total energy spend" should be taken into account as fleet fuel, (and soon to be impacting electric vehicle) impacts operator energy equation.

SUMMARY

In this paper, the importance of energy management, some example metrics and a proposed energy metric was presented. Energy measurement, like financial accounting is a macro look into company performance. The total critical load in watts to customer ratio hopes to provide a tool to make decisions on the impacts of energy costs to delivering products. As the American National Standards Institute (ANSI) accredited standards body for the entire cable industry, the SCTE Standards Program is looking to formally engage the cable community and work this proposal as either a recognized ANSI standard and/or a recommended practice for measuring energy.

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Abbreviations & Acronyms

ANSI	American National Standards Institute
CPE	Customer Premise Equipment
DC	Direct Current
HFC	Hybrid Fiber Coax
IP	Internet Protocol
kW	Kilowatt
kWh	Kilowatt hour
MSO	Multiple-system Operator
MW	Megawatt
NOC	Network Operations Center
PUE	Power Usage Effectiveness
QAM	Quadrature Amplitude Modulation
RGU	Revenue Generating Unit
RF	Radio frequency
UPS	Uninterruptable Power Supply