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Society of Cable Telecommunications Engineers
International Society of Broadband Experts

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From the Editors

In this issue, we continue the discussion on how to strategically approach procurement of energy, help address the security of energy as well as affordability, is presented from a renewable approach. We examine how to approach adopting the operational practices and standards that the Energy Management Subcommittee have published to date (December 2017). Next, a keen look at how electric vehicles could play a role in rapidly reducing emissions and costs for the cable industry is presented. Finally, a thought provoking letter to the editor introducing the concept and role of computational fluid dynamics in critical facilities are outlined. If you have feedback on this issue, have a new idea, or would like to share a success story please reach out to us journals@scte.org for consideration in an upcoming issue.

SCTE/ISBE Journal of Energy Management Senior Editors,

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Meeting the Energy Trilemma with Renewables

Clean Energy Adoption for the Cable, Telecomm, and Broadband Sectors

A Technical Paper prepared for SCTE/ISBE by

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1. Introduction

Global companies today face what is known as the energy “trilemma”—the need to balance energy security with energy that is both affordable and environmentally responsible. The U.S. Energy Information Administration (EIA) currently projects that world energy consumption will increase 28% by 2040 . Simultaneously, the energy delivery system around the world is expected to undergo massive disruption in the forms of decentralization, digitization, and decarbonization. Future-proofing energy supply has become a predominant goal for managing risk and resiliency for a majority of companies.

As a result, there has been an up swell in the acquisition of renewable energy by corporations. Nearly fifty percent of the Fortune 500 have set climate-related or clean energy acquisition targets . Since 2008, the U.S. commercial & industrial (C&I) sector has been responsible for contracting for more than 11,000 megawatts (MW) of new build renewable energy projects via power purchase agreement (PPA) alone, more than the current demand by utilities.

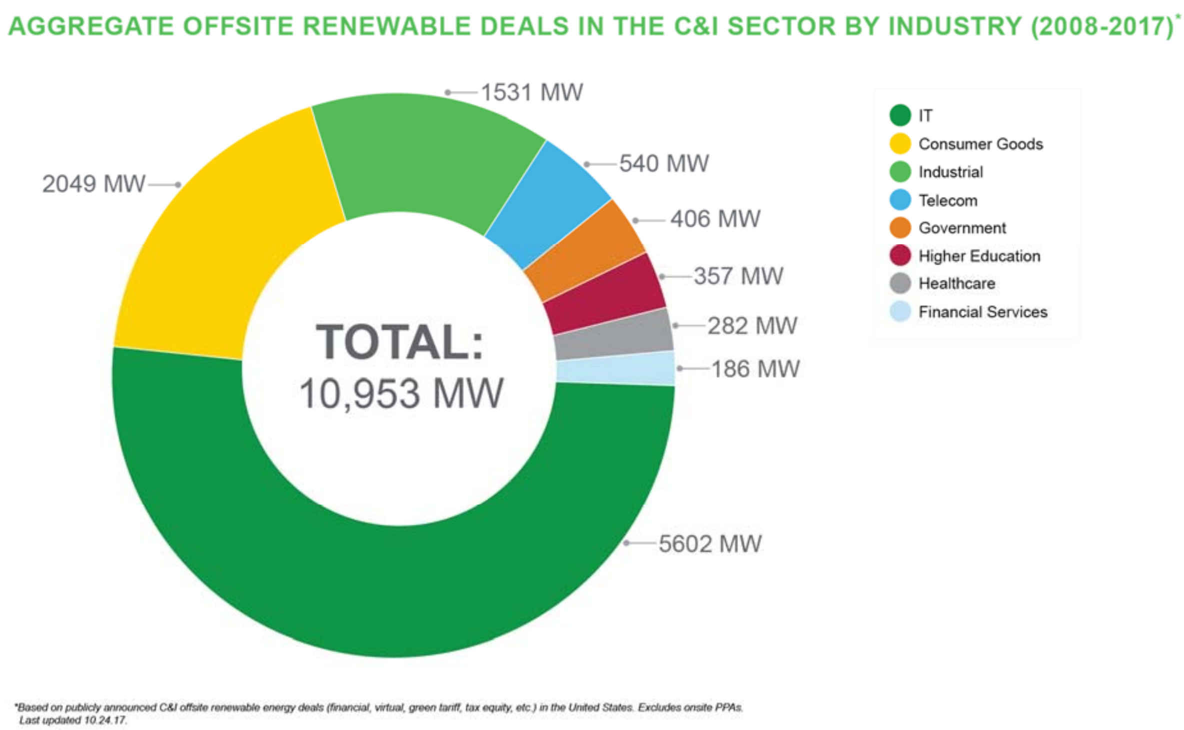

Figure 1 - Aggregate Offsite Renewable Deals in the C&I Sector by Industry (2008-2017)

This paper will explore how renewables can be used to navigate the energy trilemma and the common drivers behind the explosive growth in the C&I sector, with specific recommendations for the cable, telecomm, and broadband sectors.

2. Why Renewables, Why Now?

Until recently, C&I companies were confined to few choices when it came to their energy supply. However, global deregulation (which creates free market competition in the energy space), falling technology costs, and governmental subsidization have helped renewable energy sources such as wind power and solar power reach price-parity in many markets. Earlier this year, solar power prices surpassed conventional fuel prices in over 60 emerging economies . The dramatic decline in price for these technologies has resulted in a massive surge in demand in both the wholesale and retail markets.

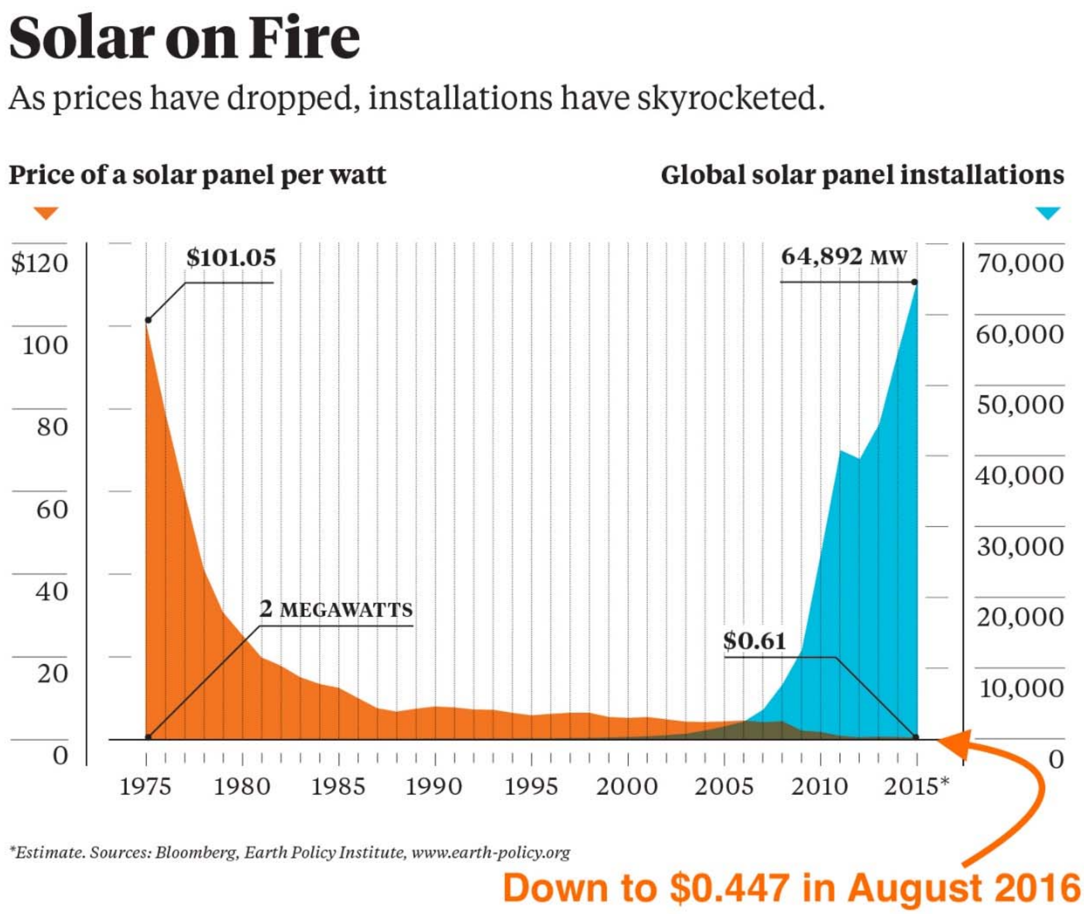

Figure 2 - Supply and Demand Curve for Global Solar Power 1975-2015

While renewable energy has been available for commercial purchase for decades, the striking difference in today's market is the number of choices available to C&I buyers. Whether relying on traditional, affordable energy attribute certificates (EACs), such as renewable energy credits (RECs) in North America, purchasing green power from a utility in the form of a green tariff, or exploring investment in an onsite system or offsite power purchase agreement, today's C&I buyer can use renewables to achieve multiple goals. These include diversifying the company's energy portfolio, hedging against future fuel price increases, reducing carbon emissions, and improving air quality and stimulating job creation in the geographies where they deploy renewable and other clean technologies.

2.1. How Companies Use Renewable Energy

The myriad of choices available in today's renewable energy market means that C&I buyers can customize their green power strategy in order to meet the unique opportunities and constraints of their business. Typically, companies use a combination of the below to address their overall operational electricity load.

2.2. Energy Attribute Certificates (EACs)

EACs originated in the United States in 1999 as a means to track and account for the trading of renewable energy. When renewable energy is generated, an EAC is simultaneously produced in a corresponding 1:1 ratio. The energy itself joins the grid and combines with all other sources of generation, to the point where it is impossible to separate it from any other type. The EAC serves as the clean power's "birth certificate" and is the instrument that conveys that power's environmental attributes. EACs underpin all renewable energy transactions where claims to these environmental attributes are made.

EACs are used in both compliance (utility) and voluntary markets and may be purchased bundled with grid-sourced electricity or separate from it (unbundled). When purchased or owned in the same ratio as purchased electricity, the owner of the EACs may make zero emission claims for that electricity. How is this possible, when electricity is sourced from the grid and is made up of a variety of generation sources? The EAC—the birth certificate—effectively guarantees that amount of clean power was added to the grid, even if the end-user sources electricity from a mixture of clean and conventional generation sources.

Beyond their ability to track environmental attributes of green generation, demand for EACs also provides a powerful market signal, particularly in emerging markets. For these markets, which typically create a type of environmental certificate system before developing other more complex contracting structures (like power purchase agreements), EACs often lay the foundation for a competitive renewable energy market to develop. When C&I buyers purchase EACs to address their purchased electricity in these regions, their purchase sends a demand signal to the market that there is a desire for clean energy. The long-term, stable REC market in North America provided the framework for additional purchasing options to arise.

EACs can be highly flexible—coming from a variety of technologies and available all over the world in varying degrees—and in some markets may also be quite affordable. Many companies begin their renewable energy journey by purchasing EACs. Some continue to address up to 100% of their load, or beyond, with this instrument. Others continue to use EACs while they explore new or additional opportunities. Still others may start with EACs, but phase out their utilization over time as they switch their renewable energy purchasing to onsite and offsite renewables and other innovative technologies. Regardless, EACs form an important and often foundational component to a C&I renewable energy strategy.

2.3. Onsite or Distributed Generation

Most companies are familiar with onsite generation, which typically takes the form of photovoltaic (PV) solar power. This so-called "distributed" form of generation can be connected to or independent from the grid, and is attractive to buyers as the most direct way to purchase renewable energy.

Today, buyers have many choices in how they use onsite generation. It's possible to purchase or lease panels with upsides and downsides to both options. However, extensive use of onsite generation is still constrained for most companies for a number of reasons, including:

- Lack of sufficient real estate for either rooftop or ground-mounted systems to fully meet operational demand, or real estate that the company does not own
- Upfront capital expenditure costs that may have lengthy payback periods
- Geographic and/or regulatory constraints, including local or state options for onsite generation, siting restrictions, or utility barriers

In order for companies to use onsite generation to meet their carbon reduction goals, onsite purchasers must also maintain ownership of the EACs associated with the generation. If the EACs are sold and not replaced (through a swapping process known as arbitrage) either as part of the onsite solar contract or for revenue reasons, the power generated can technically no longer be called "clean."

One of the more attractive features of onsite solar is its scalability, particularly for companies that do have adequate real estate to support multiple installations of relatively small size. It's therefore unsurprising that C&I deployment of onsite generation has been dominated by the retail sector. IKEA, Target, Apple, Walmart, Costco, Kohl's, and Macy's are among the top users of solar power, all taking advantage of the flat roofs of their retail stores. For companies with a large, distributed real estate footprint, onsite generation can be an ideal solution. In total as of 2016, C&I companies have installed more than one gigawatt (GW) of onsite solar across 2,000 individual systems[i].

2.4. Offsite Power Purchase Agreement (PPA)

C&I renewable energy purchasing has gained tremendous momentum over the last five years thanks to the increasing availability and attractiveness of offsite PPAs, which allow companies to purchase renewable energy at utility-scale. PPAs are particularly attractive for companies with significant electricity loads, or who have set aggressive renewable energy acquisition targets. To date, PPAs have been dominated by companies in the ICT sector, led by Google, Amazon, Facebook, Apple, Microsoft, Equinix, and Digital Realty. However, other industries are catching up, with 2017 PPAs announced by companies as diverse as T-Mobile, Kimberly Clark, Anheuser-Busch InBev, Cummins, PaPpal, and Goldman Sachs.

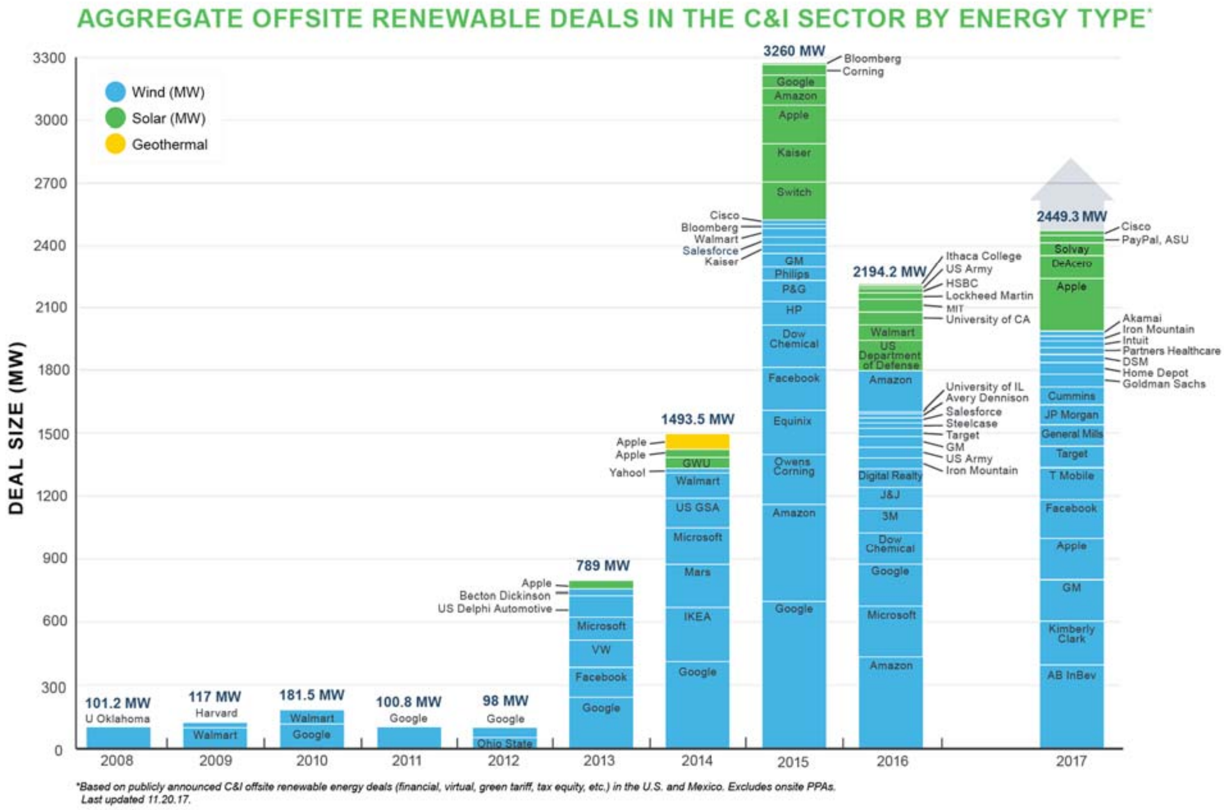

Figure 3 - Aggregate Offsite Renewable Deals in the C&I Sector by Energy Type

PPAs are unique in that they allow the purchasing company to contract for power directly with a project developer. Renewable energy projects are expensive and require investment capital to come to fruition. As a result, project developers look for guaranteed power "offtakers" who are capable of entering the long-term PPA contract and posting good credit, both of which serve to demonstrate the viability of the project to the financier. Utilities also sign PPAs with developers. Prior to the first commercial PPA in 2008, utilities were the only offtakers.

There are two predominant types of PPAs: direct (or retail-sleeved) and virtual (or financial). In a direct PPA, the purchasing entity (in this case, the C&I corporation) is physically collocated in a grid region with the project they contract with. The power is physically delivered to the operational location by the utility (the retail sleeve), and the corporation settles the difference in price directly with the developer. In a virtual PPA, the corporate buyer does not need to be in the same geography as the project. Instead, they continue to purchase their electricity as normal from their own utility, and the PPA contract is settled separately. In this case, the contract is a form of "fixed-for-floating swap," where the settlement price is dependent upon the fixed, contracted price, and the floating price of energy in the market where the project is located. If the fixed price is lower than the market price, then the developer pays the buyer a dividend. If the roles are reversed, the corporate buyer pays for *both* its consumed grid electricity as well as a dividend to the developer.

The attractiveness of PPAs in the U.S. has hinged on the availability of two federal subsidies, the wind power Production Tax Credit (PTC) and the solar power Investment Tax Credit (ITC). Both credits have been additive to the rapidly falling cost of wind and solar technology, making these generation sources significantly more competitive. In many cases, PPA contracts forecast wind power and solar power projects outperforming more conventional generation sources like coal and even natural gas, on price over the duration of the contract (which is typically 10-20 years). As a result, companies are positioning themselves to potentially save, or even make, money on a long-term renewable PPA.

PPAs are also attractive to corporate buyers because they typically carry additionality. Additionality is a nuanced term effectively meaning "but for my action". Most PPAs today come from new build projects, which are in turn displacing carbon emissions. When a corporation takes a purchasing role in developing a new renewable energy project, the company can claim that the project—and hence the emissions displacement—may not have occurred without its support. This additionality claim has been important to many companies, particularly when looking for a means to take material leadership on renewables, or to deflect scrutiny from non-governmental organizations (NGOs).

Despite their popularity, offsite PPAs have not been widely adopted. In total, just over 50 companies have executed PPAs in the U.S. For many companies, the long-term nature of the contract, the need to post credit, the various risks inherent in a PPA, or the relatively large project size have been detractors. However, as the demand for PPAs continues, these factors are changing. Smaller sized PPAs are becoming increasingly available, with shorter and shorter contract lengths. Neutral, third-party advisors are available to C&I buyers to help them successfully navigate the risks. Innovative contracting solutions, such as aggregation, continue to open up the PPA market to the next wave of interested buyers.

Like onsite generation, if a PPA buyer hopes to use the PPA to make carbon reduction claims, it must retain the ownership of (or arbitrage) the EACs affiliated with the project. This can potentially impact the PPA price, and is only one of many considerations companies must make before entering these long-term agreements.

2.5. A Portfolio Approach

For most C&I buyers, a portfolio approach to achieving their goals is appropriate. In this case, "portfolio" refers to 1) taking a strategic view of all renewable energy sourcing opportunities relevant to the company's operations, 2) purchasing a blend of EACs or green tariffs, onsite generation, and offsite PPAs to reach the business' renewable energy targets, and 3) ensuring the enduring operational success of the corporate strategy over time. Some companies may never move past the EAC purchasing stage—which is an easy, valid, and acceptable approach. Some companies, particularly those that desire additionality claims, may seek to procure offsite supply matching their total consumption. In reality, most companies will use a blend of solutions to meet their security, affordability, and responsibility goals.

Contractual Instruments	Additionality	Hedge Effectiveness	Load Coverage	CAPEX	Potential Upside	Scrutiny from NGOs	Transactional Complexity	Risk Potential
Energy Attribute Certificates	◑	○	●	◑	○	◑	◑	●
Utility or Supplier Green Program	○	○	○	◑	○	◑	●	●
Onsite Renewables	●	●	○	◑	◑	●	◑	●
Offsite Directed PPA	●	●	◑	●	◑	●	○	◑
Offsite Virtual PPA	●	◑	●	●	●	●	○	○
Offsite Investment	◑	◑	○	○	◑	◑	○	◑

KEY ○ *Requires consideration* ● *Readily meets goals*

Figure 4 - Comparative Analysis of Renewable Energy Type by Feasibility

3. Implications for the Cable, Telecomm, and Broadband Sectors

An enormous opportunity exists for companies in the cable, telecomm, and broadband sectors to act by acquiring renewables. The Power Forward 3.0 report published earlier this year by WWF, CDP, and Ceres indicates that 43% of telecomm companies have set a climate or renewable energy target[ii]. Yet, to date, no companies from this sector are members of the U.S. Environmental Protection Agency's Green Power Partnership program, which recognizes the largest U.S. renewable energy purchasers[iii]. Aside from T-Mobile, no other cable/telecomm/broadband companies have made public announcements about any offsite PPA purchases, and only Verizon rates among the top 20 largest onsite solar purchasers[iv].

For many companies, the difficult first step when it comes to renewable energy purchasing is deciding where, when, and how to begin, particularly considering the growing complexity of this increasingly global industry.

A good first place for any business to start is with a strategy. Specifically, the cable/telecomm/broadband industry should consider the following at the outset of any renewable energy procurement.

3.1. Corporate goals

Start with the end in mind—identify what will be achieved by implementing renewable energy. Is the goal to save money? Hedge against future power prices? Meet environmental targets? The answer to these questions, and the questions below, will drive decision-making in the purchasing process.

- What are the overall targets the company is trying to reach—and what are the markers of success?
- Is the purchase of renewable energy intended to reach environmental goals, financial goals, or both?
- Is material leadership, like additionality, an important consideration for the company?
- What are competitors doing? Is there pressure from any NGOs or consumer groups?
- What types of claims does the company hope to achieve with its purchase?
- Does the company have reporting or disclosure restrictions or requirements?

3.2. Size and location of energy load

The distributed footprint of retail locations, operations, and data centers in the sector can help inform the appropriate type of renewable energy to select from. Real estate or other siting considerations may also come to bear on the choice of one renewable technology or contracting type over another. Finally, the location of facilities in either regulated or deregulated states will influence the type of renewables that may be purchased there.

3.3. CAPEX appetite

The ability to outlay capital—even capital with a short payback period—is an important determination for any company contracting for renewable energy to consider. If there is capital to be directed towards renewables, it becomes easier to use EACs and/or onsite generation. If there is limited to no capital available, onsite generation with a quick payback period or offsite generation in the form of PPAs may be more appropriate.

3.4. Risk tolerance

The more complicated a contract, the greater the level of risk. Complex deals like PPAs require considerable engagement from cross-organizational stakeholders alongside tolerance for these risks, which range from the actual performance of the project, to volatility in energy market prices. PPAs also typically require longer contracting structures, which can be a difficult hurdle to overcome if a business is used to buying energy in 18-36 month tranches.

3.5. Get help

A trusted third-party advisor can help develop a strategy and provide a side-by-side comparison of appropriate opportunities. Ideally, the advisor will also run competed processes to ensure the company receives the best products/projects at the best price. A high quality advisor will be independent—in order to ensure their neutrality—and have a demonstrable track record of success alongside deep expertise on global renewables across the portfolio.

When in doubt—and assuming available capital—EACs can be the right place to start. Renewable energy purchasing in the form of these affordable and versatile credits is a great way achieve goals in a credible and accessible fashion.

4. Conclusion

Corporations today are faced with the energy “trilemma”—security, affordability, and responsibility. Renewable energy offers companies the solution to this trilemma, particularly when applied in a portfolio approach through a combination of global EACs, onsite generation, and offsite PPAs.

Companies in the cable, telecomm, and broadband sectors have considerable opportunity to take a position of leadership on renewable energy purchasing, as very few businesses in the sector have entered the market to date. Buyers must consider the goals they wish to achieve by sourcing renewables, how they will manage CAPEX, real estate, and risk challenges, and engage stakeholders. Using a buyer’s advisor can be a key means to achieving these goals while also ensuring the best product or project at the best price.

5. Abbreviations and Definitions

5.1. Abbreviations

MW	Megawatt
EAC	Energy Attribute Certificate
REC	Renewable Energy Credit, or Certificate
CAPEX	Capital expenditure
GW	Gigawatt
PPA	Power purchase agreement
ICT	Information Communications & Technology
PTC	Production Tax Credit for wind power
ITC	Investment Tax Credit for solar power
NGO	Non-governmental organization
WWF	World Wildlife Fund
CDP	Carbon Disclosure Project

5.2. Definitions

Energy “trilemma”	The increasing need for companies to acquire energy that is secure, affordable, and environmentally and socially responsible
Commercial & industrial (C&I)	Umbrella term referring to corporate entities in the U.S. and abroad

Conventional generation sources	Fossil-based fuels such as coal, oil, petroleum, and natural gas, and nuclear power
Bundled green power	Electricity, typically purchased from a utility or the government, that is paired with Energy Attribute Certificates (EACs) at the time of purchase. When purchased separately, EACs are referred to as “unbundled
Electricity grid	The shared network of generation, transmission, and distribution of electricity in a given geography
Onsite or distributed generation	Most commonly, onsite generation of solar power via photovoltaics. Some companies also use solar thermal, geothermal, biomass combustion, and micro wind turbines to produce onsite generation
EAC arbitrage	The process of “swapping” EACs. Typically, higher value EACs are sold and backfilled with less expensive/less valuable EACs. For example, solar RECs in the Pennsylvania-New Jersey-Maryland (PJM) grid region are highly valued and are commonly arbitraged for lower priced Texas wind RECs
Offtaker	A recipient of the electricity from an electricity generating project, typically a utility buyer, but more commonly, a corporation through a direct purchasing contract (or power purchase agreement)
Additionality	“But for my action.” Additionality is a term borrowed from the carbon offset industry for projects that result in displacement of carbon emissions. When applied to renewable electricity, it has come to mean a role of material leadership demonstrated by a corporate offtaker
Green Power Partnership	A program established and administered by the U.S. Environmental Protection Agency to track green power leadership by commercial entities, including colleges & universities

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[i] https://cleantechnica.com/2017/03/06/118005/
[i] https://www.seia.org/solar-means-business-report
[i] https://www.worldwildlife.org/publications/power-forward-3-0-how-the-largest-us-companies-are-capturing-business-value-while-addressing-climate-change
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Overview of SCTE/ISBE Energy Management Subcommittee Standards and Operational Practices

Adoption Strategy for SCTE•ISBE Energy-Related Published Documents

A Technical Paper prepared for SCTE/ISBE by

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1. Introduction

This publication outlines the Energy 2020 program and assists the reader with a method to get the most from SCTE•ISBE Energy Management Subcommittee authored documents regarding responsible energy management for the cable industry.

2. What is Energy 2020?

2.1. Description

Energy 2020 aims to provide cable system operators with the energy management standards, technology innovation, organizational solutions and training to help the cable industry meet Energy 2020's goals. The Energy Management Subcommittee (EMS) is the organized body responsible for the development of the documents enabling this program to meet the acknowledged goals. EMS reports to the SCTE•ISBE Engineering Committee which has the final approval of all published documents as represented by the American National Standards Institute (ANSI)-accredited industry consensus body.

2.2. Mission

The mission of the Energy 2020 program is to envision and enable what energy will look like in cable in the year 2020, targeting maximum customer uptime and enabling capacity growth via successful organizational, customer and environmental energy solutions.

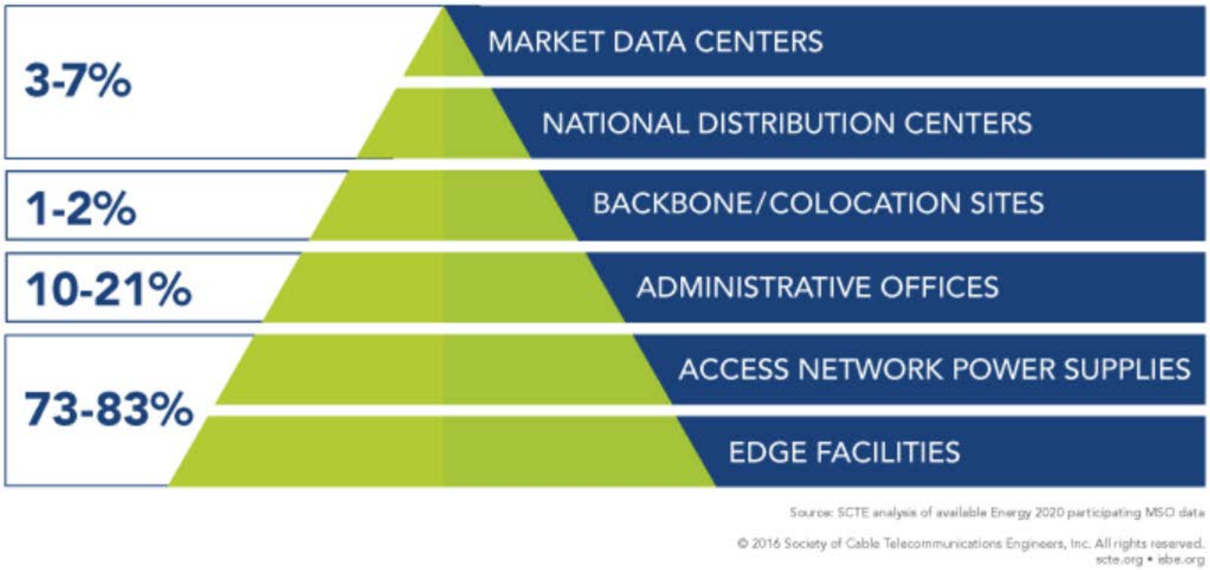

Figure 1 – Cable's Power Footprint

As depicted in Figure 1 above, edge facilities and HFC (hybrid fiber-coax) networks represent the greatest opportunity for energy cost avoidance. According to detailed SCTE•ISBE analysis of energy usage of a cross section of major operators, between 73% and 83% of cable's overall energy consumption is by hubs and headends, as well as the access network power supplies powering the active equipment on the HFC network. Cable operator and vendor collaboration centered on innovation and creative thinking are needed to drive efficiency in these areas.

2.3. Energy 2020 Goals

SCTE ISBE announced the following goals of the program:

- Reduce power consumption per unit by 20%
- Reduce energy costs by 25%
- Reduce grid dependency by 5%

3. Energy Management Standards, Practices and Metrics

As of this publication, twenty-two SCTE•ISBE documents have been published in support of the goals of Energy 2020. The information falls within an adoption framework in several focus areas:

- Enterprise Energy Management & Governance
- Energy Managed Assets
- Energy Technology
- Energy Performance Measurement & Reporting

3.1. Enterprise Energy Management and Governance

This focus area outlines energy management planning, execution and monitoring enterprise-wide across *all* managed assets and technology.

The main SCTE•ISBE document for enterprise energy management and governance follows:

3.1.1. ANSI/SCTE 234 2016 ISO 50001:2011 Energy Management Systems, Energy Metrics, With Guidance for Use

3.1.1.1. Intended Audience

Individuals within the cable industry senior teams such as sustainability officers, energy managers, chief network/technology officers, or employees having the authority to set wide spread company direction should leverage SCTE 234 2016.

3.1.1.2. Key Provisions

In 2011 the International Organization for Standardization (ISO) published 50001: Energy Management Systems - Requirements with Guidance for Use. SCTE's Energy 2020 program aligns with the underlying principles of that publication and SCTE 234 2016 serves as recognition of that international standard as the official cable industry standard.

- Companies in the cable industry shall reference the ISO 50001:2011 requirements for establishing, implementing, maintaining and improving an energy management system
- Recognition of the SCTE 211 and 213 as the specific performance measurement metrics
- To help aid, guide, and measure their adoption of ISO 50001, cable industry companies should refer to the provided SCTE 234 progress checklist

3.1.1.3. Area of Applicability

Asset mapping to market data centers, national distribution centers, backbone/colocation sites, administrative offices, access network power supplies, edge facilities. Encompasses facilities, operations, plant, regulatory, technology.

3.2. Energy Managed Assets

The managed assets focus area uniquely applies to an operator's managed assets or across multiple assets, and several documents are pertinent:

3.2.1. SCTE 184 2015 SCTE Energy Management Operational Practices for Cable Facilities

3.2.1.1. Intended Audience

Facility architects, facility design engineers, facility managers.

3.2.1.2. Key Provisions

SCTE 184 provides guidelines for design and management of mission-critical hub site facilities supporting the cable industry. SCTE 184 focuses on information, methods, metrics, and processes that balance operational energy efficiency and management with essential business availability requirements and infrastructure investment. This guideline leverages existing best practices for smart energy use in vital cable edge facilities and applies these to the specific characteristics and requirements of cable systems hub sites.

- Targets critical facility operations teams, critical facility new construction teams along with facilities designers and contractors
- Improved design features and critical infrastructure building blocks (building architecture, electrical system infrastructure, mechanical cooling systems) to achieve energy savings
- Optimize energy approaches for expansion of existing facilities and construction of new facilities

3.2.1.3. Area of Applicability

Asset mapping to market data centers, national distribution centers, backbone/colocation sites, edge facilities. Encompasses facilities, operations, plant, regulatory, technology.

3.2.2. SCTE 205 2014 Outside Plant Power Recommended Preventive Maintenance Procedure

3.2.2.1. Intended Audience

Cable technical personnel.

3.2.2.2. Key Provisions

SCTE 205 serves as a reference for cable technical personnel as to how to perform a proper preventive maintenance visit to outside plant cable power systems. As network reliability expectations increase, the powering sub-systems of the network must be depended on for near-perfect operation. The document will guide the reader through proper maintenance procedures for power systems, inclusive of power supplies, batteries, transponders and enclosures, resulting in optimal system performance, reducing outages and unnecessary truck rolls.

3.2.2.3. Area of Applicability

Asset mapping to access network power supplies. Encompasses operations, plant, regulatory, technology.

3.2.3. ANSI/SCTE 226 2015 Cable Facility Classification Definitions and Requirements

3.2.3.1. Intended Audience

Critical facility designers, operators, and engineers.

3.2.3.2. Key Provisions

The ANSI/SCTE 226 document presents a five-tier classification approach to provide cable operators with a framework within which to categorize facilities and critical infrastructure, prioritize investment decisions, establish availability expectations, and to define performance levels for the cable industry.

- Establishes five critical facility classifications (A through E) that define levels of availability, redundancy, customer serving percentage and energy efficiency targets
- Establishes required critical infrastructure element minimums for each of the five critical facility classifications
- Enables a hierarchy for critical infrastructure requirements spanning from the data center to the last mile optical transition enclosure

3.2.3.3. Area of Applicability

Asset mapping to market data centers, national distribution centers, backbone/colocation sites, edge facilities. Encompasses facilities, operations and regulatory.

3.2.4. SCTE 229 2016 Operational Practice for Cable Facility Design Process

3.2.4.1. Intended Audience

Any cable operator personnel having in interest in the design, construction, operation, and use of a cable facility. Such would include personnel in corporate and regional finance groups, technical operations groups, and groups responsible for products and services and professionals outside of the cable operator who provide design, engineering, project management and other professional services to the cable operator with respect to cable facilities.

3.2.4.2. Key Provisions

This document addresses the design of cable facilities that house inside plant equipment which is part of the network through which services are delivered to customers.

- Establishes a fundamental process which both reflects the unique characteristics of the cable industry and is consistent with good professional practice in the building design industry
- Identifies the roles and responsibilities of the cable operator's engineering, operations, and senior management groups in the design process, thus allowing for effective interaction and decision-making by the cable operator
- Identifies roles and responsibilities of licensed professionals, such as building architects and engineers, and how such professionals are critical to the development of the facility design

3.2.4.3. Area of Applicability

Asset mapping to market data centers, national distributions centers, backbone/colocation sites, edge facilities. Encompasses facilities, regulatory, technology.

3.2.5. SCTE 228 2016 Inventory of Energy Efficiency Practices for Broadband Providers

3.2.5.1. Intended Audience

Energy & sustainability teams, design and construction teams, network engineering, critical infrastructure engineering, other engineering units, business management, financial managers, budget coordinators, technical operations, and corporate real-estate.

3.2.5.2. Key Provisions

This document is meant to apply to the cable industries facilities including critical facilities, office space, call centers and warehouses. The scope of this document does not include the outside plant.

- Offers value/cost analysis for stakeholders in prioritizing energy measures (high-priority measures listed in Table 8.1)
- Lighting energy measures identified in this Operational Practice have high return on investment and should be considered high priority for near-term implementation, if applicable
- Most energy measures identified in this Operational Practice are applicable to critical facilities in the cable industry

3.2.5.3. Area of Applicability

Asset mapping to market data centers, national distribution center, backbone/colocation sites, administrative offices, edge facilities. Encompasses facilities, operations, regulatory, technology.

3.2.6. SCTE 225 2015 Cable Operator Fleet Maintenance and Vehicle Selection Operational Practice

3.2.6.1. Intended Audience

Corporate management, fleet management, and vehicle operators.

3.2.6.2. Key Provisions

Cable operators run a distributed network covering thousands of miles connecting facilities to customers and facilities to facilities. This network requires maintenance, upgrades, installation and repairs. Also, new cable subscribers require visits to their site ensuring proper deployment of equipment and turn up of service. All of this is accomplished via a fleet of vehicles that if not managed optimally can impact both the company's bottom line as well as environment.

- Defines key data points to collect to help best understand fleet metrics
- Outlines capital cash flow when managing cable operator fleets
- Defines a vehicle selector matrix to ensure right vehicle is deployed for the right job

3.2.6.3. Area of Applicability

Asset mapping to access network power supplies, edge facilities. Encompasses operations, plant regulatory, technology.

3.3. Energy Technology

The technology focus area applies to a specific technology or across a category, and can apply within a unique managed asset network environment or across multiple cable operator assets. Interest is especially indicated for the personnel types listed below the document link:

3.3.1. ANSI/SCTE 186 2016 Product Environmental Requirements for Cable Telecommunications

3.3.1.1. Intended Audience

Cable operator procurement and equipment engineering teams and inside plant equipment manufacturers

3.3.1.2. Key Provisions

ANSI/SCTE 186 defines environmental and sustainability requirements for the following equipment including but not limited to: CMTSs, receivers, modulators, video encoders, multimedia gateways, servers, routers, switches, network equipment, network storage units, edge routers, add-drop multiplexors and edge QAMs. This standard aligns with ANSI/SCTE 203 2014 for validation of compliance through test methods.

- New temperature requirements – 0 to 50° C at 0-93% non-condensing relative humidity
- Enables cable operators to address the challenge of non-uniform heat removal by specifying a front to rear exhaust
- Defines total watts, watts per square meter and watts per square foot as measures to address heat release and recognizes SCTE 184's recommendation of not to exceed 20kW per rack for optimal heat release efficiency

3.3.1.3. Area of Applicability

Asset mapping to market data centers, national distribution centers, backbone/colocation sites, edge facilities. Encompasses facilities, operations, plant, regulatory, technology.

3.3.2. ANSI/SCTE 216 2015 Adaptive Power System Interface Specification (APSIS)

3.3.2.1. Intended Audience

Network engineers, network architects, access network engineers, and critical facility engineers

3.3.2.2. Key Provisions

SCTE 216 2015 ANSI/SCTE 216 2015 enables cable operators to measure and control energy consumption associated with delivery of services. SCTE 216 defines software interfaces that allow energy measurement and optimization applications to command and control devices within a service delivery pipeline.

- Adopts international standards for device-level energy monitoring and controls, and is based on definitions provided by the IETF (Internet Engineering Task Force)
- Defines a high-level information model describing the energy related data points and control functions supported by compliant devices
- Provides definitions for a growing number of protocol 'bindings' to the information model and allows device manufacturers to choose which specific software protocols (e.g. SNMP, IPDR, etc.) to use to implement the standard

3.3.2.3. Area of Applicability

Asset mapping to market data centers, national distribution centers, backbone/colocation sites, administrative offices, access network power supplies, edge facilities. Encompasses facilities, operations, plant, regulatory, technology.

3.3.3. SCTE 218 2015 Alternative Energy, Taxes, Incentives, and Policy Reference Document

3.3.3.1. Intended Audience

Facility managers, facility engineers, data center operators, and headend/edge facility operators evaluating alternative energy technology options.

3.3.3.2. Key Provisions

SCTE 218 is an operational practice that provides cable operators with a resource to evaluate alternative energy technology options based on a given geographic location, facility type, and existing or planned infrastructure.

- Outlines decision-making priorities, evaluation strategies and provides rules, regulations and policies for both energy efficiency and alternative energy technologies
- Summary road map of federal & state incentives and policies with links to information
- Includes links to the U.S. Department of Energy's Office of Energy Efficiency & Renewable Energy (EERE), National Renewable Energy Lab (NREL) research and development, and other alternative energy financial modeling tools

3.3.3.3. Area of Applicability

Asset mapping to market data centers, national distribution centers, backbone/colocation sites, administrative offices, access network power supplies, edge facilities. Encompasses facilities, operations, regulatory, technology.

3.3.4. SCTE 219 2015 Technical Facility Climate Optimization Methodology

3.3.4.1. Intended Audience

Facility design engineers, facility managers.

3.3.4.2. Key Provisions

SCTE 219 provides cable operators with guidelines to assess facilities' existing energy efficiency and climate conditions, including recommended actions to improve air flow and facility climate conditions to reduce energy costs. Also included are advanced cooling technologies such as air-side and water-side economizers.

- Identifies simple methods such as blanking panels, properly deploying perforated tiles, and layout of equipment designed to improve air flow management and energy efficiency
- Highlights solutions that are available at minimal cost with payback periods of under 18 months
- Provides optimum measuring and monitoring techniques for climate optimization
- Outlines steps to benchmark climate performance

3.3.4.3. Area of Applicability

Asset mapping to market data centers, national distribution centers, backbone/colocation sites, edge facilities. Encompasses facilities, operations, regulatory, technology.

3.4. Energy Performance Measurement & Reporting

The performance measurement and reporting focus area applies to a specific measure or measures, or can apply within the cable network.

3.4.1. ANSI/SCTE 210 2015 Performance Metrics for Energy Efficiency & Functional Density of Cable Data Generation, Storage, Routing, and Transport Equipment

3.4.1.1. Intended Audience

Cable operator datacenter engineers and procurement teams.

3.4.1.2. Key Provisions

SCTE 210 enables a cable operator to determine how well a piece of rack or shelf equipment performs in terms of minimizing the power required to do its job. In addition, this standard provides the means to quantify the amount of useful work the equipment provides per physical space. This release focuses on the digital data transport critical facility equipment.

- Metrics for generic server equipment: the storage density as the number of terabytes per rack unit, and the processing density as the maximum number of server processor cores multiplied by the processor base frequency in GHz
- Metrics for digital data transport equipment system throughput: bits per second per rack unit
- Metrics for digital data routing/switching equipment system throughput density: bits per second per rack unit

3.4.1.3. Area of Applicability

Asset mapping to market data centers, national distribution centers, backbone/colocation sites, edge facilities. Encompasses facilities, operations, plant, regulatory, technology.

3.4.2. SCTE 211 2015 Energy Metrics for Cable Operator Access Networks 231-General Test Procedures

3.4.2.1. Intended Audience

Cable operator metrics teams, access network engineers, and access network managers.

3.4.2.2. Key Provisions

SCTE 211 enables cable operators to measure how effective changes in the access network (AN) service impact energy consumption from both a high-level and functional operations perspective.

- Creates a common definition with respect to energy metrics that can be used to influence, measure and communicate the progress of energy efficiency improvements
- Enables operators to predict and evaluate the energy efficiency and monetary impact of new equipment being considered for deployment
- When used in conjunction with SCTE 212-2015, SCTE 211 allows operators to translate operational energy management successes into financial results

3.4.2.3. Area of Applicability

Asset mapping to access network power supplies, edge facilities. Encompasses operations, plant, regulatory, technology.

3.4.3. ANSI/SCTE 213 2015 Edge and Core Facilities Energy Metrics

3.4.3.1. Intended Audience

Cable operator datacenter engineers and procurement teams.

3.4.3.2. Key Provisions

ANSI/SCTE 213 2015 provides procedures that help cable operators measure how effective changes in the service impact energy consumption from both high level and functional work perspectives.

- Defines a functional energy productivity metric based on subscriber count as:

$$\frac{\textit{Total Number of Critical Facility Subscribers}}{\textit{Total Critical Facility Power}}$$

- Defines a functional energy productivity metric based on data throughput as:

$$\frac{\textit{Total Critical Facility Data Thruput}}{\textit{Total Critical Facility Power}}$$

- Provides a structured approach to looking at facilities quickly to assess energy efficiency using PUE and productivity metrics by plotting facilities on a grid quadrant using their metric measurements

3.4.3.3. Area of Applicability

Asset mapping to market data centers, national distribution centers, backbone/colocation sites, edge facilities. Encompasses facilities, operations, plant, regulatory, technology.

3.4.4. SCTE 232 2016 Performance Metrics for Energy Efficiency & Functional Density of CMTS, Edge-QAM, and CCAP Equipment

3.4.4.1. Intended Audience

Cable operator headend and hub engineers and procurement teams.

3.4.4.2. Key Provisions

ANSI/SCTE 232 2016 is the second of multiple parts in a series that provides the cable operator with a standard reference to determine how well a piece of rack or shelf equipment performs in terms of minimizing the power required to do its job. In addition, this standard provides the means to quantify the amount of useful work the equipment provides per physical space. This part of the series focuses on the cable modem termination system (CMTS), converged cable access platform (CCAP), and other related cable operator critical facility equipment.

- Defines the energy consumption metrics for legacy I-CMTS equipment as:
  - Total chassis power (Watts) per maximum number of downstream/upstream (DS/US) channels supported by the chassis
- Defines the energy consumption metrics for CCAP equipment as:
  - Total chassis power (Watts) per maximum number of service groups supported by the chassis
  - Total chassis power (Watts) per maximum upstream and downstream throughput supported by the chassis
- Defines the functional density metrics for CCAP equipment as:
  - Maximum number of service groups per CCAP rack unit
  - Maximum upstream and downstream throughput per CCAP rack unit

3.4.4.3. Area of Applicability

Asset mapping to market data centers, national distribution centers, backbone/colocation sites, edge facilities. Encompasses operations, plant, regulatory, technology.

3.4.5. ANSI/SCTE 203 2014 Product Environmental Requirements for Cable Telecommunications Facilities – Test Methods

3.4.5.1. Intended Audience

Cable operator procurement and equipment engineering teams, and inside plant equipment manufacturers.

3.4.5.2. Key Provisions

The specification purpose of ANSI/SCTE 2013 is to define test methods to evaluate equipment compliance with criteria specified in ANSI/SCTE 186 2012. This document specifies physical, environmental, electrical, and sustainability test procedures to evaluate equipment compliance with requirements defined in ANSI/SCTE 186 2012.

- New operating temperature requirements – 0 to 50° C at 0-93% non-condensing relative humidity
- Enables cable operators to address the challenge of non-uniform heat removal by specifying a front to rear exhaust
- Defines total watts, watts per square meter and watts per square foot as measures to address heat release and recognizes SCTE 184's recommendation of not to exceed 20kW per rack for optimal heat release efficiency

3.4.5.3. Area of Applicability

Asset mapping to market data centers, national distribution centers, backbone/colocation sites, edge facilities. Encompasses facilities, operations, plant, regulatory, technology.

3.4.6. ANSI/SCTE 212 2015 Cable Operator Energy Audit Framework and establishment of Energy Baseline

3.4.6.1. Intended Audience

Cable operator outside plant managers; power supply engineers; critical facilities managers; cable operator energy managers; and energy accounting managers.

3.4.6.2. Key Provisions

SCTE 212 2015 ANSI/SCTE 212 2015 defines a framework for cable system operators to establish energy baselines for their facilities and networks.

- Requires rapid execution: delivery of 2014 baseline data to SCTE by September 1, 2015
- Continued reporting of data to SCTE monthly enables operators to measure performance against industry trends

3.4.6.3. Area of Applicability

Asset mapping to market data centers, national distribution centers, backbone/colocation sites, administrative offices, edge facilities. Encompasses facilities, operations, plant, regulatory, technology.

3.4.7. SCTE 208 2014: Cable Operator Carbon Data Collection Recommended Practices

3.4.7.1. Intended Audience

Cable operator corporate social responsibility directors, senior management, and energy managers.

3.4.7.2. Key Provisions

SCTE 208 defines the process and function of performing a carbon audit based on cable operator greenhouse gas emissions to establish and measure a baseline or year-over-year comparison of emissions by which subsequent audits may be compared.

- The carbon reporting process is outlined and includes six steps rooted in boundary definition, data management and reporting

- Definition of cable operator direct and indirect emissions scopes in preparation for generating carbon reports
- Enables cable operators to uniformly address the need for data estimation

3.4.7.3. Area of Applicability

Asset mapping to market data centers, national distribution centers, backbone/colocation sites, administrative offices, access network power supplies, edge facilities. Encompasses facilities, operations, plant, regulatory.

3.5. Energy Management Subcommittee Published Document list

Table 1 – List of Energy Published Management Subcommittee Documents

Standards	
ANSI/ SCTE 186 2012	Product Environmental Requirements for Cable Telecommunications
ANSI/SCTE 203 2014	Product Environmental Requirements for Cable Telecommunications – Test Methods
SCTE 212 2015	Cable Operator Energy Audit Framework
SCTE 216 2015	APSIS™ Adaptive Power System Interface Specification
SCTE 226 2015	Cable Facility Classification Definitions and Criteria
SCTE 234 2016	Adoption of ISO 50001:2011 Energy management systems -- Requirements with guidance for use
SCTE 237 2017	Implementation Steps for Adaptive Power Systems Interface Specification (APSIS™)
Operational Practices	
SCTE 184 2015	SCTE Energy Management Operational Practices for Cable Facilities
SCTE 205 2014	Outside Plant recommended preventive maintenance procedure
SCTE 208 2014	Cable Operator Carbon Data Collection Recommended Practices
SCTE 218 2015	Alternative Energy Taxes, Incentives, & Policy Resources
SCTE 219 2015	Technical Facility Climate Optimization
SCTE 225 2015	Cable Operator Fleet Maintenance and Vehicle Selection Operational Practice
SCTE 228 2015	Inventory of Energy Efficiency Practices for Broadband Provider Facilities
SCTE 229 2015	Operational Practice for Cable Facility Design Process
SCTE 238 2017	Operational Practice for Measuring and Baselining Power Consumption in Outside Plant Equipment and Power Supplies
Metrics	
ANSI/SCTE 210 2015	Performance Metrics for Energy Efficiency & Functional Density of Cable Data Generation, Storage, Routing, and Transportation Equipment
ANSI/SCTE 211 2015	Energy Metrics for Cable Operator Access Networks

SCTE 213 2015	Edge and Core Facilities Energy Metrics
SCTE 231 2016	General Test Procedures for Evaluation of Energy Efficiency Metrics and in Support of Functional Density Metrics
SCTE 232 2016	KPM: Energy Efficiency & Functional Density of CMTS, CCAP, and Time Server Equipment
SCTE 241 2017	Key Performance Metrics: Energy Efficiency & Functional Density of Wi-Fi Infrastructure Equipment

3.6. Documents at a Glance

3.6.1. Documents at a Glance Objective

The Documents at a Glance spreadsheet contains a single, consolidated list of all SCTE•ISBE Energy Management Subcommittee published including in-process documents for use or reference by anyone interested in understanding the nature, applicability and status of all energy-related standards and operating practices.

3.6.2. Content

For each published or in-process document, the *Documents at a Glance* spreadsheet provides information on the document type, sub classification, publish date (or target), description, mapping to applicable goals, roles or functions, adoption and training requirements, etc.

3.6.3. Distribution

Current document list posted on scte.org "SCTE•ISBE Energy Standards and Operational Practices." It is also linked in the Energy 2020 bulletin that is distributed to the SCTE•ISBE Standards Energy Management Subcommittee members monthly.

3.6.4. Frequency

Updates are made to the *Documents at a Glance* spreadsheet quarterly.

4. Conclusions

Successful adoption and implementation of the Energy 2020 mission and goals can be attained by attention to the Energy Management Subcommittee documents provided by SCTE•ISBE Standards. Member companies have collaborated to provide comprehensive and up-to-date input and as an SCTE•ISBE Standards member company, you and your company can leverage the latest intelligence regarding energy matters into the year 2020 and beyond.

5. Abbreviations and Definitions

5.1. Abbreviations

ANSI	American National Standards Institute
APSIS	adaptive power systems interface specification
CCAP	converged cable access platform
CMTS	cable modem termination system
EERE	U.S. Department of Energy's Office of Energy Efficiency & Renewable Energy
HFC	hybrid fiber-coax
ISBE	International Society of Broadband Experts
ISO	International Organization for Standardization
KPM	key performance metrics
kW	kilowatt
NREL	National Renewable Energy Lab
QAM	quadrature amplitude modulation
SCTE	Society of Cable Telecommunications Engineers

5.2. Definitions

Headend	A master facility for receiving television signals for processing and distribution over a cable television system.
QAM	quadrature amplitude modulation – television standard using both an analog and a digital modulation scheme used in a variety of broadband communications

6. Bibliography and References

Scte.org

Electric Vehicles

A RAPIDLY EMERGING OPTION FOR REDUCING FLEET EMISSIONS AND COSTS

A Technical Paper prepared for SCTE/ISBE by

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1. Introduction

Electric vehicles have made huge strides in cost and availability in the three years since the launch of SCTE Energy 2020. EV prices are rapidly coming down as battery costs have dropped precipitously in the last five years.[i] Federal and certain state policies have provided incentives or outright subsidies to encourage EV adoption as well.[ii]

Section 1.5 of SCTE's draft Fleet Operational Practice (EMS 026, September 30, 2015) notes that "For future consideration, alternate fuel vehicles could be studied to present use cases for non-petroleum based vehicles." This paper presents some approaches to analyzing electric vehicles (EVs) in vehicle selection and life cycle analysis. The impact on sustainability will be considerable, as Comcast, Charter, and other MSOs are among the largest operators of private vehicle fleets in the U.S.

Figure 1 - Battery Price History

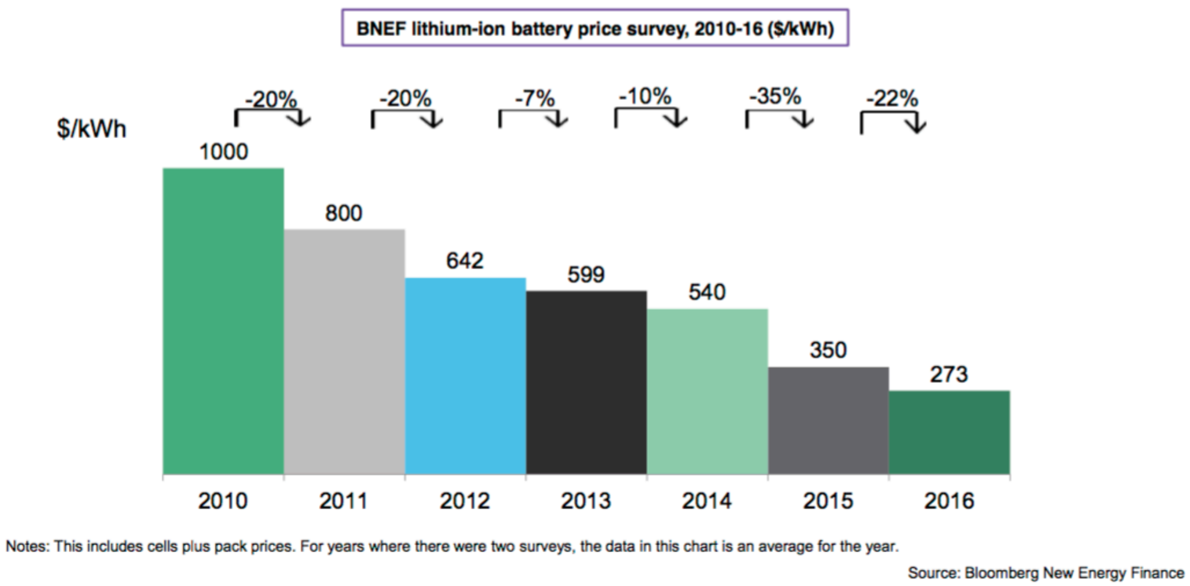
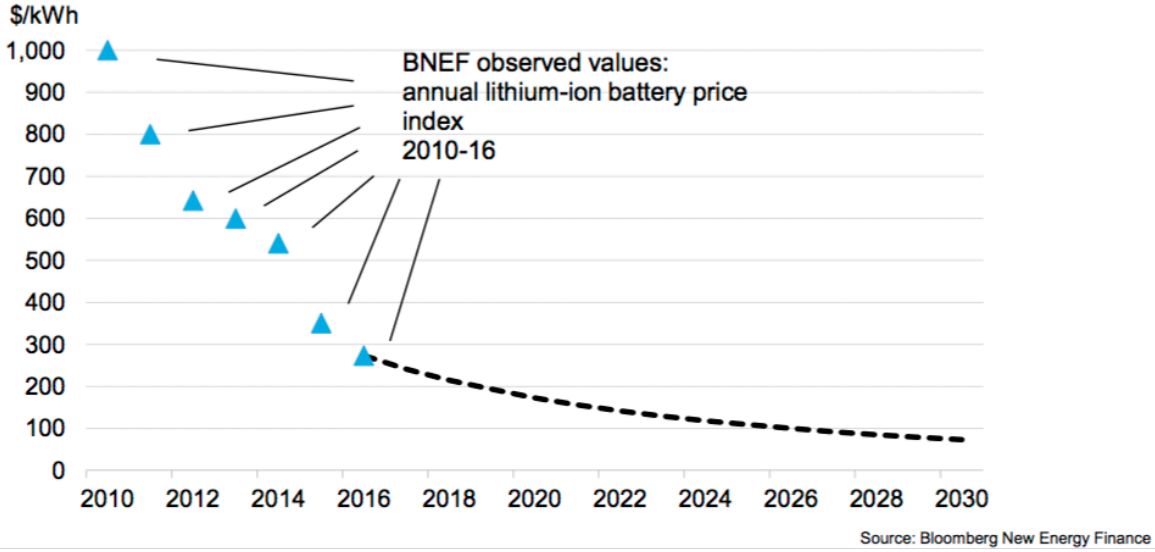


Figure 2 - Battery Price Projections



This paper evaluates the suitability of EV purchases in the context of fleet optimization for reliability, cost reduction and emissions improvements. The focus is on light-duty trucks and vans; Nissan Leafs, Chevy Volts and many other passenger vehicle options are better understood and have been cost effective for several years. Light-duty may also be where there is the most bang for the buck. Fleet managers suggest that commercial fleets generally comprise 50-60% light-duty trucks, around 20% cars and 20% medium- or heavy-duty trucks.[iii]

The paper leverages an analytic framework described by Cox Enterprises in the August Journal of Energy Management. [iv] This framework is further supplemented by work done by transportation industry analysts Sawatch Group. A surprising element will be how EV's flip conventional wisdom around total cost of ownership as a result of battery price reductions and newly demonstrated low maintenance costs.

Further, the paper details a range of fleet-suitable vehicles that are available from multiple manufacturers, both current domestically available vehicles as well as a brief overview of international and new start-up activity. The existing selection of light-duty trucks and vans is not yet as broad and tested as passenger EVs, and so having assessment criteria in hand will be critical in purchasing such vehicles now for sustainability purposes.

2. Analytic Framework

This section provides a brief context for analysis of vehicle selection to characterize the landscape of services and devices that might be covered.

2.1. Cox Model – General Considerations for a Green Fleet

The Cox Enterprise Fleet Team oversees a fleet of over 13,500 assets. Different companies may have different considerations, but the Cox model looked at three categories of inputs: general fleet considerations, telematics data, and general business and government conditions. In reviewing green fleet options, the Cox team took into account a broad range of general fleet considerations:[v]

- duty cycles
- environment
- cargo needs
- equipment or tool storage
- driver ergonomics
- productivity time studies
- work flows
- manufacturer availability
- fuel types
- alternative fuels

Cox makes use of telematics data, available from On Board Diagnostics (OBD) ports, to better assess its needs and opportunities. These include:

- vehicle idle time management
- driver behavior
- preventative maintenance reporting
- routing

Finally, the company looked at general business and governmental conditions that affect needs and available options:

- Federal and state government mandates
- vehicle/tech availability
- infrastructure support
- alignment with the Cox corporate sustainability plan

The Cox Enterprise Fleet Team then takes account of all of these factors by use of a Fleet Management System (FMS), a tool that enables them to monitor and review key performance indicators:

- Fleet Age and Mix
- Fleet Utilization
- Fuel Performance and Mileage
- Fleet Expenses
- Vehicle Repair Metrics

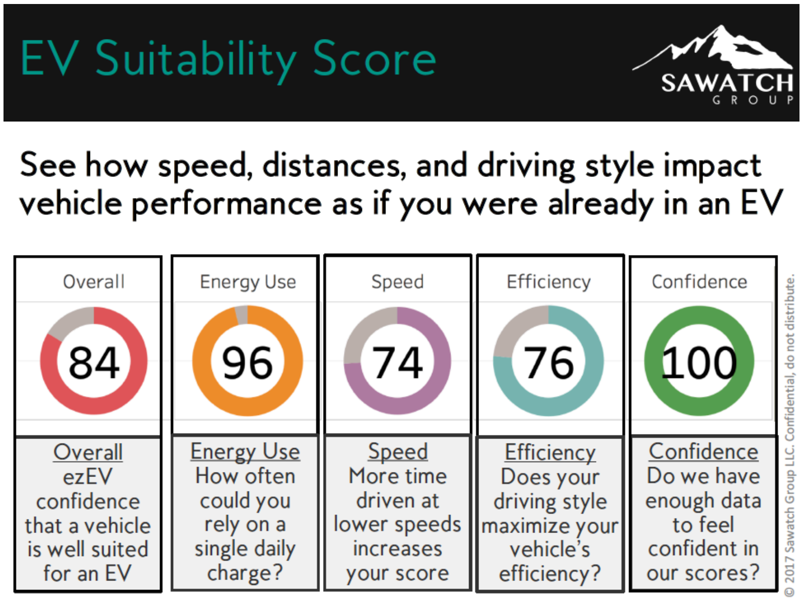
This model as presented by Cox can be very useful in informing a fleet manager's assessment of the state of play with electric drivetrain vehicle options.

2.2. Data Analytics for Assessing EV Suitability – Sawatch Group Model

Modern fleet managers such as the Cox Fleet Team gather a variety of telematics data, for example the data that is available from On Board Diagnostics (OBD) ports, and perform analysis on this data for a variety of purposes. The Sawatch Group[vi] , comprising former employees of the National Renewable Energy Laboratory, provides an example of a data analytics approach for analyzing fleets to assess the suitability of electric vehicles for their particular vehicle needs. This summary is presented as just one example of a data analytics approach.

Sawatch's "ezEV" platform translates real world driving patterns into a personalized Electric Vehicle (EV) Suitability Score. This platform is data agnostic and can utilize any existing providers' data for those with fleets already using telematics. The company also makes available a mobile phone application that drivers install on their smart phones and collect telematics data for fleets that want a low-cost data collection platform. The data is then uploaded to the cloud and run through the analytics platform to calculate the EV Suitability Score. The platform yields metrics based on energy use, speed profile, and driving style, as summarized in this table.

Figure 3 - EV Suitability Platform Output



The Sawatch analytics platform can also yield data on optimal routes, times, parking locations/durations all of which inform range needs and priority routes for EV charging station support infrastructure (EVSE) planning. Timing and location of vehicle parking can be critical to fleet charging needs. By aggregating all vehicles parking at a given facility, fleet managers using this model can optimize the ratio of EV's to EVSE.

2.3. Further Considerations: Life Cycle Costs, Emissions Impacts

Fleet managers will need to balance sustainability goals against cost impacts on their business. A key motivation for considering EVs is the trend toward lower total cost of ownership. This trend is the result of several factors:

- battery price reductions – see graphs in Introduction section above.
- fuel cost savings - passenger car EVs often go 40 miles on a 10 kWh charge, costing $1.10, compared to a gallon of gasoline for an equivalent 40 miles per gallon car, for which prices have ranged from $2.45 to $3.64 in the last 5 years.
- lower maintenance costs over the life of the vehicle - this is the logical outcome of the elimination of the many moving wear items that are part of an internal combustion engine.
- Lower maintenance costs may also translate to changes in vehicle depreciation schedules. Currently, consumer EV's depreciate more quickly, but the reasons for that are complex and changing. [vii]

Some tools exist for making life-cycle cost of ownership calculations. The Electrification Coalition developed one as part of an EV advocacy organization in Colorado. [viii] NREL/DOE have a cost calculator which uses similar assumptions to calculate 5-year total cost of ownership. [ix] A number of tools also can be found at the Drive Clean California site. [x]

In calculating sustainability impacts such as emissions reduction, the comparison between gas fueled vehicles and electric is not straightforward. For example, fuel types used in generating electricity in different regions of the country may vary from renewables to natural gas to coal, with subsequent significant differences in impact on sustainability calculations.

Finally, one way to approach sustainable calculations is to work through an accreditation program. The NAFA Fleet Management Association program for Sustainability Accreditation is summarized in section 6.

3. Energy Vehicle Availability Overview

This section provides a selected summary of currently available or very soon to be available electric vehicles. This is not an exhaustive list, in part because, as battery costs drop and demand rises, entrepreneurial companies are entering the market at an increasing rate, and major OEMs are introducing new models.[xi] It appears to be the case that major OEMs have been slow to dent the EV market, in part because dealership incentives and profit margins still skew toward older internal combustion vehicles. It is very possible that we are in the midst of another industry transition, similar to the entry of compact and sub-compact models into the U.S. market in the mid-1970's, which largely caught the Big 3 U.S. auto makers napping. Such a transition may require fleet managers to shop a little more broadly than their current list of industry suppliers.

3.1. Ford Transit Van / Lightning Systems

Lightning Systems has developed an electric Ford transit van.[xii] The company is a licensed developer as part of Ford's Advanced Fuel Qualified Vehicle Modifier (eQVM) program, which allows partners to build on a standard Ford chassis. UQM Technologies is the electric motor partner for the program. UQM has significant market share in heavy duty electric drive trucks, serving large markets in China. The Ford relationship allows the company to offer the standard Ford warranty and financing through Ford Motor Credit. Customers can order new vehicles or convert existing vehicles.

Figure 4 - Ford Transit Van Specifications

Specifications

Base Chassis (sold separately)	Ford Transit 350HD Passenger Wagon, Cargo Van, Cutaway, Chassis Cab	
GVWR	10,360 lbs	
Electric Range	50 miles	100 miles
Electric Vehicle Supply Equipment (EVSE)	J1772 with CCS Combo for DC Fast Charge	
Charge Time	6 hours (level 2) 0.5 hours (DCFC)	12 hours (level 2) 1 hour (DCFC)
Payload (depending on vehicle configuration)	2,000 - 4,000 lbs	2,000 - 3,000 lbs
Maximum Speed	55 mph (electronically limited)	
Warranty	✓ Base Chassis: Ford standard warranty ✓ EV Conversion: Lightning Systems standard warranty (Powertrain and battery 5 year / 60,000 miles)	
Options	• DC Fast Charge (50kW) • Analytics (predictive maintenance, route scoring, range analysis, driver behavior, geofencing) • Upgraded 12V battery system doubles capacity to support additional accessories	

3.2. VIA Motors / Chevrolet

VIA Motors is an electric powertrain provider that is currently building extended range vans on the Chevy Silverado truck and Chevy Express van. Extended range means the van travels 40 miles on a charge with zero emissions, can generate its own electricity while in operation, but then can go another 350 miles on gas powered generator if needed. Their research suggests that 75% of fleet vehicles go less than 40 miles a day. VIA intends to offer its own branded vehicles within two years.[xiii]

3.3. Zenith Cargo Van and Passenger Van

Zenith Motors is a privately funded company that builds passenger shuttle and cargo vans. The cargo van provides 530 cubic feet of storage, a payload of up to 3000 lbs., and provides an 80- mile range per 6.5-hour charge.[xiv]

3.4. Daimler / Mitsubishi eCanter

Mitsubishi FUSO, part of Daimler Trucks Asia, has introduced a battery electric medium duty truck to customers such as UPS and Seven-Eleven. It has a range of 50-60 miles per charge (11 hours regular charger, 1.5 with DC fast charger.)[xv]

3.5. XL Hybrids – Ford F-250

XL Hybrids is also part of the Ford eQVM program, offering an electric version of the Ford F-250 .[xvi]

3.6. Workhorse W-15

Workhorse offers an extended range pick-up that gets 80 miles all-electric based on Panasonic lithium battery. The company was formerly known as AMP Electric Vehicles, and acquired the Workhorse Custom Chassis assembly plant in order to become a full OEM to manufacture its own trucks.[xvii]

It is clear even from this short list that the traditional OEM model is under some pressure, just as the larger automotive market is facing disruptive pressures from car-sharing, autonomous vehicle development and other megatrends.

4. Developing Trends

Electric Vehicles are in a phase of rapid development, as heavy private and public investment in research over last 10 years is now coming to market. The above light-duty models are just entering the market now. It may be worth a brief look at trends in heavy-duty vehicles and the international market, again in the interest of providing fleet managers with a broader context for their sustainability approaches.

4.1. Heavy-Duty

Heavy-duty trucks seem to have attracted more attention in the EV world than light- and medium-duty, which is counterintuitive considering battery needs for heavier vehicles. Tesla has not unveiled a rumored pick-up truck, but made a recent splash with its futuristic entry into the heavy-duty market.[xviii] Aside from the hype, it may be that fleet needs, cost margins and business models result in a larger demand for heavier duty vehicles at the moment. It may be worth tracking these developments as they may bear on better availability and scale for light- and medium-duty vehicles as well.

4.1.1. Build Your Dream

Build Your Dream is a Chinese company building heavy-duty battery electric trucks, plus some other types of EVs. It is just now entering the North American market with trucks and transit buses.[xix]

4.1.2. Proterra

Proterra builds full-size transit buses, and has sold to many metropolitan transit agencies. It makes sense that transit routes might be more contained in range, and so a better fit for the cost/range tradeoff. [xx]

4.1.3. First Priority

First Priority offers box cargo trucks and other medium-duty vehicles. It doesn't appear to have a lot of traction in the market yet. [xxi]

4.1.4. Chanje

Chanje is a start-up company initially offering a medium-duty panel van. The company contracts with Ryder for fulfilment and support services. [xxii]

4.1.5. Tesla

The Tesla Semi boasts a range of 300 – 500 miles, and a futuristic design. [xxiii]

4.2. International OEMs

Developments in Europe or Asia are moving faster than in the U.S., following differing climate policies and different routing and urban configurations. Following is a short reference list of international manufacturers, which may be expected to market some models in the U.S. in the not too distant future.

4.2.1. Nissan

Nissan offers an EV cargo van, but only a "concept vehicle" in the U.S. [xxiv]

4.2.2. CNH Industrial

CNH Industrial is an Italian company providing heavy-duty electric vehicles. [xxv]

4.2.3. Navistar

Navistar is a U.S. company partnering with Volkswagen on medium and heavy-duty vehicles. The partnership is targeting 2019 for U.S. market. [xxvi]

A longer guide to globally-available medium- and heavy-duty trucks is offered by Navigant Research. [xxvii]

5. Government Incentives and Requirements

Government incentives supporting electric vehicles, and alternate fuel generally, have grown over the last decade. Federal tax credits for EV purchases may be the largest such incentive. There is push back by the Trump Administration, but it unclear whether, first, there is legislative support for rolling back incentives, and second, whether incentives have done their job and cost curves will continue to trend downward without government help. Several states continue to offer tax credits.

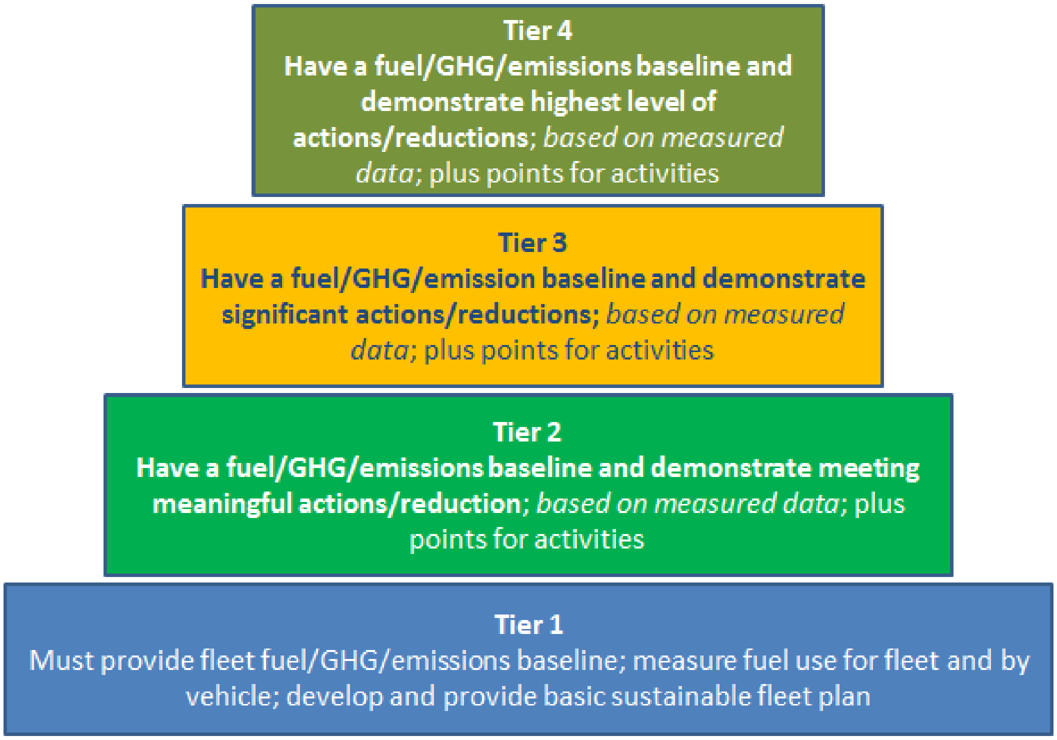
- Funding for fleet vehicles and EV charging supply equipment (EVSE) comes from the Federal Congestion Mitigation and Air Quality Program of the Federal Highway Administration. [xxviii] These funds are administered through state government agencies or non-profit groups like the American Lung Association.
- The U.S. Department of Energy Clean Cities program offers a Plug-in Electric Vehicle Handbook for Fleets. [xxix]
- The Electrification Coalition runs an aggregated purchasing project called Fleets for the Future. [xxx] A sister program funded by DOE is CALSTART. [xxxi]

- The California Air Resources Board operates the Drive Clean web site to help fleets follow sustainability policies. [xxxii]

6. Accreditation

Corporate sustainability programs often seek accreditation in order to validate their programs and gain more credibility and recognition for their efforts. The NAFA Fleet Management Association operates such a program, the Sustainable Fleet Accreditation Program. NAFA partners with CALSTART as the accreditation program's administrator. (CALSTART is a member-supported organization of companies, fleets and government agencies.) The fleet of Charter/Spectrum (dating back to the Time Warner Cable entity) has earned NAFA accreditation.

Figure 5 – NAFA Accreditation Tiers



The program provides an Official Data Collection Tool, which may provide some guidance for fleets seeking to meet sustainability goals, whether or not they seek accreditation. The Tool:

- allocates points from strategies that include efficiency, fuel reduction and emission reduction. Some examples of strategies include a no idle policy, efficient driver training courses, using telematics software, alternative fuel usage, hybrid and/or electric vehicle technology, use of smart routing technology, vehicle modernization and more.

- collects fleet fuel consumption data for the baseline year and the reporting year, if you are submitting information beyond the baseline. This will provide information regarding the percentage of alternative fuel used in your fleet and your greenhouse gas (GHG) emissions or reductions.

There are also points allocated for the percentage of alternate fuel or hybrid vehicles in a fleet, and for year-on-year total fleet-average gains in fuel economy.

7. Conclusions

Fleet management is an important component of any cable company's sustainability plan. Electric vehicles are only now emerging as an element of meeting sustainability goals, and overall technology and business trends make it likely that choosing EVs also very likely will be the low-cost alternative in the very near future.

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[i] https://data.bloomberglp.com/bnef/sites/14/2017/07/BNEF-Lithium-ion-battery-costs-and-market.pdf

[ii] https://www.arb.ca.gov/fuels/lcfs/electricity/electricityh2.htm

[iii] Author conversations with fleet managers.

[iv] Jim Bigelow, et al, "What is Your Fleet Focus, SCTE•ISBE Journal of Energy Management, August 2017, p. 40.

[v] Bigelow, et al, p. 41.

[vi] sawatchgroup.com , Ryan Daley Principal Consultant/Founder, (303) 999-8866

[vii] https://www.autotrader.com/car-news/why-do-electric-cars-lose-so-much-value-so-fast-265682

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[xxix] https://www.afdc.energy.gov/pdfs/pev_handbook.pdf

[xxx] http://www.fleetsforthefuture.org

[xxxi] https://evsmartfleets.com

[xxxii] https://www.driveclean.ca.gov/Find_Special_Resources/Fleets.php

Computational Fluid Dynamics Air Flow Modeling – Can it improve cooling in your facilities?

A Letter to the Editor on behalf of:

Arnold Murphy SCTi
John Dolan, Rogers Communications Inc.
Mike Glaser, Cox Communications Inc.
Tom Hurley, Degree Controls inc.
Daniel Howard, Hitachi Consulting
Dave Smargon, AIRSYS North America
George Gosko, Hitachi Consulting

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1. Introduction

This letter describes how air flow modeling using a software based tool called Computational Fluid Dynamics (CFD) can assist in solving cooling and air flow issues in data centers, head end and edge facilities. Most legacy facilities are not cooling optimally due to poor airflow management. Since airflow and pressure are not visible, it is not easy to develop a plan for improving airflow management without the use of an airflow modelling tool to understand air flow patterns and eliminating air bypass and recirculation, air mixing and wasted cooling capacity. As the power density in facilities continues to increase along with energy costs, development of effective and efficient cooling methods becomes necessary. CFD modeling has become a common method of determining what action to take to improve cooling effectiveness without incurring substantial costs implementing ineffective solutions that may worsen the situation.

2. Computational Fluid Dynamics

CFD which is a numerical method for calculation of nonlinear differential equations describing/relating to fluid flow has been used for many years in a range of industries including aerospace/aeronautics, automotive, building HVAC (heating, ventilation, and air conditioning), energy/power generation, and process engineering. In the last 10 years CFD has been adapted to conduct air flow modeling of data centers, head ends and edge facilities.

3. Benefits of CFD Modeling

Air flow modeling of a site offers a number of important benefits including: 1. the ability to foresee performance before adapting or executing major change, 2. the opportunity to forecast which changes in design layout will provide the greatest improvement, and 3. how growth forecasts will impact cooling requirements. CFD can be used in legacy facilities to improve air flow and cooling, in new builds to validate design or in cases of expansion of existing sites to determine how growth objectives can be met.

4. How is CFD Modeling used?

Managing air flow is key to optimizing cooling effectiveness and efficiency. As air flow patterns are invisible it is difficult to assess whether the site is experiencing issues such as air bypass or recirculation. Metrics can help to identify if these conditions exist; however, where exactly they are occurring and what is causing them cannot be assessed by calculations. CFD modeling enables the visualization of air flow patterns and offers the ability to test changes to determine what solutions would be most effective in improving air flow and cooling efficiency.

5. Building and Using a CFD model

Creating a CFD model requires an extensive array of input data including:

- site geometry
- cooling system characteristics
- a profile of existing temperatures at the rack inlet
- cooling system supply and return and
- rack heat loads.

Building the initial model is the most time intensive aspect as proper data input is required to ensure the model is representative of site conditions. Once built, the model must be validated or calibrated by comparing results to the actual site conditions. Refinements can be made to the model to reach the objective of an accurate design.

Virtually any facility type and design change can be tested including:

- changing the geometry of the facility
- the addition/reduction of cooling capacity and air flow
- replacement of cooling systems
- additions of IT load by adding more racks or increased rack density
- adding aisle containment and blanking panels to racks and
- the impact of increasing supply air temperatures to maximize energy efficiency

6. Examples of CFD Models

CFD modeling generates a number of outputs in tabular, and thermal graphic form including rack inlet temperatures, cooling system performance, and pressure and temperature mapping. The figures below are examples of thermal graphic outputs. Figure 1 is shows the variation of temperatures in a facility. We can see much of the facility is too cool with rack inlet temperatures of 17□C (62.6□F) and in another area inlet temperatures in the 24-25□C (75.2-77□F) range. Figure 2 shows the return air patterns from racks. The variations in color represent the difference in temperatures.

Figure 1 - Rack Inlet Temperatures

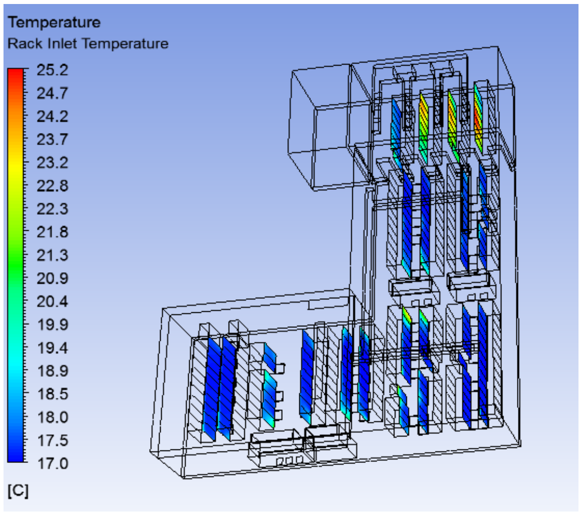
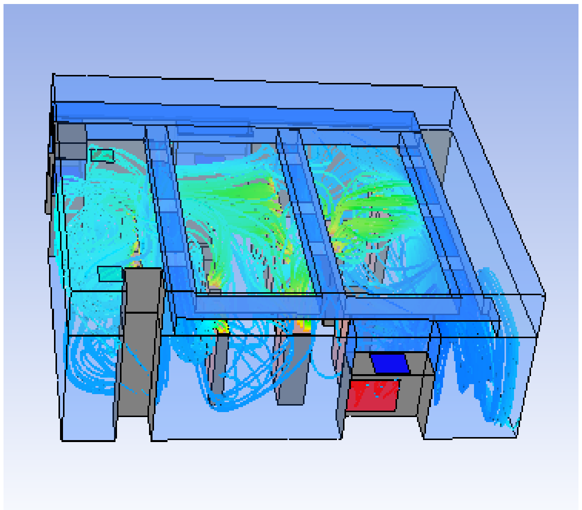


Figure 2 – Air Flow Patterns



7. Is CFD the Right Tool for You?

The most common applications of CFM are for facilities with multiple cooling systems and a physical footprint of over 500 square feet (152.4 square meters). The modeling results of smaller sites can be difficult to interpret and it may not be a cost-effective use of resources.

Creating and interpreting CFD models requires considerable skill and expertise for the data collection, modeling design and input, validation and interpretation of results. Prior to conducting any CFD modeling the parameters and objectives of the modeling exercise should be clearly laid out to focus the modeling effort and reach the end objective as quickly as possible.

8. Conclusion

CFD modeling is an effective tool to analyses air flow patterns and assess how proposed changes would impact cooling efficiency without incurring significant costs implementing different solutions on a best guess basis. Modeling of virtually any facility configuration and design alternative can be developed. It does require a knowledge resource to develop the model and interpret the results however this is offset by the ability to test different solutions and derive a viable solution for both short and long term growth of a facility.

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