Society of Cable Telecommunications Engineers

ENGINEERING COMMITTEE
Energy Management Subcommittee

SCTE OPERATIONAL PRACTICE

SCTE 218 2015

Alternative Energy, Taxes, Incentives, and Policy Reference Document

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1.0 SCOPE

This document provides cable operators with references and resources to evaluate alternative energy technology options based on a given geographic location, facility type, and existing or planned infrastructure. It functions as a selection tool to aid in describing various alternative energy technologies by recognizing which resources would have the greatest impact on reducing energy costs, electrical grid dependency and environmental impact, as well as improving system reliability and mitigating climate change risks.

Immediate and long term benefits of utilizing this document include:

- Potential for reducing electricity costs over conventional electric grid; lower transmission and distribution charges
- Potential for reducing carbon fuel consumption and emissions
- Potential for reducing dependency on electrical grid
- Potential for reducing purchase of high cost per kilowatt hour (kWh) power during peak usage periods
- Time saving in researching alternative energy technologies
- Time saving in identifying additional state and federal alternative energy incentives availability

This document impacts the industry and Cable's Energy 2020 roadmap by potentially reducing the industry's impact on the electrical grid during peak usage periods, enhancing the customer experience by improving reliability by generating power on site with less grid dependence and by reducing the environmental impact and mitigating climate change risks.

Some of the key provisions of this document are:

- Outlines decision-making priorities and 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

To achieve maximum benefit from this document, collaborate across regions either internally or with other multiple system operators (MSOs) and leverage lessons learned by in house personnel, project managers and vendors from prior MSO alternative energy deployments.

Additionally, partner with alternative energy technology manufacturers to develop cost-effective, scalable and repeatable alternative energy solutions and develop standardized kits for deploying alternative energy technologies based on a given facility type and energy consumption needs.

This document will require regular maintenance and upgrades at a minimum on an annual basis.

2.0 NORMATIVE REFERENCES

The following documents contain provisions, which, through reference in this text, constitute provisions of this document. At the time of Subcommittee approval, the editions indicated were valid. All documents are subject to revision; and while parties to any agreement based on this document are encouraged to investigate the possibility of applying the most recent editions of the documents listed below, they are reminded that newer editions of those documents might not be compatible with the referenced version.

- No normative references are applicable.

3.0 INFORMATIVE REFERENCES

The following documents may provide valuable information to the reader but are not required when complying with this standard.

- SCTE 184 2015, SCTE Energy Management Operational Practices for Cable Facilities

4.0 COMPLIANCE NOTATION

shall	This word or the adjective "***required***" means that the item is an absolute requirement of this document.
shall not	This phrase means that the item is an absolute prohibition of this document.
forbidden	This word means the value specified shall never be used.
should	This word or the adjective "*recommended*" means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighted before choosing a different course.
should not	This phrase means that there may exist valid reasons in particular circumstances when the listed behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
may	This word or the adjective "*optional*" means that this item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because it enhances the product, for example; another vendor may omit the same item.
deprecated	Use is permissible for legacy purposes only. Deprecated features may be removed from future versions of this document. Implementations should avoid use of deprecated features.

5.0 ABBREVIATIONS AND DEFINITIONS

Abbreviation	Term	Definition
AC	alternating current	In alternating current circuits, the flow of electric charge periodically reverses direction, whereas in direct current circuits, the flow of electric charge is only in one direction. The abbreviations AC and DC are often used to mean simply alternating and direct, as when they modify current or voltage. AC is the form in which electric power is delivered to businesses and residences. The usual waveform of an AC power circuit is a sine wave.
AE	alternative energy	Alternative energy is any energy source that is an alternative to utility power or an energy source that does not use fossil fuels. These alternatives are intended to address concerns about such fossil fuels. The nature of what constitutes an alternative energy source has changed considerably over time, as have controversies regarding energy use. Alternative energy sources are renewable and all have lower carbon emissions when compared to conventional energy sources. These include biomass energy, wind energy, solar energy, geothermal energy, hydroelectric energy sources.
C	Celsius	Celsius, historically known as centigrade, is a scale and unit of measurement for temperature that is used worldwide. It uses a 100 step scale between the freezing temperature (0°) and boiling temperature (100°) of fresh water. Conversion between Fahrenheit and Celsius is calculated using the following formulas: $F = 9/5 * C + 32$ $C = (F-32) * 5/9$
CCHP	combined cooling, heating and power	Also called tri-generation, refers to the simultaneous generation of electricity and useful heating and cooling from the combustion of a fuel.
CEV	controlled environmental vault	Underground concrete vault that is environmentally controlled for protecting vital access-electronics from vandalism and environmental damage. The structural design provides complete environmental protection for equipment and technicians. This underground enclosure blends nicely into residential, commercial and industrial environments where placement of larger telecommunications enclosures may not normally be accepted by municipal and urban design guidelines.
CHP	combined heating and power	Also referred to as cogeneration, a thermodynamically efficient use of fuel. In separate production of electricity, some energy must be discarded as waste heat, but in cogeneration this thermal energy is put to use. CHP captures some or all of the by-product for heating, either very close to the plant, or converts it to hot water which can be used for distributed heating.

Abbreviation	Term	Definition
CPV	concentrator photovoltaics	Concentrator photovoltaics uses optical devices such as mirrors or plastic lenses to capture a large area of sunlight that is focused onto the PV solar cell. The primary reason for using concentrators is to be able to use less solar cell collectors and less sq. ft. of area. Concentrator systems increase the power output while reducing the size or number of solar cells needed.
CREBs	Clean Renewable Energy Bonds	Clean Renewable Energy Bonds may be used by certain entities -- primarily in the public sector -- to finance renewable energy projects. The list of qualifying technologies is generally the same as that used for the federal renewable energy production tax credit. CREBs may be issued by electric cooperatives, government entities (states, cities, counties, territories, Indian tribal governments or any political subdivision thereof), and by certain lenders. The bondholder receives federal tax credits in lieu of a portion of the traditional bond interest, resulting in a lower effective interest rate for the borrower. The issuer remains responsible for repaying the principal on the bond.
CREST	cost of renewable energy spreadsheet tool	An economic cash flow model designed to allow policymakers, regulators, and the renewable energy community to assess project economics, design cost-based incentives (e.g., feed-in tariffs), and evaluate the impact of various state and federal support structures. CREST is a suite of four analytic tools, for solar (photovoltaic and solar thermal), wind, geothermal, and anaerobic digestion technologies.
CSP	concentrated solar power	Use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam.
CUE	concrete universal enclosure	Concrete enclosures that is a versatile low-cost solution for protecting vital access-electronics from vandalism and environmental damage. The structural design provides complete environmental protection for equipment and technicians. This enclosure blends nicely into residential, commercial and industrial environments where placement of larger telecommunications enclosures may not normally be accepted by municipal and urban design guidelines.
DC	direct current	Direct current is the unidirectional flow of electric charge. Direct current is produced by sources such as batteries, solar cells, thermocouples, and commutator-type electric machines of the dynamo type. Direct current may flow in a conductor such as a wire, but can also flow through semiconductors, insulators, or even through a vacuum as in electron or ion beams. The electric current flows in a constant direction, distinguishing it from alternating current.
DSIRE	Database of State Incentives for Renewables & Efficiencies	DSIRE is the most comprehensive source of information on incentives and policies that support renewables and energy efficiency in the United States. Established in 1995, DSIRE is operated by the N.C. Clean Energy Technology Center at N.C. State University and is funded by the U.S. Department of Energy.

Abbreviation	Term	Definition
DSM	demand side management	Also known as energy demand management, is the modification of consumer demand for energy through various methods such as financial incentives and behavioral change through education. DSM, which includes energy efficiency and demand response, works from the other side of the equation – instead of adding more generation to the system, it pays energy users to reduce consumption. Utilities pay for demand-side management capacity because it is typically cheaper and easier to procure than traditional generation. DSM allows energy users of all kinds to act as "virtual power plants." By voluntarily lowering their demand for electricity, these businesses and organizations help stabilize the grid, and they are paid for providing this important service. Utilities and grid operators treat demand response capacity as a dispatchable resource that is called upon only when needed.
DX	direct exchange	System in which the refrigerant circulates through copper tubing. The refrigerant exchanges heat directly with air, water or soil through the walls of the copper tubing. This simplicity allows the system to reach high efficiencies while using a relatively shorter and smaller set of tubing, reducing installation cost. DX systems, like water-source systems, can also be used to heat water in the house for use in radiant heating applications and for domestic hot water, as well as for cooling applications.
EERE	U.S. Dept. of Energy Office of Energy Efficiency & Renewable Energy	The Office of Energy Efficiency and Renewable Energy accelerates development and facilitates deployment of energy efficiency and renewable energy technologies and market-based solutions that strengthen U.S. energy security, environmental quality, and economic vitality.
F	Fahrenheit	Fahrenheit (symbol °F) is a temperature scale based on one proposed in 1724 by the German physicist Daniel Gabriel Fahrenheit (1686–1736), after whom the scale is named. The scale is usually defined by two fixed points: the temperature at which fresh water freezes into ice is defined as 32 degrees, and the boiling point of fresh water is defined to be 212 degrees, a 180-degree separation, as defined at sea level and standard atmospheric pressure. The Fahrenheit scale is not the predominant temperature scale used throughout the world, but has been adopted by the U.S., Bahamas, Belize and other western hemisphere countries.
Fleet DNA	Fleet DNA Project	The Fleet DNA Project aims to accelerate the evolution of advanced vehicle development and support the strategic deployment of market-ready technologies that reduce costs, fuel consumption, and emissions. At the heart of the Fleet DNA Project is a clearinghouse of medium and heavy-duty commercial fleet transportation data for optimizing the design of advanced vehicle technologies or for selecting a given technology to invest in. Designed by the U.S. Department of Energy's National Renewable Energy Laboratory in partnership with Oak Ridge National Laboratory, this online tool will help

Abbreviation	Term	Definition
		vehicle manufacturers and fleets understand the broad operational range for many of today’s commercial vehicle vocations.
FTTP	fiber to the premise	Fiber that terminates at any premise either business or home at a network interface unit which is a weatherproof box on the outside wall of a premise. Passive optical networks and point-to-point Ethernet are architectures that deliver triple-play services over FTTP networks directly from an operator's headend. The simplest optical distribution network architecture is direct fiber: each dedicated fiber leaving the headend or distribution point and terminating at one customers location. Such networks can provide excellent bandwidth but are more costly due to the dedicated fiber and dedicated customer fiber termination equipment.
H2A	hydrogen analysis	A spreadsheet-based tool that enables a comparative analysis of costs, energy and environmental tradeoffs of hydrogen production. H2A was first initiated in February, 2003 to better leverage the combined talents and capabilities of analysts working on hydrogen systems, and to establish a consistent set of financial parameters and methodology for analyses. The foundation of H2A is to improve the transparency and consistency of the approach to analysis, to improve the understanding of the differences among analyses, and to seek better validation of analysis studies by industry.
HE	headend	Facility at a local cable TV office that originates and communicates cable TV services, cable modem services and telephony to subscribers. In distributing cable television services, the headend includes a satellite dish antenna or terrestrial fiber for receiving incoming programming. This programming is then passed on to the subscriber.
HVAC	heating, ventilation and air conditioning	The technology of indoor and vehicular environmental comfort. Its goal is to provide thermal comfort and acceptable indoor air quality. HVAC system design is a sub discipline of mechanical engineering, based on the principles of thermodynamics, fluid mechanics, and heat transfer. HVAC is important in the design of industrial and office buildings where safe and healthy building conditions are regulated with respect to temperature and humidity, using fresh air from outdoors. The three central functions of heating, ventilation, and air-conditioning are interrelated, especially with the need to provide thermal comfort and acceptable indoor air quality within reasonable installation, operation, and maintenance costs. HVAC systems can provide ventilation, reduce air infiltration, and maintain pressure relationships between spaces.
IREC	Interstate Renewable Energy Council	Established in 1982, is a non-profit organization that believes clean energy is critical to achieving a sustainable and economically strong future. To pave this clean energy path, IREC works to expand consumer access to clean energy; generates information and objective analysis grounded in best

Abbreviation	Term	Definition
		practices and standards; and leads programs to build a quality clean energy workforce, including a unique credentialing program for training programs and instructors. Since 1982, IREC programs and policies have benefitted energy consumers, policymakers, utilities and the clean energy industry.
JEDI	Jobs and Economic Development Impact	The Jobs and Economic Development Impact models are user-friendly tools that estimate the economic impacts of constructing and operating power generation and biofuel plants at the local and state levels. First developed by NREL's WIND Exchange program to model wind energy impacts, JEDI has been expanded to analyze biofuels, coal, concentrating solar power, geothermal, marine and hydrokinetic power, natural gas, and photovoltaic power plants.
kW	kilowatt	One thousand watts – metric for measuring the electricity flow through a customer meter
kWh	kilowatt hour	The amount of kilowatts used in one hour. If a customer uses 100 kW an hour for two hours the total kilowatt hours for the two hour period would be 200 kWh.
MSO	multiple system operator	A corporate entity that owns and/or operates more than one cable system.
NREL	National Renewable Energy Laboratory	Federal laboratory dedicated to research, development, commercialization, and deployment of renewable energy and energy efficiency technologies.
OTN	optical transport node/network	A set of optical network elements connected by optical fiber links, able to provide functionality of transport, multiplexing, switching, management, supervision and survivability of optical channels carrying client signals
PEM	proton exchange membrane	PEM fuel cells work with a polymer electrolyte in the form of a thin, permeable sheet. Efficiency is about 40 to 50 percent, and operating temperature is about 80 degrees C (about 175 degrees F). Cell outputs generally range from 50 to 250 kW. The solid, flexible electrolyte will not leak or crack and these cells operate at a low enough temperature to make them suitable for homes and cars.
PV	photovoltaic	Relates to the production of direct current electricity using semiconducting materials exposed to light.
PVT	photovoltaic/thermal	Photovoltaic thermal hybrid solar collectors, sometimes known as hybrid PV/T systems or PVT, are dual purpose systems that convert solar radiation into thermal and electrical energy. The hybrid PV/T system provides more energy than a conventional solar PV system. The PV/T system generates electricity via the incorporated PV system.
QECBs	Qualified Energy Conservation Bonds	A bond that enables qualified state, tribal, and local government issuers to borrow money at attractive rates to fund energy conservation projects (it is important to note that QECBs are not grants). A QECB is among the lowest-cost public financing tools because the U.S. Department of the Treasury subsidizes the issuer's borrowing costs. QECB proceeds can be used to fund capital expenditures on a variety of projects including reducing

Abbreviation	Term	Definition
		energy consumption in publically owned buildings, implementing green community programs, developing rural capacity, specifically involving the production of electricity from renewable energy resources, supporting energy-related research facilities, research grants and research, implementing mass commuting and related facilities that reduce energy consumption and pollution, designing/running demonstration projects to promote the commercialization of energy-related technologies and processes, and launching public education campaigns to promote energy efficiency.
REC	renewable energy credit	Sometimes referred to as a renewable energy certificate or "greentag" is an environmental commodity that represents the added value, environmental benefits and cost of renewable energy above conventional methods of producing electricity, namely burning coal and natural gas.
ROI	return on investment	Performance measurement used to evaluate the efficiency of an investment or to compare the efficiency of a number of different investments. In economic terms, it is one way of considering profits in relation to capital invested or how quickly an investment will repay itself.
RPS	renewable portfolio standards	A regulation that requires the increased production of energy from renewable energy sources, such as wind, solar, biomass, and geothermal.
SAM	system advisor model	Performance and financial model to facilitate decision making in renewable energy.
SMATV	satellite master antenna television	Supplies and controls a number and types of channels to multiple televisions; not only TV channels, but FM channels as well. Using a master antenna system video signals, audio signals, and decoder signals can be distributed to hotels, motels, dormitories, hospitals and commercial properties with multiple tenants and schools.
SOFC	solid oxide fuel cells	Solid oxide fuel cells use a hard, ceramic compound of metal oxides as an electrolyte. Efficiency of these types of cells is about 60 percent, and operating temperatures are about 1,000 degrees C (about 1,800 degrees F). The high operating temperature limits applications of SOFC units and they tend to be rather large. While solid electrolytes cannot leak, they can crack. SOFC power output is up to 100 kW.
SWH	solar water heating	Solar water heating systems utilize collector panels containing liquid circulating through tubes to capture and retain heat from the sun. The solar thermal heat is trapped and transmitted to a fluid, usually water, in contact with the absorber collects the trapped heat to transfer it to storage. The most basic approach to solar heating of water is to simply put a tank filled with water in the sun. The heat from the sun will heat the tank and the water inside would absorb the heat.
TCO	total cost of ownership	Total cost of ownership is a financial estimate intended to help buyers and owners determine the direct and indirect costs of a product or system. It is a management accounting concept that

Abbreviation	Term	Definition
		can be used in full cost accounting or even ecological economics where it includes social costs, a comprehensive assessment of information technology (IT) costs or other costs across enterprise boundaries over time. It does not just evaluate the purchase price, but also the expenses incurred through its use, maintenance, repairs, insurance and other operating costs such as fuel or power.
UPS	uninterruptable power supply	An uninterruptible power supply, also uninterruptible power source or system, , is an electrical apparatus that provides emergency power to a load when the input power source, typically utility power, fails. A UPS provides near-instantaneous protection from input power interruptions, by supplying energy stored in batteries, super capacitors, or flywheels. The on-battery runtime of most uninterruptible power sources is relatively short (only a few minutes to a few hours) but sufficient to start a standby power source or properly shut down the protected equipment. A UPS is typically used to protect hardware such as computers, data centers, telecommunication equipment or other electrical equipment where an unexpected power disruption could cause injuries, fatalities, serious business disruption or data loss. UPS units range in size from units designed to protect a single computer without a video monitor (around 200 volt-ampere rating) to large units powering entire data centers or buildings.

6.0 OVERVIEW AND METHODOLOGY

6.1 Overview

SCTE has embarked on a mission to envision an energy future for the cable industry that enables reliable growth capacity through organization, customer and environmentally sound energy solutions. One of the goals of the SCTE Energy 2020 initiative is to reduce grid dependency by 10% by 2020, partly through investment in alternate energy solutions. Alternative energy use has been increasing in the U.S. and has been largely driven by goals to reduce environmental impact and mitigate climate change risks. Other drivers of this trend include regulatory requirements such as federal air pollution emissions regulations, meeting state requirements to use more renewable sources, and availability and use of federal and state financial incentives for renewable fuels. Businesses are actively implementing alternative energy technologies but are faced with numerous challenges. Key among them are access to cost-effective solutions especially in comparison to traditional energy rates, choice in alternate energy solutions, access to long-term stably priced solutions, and increased access to third-party financing vehicles and standardized and simplified processes, contracts and financing for renewable energy projects[1].

[1] Corporate Renewable Energy Buyers' Principles: Increasing Access to Renewable Energy
http://www.worldwildlife.org/pages/powering-businesses-on-renewable-energy

The growing interest in alternative energy has resulted in a myriad of resources being made available to the public. The following sections provide an overview of some of the most comprehensive resources to assist MSOs in their research, development and decision making processes for the implementation of alternative energy technologies.

6.2 Methodology

This document was prepared through collaborative desktop research. Review of published information was undertaken and resources that appear to have a wide range of information and reference to resources that spans the geographic range of MSOs (country-wide) were selected for presentation. They provide information on multiple alternative energy (choice in technology), financial models and incentives (cost and financing options), and provide location-specific information across the country. It is important to note that this is not an exhaustive list as there are additional resources available. The resources referred to in this document appear to have been regularly updated and hence current and relevant however it is very important to verify that a resource is still available early in your research process.

The alternate energy technologies were identified and categorized by the Alternate Energy Working Group consisting of MSOs and Energy Industry Specialist. Table 1 summarizes the types of alternate energy technologies suitable for the typical facility classes across the footprint of the MSO network and plant.

6.3 A Proposed Decision-Making Process for Alternative Energy Solution

1. Determine interest in alternative energy technologies and the motivation for pursuing AE technologies (reducing dependency on grid; corporate sustainability & social responsibility; trial, Financial, Operational & Strategic).
2. Select location
    a. Resource maps (section 8.3) are available to guide selection based on productivity and potential system performance. However, availability of incentive programs are a primarily driver of site selection.
3. Research available incentives/rebate programs (sections 8.1-8.2 for resources on incentives and policies, etc.)
    a. Research structure of program.
        i. Is registration required prior to design and implementation?
        ii. Do you have to use certified/approved contractors?
4. Determine costs for multiple technologies (financial modelling). See section 8.3-8.4.
5. Determine budgetary allocation and economic performance criteria (e.g. ROI, TCO (Total Cost of Ownership), etc.)
6. Design system (before or after contracting vendor)
    a. Be sure to include monitoring
7. Determine permitting, zoning requirements
8. Adjust financial model
9. Installation and commission system
10. Reduce grid dependency, reduce environmental footprint, save/avoid costs

11. Monitor/track progress.
12. Reporting & Disclosure. Share information to foster industry-wide change.

Note:
You may decide to work with a contractor for steps 2-9; however it is important to understand the process and financial models.

7.0 ALTERNATE ENERGY TECHNOLOGIES

7.1 Alternative Energy Technologies by MSO Site Type

Table 1: Alternative Energy Technologies by MSO Site Type

Class	Class A	Class B	Class C	Class D	Class E	Class Z
Facility Type	**Enterprise/National**	**Market**	**Regional**	**Edge**	**Access Network**	
Existing Facility Type(s)	Enterprise Data Center, Enterprise HE	Geographical Market Data Centers, Headend	Regional HE, Super Hub, Core Aggregation	Standard Hub	Transport Repeat (cabinet, OTN, CEV, CUE, iHUB, FTTP cabinet, etc.), SMATV, Cell backhaul aggregation enclosure, power supply, etc.	Office Space, Warehouse, call center, etc.
Alternative Energy Opportunities	Geothermal	Geothermal	Geothermal	Geothermal	Geothermal	Geothermal
	Solar - PV	Solar - PV	Solar - PV	Solar - PV	Solar - PV	Solar - PV
	Microturbine CHP (Combined Heating and Power); CCHP (Combined Cooling, Heating and Power)	Microturbine CHP; CCHP	Microturbine CHP: CCHP	Biomass - Methane Source		
	Wind - utility and Traditional	Wind - utility and Traditional	Wind - utility and Traditional	Wind - Micro	Wind - Micro	Wind - utility and Traditional
	Fuel Cell	Fuel Cell	Fuel Cell	Fuel Cell	Fuel Cell	Fuel Cell

7.2 Alternative Energy (AE) Technologies and Descriptions

There are many Alternative Energy Technology options – some more practical than others for MSO deployment. Below is a list and description of some of the existing AE technologies which have been categorized as “Practical” or “Not Practical” for MSO deployment. When considering deploying an AE technology an evaluation should be performed based on the specific needs and current infrastructure technology of the Facility. AE technologies identified as Not Practical may be practical for your specific deployment.

Alternative Energy is considered an energy source that is an alternative to using fossil fuels. Renewable energy is generated from natural processes that are continuous and replenished. While renewable energy is an alternate energy source, not all alternative energy sources and technologies are renewable.

7.3 Practical AE Technologies

7.3.1 Technologies

7.3.1.1 Geothermal

Geothermal systems can be used for a variety of applications including electricity generation, heating and cooling. The most common type of geothermal system can leverage relatively stable ground temperatures while the less common, rare type requires elevated ground temperature, such as hot springs. The principal characteristic of a geothermal system is it utilizes sub-surface temperatures to absorb heat in winter and dissipate/remove heat in summer. Utilizing the natural temperature characteristics of the Earths' resources is generally considered environmentally friendly and does not cause significant pollution concerns as with natural gas or electric powered systems.

Geothermal systems typically utilize water piped through closed loop deep or shallow wells to tap steam and very hot water for heating or utilize cool in-ground water for air conditioning. Air systems also utilize wells to tap the earths' resources for heating and cooling purposes, but they use air to transfer heat instead of water. Geothermal resources are naturally replenished and renewable; they are also generally considered environmentally friendly and do not cause significant amounts of pollution.

Initial Capital costs to install geothermal systems can be high including drilling costs, which account for over half the costs, construction costs and most systems having payback periods often exceeding 10 years, but minimal maintenance costs and reduced consumption of carbon fuels can result in lower operating costs. These systems can be installed in both new construction and retrofits, but the costs are higher in retrofits because they often require HVAC and piping controls modification and ductwork and other mechanical system modifications.

<u>Savings Characteristics of Geothermal Systems</u>

- Reduces operating costs over conventional systems
- Lower heating and cooling costs
- Less moving parts – less repairs
- Lower maintenance costs
- Reduced carbon fuel consumption, no emissions of carbon dioxide, carbon monoxide or other greenhouse gases.

Geothermal Direct Exchange (DX) Heat Pump

The oldest type of geothermal heat pump technology is the DX Geothermal system in which copper tubing is placed directly in the ground in a closed loop and filled with refrigerant. The refrigerant circulates through the tubing, exchanging heat from the refrigerant directly to soil through the walls of the copper tubing. DX systems can be used to provide hot water for heating and for domestic hot water.

Table 2: Geothermal Direct Exchange (DX) Heat Pump Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis	x	x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

Closed Loop Geothermal Heat Pump

The key difference between a Geothermal DX Heat Pump system and a Closed Loop Geothermal Heat Pump is that there are 2 heat transfer processes in the Closed Loop System. The Closed Loop System includes water or glycol filled tubing installed horizontally as a loop field in trenches or vertically as a series of long U-shapes in wells – this tubing and the liquid inside provides the heat transfer to the earth. Closed loop systems also include a heat exchanger between the closed loop and the refrigerant loop and pumps in both loops. The closed loop system is the most deployed geothermal heat pump option.

At least 1 MSO has deployed this technology.

Table 3: Closed Loop Geothermal Heat Pump Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis	x	x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

7.3.1.2 Solar

Solar power is the conversion of sunlight into electricity, either directly using photovoltaics (PV), or indirectly using concentrated solar power (CSP). Concentrated solar power systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. Photovoltaics convert light into Direct Current (DC) electric current using the photovoltaic effect.

System components may include collectors, collector mounts (intrusive or non-intrusive), power cabling and/or fluid piping, switchgear, pumps, inverters, utility interconnect, controller, and power monitoring and metering. These systems have limitation on deployments due to the physical size of the collectors and the watts per sq ft of collector surface area. Solar PV systems are currently deployed at MSO locations for non-critical loads and are currently being evaluated by the industry for Uninterruptable Power Supply (UPS) battery recharging.

PV - Photovoltaic

PV Systems are recognized by many names including photovoltaic system, photovoltaic power system, solar PV system, PV system or casually, solar array. A PV system is a power system that utilizes photovoltaics to covert the suns solar power into usable electric power. PV systems include several components including a solar collector that absorb and convert sunlight to DC power, an inverter or micro-inverter which changes the collector output DC power to Alternating Current (AC) power and an electrical distribution system to distribute the AC power to where it can be utilized which is typically through switchgear or power buss. Some PV systems have sun tracking devices which rotate the collectors on a pivot and continually align collectors with the track of the sun to maximize power generation.

PV systems can be small – similar to what is used to power yard lights and recharge cell phones – or can be multi-megawatt generating systems encompassing hundreds of square feet of land or roof space. Larger systems are typically connected to the utility power grid to reduce peak demand or so that excess power can be sold and supplied to the grid as distributed power generation. Selling and supplying excess power generated to the utility grid can reduce the payback period and increase the Return on Investment (ROI)

Table 4: Photovoltaic Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis		x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

7.3.1.3 On-Site Power Generation

Microturbine

Microturbines have become more widespread in distributed power generation systems and combined cooling heat and power (CCHP) applications. These close coupled systems generate electricity and heat close to where the electricity and heat will be used and thus reduces line loss caused by transporting power over long distances. Advanced electronic control systems which permits unattended operation and electronic power switching technology that improves commercial power grid synchronization have led to an increased deployment of this technology.

Microturbine technology is based on micro combustion. Turbines generate lower emissions, have just one moving part (turbine shaft) and the majority of the waste heat is contained in the relatively high temperature exhaust making it simpler to capture. However, reciprocating engine generators are quicker to respond to changes in output power requirements and are usually slightly more efficient, although the efficiency of microturbines is increasing. Microturbines also lose more efficiency at low power levels than reciprocating engines.

Reciprocating engines typically use simple motor oil (journal) bearings. Full-size gas turbines often use ball bearings. The 1000 °C temperatures and high speeds of microturbines make oil lubrication and ball bearings impractical; they require air bearings or possibly magnetic bearings.

Natural Gas

A natural gas powered electric generator uses a reciprocating or turbine engine that is powered by natural gas to turn an electric generator. The electricity generated is used to reduce the amount of power purchased from the electric utility grid. The power generated by the natural gas generator is typically less expensive per Kilowatt Hour (kWh) than the cost of purchasing power from the grid, but there are additional operating and maintenance costs associated with operating the natural gas generator due to the additional electrical distribution components required to connect the generator to the facility electrical distribution system. Utilizing a gas generator for primary or supplemental power also increases generator run time which increases generator maintenance requirements as well as increases natural gas costs to power the generator. Notwithstanding a catastrophic event, the natural gas used to fuel the turbine is considered extremely reliable and doesn't require a truck roll to refuel.

Table 5: Natural Gas Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis		x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

7.3.1.4 Fuel Cells

A fuel cell is a device that generates electricity via chemical reaction. Fuel cells are being deployed more often as a means to reduce grid dependency and total cost of electricity. Every fuel cell has two electrodes, one positive and one negative, called, respectively, the anode and cathode. The reactions that produce electricity take place at the electrodes. Each type of fuel cell has advantages and drawbacks compared to the others. None of these is inexpensive and efficient enough to widely replace traditional ways of generating power, such coal-fired, hydroelectric, or even nuclear power plants.

Individual fuel cells produce relatively small electrical potentials, about 0.7 volts, so cells are "stacked", or placed in series, to create sufficient voltage to meet an application's requirements. Fuels cells of various types and capacities have been deployed by Cable operators. The payback or ROI is long term making them difficult to get funding approved for installation. They typically are used within the industry for base load capacity and not for back-up power.

Table 6: Fuel Cells Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis		x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

Hydrogen

The Hydrogen-Oxygen Fuel Cell was designed and first demonstrated publicly in 1959. It was used as a primary source of electrical energy in the Apollo space program. Hydrogen is the fuel for this classification of fuel cell, but fuel cells also require oxygen as part of the combustion process. One great appeal of this type of fuel cell is that they generate electricity with very little pollution–much of the hydrogen and oxygen used in generating electricity ultimately combines to form a harmless byproduct, namely water.

Table 7: Hydrogen Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis		x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

Solid Oxide

Solid Oxide fuel cells (SOFC) use a hard, ceramic compound of metal oxides as an electrolyte. Efficiency of these types of cells is about 60 percent, and operating temperatures are about 1,000 degrees Celsius (C) (about 1,800 degrees Fahrenheit (F)). The high operating temperature limits applications of SOFC units and they tend to be rather large. While solid electrolytes cannot leak, they can crack. SOFC power output is up to 100 kilowatt (kW).

Table 8: Solid Oxide Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis		x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

Hybrid

Hybrid Fuel Cells operate without the pollution associated with the combustion of fossil fuels. However, there are also disadvantages in that it cannot store energy, the response is slow, it is difficult to cold start and its output voltage fluctuates with the load. Hybrid fuel cell technology can be applied to various fields: electricity power plants, automotive manufacturing, cogeneration, smartphone, construction and other industries. Hybrid fuel cells have the following advantages: cleanness, high efficiency and high reliability.

Table 9: Hybrid Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis		x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

Proton Exchange Membrane (PEM)

PEM fuel cells work with a polymer electrolyte in the form of a thin, permeable sheet. Efficiency is about 40 to 50 percent, and operating temperature is about 80 degrees C (about 175 degrees F). Cell outputs generally range from 50 to 250 kW. The solid, flexible electrolyte will not leak or crack and these cells operate at a low enough temperature to make them suitable for homes and cars. However, their fuels must be purified through filtration and the use of platinum, a precious and expensive metal used as a catalyst on both sides of the membrane, raises the costs. The U.S. Department of Energy estimates that platinum-based catalysts will need to use roughly four times less platinum than is used in current PEM fuel cell designs in order to represent a realistic alternative to internal combustion engines.

Table 10: Proton Exchange Membrane Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis		x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

Natural Gas Powered Fuel Cell

Fuel Cells powered by higher efficiency hydrocarbons such as natural gas can be used to generate electricity. Unlike batteries, fuel cells require a continuous source of fuel and oxygen/air to sustain the chemical reaction that generates electricity. Fuel cells can produce electricity continuously for as long as the source of fuel and oxygen/air are supplied.

Table 11: Natural Gass Powered Fuel Cell Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis		x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

7.3.1.5 Wind

Wind Energy has enormous potential for supplying electricity on both small and large scale. It is considered a green energy source, does not cause pollution, does not run out since wind energy originates from the sun, and has the potential to generate more power than can be used by the worlds' population. However, wind power accounts for a very low % of total worldwide electricity production, but is growing increasingly more popular due to declining prices of wind generators, efficiency and low operating costs. The Energy Information Administration (EIA), the statistical arm of the Department of Energy, finds wind energy to be one of the most affordable options for new electricity generation, alongside new natural gas units

However, wind turbines are not suited for supplying base load power due to the intermittent supply of wind which can be forecasted and predicted, but cannot be controlled. Wind turbines can also be a threat to the environment, can be intrusive, unsightly for some people, and be difficult to get approval from local building code officers.

Vertical Axis Wind Turbines

Vertical Axis Wind Turbines are often referred to as spinning soda or beer cans due to their appearance. They appear to be cans that are sliced open to expose flaps or blades that provide a surface area to capture the wind. They spin vertically on shaft that is attached to a generator that produces electricity. They are the least intrusive wind turbine due to their physical appearance and supporting base.

Table 12: Vertical Axis Wind Turbines Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis		
Energy cost reduction by 25% on a unit basis	x	x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

Horizontal Wind Generators

Horizontal Wind Generators – this is the traditional type of wind generator that sits atop a tall tower with large propellers. These are the most commonly deployed generator for converting wind energy to electricity. The blades or propellers are attached to a horizontal shaft and generator that are turned by wind energy. The spinning of the propellers generates electricity.

The manufacturing and installation of horizontal wind turbines requires significant upfront investments – both in commercial and residential applications. Wind turbines can also be a threat to the environment (birds, etc.), can be intrusive due to noise and can be unsightly from an aesthetics perspective.

Table 13: Horizontal Wind Generators Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis		
Energy cost reduction by 25% on a unit basis	x	x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

Microgeneration Wind Turbine

These turbines may be as small as a fifty-watt generator for boat or miniature refrigeration unit. Additional uses include generating electricity for agricultural, residential, stadiums, and arenas. As opposed to large commercial wind turbines, a small wind turbine is a wind turbine used for micro generation. Micro wind generation has a higher cost-per-kilowatt than large wind generators due to their physical size, technological limitations on the amount of power they can generate individually and the requirement to have multiple wind turbines in order to make an impact. These generation systems are being evaluated in the context of a national distributed wind energy source by combining multiple devices to generate more capacity.

Table 14: Microgeneration Wind Turbine Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis		
Energy cost reduction by 25% on a unit basis	x	x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

Utility Wind Generators

Utility Wind Generators are typically deployed in generator farms which are basically a large concentration of propeller driven horizontal wind generators with capacities often exceeding hundreds of megawatts. These generator farms can be located on vast expanses of land or more recently, in offshore, ocean or bay environments. Large wind farms provide a clean, renewable source of electricity and are a necessary component to utilities that are mandated to reduce their carbon footprint from traditional electric generation plants. Wind power is a serious and important component of utility generation and the largest and most readily deployable form of new clean energy available. Wind energy generation costs due to improvements in technology continue to decline and will decline even more as the technology continues to mature. According to the American Wind Energy Association wind turbine technology is improving including lower cost wind turbines, increased performance, and advanced operations, causing the cost of wind electricity to decline significantly in recent years.

Table 15: Utility Wind Generators Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis		
Energy cost reduction by 25% on a unit basis	x	x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

7.3.2 Not Practical AE Technologies

7.3.2.1 Geothermal Direct Air

Geothermal Direct Air utilizes air instead of water as the heating or cooling medium. The direct air systems air is conditioned by pushing and/or pulling the air through closed loop deep or shallow dry well piping or ducts that tap the earth's resources for heating and cooling purposes. The conditioned air is returned to the internal air handler unit where it transfers heat via an air-to-air heat exchanger or is pumped directly into the conditioned space.

Table 16: Geothermal Direct Air Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis	x	x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

Geothermal Power Production

Many power plants still use fossil fuels to boil water for steam and some power plants utilize this steam to generate electricity. Geothermal power stations are similar to other steam turbine thermal power stations but the steam in the geothermal plant is derived from reservoirs of hot water found a couple of miles or more below the Earth's surface.

Geothermal electricity generation is currently used in 24 countries. Geothermal power is considered to be sustainable because the heat extraction is small compared with the Earth's heat content and the water that is formed when steam cools is returned to the earth.

Table 17: Geothermal Power Production Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis	x	x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

Concentrated

Concentrator photovoltaics (CPV) uses optical devices such as mirrors or plastic lenses to capture a large area of sunlight that is focused onto the PV solar cell. Concentrating optical devices used in CPV include Fresnel lens, parabolic mirrors, reflectors, and luminescent concentrators.

CPV technology differs from flat-plate PV modules in several ways: they are usually made using high-efficiency, multi-junction PV solar cells and they use mirrors or lenses to concentrate sunlight onto the solar cells. The primary reason for using concentrators is to be able to use less solar cell collectors and less sq. ft. of area. Concentrator systems increase the power output while reducing the size or number of solar cells needed.

Concentrating light, however, requires direct sunlight rather than diffused light, limiting this technology to clear, sunny locations. It also means that, in most instances, sun tracking is required. Sun tracking devices rotate the collectors on a pivot and continually align collectors with the track of the sun to maximize power generation. Despite having been researched since the early ‘70s, it has only now entered the solar electricity sector as a viable alternative.

Table 18: Concentrated Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis		x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

Salt

Heat storage and retrieval technology allows for producing electricity at night and on overcast days as well. One thermal storage medium used is molten salt. Heat is transferred from the sun through concentrators to the molten salt in an insulated storage reservoir during the day, and then withdrawn from storage for power generation at night. This molten salt heat storage technology can be utilized to reduce power costs during high cost per kWh periods and can also be utilized as a peak demand and demand limiting strategy. This solar powered base load generation system has the potential to someday replace both coal and natural gas electric generation plants.

Table 19: Salt Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis		x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

Photovoltaic/Thermal (PV/T)

Photovoltaic thermal hybrid solar collectors, sometimes known as hybrid PV/T systems or PVT, are dual purpose systems that convert solar radiation into thermal and electrical energy. The hybrid PV/T system provides more energy than a conventional solar PV system. The PV/T system generates electricity via the incorporated PV system.

Additionally, the heat energy captured from the PV modules is transferred and then ducted into the building’s Heating, Ventilation and Air Conditioning (HVAC) system where it is used to displace heat generated through conventional fossil fuel methods. The additional energy provides PV cooling by reducing the operating temperature of the PV modules, which improves the electrical performance. The capture of both electricity and heat allow these devices to have higher exergy (energy available to be used) and thus be more overall energy efficient than solar photovoltaic (PV) or solar thermal alone.

Table 20: Photovoltaic/Thermal Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis		x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

SWH Solar Water Heating

Solar water heating (SWH) systems utilize collector panels containing liquid circulating through tubes to capture and retain heat from the sun. The solar thermal heat is trapped and transmitted to a fluid, usually water, in contact with the absorber collects the trapped heat to transfer it to storage.

This heated water can be used for domestic water purposes (showering, washing dishes, clothes, etc.) or for environmental heating of space.

The most basic approach to solar heating of water is to simply put a tank filled with water in the sun. The heat from the sun will heat the tank and the water inside would absorb the heat. This was how the very first SWH systems worked more than a century ago and is still in use in many third world countries as well as with individuals seeking low or reduced cost hot water. However, this configuration is inefficient due to lack of insulation to help retain the heat.

Basic components in a solar water heating systems include:

- Collectors to absorb heat from sun – transfer it to a fluid
- Fluid – typically water
- Heat exchangers - transfer heat from the fluid to domestic hot water system.
- Pumps - move the fluid through the collector and/or the exchanger
- Controllers to operate the pumps when there is collector heat available.

Table 21: Solar Water Heating Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis		
Energy cost reduction by 25% on a unit basis	x	x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

7.3.2.2 On-Site Power Generation

Combined Cooling and Heating CCHP

Combined cooling, heat and power (CCHP) or Trigeneration refers to the simultaneous generation of electricity and useful heating and cooling from the combustion of a carbon based fuel or a solar heat collector. Electricity is generated using a carbon or biomass fired engine that drives an electric generator or that utilizes a solar heat collector. The byproduct of this electric generation process is heat. The heat is then transferred to water using a heat exchanger and piped into the buildings HVAC system and used for environmental heating. The heat byproduct also provides environmental cooling by utilizing the heat to power an absorption chiller that generates chilled water. However, according to companies that have deployed this technology and that have experience in operating them, these systems can be very complex to operate due to the additional building management system controls and system component sequencing. They can also be costly to design and build and require an advanced skill set for the operating engineer also due to the additional building management system controls and system component sequencing and require capacity to utilize the multi-purpose heated and chilled water systems. Furthermore, the facility requires a significant hot water and chilled water piping systems which are not deployed in all facilities.

Table 22: Combined Cooling and Heating Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis		x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

Diesel

Similar to the natural gas powered electric generator the diesel fuel powered electric generator utilizes a carbon fuel (Diesel fuel) to power an electric generation motor. The electricity generated from this turbine is used to reduce the amount of power purchased from the electric utility grid. The power generated is typically less expensive per kWh than the cost of purchasing power from the grid, but there are additional operating and maintenance costs. Utilizing a gas generator for primary or supplemental power increases generator run time which increases generator maintenance requirements as well as increases natural gas costs to power the generator associated with operating the diesel fuel powered electric generator.

There are inherent risks with relying on diesel fuel generators. Severe weather events can hinder the ability of fuel trucks to deliver the necessary diesel fuel required to power the turbine. Recent storms in the south created icy road conditions that exposed the risks of relying on diesel powered devices. In some locales diesel fuel trucks were unable to make deliveries for days due to icy road conditions and the resultant snarled traffic. Some diesel operated devices ran out of fuel before their tanks could be refueled and thus had no power.

Table 23: Diesel Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis		x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

Biomass

Biomass is fuel that is developed from organic materials, a renewable and sustainable source of energy used to create electricity or other forms of power. In biomass power plants, wood waste or other waste is burned to produce steam that runs a turbine to make electricity, or that provides heat to industries and other users. The biomass used for electricity generation varies by region. Forest by-products, such as wood residues, are common in the United States.

Biomass power is a renewable source, carbon neutral electricity generated from renewable organic waste that would otherwise be dumped in landfills, openly burned, or left as fodder for forest fires. Scrap wood, mill residuals, forest resources, and properly managed sustainable forests will produce more trees. With a constant supply of wood and waste – from construction and demolition activities, to crops, to wood not used in papermaking, to municipal solid waste – green energy production can continue indefinitely.

Table 24: Biomass Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis		x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

Enabling Systems/Programs

Electric utilities are reluctant to fund large capital projects to update their electrical distribution systems. Additionally, the electric utilities are being mandated to reduce their carbon footprint from traditional electric generation plants. Out of necessity electric utility providers are offering incentives to customers willing to invest in alternative power generating sources. These alternative energy sources are then attached to the electricity grid and excess power generated is distributed through a net meter to the grid and purchased by the utility company.

Microgrids

Microgrids are similar to centralized electricity system, but are modern, small-scale, specifically designed versions. They deploy alternative energy sources – wind generators, fuel cells, solar, etc. - and are typically built for a specific need such as carbon emission reduction, to meet local capacity, reduce electricity purchase costs, diversify electricity sources, or to supplement grid power.

Microgrids also support distributed generation objectives by enabling renewable energy sources to provide relief for overburdened utility production and grids and can also be used successfully as a demand response tool to reduce peak loads.

Table 25: Microgrids Goals

Supports Goal	Short Term	Long Term
Reduce power consumption by 20% on a unit basis		
Energy cost reduction by 25% on a unit basis	x	x
Reduce grid dependency by 10% *	x	x
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

Demand Response

Increased electric consumption, increasing age and decreasing condition of electric grids have put pressure on consumers and utilities to reduce consumption during high use, peak electricity consumption periods. To induce electricity consumers to reduce power consumption during peak usage periods utility companies offer incentive payments through demand response programs. Consumers are offered payments to voluntarily go off the electric grid and run back-up power generators, shift consumption to lower consumption periods, shut off unnecessary equipment, or utilize other strategies to reduce consumption during high peak usage periods. Demand response programs and specifically demand response payments can be utilized to reduce operating expenses by using the payments to offset utility costs.

Table 26: Demand Response Goals

Supports Goal	Short Term	Long Term
Reduction of power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis	x	x
Reduction of grid dependency by 10% *		
Optimize technical facilities and datacenters footprint by 20%		
Establishment of vendor partnerships - hardware development		

* Grid connectivity required for supplemental, redundant or back up power

Demand Limiting

Increased electric consumption, increasing age and decreasing condition of electric grids have put pressure on consumers and utilities to reduce consumption during high use, peak electricity consumption periods. By voluntarily limiting peak electric consumption to under a predetermined usage amount consumers receive payments from utility companies. Consumers are offered payments to go off grid and run back-up power generators, shift consumption to lower consumption periods, shut off unnecessary equipment, or utilize other strategies to reduce consumption. Demand limiting and specifically payments received for limiting demand can be utilized to reduce operating expenses by using the payments to offset utility costs.

Table 27: Demand Limiting Goals

Supports Goal	Short Term	Long Term
Reduction of power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis	x	x
Reduction of grid dependency by 10% *		
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

Peak Shaving

This is similar to Demand Limiting in that consumers shift consumption to lower consumption, but they also shift consumption to lower cost per kWh periods. Peak Shaving is often associated with an electricity rate class called “Time-of-Use.” Under the “Time-of-Use” rate consumers pay a lower cost per kWh during off peak, low grid consumption periods and a higher cost per kWh rate during peak or high use periods. By reducing the peak or highest consumption period consumers by shifting consumption to lower cost per kWh periods consumers can lower their total cost of power.

Table 28: Peak Shaving Goals

Supports Goal	Short Term	Long Term
Reduction of power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis	x	x
Reduction of grid dependency by 10% *		
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

Net Metering

Net metering allows consumers with alternative electric generating sources to feed electricity they do not use (excess capacity) back into the grid and receive payments for this excess capacity. As an example a consumer with a Solar PV system may generate more power during the day than their home can consume. The excess power is put back into the grid and, in doing so, the electric meter runs backwards or registers a credit against evening consumption.

Net metering benefits can vary widely by state. Many states have implemented regulations requiring utilities to purchase the excess electric generation from consumers. However, the cost per kWh rate paid for the consumers excess capacity is often lower than the cost per kWh rate charged by the same utility company.

Table 29: Net Metering Goals

Supports Goal	Short Term	Long Term
Reduction of power consumption by 20% on a unit basis	x	x
Energy cost reduction by 25% on a unit basis	x	x
Reduction of grid dependency by 10% *		
Optimize technical facilities and datacenters footprint by 20%		

* Grid connectivity required for supplemental, redundant or back up power

8.0 KEY RESOURCES

8.1 DSIRE

The Database of State Incentives for Renewables & Efficiencies (DSIRE) is one of the most comprehensive collections of data and information available regarding current incentives, rules, regulations and policies for renewable energy and energy efficiency technologies.

The database includes over 1,000 financial incentives for renewable energy, over 1,400 for energy efficiency, and over 500 rules, regulations and policies for both. The database identifies these programs at the utility, local (municipal), state and federal levels as well as those offered to and for Non-Profits.

DSIRE is a partnership between the U.S. Department of Energy, the North Carolina Clean Energy Technology Center and the (Interstate Renewable Energy Council (IREC). The database and website is hosted by the staff of the N.C. Solar Center at the N.C. State University and IREC. There are five main resources available through DSIRE. Each resource has a depository of information on the program.

The information is provided by state and program type, e.g. Federal, State, Utility, Local and Non-profit. Color-coded links are provided for details on available program types by State. Links to these resources and screen shots of the websites are presented below.

8.1.1 Financial Incentives

There are a number of financing instruments available for alternative energy and below is a list of examples.

8.1.1.1 Bonds

Qualified Energy Conservation Bonds (QECB) are issued by state, local, and tribal governments in order to finance energy conservation projects. New Clean Renewable Energy Bonds (CREBs) may be issued by public power utilities, electric cooperatives, government entities (i.e. states), and some lenders in order to finance renewable energy projects. Examples of qualified projects include energy efficiency capital expenditures in public buildings, green communities, renewable energy production, various research and development and energy efficiency education campaigns.

8.1.1.2 Corporate Tax Incentives

Deductions, exclusions, or exemptions from tax liabilities are offered as an enticement to engage in a specified activity (such as investment in alternative or renewable energy). These tax incentives are only available for a finite period of time. In some cases the incentive is based on the amount of energy produced. In addition, some states allow a tax credit only if a corporation has invested a minimum amount in an eligible project and there is usually a maximum cap on the amount of credit or deduction.

8.1.1.3 Grants

There are varied types of grant programs used to encourage research, development and deployment of renewable energy technologies. These are available for a range of renewable energy technologies including wind and photovoltaics and each grant is structured differently. They are available to commercial, industry, education, and the government sectors.

8.1.1.4 Industry Support

Some states offer financial incentives to stimulate the manufacturing and development of renewable energy systems and equipment, which is used to promote economic development and the creation of jobs. These can be in the form of tax credits, exemptions, and grants. The amount of incentive can depend on the amount of eligible equipment that a company manufactures. These incentives apply to several renewable energy technologies and are designed to be temporary and usually include a sunset provision to encourage self-reliance.

8.1.1.5 Loans

Provide financing for the purchase of renewable energy or energy efficient systems. Low interest or zero interest loans for energy efficiency projects is a common DSM (demand side management) strategy for electric utilities.

8.1.1.6 Property Tax Incentives

Most property tax incentives for renewable energy systems exclude the added cost of the system in the overall assessment of the property for taxation purposes. These incentives include exemptions, exclusions, and credits.

8.1.1.7 Rebates Programs

State and local governments' pair up with utility providers in order to promote and offer rebates for the installation of renewable energy systems and energy efficient technology. Solar water heating and photovoltaics are common renewables that receive these rebates and most are administered by the utility provider.

8.1.1.8 Sales Tax Incentives

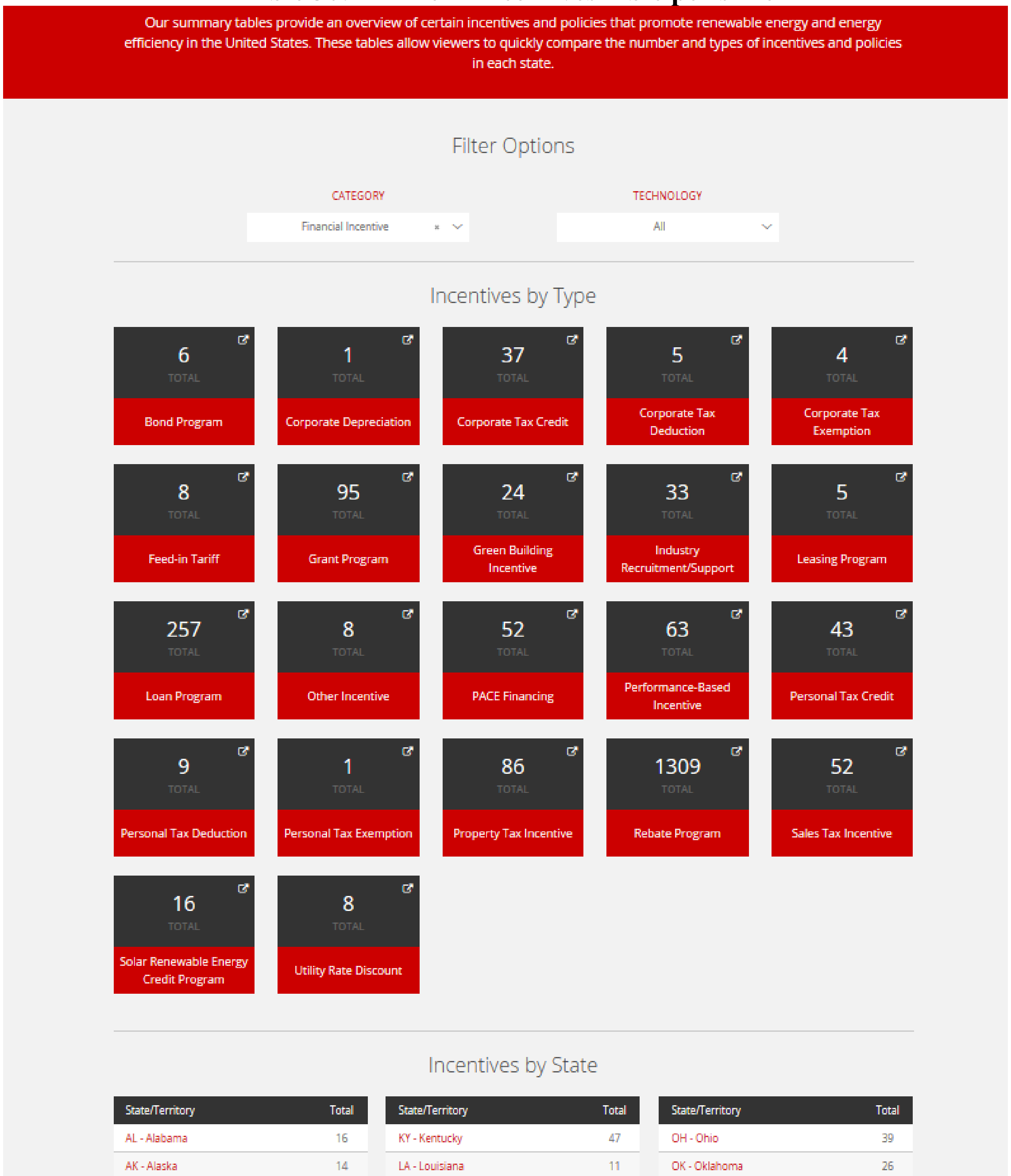
Sales tax exemptions, typically at the state sales tax level, for the retail sale of renewable energy systems or any other energy efficiency implementation.

8.1.1.9 Resources on Financial Incentives for renewable energy

Information on financial incentives for Renewable Energy by federal, state, utility local and non-profit organizations can be accessed at http://programs.dsireusa.org/system/program/tables

The screen shot, Table 30,is a preview of the page to assist you in navigating to the desired resource. First, identify the state in which you are researching an alternative energy technology. Second, select the type of program for which you are interested. Third, locate the corresponding color for the program and click on the link to get to the data.

Table 30: Financial incentives table per state



8.1.1.10 Financial Incentives for energy efficiency

Resources for energy efficiency incentives can be accessed at http://programs.dsireusa.org/system/program/tables

8.1.2 Rules, Regulations & Policies

8.1.2.1 Contractor Licensing
Specific licensing for contractors who want to install a renewable energy system that guarantees that they are experienced in the system install process as well as have the knowledge necessary to properly maintain it.

8.1.2.2 Equipment Certification
A policy that requires that renewable energy equipment meets specified standards. This helps guarantee the quality of the equipment sold to consumers which reduces issues with faulty equipment sales.

8.1.2.3 Generation Disclosure
States that implement this policy are required to provide their customers with detailed information on the electricity that the utility company provides. Examples of this information, which is typically provided on an invoice, include emission statistics and fuel mix percentages. In addition, the utility provider may be required to supply a certification stating that any renewable energy resources they use are certified as such.

8.1.2.4 Green Power Purchasing and Aggregation Policies
Government agencies, businesses, residents, schools, non-profits and others can support renewable energy by buying electricity from these sources or by procuring renewable energy credits (REC). Green power purchases are implemented through project developers or green power marketers through utility green power programs or community aggregation, which is when two or more communities aggregate their electricity loads to buy green power.

8.1.2.5 Interconnection Standards
These standards govern the technical and procedural process through which an electric customer connects an electric-generating system to the grid. They identify the technical, contractual, metering, and rate rules that system owners and utility providers must adhere to. Standards for systems that are interconnected at the distribution level are usually adopted by the state's public utility commission. Not all states have these standards and some standards only apply to investor owned utilities and not to municipal utilities and electric cooperatives.

8.1.2.6 Line Extension Analysis
When an electric customer requests service for a home or facility that is not currently being serviced by the electric grid, the customer typically has to pay a distance based fee for the cost of extending power lines to the home or facility. According to DSIRE, which supports renewable energy and energy efficiency in the United States, in a majority of cases it is more cost effective to use an onsite renewable energy system and many states require the utility to provide renewable energy options to the customer.

8.1.2.7 Net-metering

In regards to customers who create their own electricity, net-metering allows for the flow of electricity both to and from the customer. When a customer's generation is larger than their use, the excess is able to flow back to the grid which offsets electricity consumption at a future time. This is typically done using a bi-directional meter. In most states net-metering is required by law but in some cases this regulation may only apply to utilities that are investor owned.

8.1.2.8 Public Benefit Funds

Programs at the state level that ensure continued support for renewable energy resources, energy efficiency initiatives, and low-income energy programs. These programs are usually supported through a small surcharge on electricity consumption and it is sometimes referred to as the system benefits charge. Public benefit funds can support rebate programs for renewable energy systems, loan programs, research and development, and energy education programs.

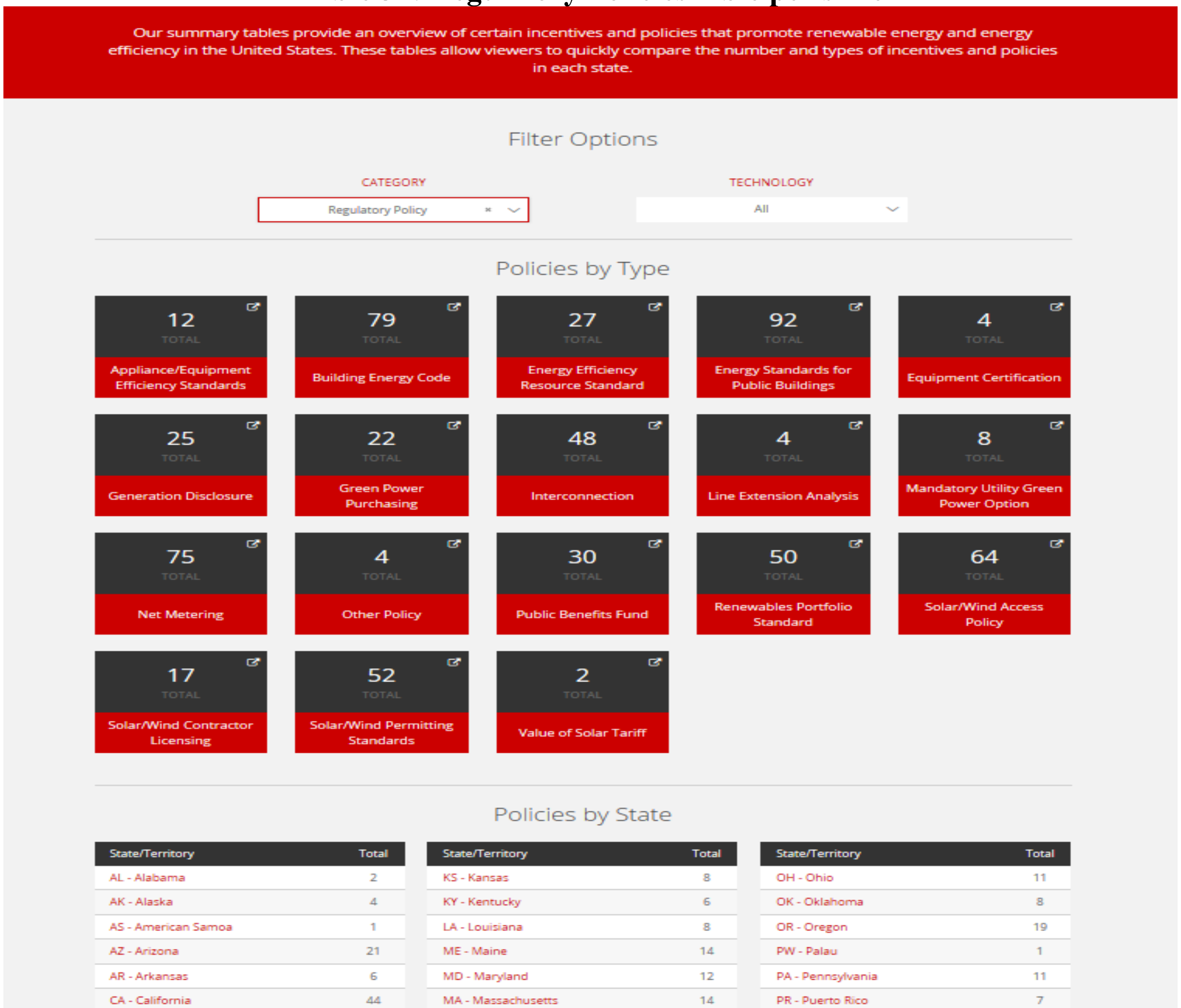
8.1.2.9 Renewable Portfolio Standards (RPS)

This is a regulation that requires utility providers to obtain a given percentage of their power from renewable sources by a predetermined date.

8.1.2.10 Rules, regulations and policies for Renewable Energy

Resources for rules, regulations and policies for renewable energy are available at http://programs.dsireusa.org/system/program/tables

Table 31: Regulatory Policies table per state


Our summary tables provide an overview of certain incentives and policies that promote renewable energy and energy efficiency in the United States. These tables allow viewers to quickly compare the number and types of incentives and policies in each state.

Filter Options

CATEGORY: Regulatory Policy

TECHNOLOGY: All

Policies by Type

Total	Policy Type
12	Appliance/Equipment Efficiency Standards
79	Building Energy Code
27	Energy Efficiency Resource Standard
92	Energy Standards for Public Buildings
4	Equipment Certification
25	Generation Disclosure
22	Green Power Purchasing
48	Interconnection
4	Line Extension Analysis
8	Mandatory Utility Green Power Option
75	Net Metering
4	Other Policy
30	Public Benefits Fund
50	Renewables Portfolio Standard
64	Solar/Wind Access Policy
17	Solar/Wind Contractor Licensing
52	Solar/Wind Permitting Standards
2	Value of Solar Tariff

Policies by State

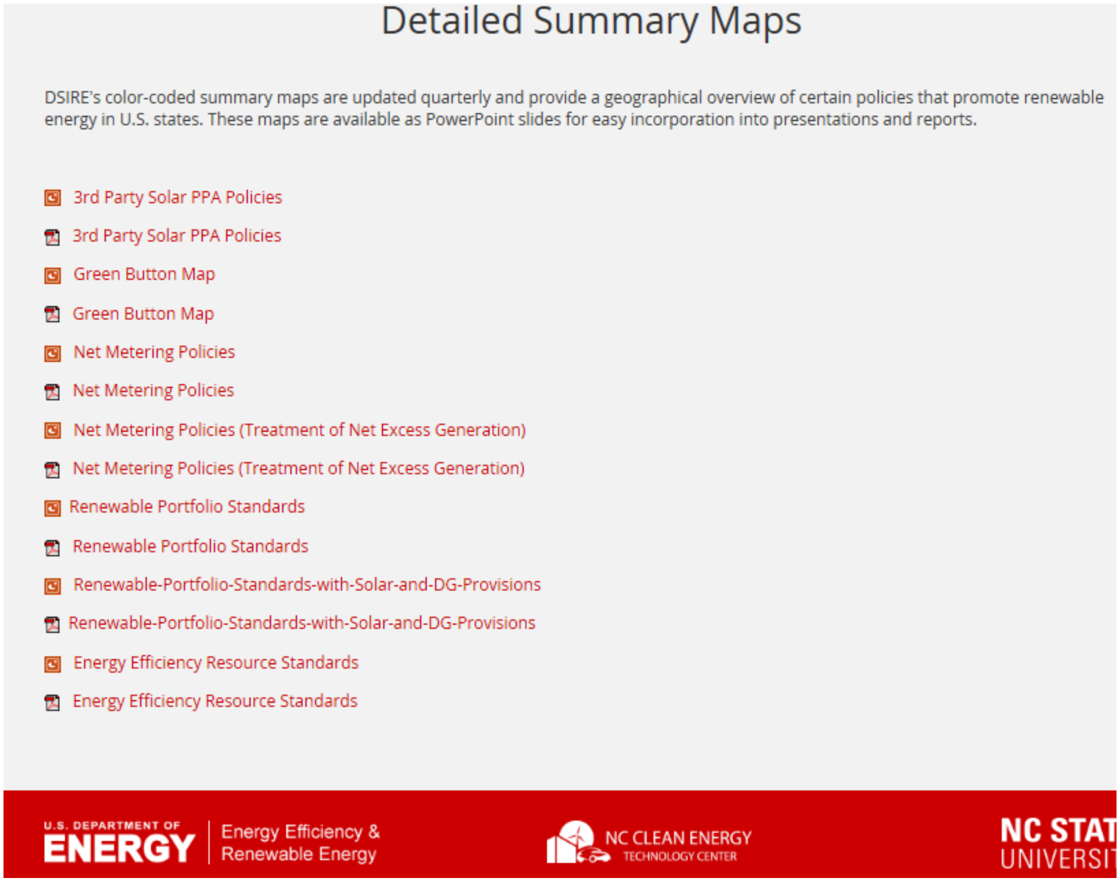
State/Territory	Total	State/Territory	Total	State/Territory	Total
AL - Alabama	2	KS - Kansas	8	OH - Ohio	11
AK - Alaska	4	KY - Kentucky	6	OK - Oklahoma	8
AS - American Samoa	1	LA - Louisiana	8	OR - Oregon	19
AZ - Arizona	21	ME - Maine	14	PW - Palau	1
AR - Arkansas	6	MD - Maryland	12	PA - Pennsylvania	11
CA - California	44	MA - Massachusetts	14	PR - Puerto Rico	7

8.1.2.11 Rules, regulations and policies for Energy Efficiency

Resources for rules, regulations and policies for energy efficiency are available at http://programs.dsireusa.org/system/program/tables

8.1.2.12 Summary maps of incentives and policies

Summary maps of incentives and policies are also available at http://www.dsireusa.org/resources/detailed-summary-maps/ . See Figure 2. There is an option to search maps through an interactive map interface or detailed color-coded maps updated quarterly see Figure 2.



Detailed Summary Maps

DSIRE's color-coded summary maps are updated quarterly and provide a geographical overview of certain policies that promote renewable energy in U.S. states. These maps are available as PowerPoint slides for easy incorporation into presentations and reports.

- 3rd Party Solar PPA Policies
- 3rd Party Solar PPA Policies
- Green Button Map
- Green Button Map
- Net Metering Policies
- Net Metering Policies
- Net Metering Policies (Treatment of Net Excess Generation)
- Net Metering Policies (Treatment of Net Excess Generation)
- Renewable Portfolio Standards
- Renewable Portfolio Standards
- Renewable-Portfolio-Standards-with-Solar-and-DG-Provisions
- Renewable-Portfolio-Standards-with-Solar-and-DG-Provisions
- Energy Efficiency Resource Standards
- Energy Efficiency Resource Standards

Figure 1: Map key for Overview of Promoted Policies

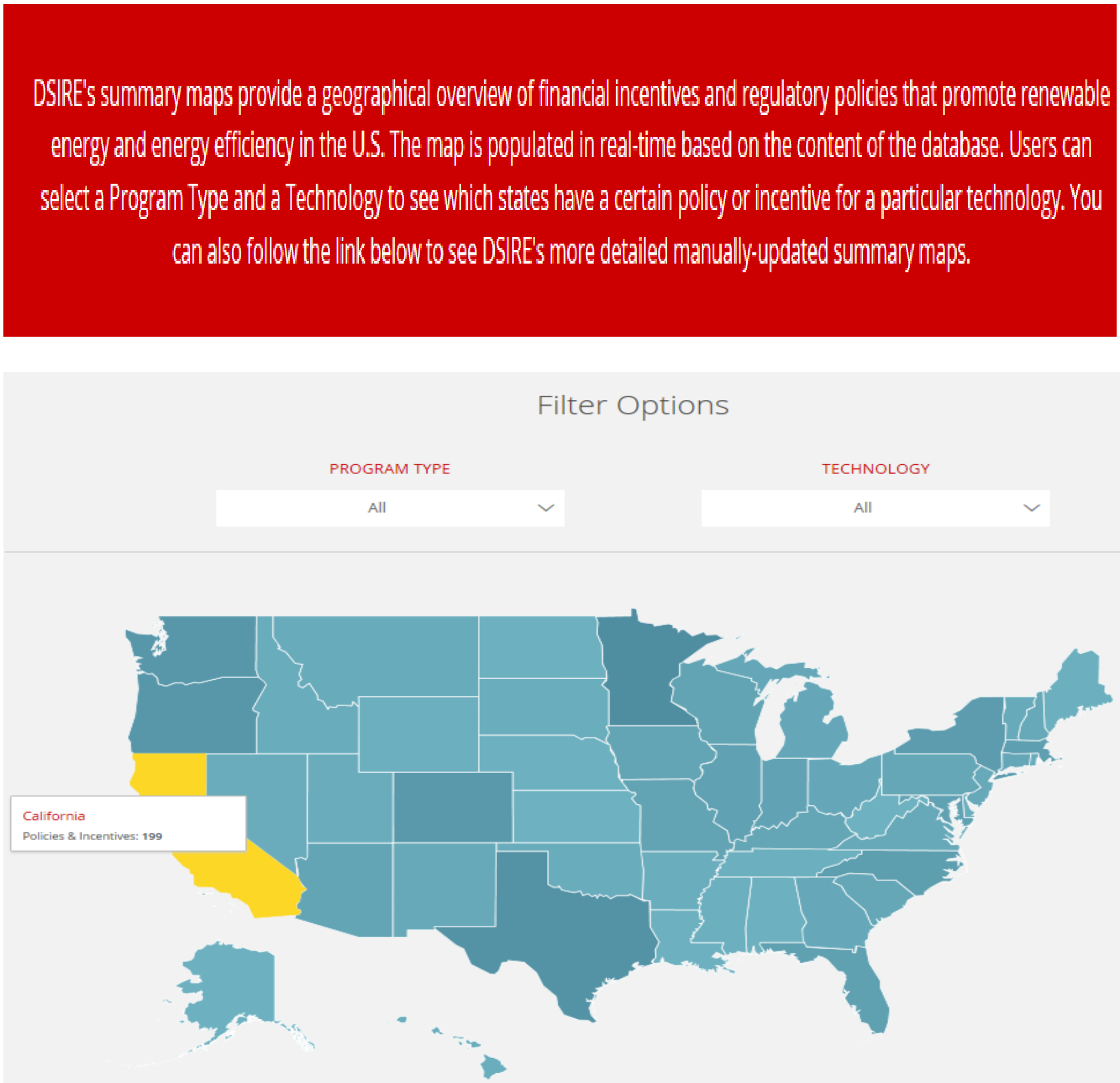


Figure 2: DSIRE's Summary Map of Incentives and Policies

8.2 U.S. Department of Energy's Office of Energy Efficiency & Renewable Energy (EERE)

EERE provides oversight for two overarching areas relevant to the Energy 2020 Alternative Energy goals. These are:

8.2.1 Renewable electricity generation

a. Solar - http://energy.gov/eere/renewables/solar
b. Geothermal - http://energy.gov/eere/renewables/geothermal
c. Wind - http://energy.gov/eere/renewables/wind
Water - http://energy.gov/eere/renewables/water

8.2.2 Sustainable transportation

e. Vehicles - http://energy.gov/eere/transportation/vehicles

f. The Alternative fuels data center - provides information on federal and state laws and incentives for alternative fuels http://www.afdc.energy.gov/laws/
g. Active funding opportunities are provided by the Vehicles Technologies Office - http://energy.gov/eere/vehicles/vehicle-technologies-office-financial-opportunities
h. Bioenergy - http://energy.gov/eere/transportation/bioenergy
i. Hydrogen fuel cells - The site provides information on the basis of various technologies, the main issues to take into consideration when thinking about renewable energy solutions to advance technical information are based on sound scientific research. There is also information on existing programs and initiatives and financing options and incentives. Each program also offers email notifications that bring relevant up to date information to your fingertips. http://energy.gov/eere/transportation/hydrogen-and-fuel-cells

Information on financial opportunities is hosted by the Department of Energy's Office of Energy Efficiency and Renewable Energy. Please note that you will be redirected to the DSIRE site for information on incentives. http://energy.gov/eere/sunshot/financial-opportunities

8.3 National Renewable Energy Lab

NREL is the national laboratory of the U.S. Department of Energy, EERE program, operated by the Alliance for Sustainable Energy, LLC. NREL focuses on research, development and commercialization, and deployment of renewable energy and energy efficiency technologies. Renewable energy sources included in NREL's portfolio are solar, wind, biomass hydrogen, geothermal and water. Systems integration around grid integration, distributed energy interconnection, battery and thermal storage and transportation, are other areas of focus.
NREL partners with private industry, federal agencies, state and local government and internationally in their programs. There is a cadre of resources in their Energy Analysis Program to assist in the decision-making to advance from concept to commercial application to market penetration for renewable energy. Featured analysis, models and tools, data and resources are available at http://www.nrel.gov/analysis/. This includes:

8.3.1 System Advisor Model (SAM)

SAM is a performance and financial model to facilitate decision making in renewable energy, are also provided in Section 8 of this document. According to the NREL, SAM can automatically download and populate data from DSIRE, OpenEI Utility Rate Database, other NREL resources data as well as other self-inputted variables to model performance, financial metrics, levelized cost of energy and cash flow, incentives, etc. Additional information on SAM can be accessed at https://sam.nrel.gov/.

8.3.2 Fleet DNA

NREL's transportation research includes a Fleet DNA resource which provides data, charts, and reports on various types of vehicles that help in the selection of technologies for fleet. Access information at http://www.nrel.gov/transportation/fleettest_fleet_dna.html. Links to additional tools are also available at this site.

8.3.3 Resource Maps

Below are several links to interactive maps that include analytical tools for renewable energy resources. These can be used to help determine which energy technologies are viable solutions in a specified region. The maps include data for wind, solar and geothermal energy resources.

Solar Prospector (http://maps.nrel.gov/prospector) is a mapping and analysis tool used to access solar geospatial data for determination of utility-scale solar plants. The data can also be downloaded from the site in several different file types. See Figure 3.

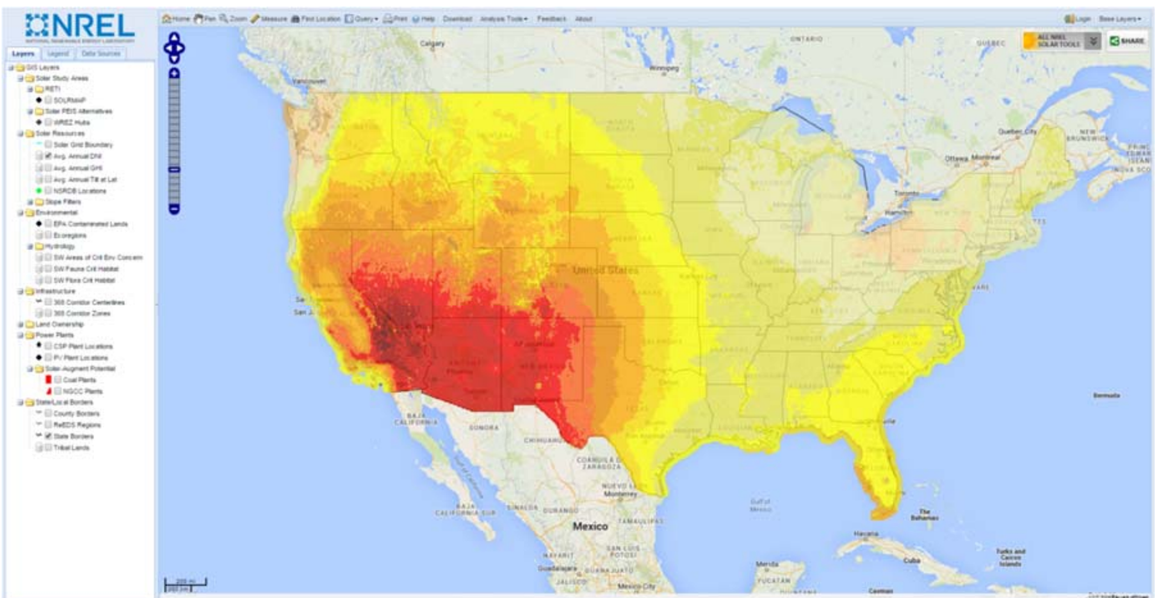


Figure 3: Solar Prospector Map and Analysis Tool

Wind Prospector (http://maps.nrel.gov/wind_prospector) is a mapping and analytics tool that provides the user with wind speeds across the continental United States. This allows for better or more informed site selection.
See Figure 4.

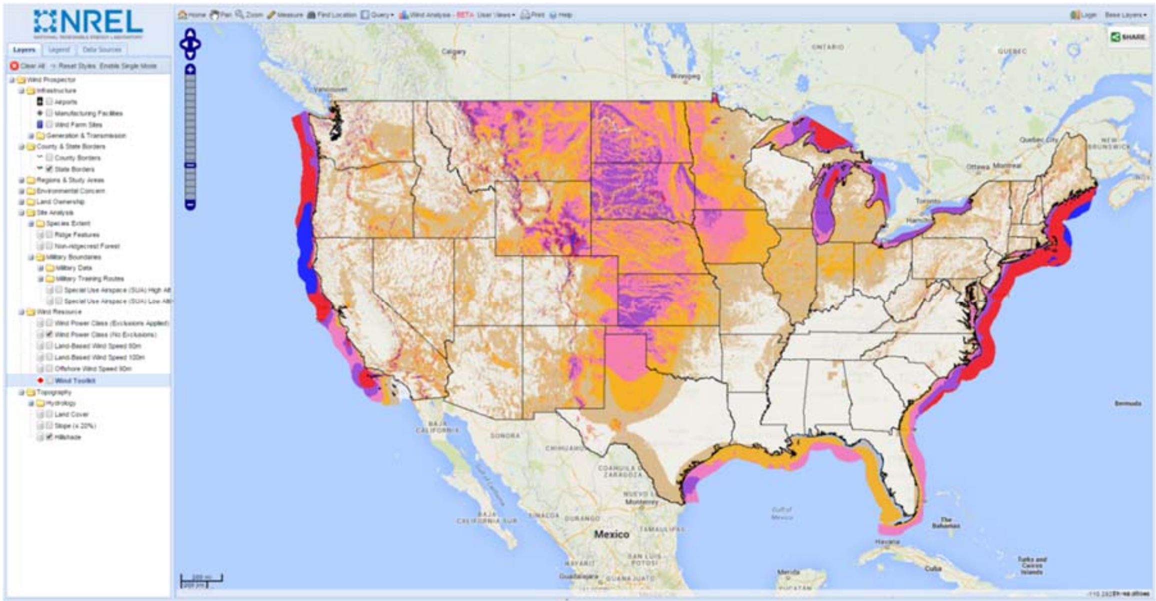


Figure 4: Wind Prospector Map and Analytics Tool

Geothermal ***Prospector*** (http://maps.nrel.gov/gt_prospector) allows users to identify locations that are favorable to geothermal energy development. See Figure 5.

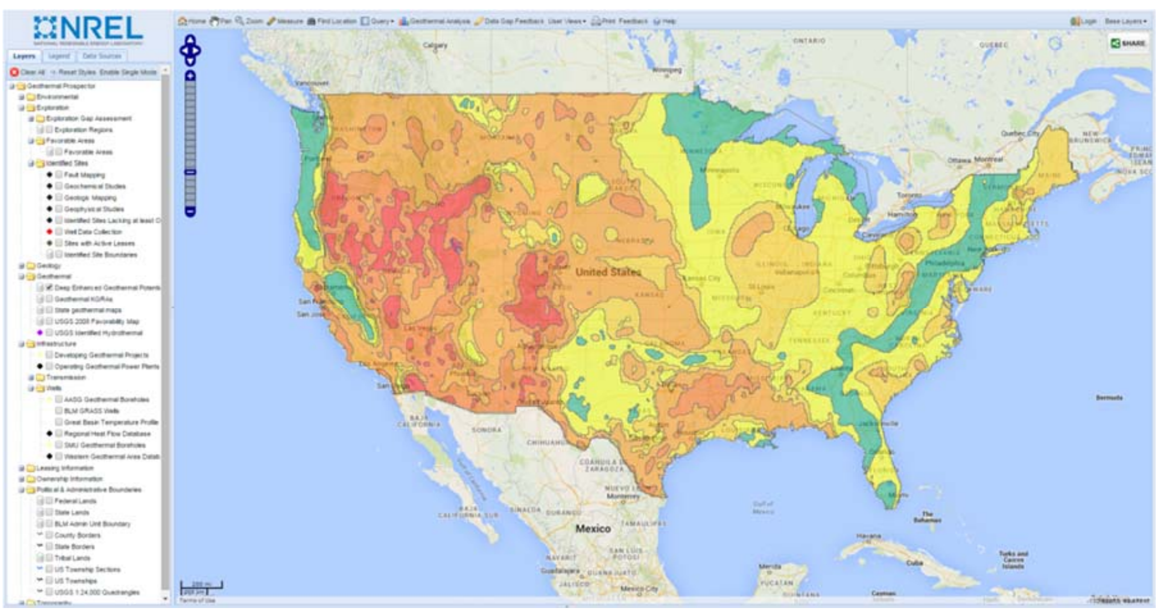


Figure 5: Geothermal Prospector Map Tool

8.4 Financial Tools

8.4.1 Cost of Renewable Energy Spreadsheet Tool (CREST)

NREL publishes a *Cost of Renewable Energy Spreadsheet Tool (CREST)*, which enables economic cash flow models. It assesses project economics, design cost-based incentives and evaluates the impact of various state and federal structure.

The tool is available for solar, wind, geothermal, anaerobic digestion and fuel cells. The spreadsheets are available at https://financere.nrel.gov/finance/content/crest-cost-energy-models. A manual, information webinars are available at the link.

8.4.2 Job and Economic Development Impact (JEDI) Model

The Job and Economic Development Impact Model estimates the economic impacts of constructing and operating power generation and biofuel plants. Available models include wind, biofuels, solar, natural gas, hydroelectric, and geothermal. Traditional fuel sources such as coal and petroleum are also modeled. A web-based JEDI PV SAM

8.4.3 H2A Hydrogen Analysis (H2A) Model

The *Hydrogen (H2AModel)* is a spreadsheet-based tool that enables a comparative analysis of costs, energy and environmental tradeoffs of hydrogen production http://www.hydrogen.energy.gov/h2a_analysis.html

9.0 SUMMARY

Deployment of AE technologies is important in achieving SCTE Energy 2020 goal to reduce grid dependence by 10% by 2020. This operational practice framework provides a guide and references to available resources that will enable MSOs to make informed, fact-based and financially sound decisions on what, where, when and how to deploy AE technologies.