

Smart Energy Resources Guide



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CHAPTER 7: BIOMASS GASIFICATION

Biomass such as manure, crop residue, and other agricultural wastes may be gasified to produce electricity. Instead of relying on biological processes as in anaerobic digestion, gasification is the process of heating material in a chamber at carefully controlled temperature, pressure, and moisture levels to produce high energy syngas. Syngas consists of CO and H₂, which can be used to generate electricity. Cleanup sites that have access to biomass may consider gasification to provide power. Gasifier projects require high capital

costs as well as regular maintenance to restock biomass and dispose byproducts. While biomass gasification is not strongly established, many companies are emerging to develop this technology.

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7.1 GASIFIER TERMINOLOGY¹⁸⁵

The following are some gasifier terms and definitions.

Char A combustible residue of carbonaceous feedstock.

Feedstock A raw material used in the manufacture of a product. In the case of gasification, biomass feedstock could include agricultural residues or manure.

Gasification Conversion of low-value carboniferous feedstocks to higher-value gaseous fuels.

Gasifier Main component of a gasification system, which converts a solid or liquid into a gas by means of heat and pressure in the presence of low levels of oxygen.

Methane (CH₄) The primary constituent of natural gas.

Oxidation A chemical reaction in which oxygen is added to an element or compound.

Slurry A liquid mixture of water and an insoluble solid, such as coal.

Syngas A gaseous fuel produced from gasification composed of CO and H₂ gas.

Town gas Coal-based syngas provided by municipalities for heating and lighting, primarily in the 19th century.

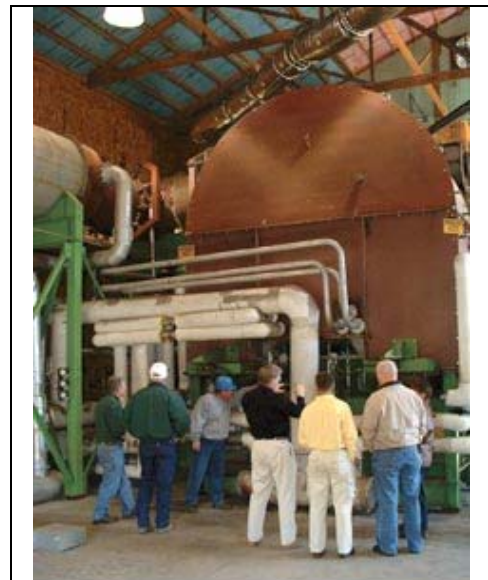


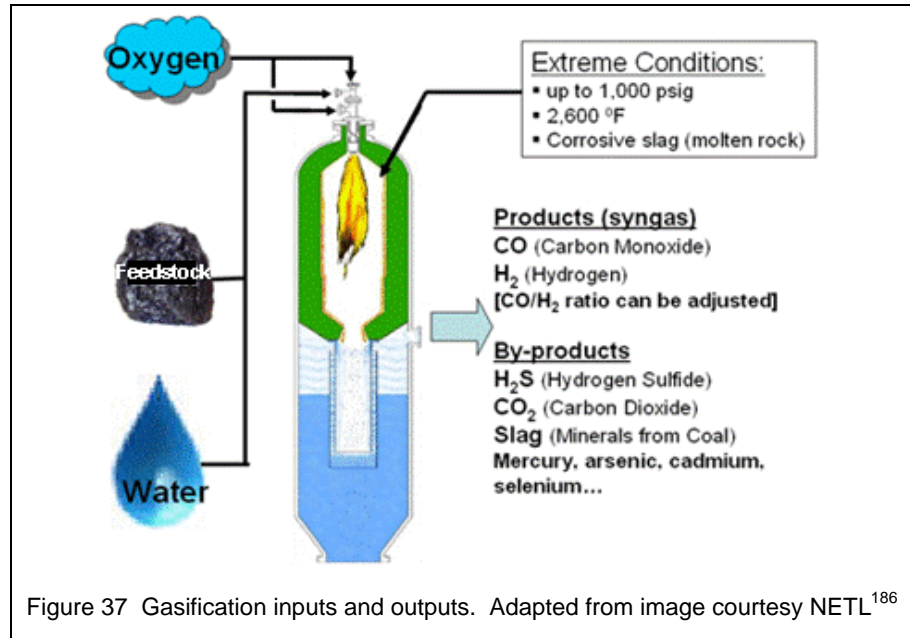
Figure 36 Coaltec Energy USA's small-scale gasifier. Image courtesy Coal Research Center¹⁸⁴

Water - gas shift reaction An inorganic chemical reaction in which water and CO react to form CO₂ and H₂ (water splitting). $\text{CO} + \text{Water (H}_2\text{O)} + \text{catalyst} + \text{heat} = \text{CO}_2 + \text{H}_2$.

7.2 GASIFIER TECHNOLOGY BASICS

Gasifiers extract energy from biomass to generate electricity (Fig. 36). Although coal can be gasified to produce energy, only when biomass is used is it considered renewable energy. Gasification uses heat, pressure, and steam to convert carboniferous matter (i.e., biomass and coal) into synthesis gas (Fig. 37). Synthesis gas or “syngas” is composed primarily of CO and H₂.¹⁸⁸

CO and H₂ are colorless, odorless, and highly flammable gases that can be used to generate electricity. Gasification is not the same as combustion. Gasification utilizes only about one-third of the oxygen needed for efficient combustion. The syngas that is produced from gasification can be used to produce steam or to fuel gas turbines.¹⁸⁹ Gasification can be applied to a wide variety of organic feedstocks including waste material from agriculture, forestry operations, food processing, and pulp and paper mills. (Fig. 38).¹⁹⁰ Cleanup sites that have these sources nearby may consider using gasification to generate electricity. See Appendix VII (page 147) for more information on the gasification process.



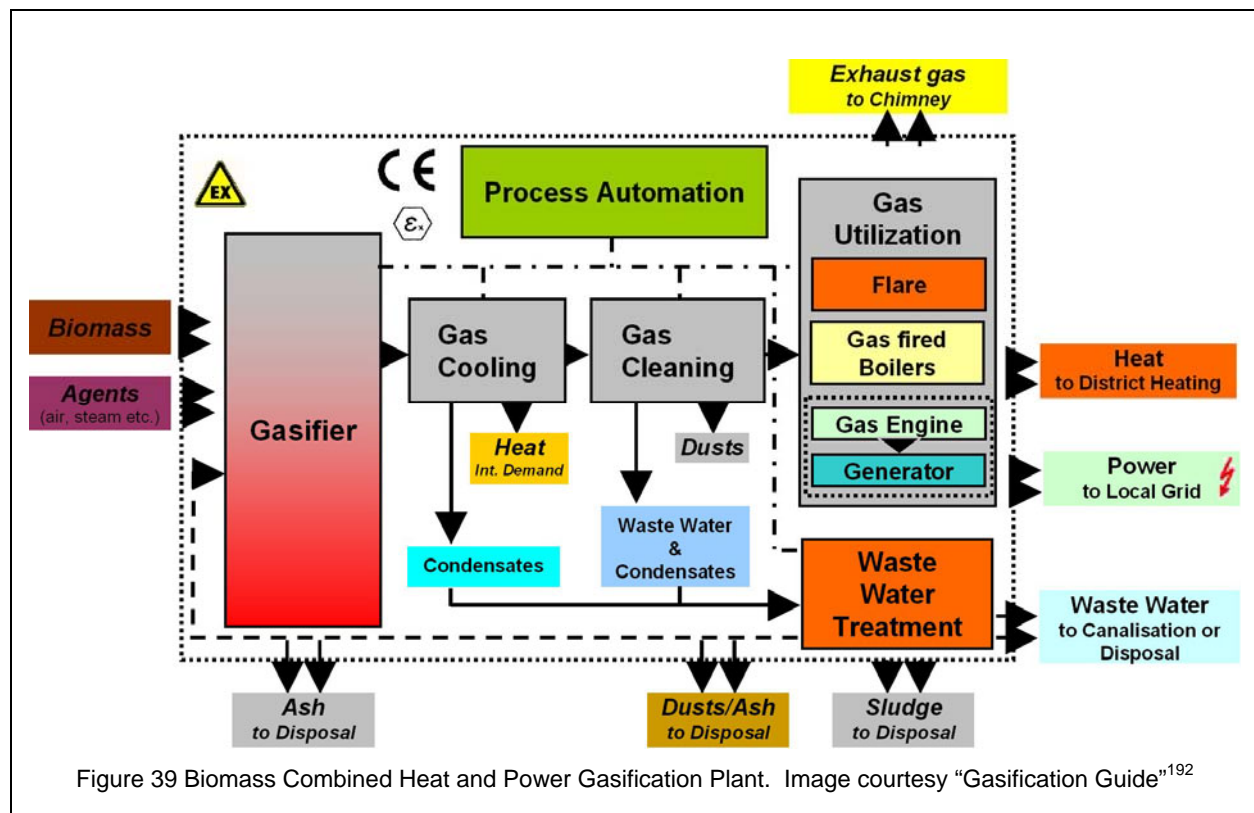
While coal gasifier technology had been used in the early 1800's to produce syngas for lighting and cooking, applications for biomass gasification for the purpose of full scale energy generation have not been fully established. Gasification is a complex technology and feasibility and applicability depend on many site-specific and feedstock variables. Some challenges with biomass gasification compared to coal gasification include its heterogeneous properties, low bulk density, and fibrous nature of herbaceous feedstock. These differences require specialized design and operation as compared to coal gasification.¹⁹¹

7.3 GASIFIER SYSTEM AND ENERGY GENERATION

This section includes information on the components of a gasifier system and details electricity generation equipment that can utilize syngas.

Gasifier System

The following image depicts the different components of a gasifier system (Fig. 39):



Energy Generation¹⁹³

Different sources of feedstock have varied energy content. Lab tests are necessary to determine the potential energy content in a fuel. Discuss with your gasifier consultant the amount of energy a gasifier is expected to produce with the type and amount of biomass available at your site.

Combustion (gas) turbines and steam turbine-generators can use syngas and waste heat to generate electricity (see Appendix V pages 139-142). To produce electricity, the syngas leaves the

gasifier and first must be cleansed of impurities such as alkalis, ammonia, chlorides, sulfides and particulates with the use of scrubbers. The syngas is then ignited to drive a combustion turbine and create electrical power through the use of a generator. Waste heat from the turbine can be used to boil water and create steam to drive a steam turbine with its own generator set. This combined heat and power operation increases energy efficiency by 33 percent compared with using a combustion turbine alone (see Appendix V page 138).

Alternatively, the CO and water in syngas may be converted to H₂ and CO₂ via a water-gas shift reaction. Hydrogen is a very clean burning fuel that can be used in fuel cells. Water may be added to the syngas prior to the water-gas shift reaction to increase the production of H₂. The syngas may also be turned into a clean burning diesel-like fuel using the Fischer-Tropsch process (a catalyzed chemical reaction).¹⁹⁴ Go to www.eere.energy.gov/afdc/pdfs/epa_fischer.pdf for an EPA factsheet on Fischer-Tropsch fuels.

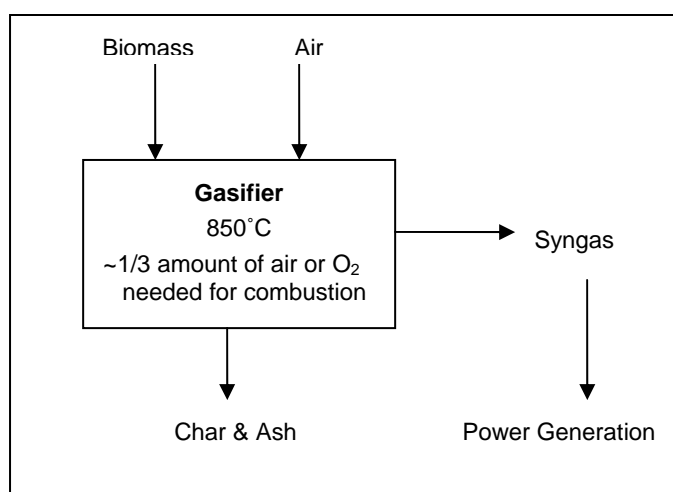


Figure 40 Small modular gasifier process (5 kW – 5 MW). Adapted from image courtesy EERE¹⁹⁵

7.4 ASSESSING BIOMASS GASIFIER PROJECT POTENTIAL

Gasification can be done on a large utility scale or a smaller scale. Cleanup sites most likely can be powered with small scale gasification systems which are rated between 5 kW and 5 MW (Fig. 40).¹⁹⁶ If there is a large source of biomass in the surrounding area, you may consider a larger facility to supply electricity to remediation equipment and to the utility grid. See Appendix XII (page 176) for net metering programs available in Region 9 states. There should be a source of biomass nearby and transportation costs should be taken into consideration when planning a gasifier.

After establishing that there is a potential source of biomass in the cleanup site area, you may need to consult the owner of the biomass resource for a potential partnership. You may then want to contact a biomass energy consultant for further assessment (see Section 10.9 page 119). Samples of biomass should be analyzed for energy, moisture, sulfur, and ash content to ensure compatibility with gasification. While each source of biomass may have different properties, there are a few databases that can provide a general sense of the composition of various types of biomass. See



NREL’s “Biomass Feedstock Composition and Property Database” (www1.eere.energy.gov/biomass/feedstock_databases.html).

“Phyllis” (www.ecn.nl/phyllis/) is another database of energy content and composition of various feedstocks compiled by the Energy Research Center of the Netherlands that may provide general estimates.

7.5 EMISSIONS REDUCTIONS, CAPITAL COST, PERMITS, INVOLVED PARTIES AND PARTNERSHIPS

This section includes information on emissions and emissions reductions associated with gasifiers, estimating capital costs, potential permit needs, potential parties that are involved in a digester project, and resources to develop partnerships.

Emissions Reductions¹⁹⁷

Gasification systems emit very low emissions of SO₂, PM, and toxic compounds such as mercury, arsenic, selenium, and cadmium. The gasification process releases CO₂ but for non-fossil fuel feedstock, the net emissions are considered to be zero because it came from recently living things including grasses, trees, and agricultural crops that are continually being renewed. In other words, if forest residue was used in a gasifier, the same amount of CO₂ released from gasification should be taken up by new forest growth, assuming the biomass will be replanted. When syngas is then used to generate electricity, net emissions are negative since this offsets the emissions that otherwise would have been emitted from fossil fuel-powered utilities. Go to the EPA Power Profiler listed on page 112 to help determine emissions reductions from using syngas to generate electricity.

Capital Cost

According to the Bioenergy Feedstock Information Network, a large scale gasifier is estimated to cost about \$1,000 per rated kW.¹⁹⁸ A 2000 NREL “Small Modular Biopower Initiative” document estimated that 25 kW—5 MW gasifiers have capital costs between \$1,600 and \$3,000 per rated kW.¹⁹⁹ At a per kWh basis, estimates range from 4.9-8.2 cents per kWh.

Permits

It is essential to garner appropriate permits early in the gasifier planning process as the design may need adjustment to comply with federal, state, and local rules. Gasifier construction and operation may need permits in the following areas:

- Land use
- Air
- Wastewater
- Hazardous waste (ash)
- Water
- Storm-water management

Gasifier consultants should be able to help with permitting issues.



Involved Parties

Many sectors may be involved in planning, designing, operating, and managing a gasification project. Involved parties may include:

- Gasifier design companies
- Biomass suppliers
- Local utility
- US Department of Agriculture (USDA)
- Permitting officers
- Local agriculture/farming association or organization
- Investors

Finding Gasifier Partners

- California Integrated Waste Management Board: List of gasifier vendors.
www.ciwmb.ca.gov/organics/conversion/Vendors/
- NREL: List of potential clean energy investors.
www.nrel.gov/technologytransfer/entrepreneurs/directory.html

7.6 SUCCESS STORY

Mount Wachusett Community College, Gardner, Massachusetts²⁰⁰

Mount Wachusett Community College partnered with Community Power Corporation, NREL, and USDA Forrest Service to install a \$1.2 million 50-kW woody biomass gasifier. The gasifier is fed 1.5 tons of wood chips per day and provides electricity to help power the school. Excess thermal energy is used for space heating and for cooling.

For more information, go to www.mwcc.edu/renewable/BiomassGasificationatMWCC.htm and www.delaware-energy.com/Download/BIO-MASS-CONF/Rob%20Rizzo.pdf.



CHAPTER 8: CLEANER DIESEL

On cleanup and redevelopment sites, diesel engines are commonly used in soil removals and construction. Common construction equipment includes wheel loaders, skid steer loaders, wheel dozers, landfill compactors, excavators, backhoes, drill rigs, scrapers, and trucks. Diesel engines are highly durable and can last for about 30 years. While stringent diesel emissions rules are reducing emissions from newly manufactured engines, in-use older engines can continue to operate for many years. Diesel emissions, especially PM, are highly toxic, potentially exposing site workers and surrounding communities to increased health risks. Clean diesel technologies and alternative fuels can reduce harmful emissions from older, higher polluting engines. Clean diesel technologies include replacing, repowering, or retrofitting older engines with advanced emission control devices that significantly reduce harmful pollutants. The two most widely used retrofit technologies are diesel particulate filters (DPFs) and diesel oxidation catalysts (DOCs). Cleaner fuels like ultra-low-sulfur diesel (ULSD), and alternative fuels such as biodiesel, also reduce emissions. In addition, simple measures like idle reduction and engine maintenance can be practiced as fundamental components of reducing diesel pollution.

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8.2	Approaches to Reduce Diesel Emissions
8.3	Clean Diesel Sample Language and Relevant Laws and Regulations
8.4	Success Stories

8.1 IMPORTANCE OF REDUCING DIESEL EMISSIONS

Reducing emissions from diesel engines is one of the most important air quality challenges facing the country. Diesel engines emit a complex mixture of air pollutants including both solid and gaseous materials that have serious human and environmental impacts (Table 7). EPA has

Particulate Matter (PM)	Nitrogen Oxides (NO _x)
<ul style="list-style-type: none"> • Irritation of airways • Coughing • Difficulty breathing • Aggravated asthma • Decreased lung function • Lung and heart disease • Acute and chronic bronchitis • Irregular heartbeat • Heart attacks 	<ul style="list-style-type: none"> • Acid Rain • Global warming • Water quality deterioration • Visibility impairments • Smog/precursor to ground-level ozone • Formation of toxic chemicals • Asthma in children • Increases lung susceptibility to toxins and microorganisms

deemed diesel exhaust as a “likely human carcinogen.”²⁰² California has also classified over 40 diesel exhaust pollutants as “toxic air contaminants.”²⁰³ Diesel activities occurring at cleanup sites may expose workers and surrounding communities to diesel pollution. The diesel pollutants that cause the most public health concerns are PM and NO_x.



Diesel pollution is a serious public health problem facing our country. The following are a few statistics that show the nationwide impacts of diesel emissions.

- In 2002, off-road diesel construction equipment emitted roughly 71,000 short tons of PM₁₀. About 95 percent of it was PM_{2.5}.²⁰⁴
- PM causes about 15,000 premature deaths a year. This is comparable to the number of deaths from 2nd-hand smoke and traffic accidents in California.²⁰⁵
- Diesel emissions result in approximately 6,000 children's asthma-related emergency room visits every year.²⁰⁶
- PM causes about 15,000 heart attacks per year.²⁰⁷
- In 2002, off-road diesel construction vehicles emitted about 764,000 tons of NO_x into our air.²⁰⁸
- EPA estimates that every \$1 invested in diesel emissions reductions generates up to \$13 in health-related benefits.²⁰⁹

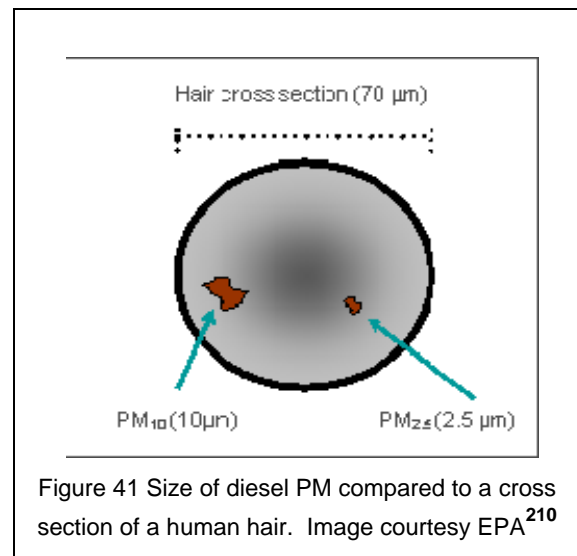
For more information on EPA engine emissions standards, see the document *Reducing Air Pollution from Non-Road Engines* published in May 2003 by the EPA Office of Air and Radiation (www.epa.gov/OMS/cleaner-nonroad/f03011.pdf).

Key Diesel Pollutants

Particulate matter is the general term for a mixture of solid particles and liquid droplets found in the air.²¹¹ Diesel engines emit particles smaller than 10 micrometers (µm) (PM₁₀) in diameter and nearly all are under 2.5 µm (PM_{2.5}) (Fig. 41). Human exposure to PM_{2.5} is especially dangerous because these particles can penetrate deep into the lungs and cause serious problems including asthma, heart attacks, and even premature death.²¹²

Nitrogen oxides (NO_x) is the term for a group of highly reactive gases that contain nitrogen and oxygen in varying amounts. NO_x form when fuel is burned at high temperatures, such as in a diesel engine. NO_x contribute to human health and environmental problems including asthma, smog, and acid rain (Table 7).

CO and SO_x pollutants are present in lower amounts in diesel exhaust compared to PM and NO_x but may also pose a risk to human health. CO can cause fatigue in healthy people and chest pain in people with heart disease. Exposure to moderate concentrations may cause angina, impaired vision, and reduced brain function. Higher concentrations can cause headaches, dizziness, confusion, nausea, and even death. SO_x can cause breathing problems for people with asthma. SO_x can also aggravate heart disease and induce respiratory illness and is a major component of





ambient PM. In addition, this pollutant is a major component in acid rain formation, which harms ecosystems and degrades buildings and statues. Hydrocarbons (HC) are a precursor to ground-level ozone.

Go to the American Lung Association of California's website for more technical information on the health effects of diesel pollution (www.californialung.org/spotlight/cleanair03_research.html).

8.2 APPROACHES TO REDUCE DIESEL EMISSIONS

There are many technologies and practices that reduce diesel emissions. The following are some examples. More details on retrofits and cleaner fuels follow. See Section 10.10 (page 121) to calculate emissions and emissions reductions.

Retrofit engines with EPA or California Air Resources Board (CARB) verified diesel emission control technologies. Alternatively, try to select contractors or rental companies that have retrofitted or newer engines.

Maintain engines in accordance with engine manual (e.g., change air filters, check engine timing, fuel injectors and pumps) and keep engines well tuned.

Refuel with biodiesel, other alternative fuels, or with cleaner fuels such as ULSD. See page 74.

Modify Operations by reducing operating and idle time. A mid-sized off-road tractor may consume as much as one gallon of diesel fuel per hour of idling.²¹³ Reducing just one hour of idling from a typical back hoe loader can avoid about 13 grams of PM emissions, 155 grams of NO_x emissions, 65 grams of CO emissions, and 65 grams of CO₂ emissions.²¹⁴ For more details, go to www.epa.gov/otaq/smartway/idlingtechnologies.htm.

Replace/Repower existing engines with new cleaner diesel engines, hybrid engines, or engines compatible with alternative fuels.

See EPA's March 2007 publication, *Cleaner Diesels: Low Cost Ways to Reduce Emissions from Construction Equipment* (www.epa.gov/sectors/pdf/emission_0307.pdf) for more information on methods of reducing diesel pollution.

Diesel Engine Retrofits

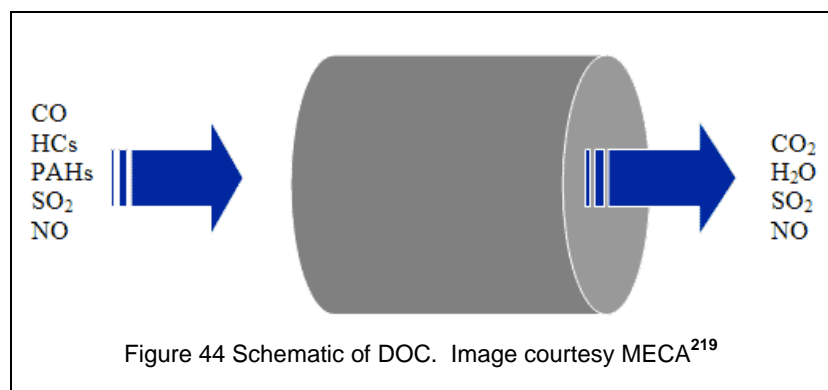
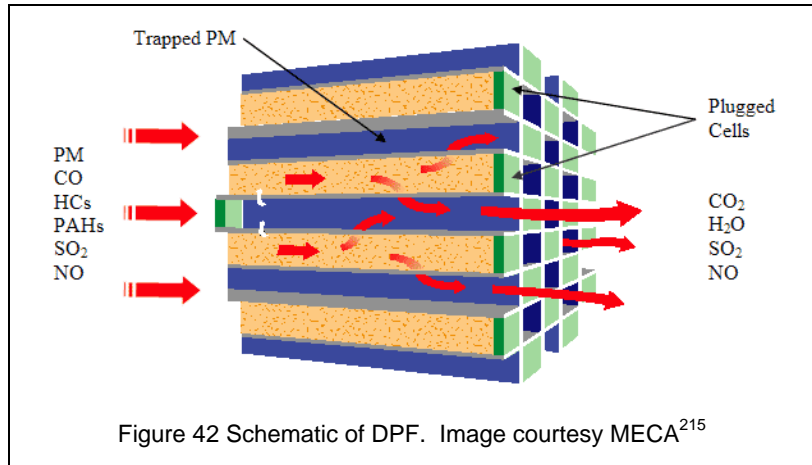
Engines can be retrofitted with many kinds of emissions control devices. This section describes the most widely used technologies (Table 8). See Appendix VIII (page 150) to see which verified retrofit technologies may be applicable for off-road equipment used at your site.

Diesel Particulate Filters (DPFs)

DPFs use ceramic filters to collect diesel PM from engine exhaust (Fig. 42, Fig. 43). Over time, PM builds up on the filters and they must be cleaned or “regenerated.”²¹⁷ For some DPFs, high enough engine exhaust temperatures can clean the filters by oxidizing (breaking down) the PM into less harmful components of CO₂ and water vapor.²¹⁸ These DPFs are called passive DPFs. Active DPFs require more maintenance because they must be removed for regeneration. DPFs require ULSD since sulfur reduces the effectiveness of DPFs.

Diesel Oxidation Catalysts (DOCs)

DOCs have been installed in off-road engines for over 30 years to reduce PM emissions. DOCs usually consist of a stainless steel container that holds a honeycomb structure (Fig. 44, Fig. 45). The interior surfaces are coated with catalytic metals such as platinum or palladium. Chemical oxidation reactions convert exhaust gas pollutants into less harmful gases. While many older engines are not compatible with passive DPFs, DOCs are able to work with these higher polluting engines.



Selective Catalytic Reduction (SCR)²²¹

While DOCs and DPFs concentrate on reducing PM emissions, SCRs are best at reducing NO_x emissions and reduce PM and HC as well. NO_x are converted to molecular nitrogen and oxygen in the SCR. A stream of ammonia or urea added to the exhaust gases pass over an SCR catalyst and cause chemical reactions that reduce NO_x emissions. SCRs greatly reduce odor caused by diesel engines and diesel smoke. SCR catalysts may also be combined with DOCs or DPFs for additional PM emissions reductions.



Figure 45 Dozer with DOC retrofit.
Image courtesy Schattanek²²⁰

Exhaust Gas Recirculation (EGR)

Diesel engines may be equipped with EGR devices to lower NO_x formation. Engine combustion chambers can reach temperatures greater than 2,500°F. At these temperatures, nitrogen and oxygen react to form NO_x which contribute to smog. An EGR device recirculates exhaust into the air intake stream. These gases displace some of the normal intake, lowering the peak temperature of the combustion process by hundreds of degrees and reduce the amount of oxygen available to form NO_x.²²² However, EGR increases PM emissions and are not compatible with many verified DOCs and DPFs for off-road engines.²²³



Table 8 Diesel Engine Retrofit Options

	Diesel Particulate Filter (DPF)	Diesel Oxidation Catalyst (DOC)	Selective Catalytic Reduction (SCR)
Technology Description	Wall-flow type filter installed in the exhaust system, much like a muffler, in which PM emissions are trapped. Active DPFs require regular maintenance to regenerate or burn off accumulated PM, when the engine is not in use. Passive DPFs regenerate during engine operation if exhaust temperature requirements are met.	Canister-like device containing a honeycomb structure that is installed in the exhaust system. A catalyst oxidizes CO and HC as the exhaust flows through, which breaks them down into less harmful components.	Device that injects urea, or some form of ammonia, into the exhaust stream and reacts over a catalyst to reduce NO _x emissions.
Cost per retrofit	\$7,000—\$10,000 ²²⁴	\$500—\$2,000 ²²⁵	\$12,000 with DOC \$20,000 with DPF ²²⁶
Emissions Reductions	PM reduced 60%-90% ²²⁷ HC reduced 60%-90% ²²⁸ CO reduced 60%-90% ²²⁹	PM reduced 40%-50% ²³⁰	SCR without DOC or DPF PM reduced 30%-50% ²³¹ NO _x reduced 75%-90% HC reduced 50%-90%
Benefits	Can be coupled with an exhaust gas recirculation system (page 71) to further reduce NO _x (up to 40%) and PM (up to 85%) though may not be compatible with currently verified DPFs ²³² Can also be coupled with a SCR to reduce NO _x and PM	Should not decrease fuel economy, shorten engine life, nor adversely affect drivability Less restrictive than DPF because DOCs are less affected by exhaust buildup in the filter Works well with older, higher emitting engines Use of ULSD increases efficiency	Commonly used in stationary applications. Often used with a DOC or catalyzed DPF to achieve greater PM reductions
Considerations	Annual maintenance costs approximately \$150-\$310 ²³³ Active DPFs require maintenance to keep filters clean. Passive DPFs oxidize PM via catalysts or high exhaust temperatures Off-road engines may require active DPFs Diesel equipment needs to meet minimum temperature requirements specific to individual filter technologies Slight fuel economy penalty from pressure buildup in the exhaust system, pressure and temperature monitors are necessary Requires ULSD 1995 and older engines may overload passive filters but may be compatible with active regeneration systems	May suffer thermal degradation when exposed to temperatures above 650°C for prolonged periods of time but these are unlikely conditions during normal operation ²³⁴ Requires normal exhaust maintenance	Requires periodic refilling of an ammonia or urea tank Requires low-sulfur diesel or ULSD



Retrofitting a Fleet

The following steps provide an approach to retrofitting a fleet.

Step 1

Inventory the fleet for each engine and determine the following:

- Type of equipment (backhoe, generator, etc.)
- Engine year, make, model, horsepower, displacement
- Engine family name (See Appendix VIII page 152)
- If a diesel emissions reduction device is already in place. New engines may have one installed.
- Turbocharged or naturally aspirated
- Mechanically or electrically controlled
- If it employs exhaust gas recirculation (page 71)

Step 2

Visit the EPA (www.epa.gov/otaq/retrofit/verif-list.htm) and CARB (www.arb.ca.gov/diesel/verdev/vt/cvt.htm) verification websites to determine compatible retrofit devices. See Appendix VIII (page 150) for verified retrofit technologies for off-road mobile engines.

Step 3

Work with vendors to assess the compatibility of your diesel equipment with a retrofit. They may need additional information such as: location for mounting retrofit device (on the muffler or on the side of the vehicle), size of the exhaust system, and if any changes will be made to the exhaust system (sometimes the retrofit device does not replace the muffler).

Step 4

Typically, datalogging is required before installing a DPF to determine if the exhaust temperatures are sufficient for passive DPF systems. Passive filters require high exhaust temperatures to oxidize the soot that accumulates on the filter. Vendors will datalog temperature information for a few days on each engine to see if required temperature minimums are met. Datalogging may cost about \$200-\$300 for two to three days of monitoring. Active DPF systems do not require high exhaust temperatures but do require maintenance.

Important Notes on Retrofitting

- Equipment retrofitted with DPFs should always include a device to monitor the increased pressure buildup in the exhaust system. These devices, called back-pressure monitoring systems, may also be installed with DOCs. A warning light in the cab will notify the equipment operator if the pressure becomes too high and maintenance is necessary.



- Retrofits may take place on-site or at the dealership, depending on the contract with the dealer.
- It is generally not recommended to remove a retrofit device from an engine for which it was designed and use it on another engine. Though this is possible if the engines are similar, it may not be in proper verified use, and may result in damage to the engine or retrofit device.
- DPFs may take from 1.5 hours to a full day to install. DOCs usually take 1.5-4 hours to install. Installations cost from \$170 to \$500 for each engine for both DOCs and DPFs.²³⁵
- SCRs require installation of a tank for ammonia (or other reagent), as well as the necessary catalyst and associated piping and controls. These retrofits can be much more involved compared to DPFs or DOCs. A dependable source of ammonia or urea supply is also required.

Cleaner and Alternative Fuels

Using cleaner and alternative fuels also helps to minimize diesel pollution. Most retrofit technologies require the use of low- or ultra-low-sulfur diesel. Many retrofits are also compatible with low blends of biodiesel. The following are commonly used cleaner and alternative fuels (Table 9). For information on where these fuels are available, go to www.eere.energy.gov/afdc/fuels/stations.html.

Ultra-Low-Sulfur Diesel (ULSD)

EPA's Clean Air Highway Diesel rule, finalized in 2001, requires a 97 percent reduction in the sulfur content of highway diesel fuel, from 500 ppm in low-sulfur diesel (LSD), to 15 ppm in ULSD (Fig. 46). While on-road diesel vehicles are already required to fuel with ULSD, off-road equipment ULSD fueling requirements begin in 2010. Highway model year 2007 and later engines must use ULSD to function properly. California's stricter rules already require ULSD in both off- and on-road engines.²³⁷ Use ULSD in both on-road and off-road equipment used in site cleanup and redevelopment activities to reduce PM emissions by about 13 percent compared to LSD.²³⁸ ULSD costs about 4-5 cents more per gallon to produce and distribute.²³⁹ Some diesel fuel may be colored red. The red dye is added to non-taxed off-road diesel to distinguish it from clear, or "white," taxed on-road diesel.²⁴⁰

Biodiesel

Biodiesel is a renewable fuel made from agricultural products such as vegetable oils. While most biodiesel is made from soybean oil in the United States, biodiesel made with canola oil and sunflower oil are also available. Biodiesel can also be produced from recycled cooking oils and animal fats, which is less energy-intensive than biofuel made from virgin crops. Biodiesel is

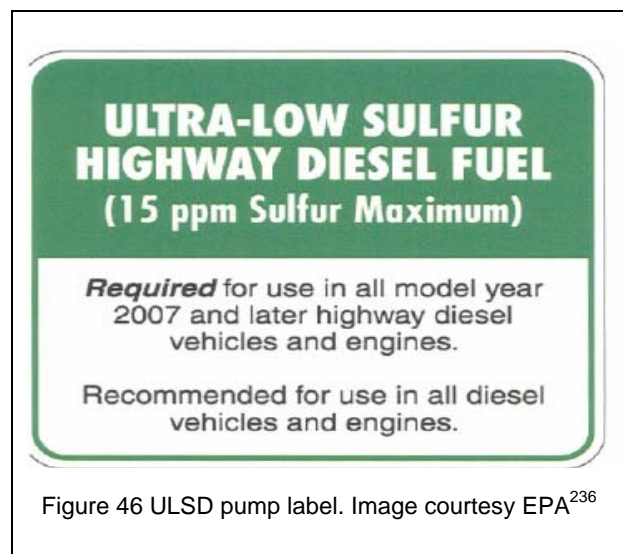


Figure 46 ULSD pump label. Image courtesy EPA²³⁶



not pure vegetable oil or animal fats. The oil must be refined through a process called *esterification* in which an industrial alcohol and a catalyst convert the oil into biodiesel.²⁴¹ Use biodiesel that conforms to ASTM standards to ensure that it performs properly.*

Biodiesel is often blended with conventional diesel in varying amounts. Biodiesel labeled “B20” is composed of 20 percent biodiesel and 80 percent conventional diesel and “B5” biodiesel is 5 percent biodiesel and 95 percent conventional diesel, etc. Biodiesel blends with ULSD will yield greater emission reductions. Most engines are compatible with biodiesel blends up to B20. Check with the manufacturer or rental company for recommendations and/or warranty issues. Biodiesel may release accumulated deposits from fuel tank walls and pipes, potentially causing clogs in the fuel filter. The fuel filter should be changed after the first tank of biodiesel. Some rubber fuel system components may also need to be replaced with biodiesel-compatible rubber, especially in older engines.

Compared to petrodiesel, biodiesel reduces PM, GHGs, sulfates, and HC. Go to Section 10.10 (page 121) to calculate your emissions reductions. Some DPFs may be compatible with biodiesel and may provide additional reductions compared with using ULSD.²⁴² As a consideration, some studies have shown a slight increase in NO_x while others show a slight decrease NO_x emissions from using biodiesel compared with conventional diesel. Further investigation is planned to yield more conclusive results.²⁴³ Also, using B20 may result in a slight fuel economy loss of around one to two percent compared to fueling with petrodiesel.²⁴⁴

Go to www.epa.gov/smartway/growandgo/documents/factsheet-biodiesel.htm for more information on benefits of biodiesel and how it is produced.

Find biodiesel fueling stations at the National Biodiesel Board website (www.biodiesel.org/buyingbiodiesel/distributors/).

Natural Gas

Natural gas burns cleaner than gasoline or diesel but must be used in vehicles with specially-designed engines. It emits 90 percent less PM and CO compared to diesel. However, natural gas is mostly CH₄, a GHG. Some studies show that there are no GHG reductions from using natural gas—the CO₂ reductions are offset by escaping CH₄.²⁴⁵ It is important to ensure that there are no leaks in the tanks. Natural gas can be used in vehicles as compressed natural gas (CNG) or liquefied natural gas (LNG). CNG is natural gas pressurized to 3,600 pounds per square inch and LNG is natural gas condensed to its liquid state by cooling it to -260 °F.²⁴⁶

A wide range of light-duty vehicles that run on CNG are available. While natural gas engines are not available for off-road heavy-duty equipment, there are natural gas options for hauling-trucks. Search

* ASTM International is an international organization that develops standards for a wide variety of materials and products. Biodiesel should comply with ASTM D6751 standards.



for natural gas vehicles at the EERE Alternative Fuels and Advanced Vehicles Data Center website (www.eere.energy.gov/afdc/afv/afdc_vehicle_search.php).

CNG is a cleaner burning fuel which reduces maintenance costs compared with conventional diesel engines.²⁴⁷ Note that CNG cylinders must be inspected every 36 months or 36,000 miles. Go to the Clean Vehicle Education Foundation website for more information on natural gas vehicles (www.cleanvehicle.org/technology/cylinder.shtml).

Go to www.eere.energy.gov/afdc/fuels/natural_gas.html for more information on natural gas.

Emulsified Diesel Fuel

Emulsified diesel is a mixture of diesel fuel, water, and other additives which lowers combustion temperatures to reduce PM and NO_x emissions.²⁴⁸ The water content in emulsified fuels is between 5 and 30 percent. This fuel can be used in any diesel engine though some power and fuel economy losses may be expected. While emulsified diesel stays well mixed for a fairly long time, the water may settle out after a few months of dormancy.²⁴⁹

Find verified emulsified fuels at the following websites:

- EPA Verified Diesel Retrofit Technology www.epa.gov/otaq/retrofit/verif-list.htm
- CARB Verified Diesel Retrofit Technology www.arb.ca.gov/diesel/verdev/vt/cvt.htm



Table 9 Cleaner and Alternative Fuels

	Ultra-Low-Sulfur Diesel	Biodiesel	Natural Gas	Emulsified Fuel
Fuel Description	Ultra-low-sulfur diesel (ULSD) has less than 15 ppm sulfur content. Low-sulfur diesel (LSD) contains less than 500 ppm sulfur content.	Renewable fuel made from animal or vegetable fats. Can be blended with conventional diesel. Usually found in 2% (B2), 20% (B20), and 100% (B100) blends.	Gas consisting mainly of methane. In the forms of compressed natural gas and liquefied natural gas.	Fuel that is mixed with water and additives to lower combustion temperatures which reduces NO _x and PM. Refer to the CARB verified list for qualified emulsified fuels.
Emissions Reductions (compared to low-sulfur diesel)	PM 13% ²⁵⁰ NO _x 3% ²⁵¹ CO 6% ²⁵² HC 13% ²⁵³	B20 PM 10% ²⁵⁴ NO _x * -2% ²⁵⁵ CO 10% ²⁵⁶ HC 21% ²⁵⁷ Sulfates 20% ²⁵⁸ CO ₂ 15% ²⁵⁹	PM 90% ²⁶⁰ NO _x 50% ²⁶¹ CO 90% ²⁶² HC 50 to 75% ²⁶³ CO ₂ 25% ²⁶⁴	PM 16 to 58% ²⁶⁵ NO _x 9 to 20% ²⁶⁶ CO 13% ²⁶⁷ HC -30 to -99% ²⁶⁸
Cost	\$0.04 -\$0.05 more per gallon than low-sulfur diesel ²⁶⁹	As of July '07, B20 was the same price as conventional diesel ²⁷⁰	~15 to 40% less than gasoline per gallon ²⁷¹	~\$0.20 more per gallon than conventional diesel ²⁷²
Considerations	Most verified retrofit technologies require the use of LSD or ULSD. In June 2006, CARB mandated the use of ULSD in both on- and off-road vehicles in California. Nationwide mandates for ULSD use in on-road engines came into effect in 2006 and mandates for LSD use in off-road vehicles came into effect in 2007.	Biodiesel blends lower than B20 experience insignificant difference in torque, horsepower, and fuel economy compared to conventional diesel. Using higher biodiesel blends may require changing fuel filters and replacement of rubber compound fuel system components with compatible rubber. Use biodiesel that meets the ASTM D6751 standard. Monitor performance in cold weather operation and ensure proper additives are used to prevent gelling.	Needs more frequent fueling. Natural gas vehicles cost about \$3,500 to \$6,000 more than gasoline equivalents. ²⁷³	May affect horsepower in some applications. Can be used in any diesel engine.

*NREL and EPA are conducting further evaluations to determine potential NO_x increase.



8.3 CLEAN DIESEL SAMPLE LANGUAGE AND RELEVANT LAWS AND REGULATIONS²⁷⁴

This section includes information on sample language used in contracts that may be useful when writing task orders. Some current state laws and regulations that address diesel emissions are also listed.

Sample Cleaner Diesel Language

Many areas of the country are placing clean diesel language in contracts, codes, laws, rules and other measures to reduce emissions from construction equipment and other diesel sources. Go to www.epa.gov/cleandiesel/construction/contract-lang.htm for examples of language that address air quality issues, particularly diesel emissions, from construction equipment and other diesel sources.

Laws and Regulations

The following are some state incentives and laws concerning alternative fuels and clean diesel practices. As of the writing of this document, no relevant laws were found for Hawaii, Nevada, or the Pacific Islands. Go to www.eere.energy.gov/afdc/laws/incen_laws.html for a more comprehensive list of state and local incentives and rules.

Arizona

- **Alternative Fuel and Alternative Fuel Vehicle (AFV) Tax Exemption:** The Arizona Use-Tax does not apply to the following: natural gas or liquefied petroleum gas used in motor vehicles; AFVs if the AFV was manufactured as a diesel fuel vehicle and converted to operate on an alternative fuel; and equipment that is installed in a conventional diesel fuel motor vehicle to convert the vehicle to operate on an alternative fuel.
- **Alternative Fuel Vehicle License Tax:** The initial annual vehicle license tax on an AFV is lower than the license tax on conventional vehicles. The vehicle license tax on an AFV is \$4 for every \$100 in assessed value. The assessed value of the AFV is determined as follows: during the first year after initial registration, the value of the AFV is one percent of the manufacturer's base retail price (as compared to 60 percent for conventional vehicles); during each succeeding year, the value of the AFV is reduced by 15 percent. The minimum amount of the license tax is \$5 per year for each motor vehicle subject to the tax.
- **Alternative Fuel Vehicle Special License Plate:** AFVs must display an AFV license plate. State or agency directors who conduct activities of a confidential nature and have a vehicle powered by an alternative fuel are exempt from the requirement of displaying an AFV special license plate. The Arizona Department of Transportation has the authority to issue regular plates to AFVs that are used by law enforcement and the federal government.
- **Clean Fuel Diesel for Heavy-Duty Equipment:** Any state agency that contracts for the use of on- or off-road heavy-duty diesel equipment in Maricopa County, Pima County, and Pinal County must construct its Requests for Proposals in a manner that gives incentives to bidders that use:



equipment retrofitted with diesel retrofit kits; newer clean diesel technologies and fuels; or biodiesel or other cleaner petroleum diesel alternatives.

- **Idle Reduction Requirement:** Heavy-duty diesel vehicles operated in Maricopa County with a gross vehicle weight rating of more than 14,000 pounds must limit idling time to no more than 5 minutes. Exemptions apply for emergency vehicles, certain traffic or weather conditions, certain driver accommodations, and idling necessary for refrigeration equipment.

California

- **Idle Reduction Requirement – Trucks:** The new engine requirements call for 2008 and newer model year heavy duty diesel engines to be equipped with a non-programmable engine shutdown system that automatically shuts down the engine after 5 minutes of idling or optionally meets a 30 gram per hour NO_x idling emission standard. The in-use truck rules require operators of sleeper berth-equipped trucks to manually shut down their engine when idling more than 5 minutes at any location within California beginning in 2008. The penalty for violating this measure is \$100 per violation.
- **In-Use Off-Road Diesel Vehicle Regulation:** This regulation establishes fleet average emission rates for PM and NO_x that decline over time. Each year, the regulation requires each fleet to meet the fleet average emission rate targets for PM or apply the highest level verified diesel emission control system to 20 percent of its total horsepower. In addition, large and medium fleets are required each year to meet the fleet average emission rate targets for NO_x or to “turn over” a certain percent of their horsepower. “Turn over” means repowering with a cleaner engine, retiring a vehicle, replacing a vehicle with a new or used piece, or designating a dirty vehicle as a low-use vehicle. If retrofits that reduce NO_x emissions become available, they may be used in lieu of turnover as long as they achieve the same emission benefits.
 - Large fleet (>5,000 hp) first average compliance date: 2010
 - Medium fleet (2,501 hp – 5,000 hp) first average compliance date: 2013
 - Small fleet (≤2,500 hp) first average compliance date: 2015

For more information on this regulation, go to www.arb.ca.gov/msprog/ordiesel/ordiesel.htm.

8.4 SUCCESS STORIES

AMCO Superfund Site, Oakland, CA, Region 9

The AMCO Superfund site was owned and operated by AMCO Chemical as a chemical distribution facility from the 1960s to 1989. Removal of lead soil in residential neighborhoods occurred in the summer of 2007. The mini-excavator and skid-steer used on the site were fueled with a B10 biodiesel blend. The biodiesel was picked up from a biodiesel distributor about 6 miles away from the site. The rental company allowed a maximum of 10 percent biodiesel blend fuel to be used in their equipment, although there are usually no technological barriers to using a higher blend. In total, this removal used 150 gallons of B10. No issues were encountered with the use of B10 in the equipment used at the AMCO removal. The use of biodiesel avoided 45 grams of PM emissions.



Site Contact:
Harry L. Allen
OSC, EPA Region 9
Phone: (415) 972-3063
E-mail: allen.harryl@epa.gov

Camp Pendleton Marine Corps Base, Superfund Site, about 40 miles north of San Diego, CA, Region 9

Camp Pendleton Marine Corps Base has nine areas of soil and groundwater contamination due to past disposal practices. From late 2007 to early 2008, 120,000 ft³ of soil were excavated and removed. Camp Pendleton made efforts to use newer engines, biodiesel, and to retrofit engines with DPFs for the excavation. Two pieces of equipment had the latest (Tier 3[†]) technology and were retrofitted with DPFs. Four pieces of equipment had the latest (Tier 3) technology and were fueled with B20. Two pieces of equipment were fueled with B5. The retrofits and DPFs reduced PM emissions by 27 percent. Compared to Tier 1 engines, Tier 3 engines emit 63 percent less PM.

Site Contact:
Martin Hausladen
RPM, EPA Region 9
Phone: (415) 972-3007
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[†] Tiers are levels of federal emissions standards that vary depending on vehicle type, size, and year of manufacture. Higher tiers are stricter than lower tiers. For more information, go to www.dieselnet.com/standards/.



CHAPTER 9: FUNDING RESOURCES AND OPPORTUNITIES

This chapter includes resources that provide information on funding opportunities for energy efficiency, renewable energy technologies, and diesel emissions reductions efforts. Details are provided for some national, regional, and state-wide incentives that are applicable in Region 9 (local incentives are not included). See Table 10 for a chart that summarizes these opportunities. This chart provides a quick overview on the type of funding and technology, sector, and geographic applicability. Details such as funding amounts, requirements, and contact information on the funding opportunities listed are included following the chart.

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9.1	Resources for Finding Funding Opportunities and Funding Opportunities Chart
9.2	National Funding
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9.4	California Funding
9.5	Hawaii Funding
9.6	Nevada Funding

9.1 RESOURCES FOR FINDING FUNDING OPPORTUNITIES AND FUNDING OPPORTUNITIES CHART

Below is a list of resources for finding funding opportunities for energy efficiency, renewable energy, and diesel emissions reduction efforts. Check these resources for national, regional, state, county, and local funding opportunities. See Table 10 for a chart summarizing some national, regional, and state-wide incentives found through these resources.

- Clean Diesel Technology Forum: Funding resources for diesel emissions reductions efforts. www.dieselforum.org/retrofit-tool-kit-homepage/retrofit-grants/
- Database of State Incentives for Renewables and Efficiency by North Carolina State University: Includes national, regional, state and local funding opportunities. www.dsireusa.org
- DOE E-Center Business and Financial Opportunities with Energy: Energy efficiency and renewable energy funding resources. <http://e-center.doe.gov/>
- EERE Federal Energy Management Program (FEMP): Incentives database for energy efficiency improvements. www1.eere.energy.gov/femp/program/utility/utilityman_energymanage.html
- Emission Reduction Incentives for Off-Road Diesel Equipment Used in the Port and Construction Sectors: Report of diesel emissions reduction funding opportunities prepared for EPA by ICF Consulting published in May 2005. www.epa.gov/sectors/pdf/emission_20050519.pdf
- Federal grants: Search for energy efficiency, renewable energy, and cleaner diesel federal grants. <http://grants.gov>



- *Funding On-Farm Biogas Recovery Systems: A Guide to Federal and State Resources:* Funding opportunities for anaerobic digesters published by the AgStar Program. www.epa.gov/agstar/pdf/ag_fund_doc.pdf
- *Funding Opportunities: A Directory of Energy Efficiency, Renewable Energy and Environmental Assistance Programs:* Document by the EPA State and Local Capacity Building Branch published September 2006. www.dep.state.pa.us/dep/deputate/pollprev/PDF/FundingOpportunities.pdf
- LMOP Funding Guide: Funding opportunities for landfill gas-to-energy projects. www.epa.gov/lmop/res/guide/index.htm
- NREL Solicitations and Request for Proposals: Renewable energy funding opportunities. www.nrel.gov/business_opportunities/solicitations_rfps.html
- Tax Incentives Assistance Project: Service provided by a coalition of public interest nonprofit groups, government agencies, and other organizations in the energy efficiency field for information on energy efficiency and renewable energy tax incentives. www.energytaxincentives.org/
- West Coast Diesel Collaborative: List of funding opportunities for diesel emissions reductions efforts. www.westcoastcollaborative.org/grants and <http://westcoastcollaborative.org/fed-funding.htm>



Table 10 Summary of National, Regional, and State Funding Opportunities for Cleaner Energy and Diesel

Funding Program	Applicability	Type of Funding	Applicable Sector	Energy Efficiency	Solar	Wind	Landfill Gas	Digester	Gasifier	Cleaner Diesel
Air Pollution Control Program Support <i>EPA</i> p. 88	National	Grant	State, tribal, municipal, intermunicipal, and interstate agencies							x
Biodiesel Tax Credit <i>IRS</i> p. 88	National	Tax Credit	Biodiesel producers							x
Clean Renewable Energy Bonds (CREBs) <i>IRS</i> p. 88	National	"Interest-Free" Loan	Governmental bodies and mutual or cooperative electric companies		x	x	x	x	x	
Congestion Mitigation Air Quality (CMAQ) Improvement Program <i>U.S. Department of Transportation (DOT)</i> p.88	National	Various	State DOTs, metropolitan planning organizations, and transit agencies							x
Conservation Innovation Grants (CIG) <i>USDA Natural Resources Conservation Service</i> p. 89	National	Grant	Non-federal governmental and non-governmental organizations, tribes, and individuals					x	x	
Consolidated Research/Training Grants <i>EPA Office of Research and Development</i> p. 89	National	Grant	State, territory and possession of the U.S., District of Columbia, universities and colleges, hospitals, laboratories, local government, tribes, and nonprofit institutions							x
Environmental Quality Incentives Program (EQIP) <i>USDA Natural Resources Conservation Service</i> p. 90	National	Cost-Share	Agricultural producers					x	x	
Farm Pilot Project Coordination (FPPC), Inc. p. 91	National	Grant	Agricultural producers					x	x	



Funding Program	Applicability	Type of Funding	Applicable Sector	Energy Efficiency	Solar	Wind	Landfill Gas	Digester	Gasifier	Cleaner Diesel
Federal Tax Credit (Business Energy Tax Credit) <i>IRS</i> p. 91	National	Tax Credit	Commercial and residential		X		X	X	X	
Modified Accelerated Cost-Recovery System (MACRS) <i>IRS</i> p. 92	National	Depreciation Deduction	Commercial and industrial		X	X	X	X	X	
National Clean Diesel Campaign (NCDC) <i>EPA</i> p. 92	National	Various	Various							X
Pollution Prevention (P2) Grants Program <i>EPA Office of Pollution Prevention and Toxics</i> p. 93	National	Grant	States, the District of Columbia, any territory or possession of the U.S., any agency or instrumentality of a state including state colleges, universities, and indian tribes							X
Public Interest Energy Research (PIER) Program <i>California Energy Commission</i> p. 93	National	Various	Commercial	X	X	X	X	X	X	
Renewable Electricity Production Tax Credit (REPC) <i>IRS</i> p. 94	National	Tax Credit	Various			X	X	X	X	
Renewable Energy Systems and Energy Efficiency Improvements Program <i>U.S. Department of Agriculture (USDA)</i> p. 95	National	Various	Agricultural producers or rural small businesses	X	X	X	X	X	X	



Funding Program	Applicability	Type of Funding	Applicable Sector	Energy Efficiency	Solar	Wind	Landfill Gas	Digester	Gasifier	Cleaner Diesel
Renewable Energy Production Incentive (REPI) <i>IRS p. 96</i>	National	Payment Incentive	Not-for-profit electrical cooperatives, public utilities, state governments, commonwealths, U.S. territories, tribal governments		X	X	X	X	X	
Renewable Energy Grants and Loans Programs <i>USDA Rural Development p. 97</i>	National	Various	Corporations, states, territories, and subdivisions and agencies thereof, municipalities, people's utility districts, and cooperative, non-profit, limited-dividend or mutual associations that provide retail or power supply service needs in rural areas	X	X	X	X	X	X	
Sustainable Agriculture Research and Education (SARE) Grants <i>USDA Cooperative State Research, Education, and Extension Service p. 97</i>	National	Grant	Researchers, agricultural educators, farmers and ranchers, and students					X	X	
West Coast Collaborative <i>EPA p. 98</i>	CA, OR, WA, AL, AZ, ID, NV, HI, Canada, Mexico	Grants	Public institutions, non-profit organizations, universities, and tribes							X
Commercial/Industrial Solar & Wind Tax Credit (Corporate) <i>AZ Dept. of Commerce p. 98</i>	AZ	Tax Credit	Businesses		X	X				
California Emerging Renewables Program (ERP) <i>California Energy Commission p. 99</i>	CA	Rebate	Customers of PG&E, SCE, SDG&E, or BVE			X	X	X	X	



Funding Program	Applicability	Type of Funding	Applicable Sector	Energy Efficiency	Solar	Wind	Landfill Gas	Digester	Gasifier	Cleaner Diesel
California Solar Initiative (CSI) <i>California Public Utilities Commission</i> p. 100	CA	Payment Incentive	Governmental bodies, non-profits, residential, business		X					
Carl Moyer Memorial Air Quality Standards Attainment Program <i>CARB</i> p. 103	CA	Grant	Any public or private entity							X
Energy Efficiency and Renewable Generation Emerging Technologies, Agriculture and Food Industries Loan Program <i>California Energy Commission</i> p. 103	CA	Loan	Agricultural and food processing industries		X			X	X	
Self Generation Incentive Program (SGIP) <i>California Public Utilities Commission</i> p. 104	CA	Rebate	Customer of PG&E, SCE, SDG&E, or SCGC			X	X	X	X	
Hawaii Renewable Energy Tax Credits OR Capital Goods Excise Tax <i>State of Hawaii, Department of Business, Economic Development and Tourism</i> p. 106	HI	Tax Credit	Commercial and residential		X	X				
Renewable Energy Producers Property Tax Abatement <i>Nevada Commission on Economic Development</i> p. 107	NV	Tax Abatement	New or expanded commercial businesses		X	X	X	X	X	
Renewable Energy Systems Property Tax Exemption <i>Nevada Department of Taxation</i> p. 107	NV	Tax Exemption	Commercial and industrial		X					



Funding Program	Applicability	Type of Funding	Applicable Sector	Energy Efficiency	Solar	Wind	Landfill Gas	Digester	Gasifier	Cleaner Diesel
Solar Generations PV Rebate Program <i>Sierra Pacific & Nevada Power Companies</i> p. 108	NV	Rebate	Commercial, residential, schools, local government, state government, other public buildings		x					



9.2 NATIONAL FUNDING

□ Air Pollution Control Program Support, EPA

This program assists state, tribal, municipal, intermunicipal, and interstate agencies in implementation of national primary and secondary air quality standards. It is also a resource that can assist in planning, developing, establishing, improving, and maintaining adequate programs for prevention and air pollution control.

Go to the Catalog of Federal Domestic Assistance listing for details:

http://12.46.245.173/pls/portal30/CATALOG.PROGRAM_TEXT_RPT.SHOW?p_arg_names=prog_nbr&p_arg_values=66.001.

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□ Biodiesel Tax Credit, IRS

In 2005, Congress granted federal tax credits for biodiesel producers. The tax credit is 50¢ per gallon of biodiesel (recycled cooking oil) and \$1 per gallon for “agri-biodiesel” (virgin vegetable oil). Biodiesel producers claim the credit by filling out IRS Form 8864 (www.irs.gov/pub/irs-pdf/f8864.pdf).

Go to www.biodiesel.org/news/taxincentive/ for more information.

□ Clean Renewable Energy Bonds (CREBs), IRS

CREBs offer a source of funding for renewable energy projects by providing essentially an interest free loan for a renewable energy project. The IRS allocates bonds to qualified lending authorities. Governmental bodies and mutual or cooperative electric companies are eligible to apply for the bonds as a funding source for renewable energy projects. These bonds are designed to be “interest free” because the holder is given a tax credit for the interest. The Tax Relief and Health Care Act of 2006 extended issuance of CREBs until December 31, 2008. Check the IRS website for future extensions.

For more details, go to www.irs.gov/irb/2007-14_IRB/ar17.html and www.elpc.org/energy/farm/crebs.php.

For more information on CREBs, call the IRS Office of Associate Chief Counsel (Tax Exempt & Government Entities) at (202) 622-3980.

□ Congestion Mitigation and Air Quality (CMAQ) Improvement Program, U.S. Department of Transportation (DOT)

The CMAQ Improvement Program provides financial assistance to areas striving to attain federal air quality standards. State DOTs, metropolitan planning organizations (MPOs), and transit agencies can invest more than \$1.6 billion annually until 2009 in projects that reduce criteria air



pollutants regulated from transportation-related sources. Clean diesel retrofit projects are eligible for CMAQ consideration.

CMAQ funds are available only to National Ambient Air Quality Standards non-attainment and maintenance areas .

While \$1.6 billion are available on a nationwide basis, areas should consult the CMAQ program and their state DOT and MPOs to determine how much CMAQ funding is available (funds are allocated to areas according to population and severity of non-attainment designation).

Under the 2005 re-authorization of the CMAQ program, diesel engine retrofits were given high priority for CMAQ funding.

For more information, go to www.fhwa.dot.gov/environment/cmaqpgs/.

Michael Koontz
CMAQ Coordinator
Federal Highway Administration
Phone: (202) 366-2076
E-mail: michael.koontz@fhwa.dot.gov

□ Conservation Innovation Grants (CIG), USDA Natural Resources Conservation Service

The CIG program is a voluntary program intended to stimulate the development and adoption of innovative conservation approaches and technologies while leveraging federal investment in environmental enhancement and protection, in conjunction with agricultural production. Biomass-to-energy projects may qualify.

- Eligible applicants include: non-federal governmental or non-governmental organizations, Tribes, or individuals.
- CIG usually has two competitions—National and State.
- National categories for potential projects change year to year. FY 2007 offered a National Technology Category that included methane recovery as a subtopic.

For details, go to www.nrcs.usda.gov/programs/cig/.

For Region 9, only California (www.ca.nrcs.usda.gov/programs/cig/) and Hawaii (www.hi.nrcs.usda.gov/programs/cig/index.html) are participating.

Tessa Chadwick
US Department of Agriculture
Phone: (202) 720-2335
E-mail: tessa.chadwick@wdc.usda.gov

□ Consolidated Research/Training Grant, EPA ORD

The Consolidated Research/Training Grant supports research and development to determine the environmental effects of air quality, drinking water, water quality, hazardous waste, toxic substances, and pesticides. It is available for each state, territory and possession, and tribal nation of the U.S., including the District of Columbia, for public and private state universities and colleges, hospitals, laboratories, state and local government departments, other public or private



nonprofit institutions, and in some cases, individuals who have demonstrated unusually high scientific ability.

Go to the Catalog of Federal Domestic Assistance listing for details:

http://12.46.245.173/pls/portal30/CATALOG.PROGRAM_TEXT_RPT.SHOW?p_arg_names=prog_nbr&p_arg_values=66.511.

Mark Thomas
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E-mail: thomas.mark@epa.gov

□ Environmental Quality Incentives Program (EQIP), USDA Natural Resources Conservation Service

EQIP is a voluntary program that provides assistance to farmers and ranchers who face threats to soil, water, air, and related natural resources on their land. EQIP was reauthorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill). Persons who are engaged in livestock or agricultural production on eligible land may participate in the EQIP program.

EQIP may cost-share up to 75 percent of the costs of certain conservation practices. Incentive payments may be provided for up to three years to encourage producers to carry out management practices they may not otherwise use without the incentive. However, limited resource producers and beginning farmers and ranchers may be eligible for cost-shares up to 90 percent. Farmers and ranchers may elect to use a certified third-party provider for technical assistance. An individual or entity may not receive, directly or indirectly, cost-share or incentive payments that, in the aggregate, exceed \$450,000 for all EQIP contracts entered during the term of the Farm Bill.

Some EQIP Requirements:

- Only land that has been irrigated for two of the last 5 years prior to application for assistance will be eligible for cost-share or incentive payments for irrigation related structural and land management practices.
- Funding may be used towards improving land management practices, such as nutrient management, manure management, integrated pest management, irrigation water management, wildlife habitat enhancement, and developing comprehensive nutrient management plans.
- Producers who are engaged in crop or livestock production on eligible land are eligible for the program. Eligible land includes cropland, rangeland, pasture, private non-industrial forestland, and other farm or ranch lands, as determined by the Secretary of Agriculture.



For more information, go to www.nrcs.usda.gov/programs/eqip/.

Arizona

www.az.nrcs.usda.gov/programs/eqip

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California

www.ca.nrcs.usda.gov/programs/eqip/

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Nevada

www.nv.nrcs.usda.gov/programs/eqip2006.html

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Rodney Dahl

Resource Conservationist, Programs

Phone: (775) 857-8500, ext. 146

E-mail: Rod.Dahl@nv.usda.gov

□ Farm Pilot Project Coordination, Inc. (FPPC)

FPPC, a non-profit organization, was designated by Congress (Public Law 107-76) to assist in implementing innovative treatment technologies to address the growing waste issues associated with animal feeding operations (AFO). FPPC's objective is to foster the conservation, development and wise use of land, water, and related resources, while providing AFOs with opportunities for profitable operation. Funding for approved pilot projects comes from monies appropriated by Congress and overseen by the Natural Resource Conservation Service, a division of the USDA. Requests for proposals are issued about twice a year. FPPC grants approximately \$2-\$3 million per RFP round. The main goal of this program is to encourage pilot projects that reduce nutrient content in waste streams generated from animal feeding operations.

To apply and for more information, go to www.fppcinc.org.

Farm Pilot Project Coordination, Inc.

Phone: (800) 829-8212

E-mail: info@fppcinc.org

Fax: (813) 222-3298

□ Federal Investment Tax Credit (Business Energy Tax Credit), IRS

The Federal Investment Tax Credit is a corporate tax credit for solar PV, solar water heat, solar space heat, solar thermal electric, solar thermal process heat, geothermal electric, fuel cells, solar hybrid lighting, direct use geothermal, and microturbines.

- Solar: Businesses and residents are eligible for a tax credit of 30 percent of the capital costs of a solar PV system. For solar, there is no cap for commercial installations. Credit drops to 10 percent of the capital cost if the system is installed after January 1, 2009.
- Microturbine: Businesses and residents are eligible for a tax credit of 10 percent of the capital costs for microturbines. The maximum microturbine credit is \$200 per kW of rated capacity. For microturbines, the credit expires January 1, 2009.



- Fuel cell: Businesses and residents are eligible for a tax credit of 30 percent of the capital costs of a fuel cell system. The credit for fuel cells is capped at \$500 per 0.5 kW of capacity. For fuel cells, the credit expires January 1, 2009.
- To apply, fill out IRS Form 3468 (www.irs.gov/pub/irs-pdf/f3468.pdf).

For more information, go to

http://dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US02F&State=federal¤tpageid=1&ee=0&re=1 and <http://www.seia.org/getpdf.php?iid=21>.

Information Specialist - IRS
1111 Constitution Avenue, N.W.
Washington, DC 20224
Phone: (800) 829-1040
www.irs.gov

□ Modified Accelerated Cost Recovery System (MACRS), IRS

Commercial and industrial sectors are eligible for recovering investments in certain property through depreciation deductions.

Microturbine, fuel cell, solar PV, solar water heat, solar space heat, solar thermal electric, solar thermal process heat, solar hybrid lighting, wind, geothermal electric and direct use geothermal properties are eligible.

- Solar power, wind power, fuel cell and microturbine property are eligible for five year accelerated depreciation.
- Fill out IRS Form 4562 (www.irs.gov/pub/irs-pdf/f4562.pdf).

For information on how to estimate accelerated depreciation, go to

www.sdenergy.org/uploads/PV-Federal%20Tax%20Credits%20Summary%206-01-04%20FINAL.pdf.

For more information, go to

www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US06F&State=Federal¤tpageid=1.

Information Specialist - IRS
1111 Constitution Avenue, N.W.
Washington, DC 20224
Phone: (800) 829-1040
www.irs.gov

□ National Clean Diesel Campaign (NCDC), EPA

The NCDC is an EPA program that works to reduce pollution resulting from existing diesel vehicles and equipment. Fleet owners are encouraged to install pollution-reducing devices on the vehicles and to use cleaner-burning diesel fuel.

For a listing of potential funding resources, go to www.epa.gov/cleandiesel/grantfund.htm.



□ Pollution Prevention (P2) Grants Program, EPA Office of Pollution Prevention and Toxics

The goal of the P2 Grants Program is to assist businesses and industries to better identify environmental strategies and solutions for reducing or eliminating waste at the source. Funds awarded through this grant program support businesses and industries to reduce the release of potentially harmful pollutants across all environmental media: air, water, and land. EPA is interested in supporting projects that reflect comprehensive and coordinated pollution prevention planning and implementation efforts within the state or tribe.

Eligible applicants include the 50 States, the District of Columbia, the U.S. Virgin Islands, the Commonwealth of Puerto Rico, any territory of or possession of the U.S., any agency or instrumentality of a state including state colleges, universities, and Indian Tribes that meet the requirement for treatment in a manner similar to a state in 40 CFR 35.663 (Code of Federal Regulations) and intertribal consortia that meet the requirements in 40 CFR 35.504. Local governments, private universities, private nonprofit organizations, private businesses, and individuals are not eligible for funding.

- Grant recipients must provide at least a 50 percent match of the total allowable project cost by the time of award to be considered eligible to receive funding.
- For purposes of this grant announcement, pollution prevention/source reduction is defined as any practice which:
 - Reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment or disposal;
 - Reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants; and
 - Reduces or eliminates the creation of pollutants through increased efficiency in the use of raw materials, energy, water, or other resources; or protection of natural resources by conservation.
- \$4.5 million in total program funding were available for FY 2007.
- P2 Grants is an annual program. Go to the link below to check for RFPs.

For more information, go to www.epa.gov/oppt/p2home/pubs/grants/ppis/ppis.htm.

EPA, Region 9
Eileen Sheehan
Pollution Prevention Coordinator
Waste Division
75 Hawthorne St.
San Francisco, CA 94105
Phone: (415) 972-3287
E-mail: sheehan.eileen@epa.gov

□ Public Interest Energy Research (PIER) Program, California Energy Commission (CEC)

The PIER Program supports energy research, development and demonstration (RD&D) projects that will help improve the quality of life in California by bringing environmentally safe, affordable



and reliable energy services and products to the marketplace. Applicants need not be a California business.

The PIER Program annually awards up to \$62 million to conduct public interest energy research by partnering with RD&D organizations including individuals, businesses, utilities, and public or private research institutions.

PIER funding efforts are focused on the following RD&D program areas:

- Renewable Energy Technologies
- Energy Innovations Small Grant Program
- Energy-Related Environmental Research
- Energy Systems Integration
- Buildings End-Use Energy Efficiency
- Climate Change Program
- Environmentally-Preferred Advanced Generation
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Natural Gas Research
- Transportation Research

For more information, go to www.energy.ca.gov/pier.

For current solicitations, go to www.energy.ca.gov/contracts/pier.html.

Martha Krebs
Deputy Director
PIER Program
Phone: (916) 654-4878
E-mail: mkrebs@energy.state.ca.us

□ Renewable Electricity Production Tax Credit (REPC), IRS

This incentive applies to biomass, landfill gas, wind power, hydroelectric, geothermal electric, municipal solid waste, refined coal, and indian coal. First enacted under the Energy Policy Act of 1992, it has subsequently been renewed, most recently by the Tax Relief and Health Care act of 2006 which extends it to December 31, 2008. Commercial and industrial entities may apply for this tax credit.

- Indexed for inflation, wind power currently receives 1.9¢ per kWh produced.
- Indexed for inflation, landfill gas currently receives 1.0¢ per kWh produced for the first 10 years of operation.
- Indexed for inflation, “open-loop biomass” currently receives 1.0¢ per kWh produced for the first 10 years of operation.
 - “Open-loop biomass” is residual biomass that otherwise may be considered “waste” materials, e.g., livestock manure, forestry residues.



- Indexed for inflation, “closed-loop biomass” currently receives 1.9¢ per kWh produced for the first 10 years of operation.
 - “Closed-loop biomass” is biomass that was produced specifically for fuel generation.
- To apply for the credit, a business must complete Form 8835, "Renewable Electricity Production Credit" (www.irs.gov/pub/irs-pdf/f8835.pdf), and Form 3800, "General Business Credit" (www.irs.gov/pub/irs-pdf/f3800.pdf).

For more information, go to

http://dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US13F&State=federal¤tpageid=1&ee=1&re=1.

Information Specialist - IRS
1111 Constitution Avenue, N.W.
Washington, DC 20224
Phone: (800) 829-1040
www.irs.gov

□ Renewable Energy Systems and Energy Efficiency Improvements Program, USDA

The 2002 Farm Bill established the Renewable Energy Systems and Energy Efficiency Improvements Program under Title IX, Section 9006. This section directs the Secretary of Agriculture to make loans, loan guarantees, and grants to farmers, ranchers and rural small businesses to purchase renewable energy systems and make energy efficiency improvements. Congress provided nearly \$23 million to fund the program in each fiscal year from 2003-2006. For FY 2007 there were approximately \$11.4 million in funding for competitive grants and \$176.5 million in authority for guaranteed loans. Funds are expected to be available in the future.

Applicants may qualify for a grant, a guaranteed loan, or a combination of both.

- Eligible renewable energy projects include systems that generate energy from wind, solar, biomass, or geothermal source or that produce hydrogen derived from biomass or water using a renewable energy source.
- Energy efficiency projects typically involve installing or upgrading equipment that results in a significant reduction in energy use from current operations.
- Eligible applicants are agricultural producers and rural small businesses demonstrating financial need.
- The renewable energy or energy efficiency project must be located in a rural area.
- The project must be for a pre-commercial or commercially available and replicable technology.
- Grant request must not exceed 25 percent of the eligible project costs. Renewable energy grants can range from \$2,500 to \$500,000. Energy efficiency grants can range from \$1,500 to \$250,000.
- Loan guarantees can be for up to 50 percent of total eligible project costs. Guarantees can range from \$5,000 to \$10,000,000 per project.



- Eligible project costs include: Post-application purchase and installation of equipment, except agricultural tillage equipment and vehicles; Post-application construction or project improvements, except residential; Energy audits or assessments; Permit fees; Professional service fees, except for application preparation; Feasibility studies; Business plans; Retrofitting; and Construction of a new facility only when the facility is used for the same purpose, is approximately the same size, and based on the energy audit will provide more energy savings than improving an existing facility. Only costs identified in the energy audit for energy efficiency projects are allowed.

For more information go to www.rurdev.usda.gov/rbs/farbill/.

To apply, contact your State Office Rural Energy Coordinators:

Arizona
Alan Watt
USDA RD
230 N. 1st. Avenue, Suite 206
Phoenix, AZ 85003-1706
Phone: (602) 280-8769
E-mail: alan.watt@az.usda.gov

Hawaii
Tim O'Connell
USDA RD
Federal Building, Room 311
154 Waiianuenu Avenue
Hilo, HI 96720
Phone: (808) 933-8313
E-mail: tim.oconnell@hi.usda.gov

California
Charles M. Clendenin
USDA RD
430 G Street, # 4169
Davis, CA 95616-4169
Phone: (530) 792-5825
E-mail: chuck.clendenin@ca.usda.gov

Nevada
Dan Johnson
USDA RD
555 West Silver Street, Suite 101
Elko, NV 89801
Phone: (775) 738-8468, ext. 112
E-mail: dan.johnson@nv.usda.gov

□ Renewable Energy Production Incentive (REPI), IRS

The REPI provides payments for electricity produced and sold by new qualifying renewable energy generation facilities. This incentive applies to solar PV, wind, geothermal, biomass, landfill gas, livestock methane, ocean technologies, and fuel cells using renewable fuels. The REPI program was created by the Energy Policy Act of 1992 to provide financial incentives for renewable energy electricity produced and sold by qualified renewable energy generation facilities.

Eligible electric production facilities that may be considered to receive REPI payments include not-for-profit electrical cooperatives, public utilities, state governments, commonwealths, territories of the United States, District of Columbia, Indian tribal governments, and political subdivision thereof, and native corporations that sell the facility's electricity.

- Qualifying facilities are eligible for annual incentive payments of 1.5¢ per kWh produced and sold (1993 dollars and indexed for inflation) for the first 10-year period of their operation, subject to the availability of annual appropriations in each federal fiscal year of operation.
- Applicants must meet qualified technology and facility location requirements.



To apply and for more information go to www.eere.energy.gov/repi/.

Christine Carter
DOE

1617 Cole Boulevard
Golden, Colorado 80401
Phone: (303) 275-4755
E-mail: christine.carter@go.doe.gov

Information Specialist - REPI
DOE

Weatherization and Intergovernmental
Program
Washington, DC
E-mail: repi@ee.doe.gov

□ Renewable Energy Grants and Loans Programs, USDA Rural Development

Under the authority of the Rural Electrification Act of 1936, USDA Electric Programs make direct loans and loan guarantees to electric utilities to serve customers in rural areas.

- High Energy Cost Grants (CFDA 10.859): These grants are available for communities with average home energy costs exceeding 275 percent of the national average. Funds may be used for improving and providing energy generation, transmission and distribution facilities. Grant funds may be used for on-grid and off-grid renewable energy projects, energy efficiency and energy conservation projects serving eligible communities. For more details, go to www.usda.gov/rus/electric/hecgp/overview.htm.
- Treasury Loans: These loans are available for distribution, subtransmission, and renewable generation facilities that provide retail or power supply service needs in rural areas. For more details, go to www.usda.gov/rus/electric/loans.htm.

Karen Larsen

Rural Development Electric Programs
USDA

1400 Independence Avenue, SW Stop 1560, Room 5165-South
Washington, DC 20250-1560
Phone: (202) 720-9545
E-mail: energy.grants@wdc.usda.gov
Fax: (202) 690-0717

□ Sustainable Agriculture Research and Education (SARE) Grants, USDA Cooperative State Research, Education, and Extension Service

The SARE program is part of USDA's Cooperative State Research, Education, and Extension Service, first funded by Congress in 1988. SARE is a competitive grants program providing grants to researchers, agricultural educators, farmers and ranchers, and students in the United States. The SARE program is divided into four regions, with each region announcing its own calls for proposals.

- Research and Education Grants: Ranging from \$30,000 to \$150,000 or more, these grants fund projects that usually involve scientists, producers, and others in an interdisciplinary approach.
- Professional Development Grants: To spread the knowledge about sustainable concepts and practices, these projects educate Cooperative Extension Service staff and other agriculture professionals.



- Producer Grants: Producers apply for grants that typically run between \$1,000 and \$15,000 to conduct research, marketing and demonstration projects and to share results with other farmers and ranchers.

For more information on the Western Region, go to <http://wsare.usu.edu/>.

Western Region SARE
Utah State University
Phone: (435) 797-2257
E-mail: wsare@mendel.usu.edu

□ West Coast Diesel Collaborative Grants, NCDC

The National Clean Diesel Campaign provides monies for regional collaboratives to award as grants for projects that reduce diesel emissions from existing diesel engine operations. States, Federally Recognized Indian Tribes and Tribal Consortia, local governments, international organizations, public and private universities and colleges, hospitals, laboratories, and other public or private nonprofit institutions are eligible to apply. Applicable technologies, fuels, and practices include emissions control technologies, idling reduction strategies, cleaner burning fuels, and alternative and biofuels production, distribution, and use. All projects must demonstrate applications, technologies, methods or approaches that are new, innovative or experimental.

Go to www.epa.gov/region09/funding/cleandiesel.html and www.epa.gov/diesel/grantfund.htm for more information.

Wayne Elson
West Coast Diesel Collaborative Construction Sector Lead
EPA Region 10
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Seattle, WA 98101
Phone: (206) 553-1463
E-mail: elson.wayne@epa.gov

9.3 ARIZONA FUNDING

□ Commercial/Industrial Solar & Wind Tax Credit (Corporate)

This tax credit was established by the Arizona legislature in 2006 to stimulate the production and use of solar energy in commercial and industrial applications by subsidizing the initial cost of solar energy devices. It is applicable towards solar PV, wind power, passive solar space heat, solar water heat, solar thermal electric, solar thermal process heat, solar cooling, solar pool heating, and daylighting.

- Businesses are eligible for a tax credit equal to 10 percent of the installed cost of the PV or wind power system.
- Tax credit applies to taxable years from January 1, 2006 through December 31, 2012.
- The maximum credit per taxpayer is \$25,000 for any one building in the same year and \$50,000 in total credits in any year.



- To qualify for the tax credits, a business must submit an application to the Arizona Department of Commerce. The Department of Commerce may certify tax credits up to a total of \$1 million each calendar year.

For more information, go to:

- Arizona Department of Commerce
www.azcommerce.com/BusAsst/Incentives/Solar+Energy+Tax+Incentives+Program.htm
- Commercial Solar Energy Tax Incentives Program Summary
www.azcommerce.com/doclib/finance/solar%20program%20summary.pdf
- Commercial Solar Energy Tax Credit Program: Program Guidelines
www.azcommerce.com/doclib/finance/solar%20guidelines.pdf

Arizona Department of Commerce
1700 W. Washington St., Suite 600
Phoenix, AZ 85007
Phone: (602) 771-1100
www.azcommerce.com

Arizona Department of Revenue
1600 W. Monroe
Phoenix, AZ 85007-2650
Phone: (602) 255-2060
www.azdor.gov

9.4 CALIFORNIA FUNDING

□ California Emerging Renewables Program (ERP), California Energy Commission (CEC)

The ERP provides incentives for wind turbines and fuel cells. The ERP is an element of the Renewable Energy Program pursuant to Senate Bill 10381, Senate Bill 1832, Senate Bill 12503, and Senate Bill 107.4.

- Wind power: First 7.5 kW receives \$2.50 per watt, then increments between 7.5-kW and 30-kW receives \$1.50 per watt. Wind turbines must be rated 50 kW or less.
- Fuel cell: \$3.00 per kW. Incentive available for up to 30 kW.

Requirements:

- Must be customer of Pacific Gas and Electric (PG&E), Southern California Edison (SCE), San Diego Gas and Electric (SDG&E), or Southern California Water Company (Bear Valley Electric Service).
- Must use new components that are approved by the California Energy Commission. Find a list of eligible equipment at www.consumerenergycenter.org/erprebate/equipment.html.
- System must have a five-year warranty.
- System must be sized to produce electricity primarily to offset part or all of the customer's needs at the site of installation. The expected production of electricity by the system may not be more than the historical or expected electrical needs of the electricity consumer at the site of installation.
- All systems must be installed with a performance meter.



For more information and to apply, go to
www.consumerenergycenter.org/erprebate/program.html.

See the *Emerging Renewables Program Final Guidebook*, Eighth Edition, December 2006, (www.energy.ca.gov/2006publications/CEC-300-2006-001/CEC-300-2006-001-ED8F.PDF) for more details.

California Energy Commission
Emerging Renewables Program
1516 Ninth Street MS-45
Sacramento, CA 95814
Phone: (800) 555-7794 in CA or (916) 654-4058 outside CA
E-mail: renewable@energy.state.ca.us

□ California Solar Initiative (CSI), California Public Utilities Commission

The California Solar Initiative is made up of two components. The California Public Utilities Commission (CPUC) will provide over \$2 billion in incentives over the next decade for existing residential homes and existing and new business, industrial, non-taxable (government and non-profit) and agricultural properties. The CSI also includes an additional \$350 million from the California Energy Commission (CEC) for the New Solar Homes Partnership. Find the *California Solar Initiative Program Handbook* at www.qosolarcalifornia.ca.gov/documents/index.html.

The CSI includes two incentives types (customers can only participate in one):

- Performance Based Incentive (PBI)

For this incentive type, all customers that install systems greater than 100 kW CEC-AC* will receive a monthly payment based on the actual energy produced, for a period of 5 years. Systems less than 100 kW CEC-AC may opt for PBI. PBI is required for Building Integrated PV (BIPV) Systems. Once the PBI incentive rate has been determined and a confirmed reservation issued, the incentive rate per kWh will remain constant for the 5-year term (Fig. 47). Program Administrators will make monthly payments to applicants based on actual electricity generated in kWh per the monthly reading of the meter after commissioning of the system.

- Expected Performance Base Buydown (EPBB)

Under this incentive, all systems less than 100 kW will be paid a one-time, up-front incentive based on expected system performance, which considers factors such as equipment ratings, geographic location, tilt, and shading (Fig. 47). Residential and small projects can also choose to opt-in to the PBI payment approach. On January 1, 2008, PBI will apply to

* CEC-AC is California Energy Commission Rated AC output of the PV system that takes into consideration real-world conditions and inverter efficiency.



systems equal to or greater than 50 kW CEC-AC. Starting in 2010, all systems greater than 30 kW will be under the PBI.

MW Step	Statewide MW in Step	EBPP Payments (per watt)			PBI Payments (per kWh)		
		Residential	Commercial	Gov't/ Nonprofit	Residential	Commercial	Gov't/ Nonprofit
1	50	n/a	n/a	n/a	n/a	n/a	n/a
2	70	\$ 2.50	\$ 2.50	\$ 3.25	\$ 0.39	\$ 0.39	\$ 0.50
3	100	\$ 2.20	\$ 2.20	\$ 2.95	\$ 0.34	\$ 0.34	\$ 0.46
4	130	\$ 1.90	\$ 1.90	\$ 2.65	\$ 0.26	\$ 0.26	\$ 0.37
5	160	\$ 1.55	\$ 1.55	\$ 2.30	\$ 0.22	\$ 0.22	\$ 0.32
6	190	\$ 1.10	\$ 1.10	\$ 1.85	\$ 0.15	\$ 0.15	\$ 0.26
7	215	\$ 0.65	\$ 0.65	\$ 1.40	\$ 0.09	\$ 0.09	\$ 0.19
8	250	\$ 0.35	\$ 0.35	\$ 1.10	\$ 0.05	\$ 0.05	\$ 0.15
9	285	\$ 0.25	\$ 0.25	\$ 0.90	\$ 0.03	\$ 0.03	\$ 0.12
10	350	\$ 0.20	\$ 0.20	\$ 0.70	\$ 0.03	\$ 0.03	\$ 0.10

Figure 47 PBI and EPBB incentive amounts by step. Step increases based on participation. Go to www.csi-trigger.com to see current step level. Image courtesy CPUC²⁷⁵

Requirements to qualify for PBI or EPBB:

- Must be customer of PG&E, SCE, or SDG&E.
- System equipment and retailers must be certified by CEC. (www.consumerenergycenter.org/erprebate/equipment.html)
- PV systems must be at least 1 kW to be eligible. The maximum limit for an eligible system is 5,000 kW though the incentive can only apply up to 1,000 kW.
- System output (kW) are calculated using CEC-AC standards. See the *CSI Program Handbook*, Section 2.2.5 “System Size” for details (www.gosolarcalifornia.ca.gov/documents/CSI_HANDBOOK.PDF). EPBB applicants go to www.csi-epbb.com/ for the EPBB calculator.
- All existing residential and commercial customers are required to have an energy efficiency audit conducted on their home or building. See Section 2.3 “Energy-Efficiency Requirements” of the *CSI Handbook* for details (www.gosolarcalifornia.ca.gov/documents/CSI_HANDBOOK.PDF).
- All systems must have a minimum 10-year warranty provided both by the manufacturer and installer to protect the purchaser against defective workmanship, system or component breakdown, or degradation in electrical output of more than 15 percent from their originally rated electrical output during the ten-year period. The warranty must cover the solar generating system and provide for no-cost repair or replacement of the system or system components, including any associated labor during the warranty period.
- Meters must have a one-year warranty to protect against defective workmanship, system or component breakdown, or degradation in electrical output of more than 15



percent from their originally rated electrical output during the warranty period. On or before January 1, 2008, the warranty requirements will be increased to a minimum of 5 years for meters, unless the CEC establishes alternate requirements.

- Equipment installed under the CSI program is intended to be in place for the duration of its useful life. Only permanently installed systems are eligible for incentives.
- The Host Customer, or designate, must also submit an application and enter into an interconnection agreement with their local electric utility for connection to the electrical distribution grid. Proof of interconnection and parallel operation is required prior to receiving an incentive payment.
- The CSI program requires accurate solar production meters for all projects that receive CSI program incentives. For systems with a system rating of less than 10 kW, a basic meter with accuracy of ± 5 percent is required. For systems with a system rating of 10 kW and greater, an interval data meter with accuracy of ± 2 percent is required.

When to apply for CSI incentives:

- Select a solar installer
- Determine that the cleanup site is eligible for CSI Incentives
- Apply for and reserve your incentives

PG&E customers visit: www.pge.com/csi

SCE customers visit: www.sce.com/rebatesandsavings/CaliforniaSolarInitiative/

SDG&E customers visit:

www.sdenenergy.org/ContentPage.asp?ContentID=377&SectionID=406&SectionTarget=370

- Install the PV system
- Collect the rebate or payments

For details on the application process, refer to Chapter 4 of the *CSI Handbook* (www.gosolarcalifornia.ca.gov/documents/CSI_HANDBOOK.PDF).

Pacific Gas & Electric
Program Manager, California Solar Initiative Program
Attn: California Solar Initiative
P.O. Box 7265
San Francisco, CA 94120-7265
Phone: Business Customers: 1-800-468-4743; Solar Hotline: 1-415-973-3480
Fax: 415-973-2510
E-mail: solar@pge.com
www.pge.com/solar

San Diego Area: California Center for Sustainable Energy (formerly the San Diego Regional Energy Office)
John Supp, Program Manager
California Center for Sustainable Energy
Attn: CSI Program Manager
8690 Balboa Avenue Suite 100
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Phone: (858) 244-1177; (866)-SDENERGY
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E-mail: csi@energycenter.org
www.energycenter.org

Southern California Edison
California Solar Initiative Administrator
6042A Irwindale Avenue
Irwindale, CA 91702
Phone: (800) 799-4177
Fax: (626) 302-6253
E-mail: greenh@sce.com
www.sce.com/rebatesandsavings/CaliforniaSolarInitiative/

□ Carl Moyer Memorial Air Quality Standards Attainment Program (CMP), CARB

CMP is administered by CARB in partnership with local air quality districts throughout the state. CMP funds may only be used to generate surplus emission reductions such as to reduce emissions beyond what is required by applicable standards or regulations, not to be used to comply with any applicable emission standards or regulations. Both public agencies and private entities that own and operate eligible diesel equipment can apply for CMP grant funds. Eligible projects may include the repowering or retrofitting of existing engines and vehicles, as well as the purchase of new low-emission engines or vehicles.

For more information, go to www.arb.ca.gov/msprog/moyer/moyer.htm.

To apply, contact your local air district: www.arb.ca.gov/msprog/moyer/contacts.htm.

California Air Resources Board
Phone: (916) 323-6169

□ Energy Efficiency and Renewable Generation Emerging Technologies, Agriculture and Food Industries Loan Program (Loan Program), California Energy Commission

The Loan Program offers 3.2 percent interest loan funds for the purchase of proven cost-effective energy efficient and renewable generation emerging technologies applicable to the agricultural and food processing industries.

Applicable technologies include:

- Food and animal waste bio-energy generation
- Solar PV and solar thermal systems
- Thermal heat pumps
- Electrodialysis membrane systems
- Enterprise energy management systems
- Heating and cooling topping cycle systems
- Ultra-low NO_x controlled energy efficient burners

An energy efficient emerging technology is defined as a technology that is commercially available, is proven through an independent evaluation to reach new efficiency performance



benchmarks when compared to current technologies, and has yet to be adopted by no more than 10 percent of the agricultural and food industries in California.

Available Funding

The Loan Program has approximately \$3 million available for project financing. The maximum loan amount for any applicant is \$500,000 to finance a single project or multiple projects. The minimum loan amount for any applicant is \$50,000. Funds are available for the design, purchase and installation of the eligible emerging technology. The interest rate is 3.2 percent. Interest will be calculated as simple interest and the rate will remain fixed during the life of the loan. The maximum repayment term cannot exceed 7 years. Interest accrues starting from the date funds are disbursed to the loan recipient.

Only the following types of facilities are eligible to apply for funding under this program:

- Food and Fiber Processing
- Animal Feeding and Processing
- Breweries, Wineries, Creameries
- Irrigation Districts
- Agricultural Production

Application Process

Securing the loans will require one of the following types of collateral:

- Standby Letter of Credit (a letter of credit is the preferred security)
- Certificate of Deposit (a CD will be considered if applicant is unable to obtain a letter of credit on terms acceptable to the Commission)

Applications are continuously accepted on a first come first served basis as long as funds are available. The program began in April of 2007.

For more information and applications, go to

www.energy.ca.gov/process/agriculture/loansolicitation/index.html.

Ricardo Amón

California Energy Commission

Grants and Loans Office

Attn: Emerging Energy Efficient Technologies Loan Demonstration Program

1516 Ninth Street, MS-1

Sacramento, CA 95814-5512

Phone: (916) 654-4019

E-mail: ramon@energy.state.ca.us

□ Self Generation Incentive Program (SGIP), California Public Utilities Commission

California's Assembly Bill 970, enacted in September 2000, ordered the establishment of additional energy supply and programs in the state. In March 2001, the California Public Utilities Commission introduced the SGIP. Eligible technologies include wind turbines, gas turbines, internal combustion engines, microturbines, and fuel cells using renewable fuels (Fig. 48). Approximately \$500 million was made available for 2003 to 2008.



Incentive Levels	Eligible Technologies	Incentive Offered (\$/Watt)	Minimum System Size	Maximum System Size	Maximum Incentive Size
Level 2 Renewable Non-Solar	Wind turbines	\$1.50/W	30 kW	5 MW	1 MW
	Renewable fuel cells	\$4.50/W			
	Renewable fuel microturbines and small gas turbines	\$1.30/W	None		
	Renewable fuel internal combustion engines and large gas turbines	\$1.00/W	None		
Level 3 Non-Renewable Non-Solar	Non-Renewable fuel cells	\$2.50/W	None	5 MW	1 MW
	Non-Renewable & Waste Gas fuel microturbines and small gas turbines	\$0.80/W			
	Non-Renewable & Waste Gas fuel internal combustion engines and large gas turbines	\$0.60/W			

Large gas turbines are ≥ 1 MW in capacity. Small gas turbines and microturbines are <1 MW in capacity.

Figure 48 Self-Generation Incentive Program incentive rates.²⁷⁶

Minimum Requirements:

- Must be customer of Pacific Gas and Electric (PG&E), Southern California Edison (SCE), San Diego Gas and Electric (SDG&E), or Southern California Gas Company.
- May not use more than 25 percent fossil fuel annually.
- All self-generation equipment must be connected to the electricity grid and installed on the customer’s side of the utility meter.
- Self-generation equipment must be new and permanent; demonstration units are not eligible.
- A portion of the facility’s electric load must be offset by the equipment.

The 2007 Self-Generation Incentive Program Handbook is available at www.socalgas.com/business/selfgen/docs2007/2007_SGIP_Handook.pdf.

For more information, go to www.cpuc.ca.gov/PUC/energy/051005_sgip.htm and contact local utilities to apply.

Pacific Gas & Electric Co.
Self-Generation Incentive Program
P.O. Box 770000
Mail Code B29R
San Francisco, CA 94177
Phone: (415) 973-6436
Fax: (415) 973-2510
E-mail: selfgen@pge.com
<http://www.pge.com/selfgen/>

San Diego Regional Energy Office
(Administrator for San Diego Gas & Electric)
401 B Street, Suite 800

San Diego, CA 92101
Phone: (619) 595-5630
Fax: (619) 595-5305
E-mail: selfgen@sdenergy.org
<http://www.sdenergy.org/ContentPage.asp?ContentID=35&SectionID=24>

Southern California Edison
Program Manager, Self Generation
Incentive Program
2131 Walnut Grove Avenue
3rd floor, MS B10
Rosemead, CA 91770
Phone: (800) 736-4777



Fax: (626) 302-6253
E-mail: greenh@sce.com
www.sce.com/RebatesandSavings/SelfGenerationIncentiveProgram/
Southern California Gas Company
Self-Generation Incentive Program
Administrator

555 West Fifth Street, GT15F4
Los Angeles, CA 90013
Phone: (800) GAS-2000
Fax: (213) 244-8384
E-mail: selfgeneration@socalgas.com
www.socalgas.com/business/selfgen

9.5 HAWAII FUNDING

□ Hawaii Renewable Energy Tax Credits OR Capital Goods Excise Tax

These two incentives are tax credits and are essentially the same and one may not be used in conjunction with the other. Businesses and residents are eligible to apply. Eligible technologies include solar PV, wind power, solar water heat, solar space heat, and solar thermal electric.

For PV systems, the maximum allowable credits are as follows:

- Commercial property is eligible for a credit of 35 percent of the initial cost or \$500,000, whichever is less.
- Single-family residential property is eligible for a credit of 35 percent of the initial cost or \$5,000, whichever is less.
- Multi-family residential property is eligible for a credit of 35 percent of the initial cost or \$350 per housing-unit, whichever is less.

For wind power systems, the maximum allowable credits are as follows:

- Commercial property is eligible for a credit of 20 percent of the actual cost or \$500,000, whichever is less.
- Single-family residential property is eligible for a credit of 20 percent of the actual cost or \$1,500, whichever is less.
- Multi-family residential property is eligible for a credit of 20 percent of the actual cost or \$200 per unit, whichever is less.

For more information, go to www.hawaii.gov/dbedt/info/energy/renewable/solar.

Hawaii Department of Taxation
Taxpayer Services Branch
P.O. Box 259
Honolulu, HI 96809
Phone: (808) 587-4242
www.state.hi.us/tax



9.6 NEVADA FUNDING

□ Renewable Energy Producers Property Tax Abatement

This incentive is a tax abatement for new or expanded commercial businesses. This incentive is applicable for solar PV, wind, solar thermal electric, landfill gas, biomass, municipal solid waste, and anaerobic digesters. Expires June 30, 2009.

- The incentive is a 50 percent property tax abatement for 10 years for real and personal property used to generate electricity from renewable energy resources or for a facility for the production of an energy storage device.
- The generation facility must have a capacity of at least 10 kW and use biomass, solar, or wind resources as its primary source of energy.
- The business must also meet capital expenditure, employee compensation, and other requirements to be eligible for the incentive.

For more information, go to:

- Nevada Commission on Economic Development Tax Abatement Factsheet
www.expand2nevada.com/whatwedo/pdfs/08renewableenergy.pdf
- Database of State Incentives for Renewables and Efficiency by North Carolina State University
www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=Nv01F&state=Nv&CurrentPageID=1&RE=1&EE=0

To apply, contact:

Susan Combs
Nevada Commission on Economic Development
108 E. Proctor Street
Carson City, NV 89701
Phone: (775) 687-4325
Phone 2: (800) 336-1600
Fax: (775) 687-4450
E-mail: scombs@bizopp.state.nv.us

□ Renewable Energy Systems Property Tax Exemption

This incentive is a property tax exemption that applies to solar PV, passive solar space heat, solar water heat, and solar space heat. Commercial and industrial sectors may apply. This exemption was enacted in 1997 and runs until January 2009. The renewable energy property tax exemption cannot be claimed if another state tax abatement or exemption is claimed by the same building.

- There is a 50 percent tax abatement for qualifying systems for 10 years.
- The generation facility must have a capacity of at least 10 kW.



For more information, go to

http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=NV02F&state=NV&CurrentPageID=1&RE=1&EE=0.

Information Specialist – Dept. of Taxation
NV Department of Taxation
1550 E. College Parkway, Suite 115
Carson City, NV 89706
Phone: (775) 684-2000
Fax: (775) 684-2020

□ Solar Generations PV Rebate Program, Sierra Pacific Power and Nevada Power

Solar Generations is a program administered by Sierra Pacific Power Company and Nevada Power Company to help these utilities meet their renewable portfolio standards. It provides a rebate on PV systems for businesses, residences, schools, local government, state government, and other public buildings serviced by Sierra Pacific Power or Nevada Power. The utilities will own the renewable energy credits from the electricity produced by the customer's PV system (See Section 2.5 page 11).

Incentive amounts are:

- Schools: \$5 per watt AC (up to a total capacity of 570 kW for all school projects).
- Public Buildings: \$5 per watt AC (up to a total capacity of 570 kW for all public building projects).
- Residences/Small Businesses: \$3 per watt AC (up to a total capacity of 760 kW each of the remaining program years).

Eligibility requirements:

- Rebate applies to a maximum of 5 kW of rated AC output for residential systems and 30 kW of rated AC output for small businesses, schools, or public buildings.
- The equipment installed must be on the list of certified PV modules and inverters provided by the California Energy Commission (CEC) Program found at www.consumerenergycenter.org/erprebate/equipment.html.
- A Nevada-licensed electrical contractor must install the system. The State of Nevada requires PV system installers in Nevada to hold an annually renewable PV license requirement. A list of contractors who have participated in Solar Generations training is available at www.solargenerations.com/contractors.html though this does not guarantee that they are properly licensed.
- Program participants must also sign a net metering agreement with the utility.

For more information, go to www.solargenerations.com.

SolarGenerations Rebate Program
6100 Neil Road
Reno, NV 89511
Phone: (866) 786-3823
E-mail: info@SolarGenerations.com



CHAPTER 10: TOOLS

This chapter includes tools related to energy efficiency, purchasing cleaner energy, renewable energy, and cleaner diesel. Energy efficiency tools include calculators to assess efficiency of pumps, potential federal technical assistance resources, and a toolkit on greener cleanups. Tools to assist in purchasing cleaner energy include resources of further information on how to buy green energy, where to find clean energy programs, and a resource on clean energy technical assistance. General renewable energy tools include calculators to estimate emissions and emissions reductions, software to help model the energy outputs and benefits of a renewable energy system, map data depicting renewable energy resources in the state, potential technical assistance resources, and resources on checking a renewable energy contractor’s licenses. There is a tools section for each of the renewable energy technologies detailed in this guide with calculators and models, surveying equipment, sources of further information and potential technical assistance resources. The clean diesel tools section includes calculators to help quantify emissions and emissions reductions, sources of further information, and potential technical assistance resources for cleaner diesel fuels, practices, and technologies.

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10.1	Energy Efficiency Calculators, Technical Assistance Resources and Informational Resources
10.2	Purchasing Clean Energy Informational Resources
10.3	General Renewable Energy Economic Calculations
10.4	General Renewable Energy Calculators, Technical Assistance, Informational Resources and Contractor Licensing Information
10.5	Solar Power Tools
10.6	Wind Power Tools
10.7	Landfill Gas-to-Energy Tools
10.8	Anaerobic Digestion Tools
10.9	Biomass Gasification Tools
10.10	Clean Diesel Tools

10.1 ENERGY EFFICIENCY CALCULATORS, TECHNICAL ASSISTANCE RESOURCES, AND INFORMATIONAL RESOURCES

- [Agricultural Pumping Efficiency Program \(California Public Utilities Commission \(CPUC\) and California State University \(CSU\) Fresno\)](#): The Agricultural Pumping Efficiency Program is a local resource for California. It is comprised of a partnership between the CPUC and CSU at Fresno's Center for Irrigation Technology. PG&E and SCE customers are eligible. This program provides free pump efficiency tests, educational seminars, and incentives for pump retrofits. Check with your local utility to see if similar programs are available for your cleanup site. www.pumpefficiency.org/

For the Pumping Cost Analysis Calculator for electric pumps, go to <http://www.pumpefficiency.org/Pumptesting/costanalysis.asp>.

Agricultural Pumping Efficiency Program
Center for Irrigation Technology



6014 North Cedar Ave.
Fresno, CA 93710
Phone: (800) 845-603

- **Federal Energy Management Program (FEMP) (EERE)**: FEMP is a potential resource to help improve energy efficiency and implement renewable energy projects at your site. FEMP works to reduce costs and environmental impacts of the federal government by advancing energy efficiency and water conservation, promoting the use of distributed and renewable energy, and improving utility management decisions at federal sites. FEMP helps federal energy managers identify, design, and implement new construction and facility improvement projects. This service may be applicable for fund-lead sites. www1.eere.energy.gov/femp/

FEMP Help Desk
1000 Independence Ave., SW
Washington, DC 20585-0121
Phone: (202) 586-5772
www1.eere.energy.gov/femp/about/contacts.html

- **Greener Practices for Business, Site Development and Site Cleanups: A Toolkit (Minnesota Pollution Control Agency)**: Use this online toolkit of greener cleanup options, a decision tree, and success stories, to determine how to reduce the environmental footprint from remediation activities. www.pca.state.mn.us/programs/p2-s/toolkit/index.html
- **Pumping System Assessment Tool (EERE)**: The Pumping System Assessment Tool is an online calculator that helps industrial users assess the efficiency of pumping system operations. www1.eere.energy.gov/industry/bestpractices/software.html#psat
- **Technical Assistance Project (TAP) for State and Local Officials (EERE)**: TAP is available to provide state and local officials with quick, short-term access to experts at DOE national laboratories for assistance with their renewable energy and energy efficiency policies and programs. TAP projects are available on a first come, first served basis. Project budgets are limited to \$5,000 in staff time and travel. Typically, this can provide a few days of on-site assistance or a week's worth of analysis and consultations via phone and e-mail. www.eere.energy.gov/wip/tap.cfm

To apply, go to www.eere.energy.gov/wip/how_to_apply.cfm.

Julie Riel
DOE Golden Field Office
Golden, Colorado
Phone: (303) 275-4866
E-mail: julie.riel@go.doe.gov

10.2 PURCHASING CLEAN ENERGY INFORMATIONAL RESOURCES

- **EERE Green Power Network**: Find state-by-state clean energy purchasing options. www.eere.energy.gov/greenpower/buying/buying_power.shtml



- *The Guide to Purchasing Green Power* (DOE, EPA, World Resources Institute, and Green-e, September 2004): Document detailing steps to purchasing clean energy. www.epa.gov/greenpower/buygp/guide.htm
- *Green Power Marketing in the United States: A Status Report* (NREL March 2003): Document detailing the status of green power marketing in the U.S. www.nrel.gov/docs/fy04osti/35119.pdf
- EPA Green Power Partnership: The EPA Green Power Partnership is a program that encourages U.S. organizations to voluntarily purchase green power as a way to reduce the risk of climate change and the environmental impacts associated with conventional electricity use. This program can assist in navigating the complexities of making a green power purchase. The Green Power Partnership is also available to help identify green power products. To find state-by-state green power products, go to <http://www.epa.gov/greenpower/pubs/gplocator.htm>.
www.epa.gov/greenpower/
James Critchfield
EPA HQ
Green Power Partnership
Phone: (202) 343-9442
E-mail: critchfield.james@epa.gov

10.3 GENERAL RENEWABLE ENERGY ECONOMIC CALCULATIONS

There are many different ways to look at the economic benefits of installing a renewable energy system. A few methods of analyzing the economics are: (1) rate of return, (2) payback time, and (3) total lifecycle payback. An explanation of these analyses follows using solar PV as an example.

Simple Calculation of Monthly Electricity Bill Savings

The simple calculation in Box 8 estimates electricity bill savings from your site’s renewable energy system. Enter the proposed rated power output of the system and the average kWh production each month per rated kW. Using solar PV as an example, 135-150 kWh per month is the general estimate of monthly energy production from a 1-kW system in Region 9 states. Look on your electricity bill for your cost of electricity per kWh. This simple calculation does not take into account that electricity prices are steadily increasing.

Box 8 Monthly Electricity Bill Savings
B = S * O * U
B = Monthly Electricity Bill Savings (\$)
S = Rated Power Output (kW)
O = Average Energy Output (kWh per kW per month);
U = Utility price per kWh (\$)



Simple Payback Time²⁷⁷

Simple payback time is defined as the time it takes for a renewable energy system to save enough money to pay for itself. This simplified calculation (Box 9) usually only takes into consideration the capital cost of the system and monetary savings from a reduced or eliminated energy bill and does not include operation and maintenance costs. In this model, reduced pollution levels and other non-monetary valued benefits are also not included. Another shortfall of simple payback time is that it does not account for the savings accrued after the payback time. This equation may overestimate the payback time since energy prices are expected to continue to increase.

Box 9 Simple Payback Time
$PB = C \div B$
PB = Payback Time (years)
C = Capital Cost (\$)
B = Annual Electricity Bill Savings (\$ per year)

Total Lifecycle Payback²⁷⁸

The total lifecycle payback accounts for savings gained after the payback time until the end of the useful life of a renewable energy system (Box 10). Solar PV systems usually last 25-30 years, resulting in savings 2-3 times greater than the initial capital cost. The drawback of this calculation is that it does not reflect the time value of money (having a dollar today is worth more than having a dollar in the future).

Box 10 Total Lifecycle Payback
$R = B \div C * Y$
R = Total Lifecycle Payback Ratio
B = Annual Electricity Bill Savings (\$ per year)
C = Capital Cost (\$)
Y = Years of operation (years)

10.4 GENERAL RENEWABLE ENERGY CALCULATORS, TECHNICAL ASSISTANCE, INFORMATIONAL RESOURCES AND CONTRACTOR LICENSING INFORMATION

- EPA's Power Profiler: Use this online calculator to determine the emissions emitted from electricity use. It can also be used to determine the pollution avoidance from a renewable energy system. Estimate CO₂, NO_x, and SO₂ emissions avoidance from using renewable energy rather than conventional electricity. To calculate pollutants avoided, enter the estimated amount of renewable energy produced by your renewable energy system into the Profiler instead of entering total electricity consumed. www.epa.gov/cleanenergy/powerprofiler.htm
- Federal Energy Management Program (FEMP) (EERE): FEMP is a potential resource to help improve energy efficiency and implement renewable energy projects at your site. FEMP works to reduce costs and environmental impacts of the federal government by advancing energy efficiency and water conservation, promoting the use of distributed and renewable energy, and improving utility management decisions at federal sites. FEMP helps federal energy managers identify, design, and implement new construction and facility improvement projects. This service may be applicable for fund-lead sites. www1.eere.energy.gov/femp/



FEMP Help Desk
1000 Independence Ave., SW
Washington, DC 20585-0121
Phone: (202) 586-5772
www1.eere.energy.gov/femp/about/contacts.html

- Greenhouse Gas Equivalencies Calculator (EPA): Translate tons of CO₂ and other pollutants into terms that are easier to conceptualize such as number of passenger cars driven, number of seedlings planted, and number of homes powered for a year.
www.epa.gov/cleanenergy/energy-resources/calculator.html
- The Guide to Purchasing Green Power (DOE, EPA, World Resources Institute, and Green-e, September 2004): Document detailing steps to purchasing clean energy including developing a renewable energy project. www.epa.gov/greenpower/buygp/guide.htm
- HOMER (NREL): Optimization software model to analyze the technical and economic feasibility of distributed power including solar PV, wind power, microturbine, fuel cell, and generators.
<https://analysis.nrel.gov/homer/>
- Renewable Energy Atlas of the West: Maps of solar, wind, geothermal and biomass resources created by the Western Resource Advocates, Northwest Sustainable Energy for Economic Development, GreenInfo Network, and Integral GIS, Inc. that can help assess renewable energy potential in the area surrounding a cleanup site. www.energyatlas.org

Arizona: www.energyatlas.org/PDFs/atlas_state_AZ.pdf
California: www.energyatlas.org/PDFs/atlas_state_CA.pdf
Hawaii: not yet available
Nevada: www.energyatlas.org/PDFs/atlas_state_NV.pdf
- RETScreen International (Natural Resources Canada): This website provides green energy analysis tools developed by Natural Resources Canada in partnership with international organizations such as the United Nations Environmental Programme, NASA, and the World Bank. This MS Excel-based program requires detailed inputs of renewable energy equipment data. This tool can be used for solar, wind, and biomass renewable energy projects.
www.retscreen.net
- Technical Assistance Project (TAP) for State and Local Officials (EERE): TAP is available to provide state and local officials with quick, short-term access to experts at DOE national laboratories for assistance with their renewable energy and energy efficiency policies and programs. TAP projects are available on a first come, first served basis. Project budgets are limited to \$5,000 in staff time and travel. Typically, this can provide a few days of on-site assistance or a week's worth of analysis and consultations via phone and e-mail.
www.eere.energy.gov/wip/tap.cfm

To apply, go to www.eere.energy.gov/wip/how_to_apply.cfm.

Julie Riel
DOE Golden Field Office
Phone: (303) 275-4866
E-mail: julie.riel@go.doe.gov



Renewable Energy Contractors' Licenses

Below are websites that will help you to determine whether a prospective contractor is licensed in that state.

- Contractor's License Reference Site: www.contractors-license.org/
- North American Board of Certified Energy Practitioners: www.nabcep.org
- Arizona Registrar of Contractors: www.rc.state.az.us/
- California Contractors State License Board: www.cslb.ca.gov
- Hawaii Department of Commerce: <http://hbe.ehawaii.gov/cogs/search.html>
- Nevada State Contractors Board: www.nvcontractorsboard.com

10.5 SOLAR POWER TOOLS

Solar Power Calculators

- My Solar Estimator (FindSolar.com): Findsolar.com is created through a partnership among solar professional organizations and DOE. This site provides information on solar incentives, a listing of qualified solar professionals, and a user-friendly PV sizing and economic analysis tool called "My Solar Estimator." This tool outputs solar availability, size of system (kW), space requirements, costs, rebates, loan considerations, savings and benefits including increased property value, return on investment, break even point, and monthly energy bill savings. www.findsolar.com
- PV Watts (Renewable Resource Data Center): PV Watts is a tool hosted by the Renewable Resource Data Center which is supported by the National Center for Photovoltaics and managed by EERE. Use PV Watts to estimate the energy output of your PV system and energy bill savings. www.pvwatts.org
- Clean Power Estimator (Clean Power Research): Clean Power Research provides consulting and software that evaluates the economics of clean energy investments. Use the Clean Power Estimator to estimate the energy output, emissions reductions, and financial benefits of a grid-connected PV system. www.consumerenergycenter.org/renewables/estimator/index.html
- Economic Analysis Tool (OnGrid Solar): OnGrid Solar is a private company that provides financial payback analysis for solar PV installations. Visit the site for a free demo of the Excel tool. Subscription starts at \$100 per month. www.ongrid.net



Solar Power Surveying Equipment

- **Solar Pathfinder:** This device can be used to evaluate annual sun/shading data and is useful for siting a PV system. Its polished transparent dome reflects surrounding buildings, trees, and other obstructions that create shadows (Fig. 49). Included in the kit are “Sunpath Diagrams,” which show the sun’s average path through the sky specific to your site. The device helps to determine year-round shadows made by surrounding obstructions. As of the writing of this guide, one Pathfinder set costs \$259. www.solarpathfinder.com

The Pacific Energy Center, run by PG&E, lends Solar Pathfinders and other surveying tools free of charge to customers working on energy efficiency and renewable energy projects in California. Tools may be loaned for about 2-4 weeks.

<http://www.pge.com/mybusiness/edusafety/training/pec/toolbox/tll/>.

For other states and territories, check your local utility for similar services.



Solar Power Informational Resources

- ***A Consumer’s Guide: Get Your Power from the Sun* (EERE, December 2003):** A EERE document written for residents who are interested in installing a PV system for their homes. www.nrel.gov/docs/fy04osti/35297.pdf
- **EERE Solar PV Website:** Website with technology information on solar PV. www1.eere.energy.gov/solar/photovoltaics.html

10.6 WIND POWER TOOLS

Wind Power Calculators

- **Wind Energy Payback Period Workbook (EERE):** Use this tool to estimate the payback period for your wind power system. www.eere.energy.gov/windandhydro/windpoweringamerica/filter_detail.asp?itemid=1415
- **Wind Speed Calculator (Danish Wind Industry Association):** Input a known wind speed at a certain height and this calculator outputs estimated wind speeds at other heights. Enter wind speeds in meters per second. This calculator also takes into account variation in terrain which would affect wind speed estimates. www.windpower.org/en/tour/wres/calculat.htm

Wind Surveying Equipment

- **Pacific Energy Center (PG&E):** The Pacific Energy Center, run by PG&E, lends anemometers and other surveying tools free of charge to customers working on energy efficiency and



renewable energy projects in California. Tools may be loaned for about 2-4 weeks.

<http://www.pge.com/mybusiness/edusafety/training/pec/toolbox/tll/>.

For other states and territories, check your local utility for similar services.

Wind Power Technical Support

- California Wind Energy Collaborative (California Energy Commission and University of California at Davis): The California Wind Energy Collaborative is a partnership between the University of California at Davis and the California Energy Commission that supports the development of wind power in California. They provide short training courses for the general public that provides practical information on selecting, installing, and owning a wind turbine. <http://cwec.ucdavis.edu/>

California Wind Energy Collaborative

E-mail: info@cwec.ucdavis.edu

Dr. C.P. (Case) van Dam
Department of Mechanical and
Aeronautical Engineering
University of California, Davis
1 Shields Avenue
Davis, CA 95616
Phone: (530) 752-7741
E-mail: cpvandam@ucdavis.edu

Dr. Bruce R. White
Department of Mechanical and
Aeronautical Engineering
University of California, Davis
1 Shields Avenue
Davis, CA 95616
Phone: (530) 752-6451
E-mail: brwhite@ucdavis.edu

Wind Power Informational Resources

- American Wind Energy Association (AWEA): This website provides information on installers/contractors, state-specific wind power rules, interconnection issues, and wind power incentives (www.awea.org/smallwind/states.html). Find general information on planning a wind project using the AWEA “Small Wind Toolbox” (www.awea.org/smallwind/toolbox).
www.awea.org
- British Wind Energy Association Briefing Sheet: Wind turbine technology factsheet.
www.bwea.com/pdf/briefings/technology05_small.pdf
- Danish Wind Industry Association: More information on how wind turbines work and wind turbine technology. <http://www.windpower.org/en/core.htm>
- Permitting Small Wind Turbines: A Handbook (American Wind Energy Association): Guide on permitting information for wind turbines. www.awea.org/smallwind/documents/permitting.pdf
- Small Wind Electric Systems: A U.S. Consumer's Guide (EERE, March 2005): An EERE document written mainly for residents who are interested in installing a wind turbine.
www.eere.energy.gov/windandhydro/windpoweringamerica/pdfs/small_wind/small_wind_guide.pdf
- Small Wind Electric Systems: An Arizona Consumer's Guide (EERE, March 2005): An EERE document written mainly for residents who are interested in installing a wind turbine with information specific to Arizona.
www.eere.energy.gov/windandhydro/windpoweringamerica/pdfs/small_wind/small_wind_az.pdf



- EERE Wind Power Website: Information on wind power technology. www1.eere.energy.gov/windandhydro/wind_technologies.html
- NREL Wind Power Website: Information on wind power technology. www.nrel.gov/wind/
- Wind Energy Manual (Iowa Energy Center, 2006): Details on wind power history, technology, and considerations. www.energy.iastate.edu/Renewable/wind/wem-index.htm

10.7 LANDFILL GAS-TO-ENERGY TOOLS

LFGE Calculators

- LFGE Benefits Calculator (LMOP): The LFGE Benefits Calculator can be used to estimate direct, avoided, and total GHG reductions, as well as environmental and energy benefits from a landfill gas-to-energy project. www.epa.gov/landfill/res/calc.htm
- LFGE Potential Project Locator Tool (LMOP): This LMOP tool can help developers determine potential LFGE project sites within a 20-25 mile radius of a particular address. Contact LMOP for assistance. www.epa.gov/lmop/contact/index.htm
- Landfill Gas Emissions Model (LandGEM) (EPA Technology Transfer Network): This model can be used to estimate total LFG and methane generation, as well as emissions of CO₂, NMOCs, and other air pollutants from MSW landfills. It is not intended to characterize emissions from co-disposal landfills. www.epa.gov/ttnecat1/products.html#software
- Landfill Gas Energy Cost Model (EPA, LMOP): Use this tool to estimate the economic feasibility of your MSW LFGE project. <http://www.epa.gov/lmop/res/#5>

LFGE Informational Resources

- *A Landfill Gas to Energy Project Development Handbook* (EPA LMOP, September 1996): This LMOP handbook includes information on the major aspects of LFG project development, including economic analysis, financing, choosing project partners, environmental permitting, and contracting for services. <http://epa.gov/lmop/res/pdf/handbook.pdf>

See *Appendix A: Calculations of Landfill Gas Energy Recovery Project Costs* for an overview of costs. Though the cost estimates are outdated, it may be useful to better understand the services and equipment that must be included and their relative costs.

www.epa.gov/lmop/res/pdf/hbookapp.pdf

- *Guidance for Evaluating Landfill Gas Emissions From Closed or Abandoned Facilities* (EPA, September 2005): Use this guidance document for procedures on how to evaluate emissions from co-disposal landfills. www.epa.gov/nrmrl/pubs/600r05123/600r05123.pdf
- *Landfill Gas-To-Energy Potential in California* (California Energy Commission, September 2002): Document that provides information on landfills in California, their potential for generating electricity, applicable technologies, and information on current LFGE projects in California. www.energy.ca.gov/reports/2002-09-09_500-02-041V1.PDF



- *Economic and Financial Aspects of Landfill Gas to Energy Project Development in California* (California Energy Commission, April 2002): Provides general information on LFGE technology and summarizes existing LFGE projects in California.
www.energy.ca.gov/pier/final_project_reports/500-02-041v1.html

LFGE Technical Resources

- Landfill Methane Outreach Program, (EPA): The Landfill Methane Outreach Program (LMOP) is an EPA assistance and partnership program that promotes the use of landfill gas as a renewable energy source. LMOP provides technical, informational, and marketing services, such as:
 - Technical assistance, guidance materials, and software to assess a potential project's economic feasibility;
 - Assistance in creating partnerships and locating financing for projects;
 - Informational materials to help educate the community and the local media about the benefits of LFG; and
 - Networking opportunities with peers and LFG experts to allow communities to share challenges and successes.

www.epa.gov/lmop

Contact LMOP for assistance on your landfill project (www.epa.gov/lmop/contact).

- Methane to Markets Partnership: The Methane to Markets Partnership is a voluntary, non-binding framework for international cooperation to advance the recovery and use of methane as a valuable clean energy source. www.methanetomarkets.org

10.8 ANAEROBIC DIGESTION TOOLS

Anaerobic Digestion Calculators

- Biomass Cost of Energy Calculator (California Biomass Collaborative): Use this calculator to estimate the cost of energy generated from an anaerobic digester. Requires input of detailed technical, financial, and economic assumptions.
<http://faculty.engineering.ucdavis.edu/jenkins/CBC/Calculator/index.html>
- FarmWare (AgStar): Decision support software package that can be used to conduct pre-feasibility assessments for swine and dairy manure digesters.
www.epa.gov/agstar/resources/handbook.html
- Financial Analysis Model (New York Agriculture Innovation Center): This spreadsheet model is useful for potential manure digester projects. It estimates financial projections for implementing anaerobic digestion, cogeneration, solids separation, composting, and liquid manure spreading for a farm. Requires detailed inputs including capital costs, depreciation terms, projected construction schedule, and operating costs such as labor hours, fuel use, and insurance costs. This model can be used after initial consultation with vendors.
<http://hive.bee.cornell.edu/extension/manure/FinancialAnalysis.htm>



Anaerobic Digestion Informational Resources

- *Agricultural Biogas Casebook Update 2004*, (Resource Strategies, Inc.): Collection of case studies of digesters in the Great Lakes region.
www.rs-inc.com/downloads/Experiences_with_Agricultural_Biogas_Systems-2004_Update.pdf
- Cornell University Anaerobic Digester Website: Technical papers and case studies on anaerobic digesters. www.manuremanagement.cornell.edu/HTMLs/AnaerobicDigestion.htm
- Minnesota Department of Agriculture Anaerobic Digester Web Page: Collection of anaerobic digester studies. www.mda.state.mn.us/renewable/waste/digester-refs.htm
- Penn State University Anaerobic Digester Website: General information on digester technologies, digester safety, case studies, and vendors.
www.biogas.psu.edu/anaerobicdigestion.html
- EERE Anaerobic Digester Web Pages: DOE website providing basic information on digesters.
www.eere.energy.gov/consumer/your_workplace/farms_ranches/index.cfm/mytopic=30002

Anaerobic Digestion Technical Resources

- AgStar Program: The AgSTAR Program is a voluntary effort jointly sponsored by the EPA, the USDA, and DOE. The program encourages the use of biogas capture and utilization at animal feeding operations that manage manures as liquids and slurries. www.epa.gov/agstar
AgStar Handbook This handbook is for livestock producers, developers, investors, and others in the agricultural and energy industry that may consider biogas technology as a livestock manure management option. www.epa.gov/agstar/resources/handbook.html
Managing Manure with Biogas Recovery Systems Improved Performance at Competitive Costs This document provides a general overview on anaerobic digesters.
www.epa.gov/agstar/pdf/manage.pdf
- Methane to Markets Partnership: Methane to Markets is a voluntary partnership among international corporations and organizations to advance the recovery and use of methane as a valuable clean energy source. www.methanetomarkets.org

10.9 BIOMASS GASIFIER TOOLS

The following is a list of state-specific information and biomass energy organizations that may be able to provide assistance. Also provided are potential consulting resources that may be able to help to plan a gasifier project.

Biomass Gasifier Informational Resources

- *Analysis of Hawaii Biomass Energy Resources for Distributed Energy Applications* (University of Hawaii at Manoa for the State of Hawaii, December 2002): Research paper studying energy content and chemical composition of different biomass resources available in Hawaii.
www.hawaii.gov/dbedt/info/energy/publications/biomass-der.pdf



- “Arizona Biomass Energy Opportunities” (Prepared by TSS Consultants for Greater Flagstaff Forests Partnership, March 2004): Report discussing benefits of using biomass waste from Arizona forest management practices for energy production. www.cc.state.az.us/divisions/utilities/electric/EPS-TSSC.pdf
- Bioenergy Feedstock Information Network: Database of biomass-to-energy documents from the DOE Oak Ridge National Laboratory, DOE Idaho National Laboratory, NREL, and other research organizations. <http://bioenergy.ornl.gov/main.aspx>
- “Biomass Energy Project Guide” (Oregon Department of Energy): List of steps to plan and implement a gasification project. www.oregon.gov/ENERGY/RENEW/Biomass/guide.shtml
- California Biomass Collaborative: Collaboration of government, industry, educational institutions supporting the growth of biomass energy administered by the University of California at Davis. <http://biomass.ucdavis.edu/>
- California Biomass Energy Alliance: Association of biomass fueled power plants in California. www.calbiomass.org/
- International Energy Agency (IEA) Bioenergy: IEA Bioenergy is an organization set up in 1978 by the IEA with the aim of improving cooperation and information exchange between countries that have national programs in bioenergy research, development and deployment. Go to their website for technical documents related to gasifiers. www.ieabioenergy.com/

IEA Bioenergy’s Task 33 has the goal of promoting biomass gasification. It is being conducted by experts from Austria, Canada, Denmark, European Commission, Finland, Germany, Italy, The Netherlands, New Zealand, Sweden, Switzerland, and the U.S. www.gastechnology.org/webroot/app/xn/xd.aspx?it=enweb&xd=iea/homepage.xml
- www.TarWeb.net: Information on tars and other contaminants in gasifier-produced syngas.
- Gasification Technologies Council: Organization of gasifier companies that focus mainly on fossil fuel gasification. Find information on gasification technology. www.gasification.org
- Intelligent Energy for Europe Programme Gasification Guide: "Guideline for Safe and Eco-friendly Biomass Gasification" project supported by the Intelligent Energy for Europe Programme. The document is not yet completed but check the website for updates. www.gasification-guide.eu/

Potential Biomass Gasifier Technical Resources

- Arizona Department of Commerce Energy Programs: www.azcommerce.com/Energy/
- Biomass Energy Resource Center: The Biomass Energy Resource Center is a non-profit organization that works on projects around the country to install systems that use biomass, focusing on woody biomass, to produce heat and/or electricity. They have partnered with schools, communities, colleges, businesses, utilities, and government agencies. Services include:
 - Providing information for potential projects;



- Carrying out or coordinating project-related pre-feasibility studies, feasibility studies, and other reports;
- Carrying out, coordinating, or consulting on the development of biomass energy projects;
- Managing the operations of biomass energy projects; and
- Conducting assessments of working biomass systems.

www.biomasscenter.org

Biomass Energy Resource Center

Montpelier, VT 05601

Phone: (802) 223-7770

E-mail: contacts@biomasscenter.org

- Hawaii Natural Energy Institute (University of Hawaii at Manoa): www.hnei.hawaii.edu/
- Nevada Biomass Working Group (Office of the Governor, Nevada State Office of Energy): <http://energy.state.nv.us/renewable/biomass.htm>
- Nevada Renewable Energy & Energy Conservation Task Force: www.nevadarenewables.org/?section=biomass
- Renewable Energy Center (University of Nevada at Reno): www.unr.edu/geothermal/UNRREC.htm
- Western Governors' Association Western Regional Biomass Energy Program: www.westgov.org/wga/initiatives/biomass/index.htm

10.10 CLEAN DIESEL TOOLS

Clean Diesel Calculators

- EPA Modeling and Inventories: Go to www.epa.gov/otag/models.htm for a list of EPA models to inventory emissions across a city, county, or state.
- The Quantifier (EPA): Calculate diesel emissions from your site and the reductions from using cleaner and alternative fuels, retrofits, and engine upgrades for both on-road and off-road engines using this EPA online tool. Emissions output units are in tons. <http://cfpub.epa.gov/quantifier/>
- Biodiesel Emissions Reduction Calculator (OTAQ): Estimate the percent emissions reductions from different blends of biodiesel with this OTAQ MS Excel calculator. Follow the “biodiesel reduction spreadsheet” link found at www.epa.gov/otag/retrofit/techlist-biodiesel.htm.
- National Biodiesel Board Emissions Calculator: Enter the amount of biodiesel used to calculate emissions reductions in terms of percentage and pounds of pollutant. [www.biodiesel.org/\(X\(1\)S\(ux4dpq55txmx5rjn25h1k55\)\)/tools/calculator/default.aspx?AspxAutoDetectCookieSupport=1](http://www.biodiesel.org/(X(1)S(ux4dpq55txmx5rjn25h1k55))/tools/calculator/default.aspx?AspxAutoDetectCookieSupport=1)



- Biodiesel Comprehensive Calculator (BioFleet): Estimate quantified emissions reductions from using biodiesel with the BioFleet calculator. BioFleet is a biodiesel market development program sponsored by the Canadian government. Note that input and output values are in metric units. http://biofleet.net/index.php?option=com_wrapper&Itemid=58
- Construction Mitigation Calculator (Sacramento Metropolitan Air Quality Management District): The purpose of this MS Excel tool is to calculate emissions from construction activities to see if the levels are below required thresholds. This tool can be used to estimate total PM and NO_x emissions for a cleanup project. www.airquality.org/ceqa/index.shtml#construction
- Idle Reduction Savings Calculator (Argonne National Laboratory): While this tool was developed with a focus on on-road vehicles, it can provide approximate values for emissions savings from idle reduction of off-road vehicles. Follow the link in the right side navigation bar. www.transportation.anl.gov/research/technology_analysis/idling.html

Clean Diesel Informational and Technical Assistance Resources

- Alternative Fuel Station Locator Website (EERE): Visit this website to find a biodiesel, natural gas, or ethanol fueling station. www.eere.energy.gov/afdc/infrastructure/locator.html
- Diesel Technology Forum: The Diesel Technology Forum is a non-profit educational organization that provides information on cleaner and alternative fuels and cleaner diesel technology. www.dieselforum.org
- Manufacturers of Emission Controls Association (MECA): Go to MECA's website for information on diesel emission reduction technologies and manufacturers of diesel retrofits. www.meca.org
- National Biodiesel Board: The National Biodiesel Board is the national trade association for the biodiesel industry. Visit their website for more information on biodiesel and locations of biodiesel distributors. www.biodiesel.org
- Off-road Diesel Retrofit Guidance Document (Western Regional Air Partnership [WRAP], November 2005): The WRAP is a voluntary organization of western states, tribes and federal agencies. It was formed in 1997 as the successor to the Grand Canyon Visibility Transport Commission to help the region comply with EPA's regional haze regulations. Use this document to help guide you through retrofitting a fleet. www.wrapair.org/forums/msf/offroad_diesel.html
- EPA National Clean Diesel Campaign (NCDC): The National Clean Diesel Campaign is an OTAQ program. NCDC is a public-private partnership that collaborates with businesses, government and community organizations, industry, and others to reduce diesel emissions and protect human health and the environment. www.epa.gov/cleandiesel
Go to www.epa.gov/cleandiesel/publications.htm for informational publications.
- EPA Office of Air and Radiation: Visit this website for more information on diesel PM. www.epa.gov/airtrends/pm.html
- West Coast Collaborative: The West Coast Collaborative is the NCDC regional collaborative that serves Alaska, Arizona, California, Canada, Hawaii, Idaho, Mexico, Oregon, and Washington.



CLEANUP – CLEAN AIR
DIESEL EMISSIONS & GREENHOUSE GAS REDUCTIONS

Contact the West Coast Collaborative for assistance in reducing diesel emissions.

www.westcoastcollaborative.org