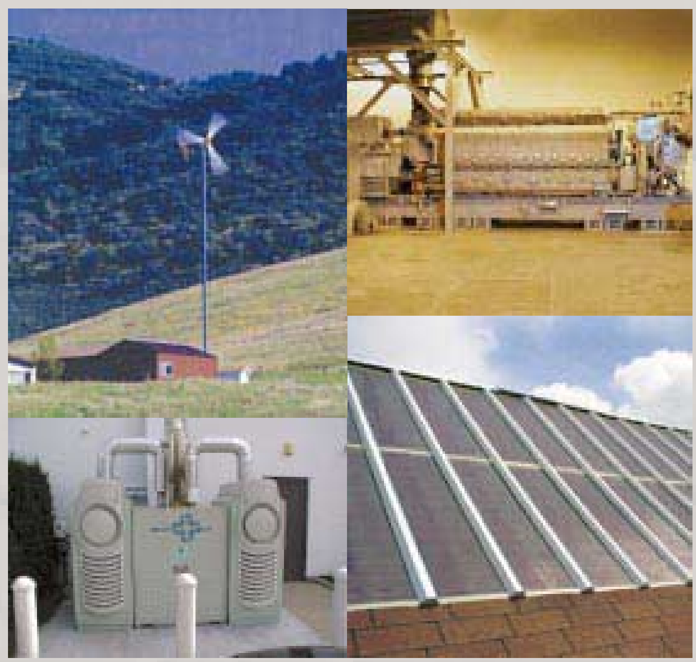
MICROPOWER AT THE CROSSROADS

Public Health and the Future of Distributed Generation



TexPIRG
Public Citizen
Environmental Defense

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EXECUTIVE SUMMARY

The debate over Texas's energy future has focused increased attention on micropower, the generation of electrical energy by homeowners and businesses near the place it is used as an alternative or supplement to the statewide power grid.

Micropower, also known as distributed generation (DG), is a growing sector of the energy market that holds great promise for locally controlled power generation.[1] Having facilities widely dispersed increases reliability, and some of these technologies are among the most environmentally friendly electricity generating technologies ever invented. But continued reliance on other types of micropower, technologies that are highly polluting, poses a threat to public health.

Currently, micropower is not subject to the same air pollution controls as central power plants, and the most prevalent form of micropower currently in operation is also the most polluting form – diesel engines. These generators are far more widely dispersed than most people realize. They have been installed outside many public buildings, hospitals, banks, hotels, and other commercial businesses.

As micropower has grown, policy makers have come to realize that limits on emissions from micropower facilities are needed to avoid the cumulative effects of many small but very dirty generators. And states increasingly recognize that they can increase energy generation flexibility and realize major environmental improvements by encouraging the cleanest forms of micropower.

In 2001, the Texas Commission on Environmental Quality (TCEQ)[2] set air pollution standards for new micropower units. Although the permitted pollution levels in the new rule were still higher than those for central station power plants, this was a major step forward for air quality in Texas. For the first time, diesel generators and other micropower facilities that come online in the state will have to meet emissions standards.

But this is only half the job. Polluting micropower units already in place throughout Texas when the rule took effect are not covered by the new rule. The TCEQ should set strict standards for existing micropower that fully protect human health and the environment.

Two-thirds of all Texans live in areas where air quality does not meet health-based standards. Due to this poor record of controlling air pollution, Texas is at risk of losing major sources of federal funding for highway construction. Increased use of existing small electric generators on hot summer days could threaten efforts to come into compliance with these standards. We need to reduce pollution wherever we can, and cleaning up dirty micropower provides a great opportunity to do this.

The TCEQ must set emissions standards at levels that limit diesel applications to emergency situations and only when generators are operated in conjunction with emission-control measures. At the same time, more needs to be done to promote clean micropower technologies.

Micropower is at a crossroads. New policies should promote clean technologies, not allow the increased use of dirty technologies. And standards need to establish uniform environmental treatment of the various micropower technologies and applications.

We have produced this report to point the way to a clear future direction. As we work to promote the highest possible level of efficiency in our use of energy, we must simultaneously support sustainable, reliable, versatile technologies that can bring efficient energy generation right to the source of use while reducing harmful air pollution.

Policy Recommendations

Principles

To ensure that public health is protected and new technologies that reduce pollution are encouraged, distributed generation policy should be based on the following principles:

- o Distributed generation must be as clean as or cleaner than the cleanest central power plant technology currently in widespread use.
- o State rules and incentives must promote the cleanest energy industry for the future of Texas.
- o Regulations should be as simple as possible so manufacturers can anticipate changes and comply with new technology requirements.

Primary Recommendations

State agencies can help move micropower in the right direction. To protect the health of Texans and the air quality of the state while helping to assure reliable local power generation, we recommend the following immediate policy actions:

- o Conduct a comprehensive inventory of existing micropower and other on-site generation.
- o Set stringent standards governing the use of all existing micropower units operated in Texas.
- o Ensure aggressive enforcement of standards and establish significant penalties for violation.

Additional Recommendations

In addition, many other specific policies could advance clean micropower while curbing the use of dirty micro-power. We recommend that Texas:

Establish standards and rules for micropower operation:

- Require that transmission grid operators draw on clean, efficient micropower before similarly priced dirty generation facilities.
- Ensure that diesel generators are only used for true emergency back-up power supply.
- Require ultra low-sulfur diesel for all diesel engines in East Texas.

Promote the cleanest forms of micropower:

- Provide incentives for developers to include clean micropower at new residential or commercial construction projects.
- Expand the availability of financial incentives, including financing assistance, buy down programs, and grants, for the installation of clean micropower.
- Require formal consideration of clean micropower as a potential least- cost alternative to transmission and distribution upgrades and a means of avoiding the cost of future environmental regulation.
- Provide incentives for the trade-in and upgrade of polluting micropower installations.
- Expand funding for clean micropower technology advancement.

Clear hurdles to the implementation of clean micropower:

- Develop incentive tariffs and reduced standby and exit fees for clean micropower installations.
- Standardize insurance requirements and develop policies to assure that small consumers can afford to interconnect to the grid.

What Is Micropower?

For more than a century the standard formula for generating and distributing electricity has been simple. Build a huge power plant and run power lines to population centers where industry and people need the electricity. Connect the individual home or business to the electrical grid and power up the plant.

Primarily using fossil fuels, these facilities have grown in scale and quantity as our demand for electrical power has increased. While these giant power plants have helped to provide a cheap, reliable electricity source for consumers, many have also been major polluters. Despite advances in technology, these large central power plants continue to dominate our energy system in size, environmental consequences, and convenience.

The dominance of this model has facilitated the proliferation of electrically powered devices to the point where most of us never think about how power is generated. We just plug our computer into the wall outlet and get to work.

In some cases it has been advantageous to develop localized power generating capacity. Geographically isolated facilities and some large factories have been using local power generation for years, frequently deploying many of the same technologies that cause environmental harm. But it was a rare occurrence when an individual would need or want independent local power generation for a home or small business.

Deregulation of the electric power production industry and the recent turmoil in energy markets has started to change all that. With growing concerns about the reliability of traditional power sources due to increases in power plant down time, more and more consumers have been questioning the conventional model of central power plants. They are looking for more reliable energy sources, searching for greater control over power costs, and seeking alternatives to traditional power sources that degrade the environment and undermine public health.

The combination of advancing technology, widespread concerns about the pollution from large central power plants, and reliability questions has made localized power generation an idea whose time has come. Instead of concentrating power sources at large plants, distributed generation systems locate power sources closer to the consumer – in an office building, a neighborhood, a factory, or a home.[3]

For many, small power generation units located near the point of use have been a safety and reliability measure to supply back-up power during blackouts. Others have suggested that in light of escalating energy costs during peak demand periods, micropower can be used as a cheaper alternative power source or a source of profit by selling the distributed power into the grid.

In grid-congested areas where transmission line upgrades would otherwise be needed, micropower has the potential to significantly reduce costs for power. Transmission and distribution costs can reach $1.50 for every $1.00 spent on electricity generation.[4] In addition, society can benefit through enhanced reliability and decreased need for infrastructure.

Table 1: The Economic Benefits of Decentralized Power (¢/kWh)[7]

Benefit	Savings
Substation deferral	0.16-0.6
Transmission system losses	0.2-0.3
Transmission wheeling	0.28-0.71
Distribution benefits	0.067-0.17
Enhanced reliability	1.0
Total	**1.7-2.8**

Estimates of the monetary value of these benefits range as high as 2.8 ¢/kWh. This is a substantial savings from current generating and distribution costs, which are now typically 4-9 ¢/kWh.

This is particularly valuable in Texas, where the aging power grid threatens to cause significant problems in delivering electricity around the state. Transmission constraints in the Dallas area are on the verge of disrupting power supplies. The Electric Reliability Council of Texas (ERCOT), operator of the Texas grid, found six major corridors with transmission constraints in a recent study.[5] In 2001, ERCOT paid $28.7 million to electric companies to take power off the grid to relieve congestion.[6] Until transmission and distribution constraints are addressed, the dirty micropower units now in place may be relied upon too heavily, threatening Texans' health.

Growing interest in local control of electrical power generation is both an opportunity for and a threat to Texas residents. Although cleaner technologies are now available, older, dirtier micropower technologies are still predominant. We cannot allow the growth of localized power generation to undermine air quality standards.

The affordability of meeting stricter emissions standards was documented in a 2002 study by Energy Nexus Group analyzing the economic feasibility of complying with proposed new standards for micropower in California. The study found that with the amount of technology advancement expected under normal market forces, nearly all of the cleanest technologies will meet the standards in 2003, most of the new technologies will meet the standards in 2007, and all but the dirtiest technologies will meet the standards in 2012. The study determined the cost of adding emissions control equipment to fossil fuel-based micropower to be only about 1 ¢/kWh.[8]

As public agencies consider regulations addressing micropower technologies, we have the opportunity to promote cost-effective renewable energy sources that are significantly less harmful to our health. But if the growing demand for micropower results in the increased use of polluting units already in place, we face the prospect of higher levels of localized emissions that place our respiratory health at significant risk.

What follows is an overview of the pollution and public health impacts of many of the technologies currently

Figure 1: Emissions from Micropower Technologies[9]

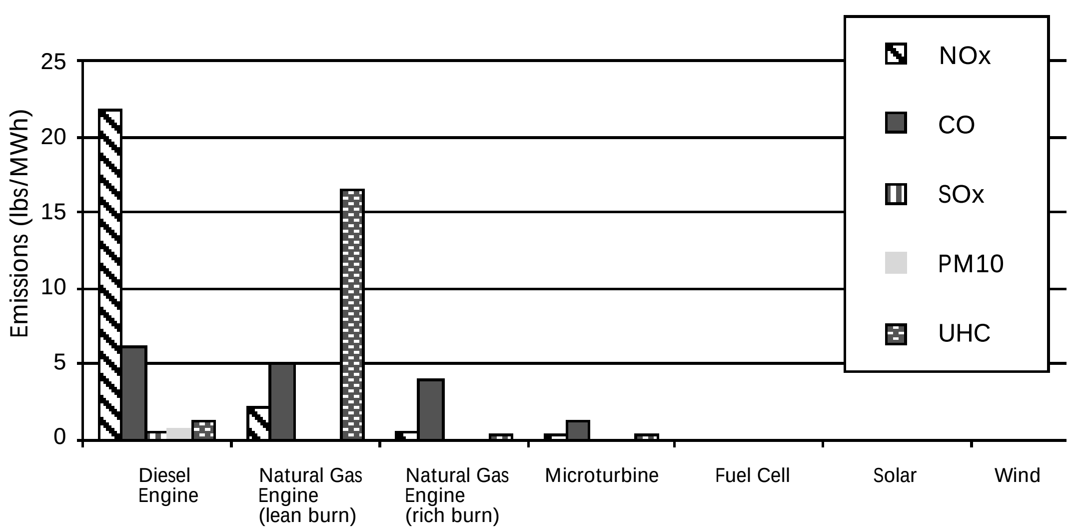
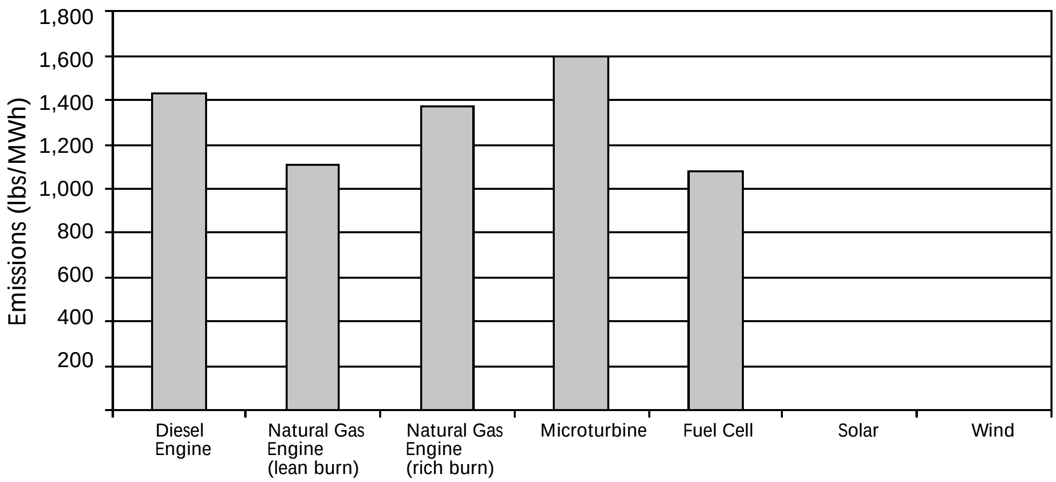


Figure 2: Carbon Dioxide Emissions from Micropower Technologies[10]



available to those interested in the deployment of distributed generation. We have grouped the various technologies into three categories based on their current environmental performance. Environmental regulations should be emissions-based, so that emerging technologies have equal opportunity to meet emissions standards in the future.

- **Clean Micropower** – The cleanest distributed generation technologies, primarily using renewable fuel sources. These include solar, wind, and fuel cells. These forms of power generation have minimal negative public health impacts. In addition, high-efficiency combined heat and power systems can significantly reduce negative impacts.
- **Dirty Micropower** – The dirtiest and best-known technologies, using fossil fuel sources. Diesel generation is the most prevalent technology, but there are also gasoline and natural gas engines that are excessively polluting. These forms of power generation undermine public health and cause disease.
- **New Micropower** – Emerging technologies have the potential to deliver cleaner power. Options such as alternative fuels and microturbines hold promise for the future. The health impacts of these forms of power generation vary.

On-site power generation in itself is no panacea for the problems plaguing the energy market. If the appeal of micropower leads to the increased use of the most available and least expensive technology, then some of the problems – including increased pollution, inefficient energy production, costs tied to non-renewable fuels, and growing public health problems – will be perpetuated.

The technology is available to avoid those pitfalls and to promote efficient and increasingly cost-effective micropower that can benefit the environment, the reliability of the electricity system, and public health. Some of the potential advantages of clean micropower include:

- Power doesn't have to travel long distances over the grid, reducing energy loss and the need to build new power lines.
- Wind and solar technologies are fueled by renewable energy sources.

- Generation at point of use allows for the utilization of waste heat for other energy needs.
- Local generation can enhance the reliability of the electricity system by reducing the burden on the grid.
- Fewer large, central-station power plants will be needed as micropower increases.
- The potential for large-scale blackouts is reduced.
- Local control of energy sources allows increased responsiveness to local concerns.
- Power sources can be built to appropriate scale for local consumption.

The vast majority of micropower units currently operating in Texas are diesel generators. Diesel generators release as much as 363 times more smog-forming pollutants than the most efficient natural gas power plant technologies.[11] These pollutants have been shown to increase the risk of serious health problems ranging from headaches and nausea to asthma complications and lung cancer.[12]

The opportunity to end this threat to public health is at hand if we use emission standards and policy incentives for distributed generation to push newer technologies to the forefront.

THE CLEANEST MICROPOWER TECHNOLOGIES

Solar and wind technologies have been proven effective for local power generation throughout the country. With free fuel, advanced technology, and incentives provided by the state, these technologies are becoming more cost effective and cost competitive.[13]

Recently the power industry has made substantial advances in fuel cell technologies and in using combined heat and power systems to increase energy efficiency. Public agencies, small and large businesses, and individual homeowners are taking advantage of these advancements to install localized and independent power generation capacity.

These clean technologies are not without their environmental impact, but they substantially reduce the environmental impacts of electricity generation.

Solar Photovoltaics

Solar PV is a valuable resource for Texas. The state's solar potential is excellent, and solar power generation peaks at the same time that energy demand peaks – in the heat of summer afternoons.

Photovoltaic technology converts sunlight directly into electricity without using any moving parts. The basic building block is the photovoltaic cell, which is made of semiconductor materials. Cells can be connected together to form modules, and modules can be connected to form arrays. A few PV cells will power a hand-held calculator, while interconnected arrays can provide electricity for a remote village or serve as a power plant for a city. PV is a truly unique technology with many advantages. According to the U.S. Department of Energy, "it is easy to foresee PV's 21st century preeminence."[14]

Although PV panels only generate electricity when the sun is shining, connection with the grid makes it possible to depend on PV, both from the consumer and the state planning perspectives. On hot days, when electricity consumption is at its peak, PV panels feed excess electricity into the grid. In the evening when the sun is down and electricity demand is lower, customers draw electricity from the grid. Recent improvements in "net metering" – in which the electricity meter runs backward when power is being fed into the grid – have made this much more practical for consumers.

Texas has significant programs to promote the use of solar power, most notably in Austin and San Antonio. Large arrays have been installed on the convention center in Austin, at power plants, and at schools throughout the state. The customer service center for San Antonio's utility recently coated its rooftop with PV cells.

The oil and gas industry is the largest user of PV. Solar cells are used on the control units at many oil and gas facilities, where reliability is at a premium.

Photo by Amanda Buehler

Advantages of Photovoltaic Technologies

- **Simplicity** – With no moving parts (or very few, for some applications), operation and maintenance costs are minimal.
- **Versatility** – PV can connect to the existing infrastructure of the utility grid and serve as an alternative power source during peak periods of power demand or it can operate remotely (off the utility power-line grid). Many PV systems are easily transported.
- **Reliability** – First developed for U.S. man-made satellites in the 1950s – where low maintenance was an absolute necessity – and now with over 40 years of technical advancements improving performance, PV has very high online availability.[15]
- **Scalability** – PV is modular and can be easily scaled according to the amount of power needed.

Solar Power at the UT-Houston Health Science Center

The University of Texas-Houston Health Science Center has made great strides in local power production. What started as a demonstration project has proven successful and become a power source the center will count on for decades.

In 1998, four large solar panels were installed on the roof of a garage at the center. The 21 kW system produces 39,000 kWh of electricity per year – enough electricity to power ten average Texas homes.[16] The solar panels provide electricity for the building, generating up to 20 percent of the power used by the six-floor garage.[17]

In 2001, the Health Science Center more than doubled its PV capacity. The center added another 24 kW of solar panels to the original array and a 7 kW mounted PV system on an awning. The new additions bring the total annual amount of power produced to 80,000 kWh.[18] In addition to producing power, the awning panels shade a row of south-facing windows, reducing the air conditioning load for one floor of the building.

Photo by UTHHSC

To date, these facilities have resulted in emissions reductions of 105 tons of CO_2, 506 pounds of NO_x, and 827 pounds of SO_2.[19]

The university is now finalizing plans to install a 15 kW array adjacent to the existing panels. Long-range plans also include a much larger array – an 80 kW system on the School of Nursing and Student Community Center, which is currently under construction and is scheduled to be completed in 2004.[20]

The installation of the original solar panels was funded with $45,000 from a Utility Photovoltaic Match-Up grant as part of the Clean Power Alliance. The State Energy Conservation Office also contributed $30,000 to the project.[21]

- **Peak Output** – PV power output peaks when demand peaks.
- **Quiet** – PV systems make no noise.
- **Sustainability** – PV shares the two advantages common to all renewable energy sources: it has a low environmental impact (it is nonpolluting) and the fuel is free.
- **Environmental** – Solar PV has zero operating emissions. Therefore, solar PV is exempt from all air quality permitting requirements.

Wind

Wind turbines are an excellent local power generation option for many Texas residents and businesses. A wind turbine consists of a rotor, an electrical generator, a speed control system, and a tower. When the wind blows and spins the propellers of the turbine, which are akin to airplane propeller blades, the kinetic energy of the wind is converted to mechanical power, which in turn drives the electrical generator and produces an electrical current.

Most people are familiar with these turbines when they are grouped together in a wind farm and operate like a conventional power plant, feeding electricity to the utility grid. But small turbines can be installed and operated individually to satisfy the electrical needs of a home or business, just as they were on farms for hundreds of years.

Individual turbines vary in size, ranging from about 30 feet high with propellers between 8 and 25 feet in length to 20 stories high with propellers over 300 feet in length.[22]

Single home-sized wind turbines in the 10-50 kW range are becoming more popular in many places. Since they don't need as much wind as the larger turbines, they can be effective in more areas. These

Wind Turbines at Laredo Community College

In 1992, four 10 kW Bergey wind turbines were installed along the Rio Grande at Laredo Community College as part of a state-sponsored renewable energy demonstration program.[26] The original purpose of the wind turbines was to power an electric pump to use Rio Grande water for irrigation at an experimental farm.

The pumping system was not successful due to heavy sediments and pollution in the water, but the wind turbines functioned well. In 1996, the College connected the four turbines to the electricity grid to reduce utility bills. The endeavor was successful and has resulted in annual savings of approximately $3,000.[27]

Photo by Bergey Windpower

installations are especially attractive to farmers and ranchers who may be distant from other sources of power generation.

Advantages of Wind Technologies

- **Simplicity** – Operation and maintenance costs are minimal. Modern wind turbines require maintenance checks only once every six months.[23]
- **Versatility** – Wind turbines can connect to the existing infrastructure of the utility grid or can operate remotely (off the utility power line grid).
- **Reliability** – Wind power is the fastest growing energy source worldwide and its proven reliability has much to do with its success.[24] Small wind systems are designed to operate for at least 30 years.[25]
- **Sustainability** – Wind-generated power shares the two advantages common to all renewable energy sources: it has a low environmental impact (it is nonpolluting) and the fuel is free.
- **Quiet** – Modern wind turbines are much quieter than combustion turbines.
- **Environmental** – Wind technologies have many of the same advantages as solar photovoltaic technologies. Like solar PV, wind has zero operating emissions. Wind turbines are therefore exempt from all air quality permitting requirements.

Fuel Cells

Where solar photovoltaics or wind turbines are not feasible, fuel cell technologies are a good local power generation option, especially when operated in combined heat and power applications. (See below for more about combined heat and power.) Although they now use fossil fuels to create hydrogen, fuel cells emit far less pollutants than diesel and most other fossil fuel generators. Emissions from current cells are primarily CO_2 and water. With further development they will be able to utilize renewable energy to produce their hydrogen fuel.

Through the chemical reaction of combining hydrogen and oxygen to make water, fuel cells convert chemical energy into electricity and heat without combustion. They operate similarly to batteries. Both batteries and fuel cells utilize an electrolyte separated by an anode and a cathode to generate a direct electrical current, and both can be combined into groups to increase power output.

Batteries store their fuel, then periodically run down and require recharging. Fuel cells, on the other hand, are fed a continuous supply of fuel. The varying types of fuel cells all rely on hydrogen as their fuel, but they can get it from a variety of sources.

Four different types of fuel cells – the Phosphoric Acid Fuel Cell (PAFC), the Molten Carbonate Fuel Cell (MCFC), the Proton Exchange Membrane (PEM), and the Solid Oxide Fuel Cell (SOFC) – have been or are operating in 16 countries, and several more types are being developed and tested.

Fuel cells are being developed for use in both vehicles and stationary applications. These applications include power for individual facilities such as hospitals, office buildings, and schools; primary power sources for remote villages and campgrounds; utility power plants; and power sources for temporary needs such as construction sites. As distributed electrical generation becomes more widespread, fuel cells could serve as primary power and thermal energy sources for virtually anything.

Most fuel cells are named for their electrolyte, and they each have different properties, capabilities, fuel requirements

FUEL CELL AT REBEKAH BAINES JOHNSON HEALTH CENTER

The first commercial fuel cell in Texas began operating in June 2002 at the RBJ (Rebekah Baines Johnson) Health Center in Austin. The unit is a UTC PC25C, one of 250 of its kind in the world.[30] The 200 kW fuel cell uses natural gas as its source of hydrogen. It meets all of the electricity needs of the health center – equivalent to the power needed for 140 homes.[31]

Additionally, excess heat from the fuel cell is used to satisfy the water heating needs of the health center. Thus far, it has generated more heat than the five-story, 50,000 square foot building uses in the summer. As a result, the facility's natural gas boilers have not been used since installation of the new system, eliminating the natural gas bill associated with water heating.[32]

Installation of the fuel cell cost $1.2 million. $200,000 of this came from a grant from the U.S. Department of Defense.[33]

Austin Energy, the city utility, plans to use the cell as a tool for public education. They will provide public tours of the unit and will be using it as a research laboratory to learn more about using the technology at other Austin facilities in the future.

Photo by Austin Energy

and emissions. For example, the PAFC that is commercially available today is offered in the 200 kW size, though it is technically able to operate in the range of 50 kW to 11 MW. The PAFCs in operation today use either natural gas or propane, but could also be fueled by methane, alcohols, landfill gas, or anaerobic digester gases.

California's South Coast Air Quality Management District conducted its own emissions test on the PAFC. The results prompted the district to grant an exemption to PAFCs using natural gas from all air quality permitting requirements in the Los Angeles basin.

In the future, renewable energy sources may be widely used to generate the hydrogen needed to power fuel cells. Sunline Transit has a new hydrogen generation facility powered by wind and solar energy.[28]

The Public Utility Commission of Texas is developing a fuel cell commercialization plan for the state. The draft plan concludes that 200 MW of new fuel cell capacity could be achieved each year from 2006-2010 with moderate incentives. The commission recommends that these incentives be funded by a fee on traditional generators scaled by their total emissions.[29]

Advantages of Fuel Cell Technologies

- **Low emissions** – Fuel cells emit fewer pollutants than any other fossil fuel-based micropower technology.
- **Quiet** – Fuel cells are quiet.
- **Versatility** – Fuel cells are modular in design; so they can be stacked to increase power output.
- **Simplicity** – With few moving parts, fuel cells are low-maintenance.
- **Flexibility** – Fuel cells can use different fuel sources since they only need hydrogen and oxygen.
- **Reliability** – Fuel cells are online a greater percentage of the time than large power plants.

Combined Heat and Power

Combined heat and power (CHP) is not a specific generating technology but rather an application of technologies to meet end-user needs for heating or cooling as well as mechanical and electrical power.

Recent technology developments – particularly in turbines and microturbines – have made small-scale CHP systems more cost-effective and reliable. When

CHP at Baylor

Baylor University's electrical and cooling systems were constructed piecemeal as the university steadily grew, as is the case at many universities. In 1997, faced with further expansion plans, university business managers decided to integrate and modernize the energy system throughout the 70-building campus. They hired Sempra Energy Solutions to evaluate the university's energy production and use.

One of Sempra's top recommendations was an expansion of the university's generators into a full CHP system. The existing cogeneration facility was upgraded with three new chillers, components to distribute chilled air and water to campus buildings, and a 70,000 lb/hr heat recovery steam generator.

In addition, the university took advantage of many opportunities to reduce electricity use by installing energy-efficient equipment and a centralized energy management system. The CHP system and efficiency upgrades combined are expected to reduce Baylor's utility bills by a third, saving $1.6 million every year. All of the upgrades will be paid for with cost savings.

For these efforts, Sempra Energy won the Energy Project of the Year Award from the Association of Energy Engineers in 2000 and the first Energy Star Combined Heat and Power Project Award from the U.S. EPA.

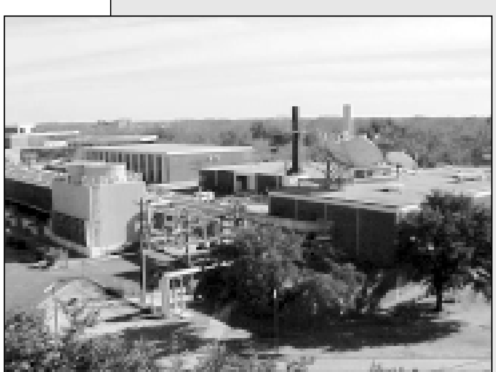


Photo by Baylor University

properly designed, fossil fuel-based generators can dramatically increase their efficiency through modification into CHP systems.

Gas turbines require heat to create the steam that turns the turbine. Some of this heat energy is converted to the motion energy of the turbine, and some of it escapes. In CHP systems, the heat that is normally released as waste heat is instead recovered and used to heat water, rooms, and buildings and/or drive motors for air conditioning or refrigeration. CHP systems can also use waste heat to provide steam to generate more electricity, like "cogeneration" at large power plants. Combined heat and power systems can be employed in many commercial and industrial facilities where there is a relatively constant thermal need. CHP can also be used with fuel cells, which create heat as part of the chemical reaction that generates electricity.

Recovering and reusing waste heat in this manner can make generators more than 80% efficient, more than double the 33% average efficiency of conventional electricity generating systems.[34] The increased efficiency saves the extra fuel that otherwise would be necessary to operate heating systems – often replacing old, inefficient and dirty boilers.

Texas is already the nation's leader in implementation of CHP with 9,829 MW installed – 10% of the state's power. However, there is still much untapped potential. The 110 best sites could install at least 20,000 MW of additional capacity.[35]

Increased fuel efficiency translates directly into reduced emissions of greenhouse gases and other pollutants. NO_x, which forms smog, and CO_2, the principal global warming pollutant, are significantly reduced. Combined heat and power systems also reduce SO_2 emissions, precursors to acid rain, and particulate matter, a cause of chronic lung disease.

Because it is still based on burning fossil fuels, CHP is not a sustainable energy resource on the level of wind and solar. But as long as fossil fuels are used to drive generators, CHP should be widely encouraged as a very good improvement over less efficient technologies.

Advantages of CHP Systems

- **Efficiency** – Increases efficiency of fuel use by capturing waste heat for heating, cooling and other on-site energy requirements.
- **Flexibility** – Can be designed to deliver multiple energy services.
- **Reliability** – Advanced technology and local control enhance service delivery.
- **Improved Environmental Performance** – Produces lower emissions than conventional separate systems.

Key Recommendations for Clean Micropower

Electricity generation has always had serious negative impacts on air quality. We now have the opportunity, however, to generate our power with minimal environmental consequences. State agencies must do all they can to encourage the widescale implementation of clean technologies, as they simultaneously encourage energy users to consume energy as efficiently as practical. The many energy consumers who are making a transition to micropower should be using the best available technology.

Recommended policy actions include the following:

- Provide incentives for developers to include clean micropower at new residential or commercial construction projects.
- Expand the availability of financial incentives, including buy-down programs, tax credits, and grants, for the installation of clean forms of micropower.

Photo by Amanda Buehler

- Require formal consideration of clean micropower as a potential least- cost alternative to transmission and distribution upgrades and a means of avoiding the cost of future environmental regulation.
- Improve buyback rules to pay micropower operators the retail rate for electricity they send to the grid. Evaluate annually the value to the distribution system of the power fed to the grid, paying a premium for the excess electricity produced during peak demand times.
- Develop incentive tariffs and reduced standby and exit fees for clean micropower installations.
- Expand funding for clean micro-power technology advancement.
- Require the automatic weekly startup for maintenance of micropower units to take place during times that typically have low ozone levels.

The Dirtiest Micropower Technologies

The internal combustion engine (ICE), the traditional technology used in vehicles, is also the predominant technology for portable and stationary generators. Also called reciprocating engines, ICEs can use a variety of fuels, including diesel, gasoline, natural gas, and propane. Diesel is the most common fuel for ICEs used as distributed generation.

Diesel Generators

Although there are now many competitive technologies available for micropower, diesel generators have historically dominated the micropower market. This form of micropower has also been the most cost effective for consumers, largely because the public health and environmental costs of burning diesel fuel are not accounted for in the cost of generation.

The diesel generator is also the most polluting form of micropower. Many people are familiar with the black plumes of smoke released by diesel trucks and buses. Diesel generators are no different. The harmful health effects of diesel exhaust have been studied and well documented for decades. Because many diesel generators are located in dense urban settings, this technology could significantly increase the public's exposure to cancer-causing pollutants.

Quantifying the Problem

Diesel generators are widely used throughout Texas, providing power for everything from businesses to agricultural equipment to homes. Diesel generators are found in the basements of office buildings or powering lights used during freeway construction.

The State of Texas has no inventory of the number of diesel generators in the state. Until recently, there were few reporting requirements for operators of diesel micropower to register their units.

The only documentation of distributed generation in Texas comes from applications some DG operators have filed for an exemption from regular permitting requirements. Companies installing small micropower units that meet a list of maximum size and emissions requirements may apply to the TCEQ for a standard permit exemption that allows them to operate independent of normal permits and reporting.[36] Exempted are high rise buildings and hospitals, which do not even have to apply for the waiver to be exempt. Because there is little enforcement of this requirement, the compliance rate of industrial facilities is not known.

An analysis of 58 standard permit exemptions in the Dallas/Fort Worth metropolitan area reveals an estimated 32 MW of micropower capacity. The 237 standard permit exemptions available for the Houston area cover an estimated 111 MW of capacity. Estimated annual emissions for these generators are shown in Table 3. Total emissions are likely to be much higher due to generators in place that have not applied for permit exemption.

Data from other states likely presents a better picture of the total number of

Table 2: Estimated Diesel Generators in Texas[38]

Diesel Generators by Type of Use	Number in Texas	NOx (tons/yr)	PM (tons/yr)
Emergency Stand-by Generators	6,984	1,698	85
Prime Generators	2,345	4,373	207
Portable Generators	23,806	10,801	697
TOTAL	33,134	16,872	989

Table 3. Inventoried Micropower Units in the Dallas and Houston Metropolitan Areas[37]

	Dallas	Houston
Number of Units	58	237
Capacity (kW)		
Number Reporting	29	138
Amount Reported	17,933	63,386
Estimated Total	32,056	111,599
NO_x Emissions (tons/yr)		
Number Reporting	46	150
Amount Reported	399	557
Estimated Total	477	884
CO Emissions (tons/yr)		
Number Reporting	45	147
Amount Reported	113	763
Estimated Total	137	1,201
PM Emissions (tons/yr)		
Number Reporting	13	85
Amount Reported	3	68
Estimated Total	11	167
SO_2 Emissions (tons/yr)		
Number Reporting	24	86
Amount Reported	23	39
Estimated Total	55	93
VOC Emissions (tons/yr)		
Number Reporting	20	125
Amount Reported	17	58
Estimated Total	52	106

diesel generators in Texas. The California Air Resources Board (CARB) has made the best attempt among state air quality agencies to quantify diesel generator ownership. CARB estimates that there are a total of 65,382 diesel generators in California. Assuming an equal number per capita in Texas, this equates to 33,134 diesel generators in the state, including portables. (See Table 2.)

Diesel generators are used in a variety of ways, with three general categories of use:[39]

Emergency standby generators – Often referred to as "back-up generators" or BUGs, these are generators that operate on a temporary basis as back-up power supplies in the event of power outages.

Prime generators – Generators used on a regular basis to supplement energy from the power grid.

Portable generators – Generators that are moved from location to location to provide power (motor vehicles and engines used to propel equipment directly are not considered portable generators).

The more hours a diesel engine operates, the more pollutants it releases into the air we breathe. For example, emergency back-up generators in normal operation are generally used only 25-50 hours a year while prime engines operate anywhere from 100 to several thousand hours per year. Hence, although there are far more emergency generators in Texas, prime engines could be a larger source of diesel pollution in the state due to their longer hours of operation.

Emissions

Diesel generators are a significant source of air pollution in the state of Texas and nationwide.[40] As diesel fuel burns, over forty identified toxic air contaminants are released into the air we breathe. The primary pollutant is nitrogen oxides, which can cause lung function deterioration and other serious human health effects. Additional pollutants include carbon monoxide, carbon dioxide, sulfur oxides, and volatile organic compounds.

Each year, the 33,000 diesel generators believed to exist in Texas emit an estimated 16,000 tons of nitrogen oxides and 900 tons of sulfur dioxide, assuming average operating and emission rates.[41] See Table 5 for a description of the health and environmental effects of these and other pollutants from diesel generators.

Emissions from diesel generators can have a large impact on ambient air quality at times of heavy use. This can be a major factor influencing attainment with air quality standards. Hot summer days, when air problems are at their worst, are the most likely time that micropower will be in operation to boost an electricity load that is heightened by the heavy use of air conditioning. In other words, diesel generators put out their highest levels of pollution exactly when air quality is the most sensitive to pollution increases.

Two diesel generators in close proximity to a children's playground in Richardson

Since there has not been any requirement for registering most diesel generators or any statewide inventory of diesel generators, it is not possible to measure this impact with precision. However, estimates can give us a good picture of how big a problem this is likely to be. Assuming the same number of diesel generators per capita in Texas as have been counted in California, and assuming that the average size of these generators is 330 kW,[42] 20% of these generators operating for three hours on a day of tight electricity supplies in Dallas/Fort Worth would emit four tons of NO_x. 20% of the generators in Houston would emit 3.6 tons of NO_x over three hours. (See Table 4.) This amount of

Table 4. Estimated NO_x Emissions from Diesel Generators During Peak Use[43]

Metropolitan Area	Estimated Number of Diesel Generators	Estimated Capacity of Diesel Generators (MW)	NOx Emission Rate (lbs/MWh)	NOx Emissions (tons/day)
Houston	1,686	556	21.8	3.6
Dallas/Fort Worth	1,842	608	21.8	4.0

pollution could keep these cities from complying with clean air standards.

Judging by utility industry estimates, the amount of micropower capacity used in Table 5 to calculate potential NO_x emissions on peak days appears to be a low estimate. The Electric Power Research Institute (EPRI), a non-profit energy research consortium founded and supported by electric utilities, estimates that installed capacity of backup generators in the U.S. is equal to 10% of total peak demand.[44] Peak generating capacity in Texas in 1999 was 76,272 MW, yielding an estimated total backup generator capacity of 7,600 MW for the state.[45]

Table 5: Description of Emissions

Name of Pollutant	Abbreviation	Source and Environmental Impacts	Health Impacts
Carbon Monoxide	CO	CO is produced by burning organic matter such as fossil fuels, wood and charcoal. Motor vehicles produce 67% of the man-made CO that is released into the atmosphere.	Fatigue, angina, reduced visual perception and dexterity, death in closed space.
Carbon Dioxide	CO_2	CO_2 is produced by burning organic matter such as fossil fuels, wood and charcoal. CO_2 is a greenhouse gas.	Major contributor to global warming, which has been linked to an increase in the spread of disease.
Nitrogen Oxides	NO_x	Oxides of nitrogen are the chemicals responsible for giving smog its brown appearance. NO_x contributes to the formation of ozone, production of particulate matter, and acid rain.	Irritates lung tissue, causes bronchitis and pneumonia, has been linked to a decrease in lung function growth.
Particulate Matter	PM	Particulate matter consists of soot and dust particles that are smaller than the diameter of a human hair. Electricity generation, transportation and industry generate roughly equivalent proportions of PM.	Penetrates deep into the lungs and is associated with numerous respiratory and cardiac problems and cancer.
Sulfur Oxides	SO_x	Oxides of sulfur are produced by the burning of fossil fuels. Large emitters of SO_x include motor vehicles, refineries and power plants. SO_x contributes significantly to acid rain.	Reduces respiratory volume, increases breathing and nasal airway resistance.
Volatile Organic Compounds	VOC/UHC	VOCs are a class of reactive organic gases that contribute to the formation of ozone and smog. Motor vehicles, refineries and power plants are the primary source of VOCs. Levels of VOCs are often determined by measuring unburned hydrocarbons (UHC).	Coughing, fatigue and nausea; contributes to the inflammation of lung tissue and reduced lung capacity.
Air Toxics		Air toxics like benzene, toluene, and formaldehyde are formed from fossil fuel processing and combustion. The U.S. EPA has identified 188 chemicals as hazardous air pollutants.	Cancer, reproductive disorders, developmental disorders.

Health Impacts

The extended use of diesel generators can result in serious human health impacts, especially since most non-agricultural diesel generators are located in densely populated urban areas. Where large numbers of people are, so too are these under-regulated, high-emitting engines that spew smog-forming chemicals, fine particles, and known cancer-causing agents.

This can create significant health risks for entire neighborhoods. People living within 10-20 average city blocks of a diesel generator operating only 100 hours per year experience elevated mortality risks.[46]

Cancer Risk

In recent years, an increasing number of health organizations, as well as the U.S. EPA and state environmental agencies, have recognized the cancer-causing effects of diesel exhaust exposure.[47] Air pollution control officials now estimate that based on a lifetime risk of seventy years exposure, diesel exhaust may be responsible for over 125,000 cancer cases each year nationwide, including 2,470 in Dallas/Fort Worth and 2,270 in Houston.[48]

The cancer risk from an emergency standby engine is equivalent to that of an idling school bus. The cancer risk from prime engines (including non-agricultural engines and agricultural engines) is more than that of a low-volume freeway or that of a facility that has constant diesel truck traffic. Both current diesel back-up generators and prime engines substantially surpass the acceptable risk level of one in a million cancer cases established by the U.S. EPA.

Diesel generator located at the Eagle Mountain International Church outside Fort Worth

The California Air Resources Board has estimated that a person's lifetime cancer risk increases by 50% if he or she lives near a single one-megawatt diesel

Figure 3: Potential Cancer Risk from Activities Using Diesel Fueled Engines

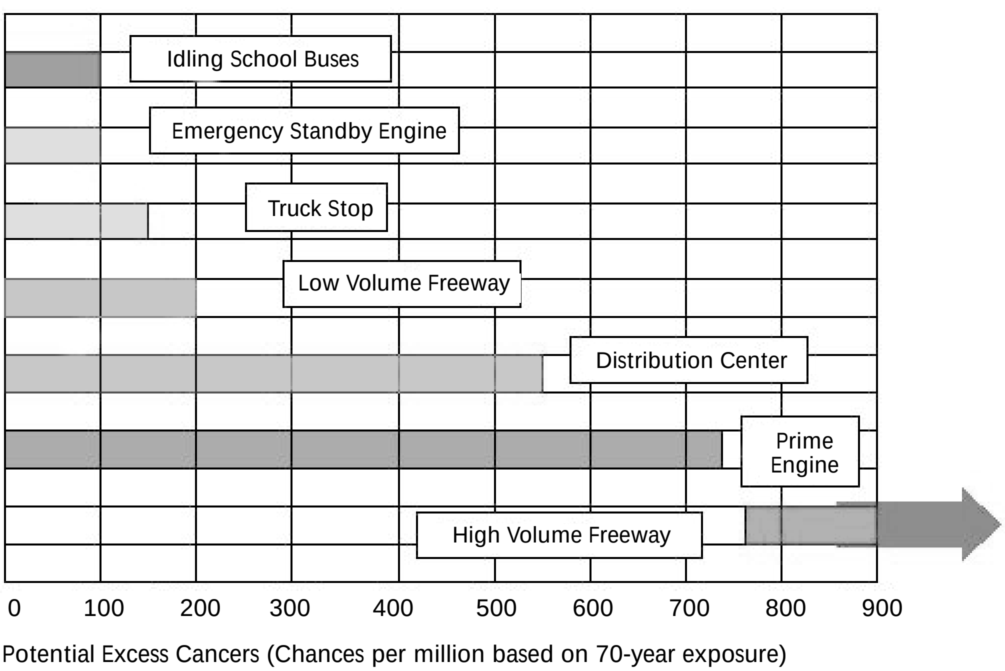


Table 6: Emissions of Diesel and Gas Micropower and Large New Power Plants (lbs/MWh)[55]

Generator Type	Efficiency	NO_x	CO	SO_2	PM10	UHC	CO_2
Diesel Engine	38%	21.8	6.2	0.5	0.8	1.2	1,432
Natural Gas Engine (lean burn)	36%	2.2	5.0	0.01	0.03	16.5	1,108
Natural Gas Engine (rich burn)	29%	0.5	4.0	0.01	0.03	0.4	1,376
Combined Cycle Natural Gas Power Plant	51%	0.06	0.1	0.004	0.04	0.05	776

generator that runs for as little as 250 hours annually.[49] Under Texas rules, diesel generators are allowed to run up to 200 hours per year without pollution controls. Another California study found the cancer risk in five cities to be 70-140 times higher than commonly accepted levels in the most affected neighborhoods.[50]

Non-Cancer Health Risks

Diesel exhaust is also known to cause numerous non-cancer respiratory problems. Diesel is a major source of particulate matter (PM), or soot, which can lodge deep in the lungs and result in the exacerbation of asthma, respiratory infections, increased susceptibility to allergens, chronic obstructive lung disease, pneumonia, and heart disease. A recent study found that even short-term exposure to PM may increase the chance of heart attacks in at-risk populations.[51]

Diesel generators located behind the St. Paul Medical Center in Dallas

A recent study conducted for the Houston Mayor's Office found that the lives of 435 people in the Houston area are cut short each year due to PM. Complying with clean air standards would save $3 billion per year, according to the study.[52]

Diesel exhaust also contains nitrogen oxides (NO_x). NO_x in the presence of sunlight and volatile organic compounds forms smog. Recently, the USC Keck School of Medicine found in a long-term study that both NO_x and PM can permanently reduce the lung function of a child living in Southern California by as much as 10%. Diesel exhaust was believed to be a significant contributor.[53]

Many other toxic substances are found in diesel exhaust. More than 40 components of diesel exhaust are listed as hazardous air pollutants by the U.S. EPA.[54]

Other Fossil Fuel Internal Combustion Engines

Natural Gas Engines

Internal combustion engines fueled by natural gas are cleaner than diesel generators, but still have high emissions of dangerous air pollutants. Natural gas generators have large reductions in NO_x and SO_x compared with diesel generators, medium reductions in PM and CO_2, and minimal reductions in CO and VOCs.

Natural gas engines are offered with two carburetor tuning settings – rich burn (stoichiometric) or lean burn (in which the air/fuel ratio is increased). However, the choice is a trade-off of lowering emissions of one pollutant while increasing those of another. The rich burn tuning will reduce NO_x and hydrocarbon emissions, but increase CO_2 emissions. All other emissions are similar between the two tunings.[56] Natural gas generators still contribute significantly to the same environmental and health impacts described in Table 5.

Engines Using Other Fossil Fuels

ICEs can also use gasoline and propane as fuel. Though not as common as diesel and natural gas generators, gasoline and propane generators are commercially available.

Emissions levels from gasoline-fueled ICEs fall between those of natural gas and diesel-fueled generators. Gasoline generators are the cheapest generators on the market, but have a reputation of high maintenance requirements as compared to generators using any of the other fossil fuels.

Propane generators emit very similar amounts of pollutants as the natural gas generators.[57]

Improving Engines for Emergency and Portable Use

Due to the severe public health and environmental hazards associated with ICE generators, their use should be limited to emergency back-up generation and portable operations, and then only when operated in conjunction with emission-control measures. The pollution-reducing measures that can reduce the harmful impact of diesel generators on nearby communities include fuel advancements, control technologies, improved efficiency, and stringent operations standards.

- Fuel Advancements — The U.S. EPA recently adopted regulations requiring petroleum producers to distribute low-sulfur diesel (15 ppm sulfur content) nationally by 2006 for vehicle use. This rule should also apply to diesel micropower. Texas should institute this requirement on its own. Because most advanced diesel pollution control devices are sulfur-sensitive, such steps to require low sulfur diesel are essential to achieve further emissions reductions for diesel engines.

Portable 60 kW diesel generator located behind the Honeywell facility in Richardson

- After-Treatment Technology / Emission Control – Particulate traps physically capture particulate matter in a filter and can reduce PM emissions by 83%.[58] Selective catalytic reduction (SCR) uses ammonia as a catalyst to break down NO_x. SCR systems have been shown to reduce NO_x by 65% to 99%.[59] Nitrogen oxide adsorbers have the potential to reduce NO_x by 90%. This technology involves both a chemical catalyst and burning the filter clean. Even with these improvements, however, diesel and other fossil fuel generators are still dirtier than the good micropower technologies discussed earlier.

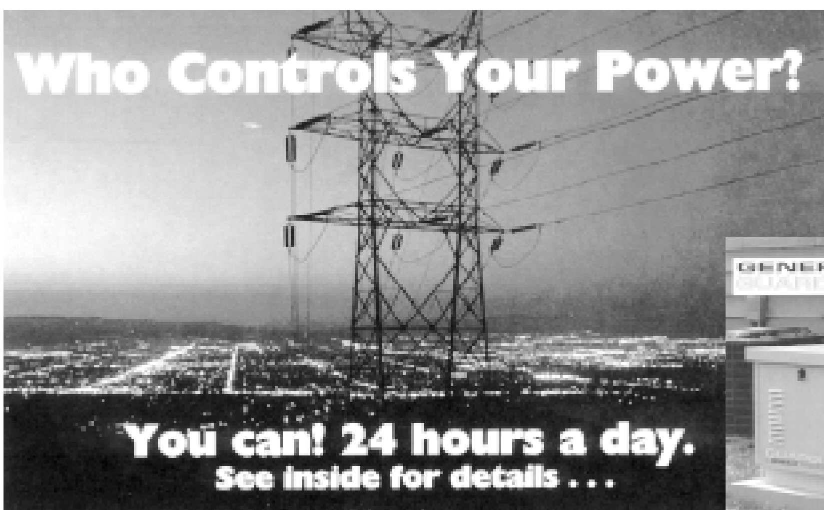
- Increased Efficiency – The efficiency of ICE generators can be improved by ensuring proper installation and sizing. Improper installation can account for a 25% loss in efficiency. Another way to improve efficiency is to capture and reuse the generator's heat in a combined heat and power application. The waste heat produced by the generator can be recovered to provide energy for further electricity production or space and water heating. This can reduce emissions by 35 to 50%.

- Hours of Use – Reducing the operating hours of ICE generators will also reduce the amount of pollution that is released into the air we breathe.

Key Recommendations for Dirty Micropower

The Texas state government has an obligation to protect the state's air quality. Since the move to local power generation is likely to result in an increased reliance on the most polluting forms of electricity generation, state agencies should take steps to discourage the use of dirty micropower. This would include the following measures:

- Require that transmission grid operators draw on clean, efficient micropower before similarly priced dirty installations.
- Ensure that diesel generators are only used for true emergency back-up power supply. Establish a clear and limited definition of "emergency use."
- Provide incentives for the trade-in and upgrade of polluting micropower installations.
- Require ultra low-sulfur diesel for all diesel engines in East Texas, on and off-road.



Manufacturers and distributors of diesel generators have used the "energy crisis" to encourage consumers to purchase polluting home power systems.

NEW MICROPOWER TECHNOLOGIES

New technologies for generating local power are emerging in the marketplace. Although they are not as clean as the renewable energy sources, most of these alternatives are distinct improvements over current diesel generators. By requiring the same emissions limitations regardless of technology, state officials will push manufacturers to improve these technologies to limit harmful emissions.

Some of these micropower options can be used in combined heat and power applications. They are not as simple to operate and maintain as sustainable options such as wind and solar, but they are often versatile and reliable. Most of the available technologies in this category utilize carbon-based fuels. While they pollute less than diesel engines, they still emit harmful gases.

Alternative Fuel Reciprocating Engines

The reciprocating engine, or internal combustion engine, is the traditional engine used in vehicles and diesel generators, as noted above in the "Dirtiest Micropower" section. This system draws air into a cylinder, compresses the air to heat it, then injects fuel, which ignites when mixed with the hot air. The resulting explosion moves the piston. It is an open system, meaning that it does not reuse the air it draws in; instead it releases it into the atmosphere as exhaust heat and gases.

Stationary reciprocating engines, like the diesel generator, are typically 5 MW or less, with the 1-3.5 MW range being the largest growing segment recently.[60]

When fueled by traditional fossil fuels, these engines are the most polluting of the micropower options. When operated with alternative fuels, however, their emissions can be reduced. See Appendix C for information on alternative fuels.

Turbines

A "gas turbine" differs from the reciprocating engine in that it uses a continuous combustion process rather than intermittent combustion. Like a reciprocating engine, the basic gas turbine is an open system, but it can be modified to reuse its exhaust heat. Exhaust treatment technologies can reduce NO_x emissions significantly, and some manufacturers are now incorporating similar technology into the combustion process itself.[61]

Gas turbines have traditionally been manufactured to generate several hundred megawatts for use as central power plants. Now some manufacturers are scaling down their units to less than 30 MW.[62] Most new turbines are fueled by natural gas. Some can also use other petroleum fuels or a dual-fuel configuration.

Microturbines

Introduced over the last few years, the microturbine is a relatively new technology with a rapidly growing market. Based on the same technology as a jet engine, although much reduced in size and improved with advanced components and software, microturbines can provide power in the 25 kW to 500 kW range. The initially available commercial units generate power ranging from 28 kW to 75 kW. These smaller units are about the size of a refrigerator.

The turbine shaft of a microturbine spins as fast as 100,000 rpm. The high-frequency power generated is then converted to 60Hz for common use. This simple design lends itself well to the low-maintenance needs of distributed generation.[63]

Microturbines have the potential to operate on a variety of fuels. Manufacturers, with some support from federal and state agencies, are working to improve microturbine performance, including generation efficiency. Models built to date have lower efficiency, and thus higher CO_2 emissions, than traditional engines.

In addition to their small physical size and flexibility regarding fuel sources, microturbines have only one moving part and, therefore, low maintenance costs. They are highly suitable for combined heat and power applications.

Microturbines' advanced fuel combustion technology results in low NO_x emissions, without any emission control technology, in comparison with gas-fired central station plants. Early tests indicate that this emissions performance will be maintained over extended operating periods. Capstone Turbine Corporation claims that current units emit NO_x at the rate of 0.50 lbs/MWh, and projects that performance improvements will decrease NO_x emissions to 0.14 lbs/MWh by 2005 and 0.05 lbs/MWh by 2008.

Stirling Engines

Stirling engines are powered by the expansion of a gas that results when the gas is heated and the compression of a gas that results when the gas is cooled. In this closed cycle system, a fixed amount of gas is externally heated, usually by combustion, and as it expands and contracts, it moves the pistons.

Theoretically these engines can use any heat source. Currently systems are being developed that use biomass, woodchips and solar heat. Stirling engines are physically smaller than conventional engines and relatively quieter. Engines ranging from 500 watts to 10 kW are either available now or under development.

Emissions associated with Stirling engines vary according to the heat source used. The Stirling engine itself has no emissions, so when it is developed to use solar heat as the heat source, the entire system will be emission-free. When fossil fuels are burned to provide the heat source, there are emissions. Since the combustion takes place externally, it can be monitored to burn fuels completely and limit the temperature, reducing emissions somewhat.

Potential Advantages of Emerging Technologies

Technical advancements, including improvements in fuel combustion and emissions reduction equipment, have the potential to significantly reduce the environmental impacts of these micropower technologies. Federal, state and manufacturer-funded research and development programs are pursuing such improvements. Clear emissions standards help provide clear signals regarding technology performance targets, and strong incentive policies can establish attractive market advantages for the cleanest micropower technologies.

Key Recommendations for New Micropower

These technologies already show the promise of being safer for public health than the dirtiest forms of micropower. But to make sure that they move toward the cleanest micropower technologies, we must ensure that pollution standards are applied across the board to all developing technologies, and complement the standards with policies that provide economic and other incentives to the cleanest micropower systems.

State agencies should take the following actions:

- Expand funding for clean micro-power technology advancement.
- Ensure adequate enforcement of emissions standards and establish significant penalties for violation.

POLICY RECOMMENDATIONS

Micropower is here to stay, and is likely to expand rapidly in the coming years. This is both an opportunity and a risk for public health in Texas. Clean micropower options have lower emission rates than traditional electricity generators, but to date the most common micropower technology – the diesel generator – is also the most polluting.

Principles

To ensure that public health is protected and that new technologies that reduce pollution are encouraged, distributed generation policy should be based on the following principles:

o Distributed generation must be as clean as or cleaner than the cleanest central power plant technology currently in widespread use. Regulations should target attainment of equivalent performance as soon as practical.

o State rules and incentives must promote the cleanest energy industry for the future of Texas.

o Regulations should be as simple as possible so manufacturers can anticipate changes and comply with new technology requirements.

Primary Recommendations

State agencies can help move micro-power in the right direction. To protect the health of Texans and the air quality of the state while helping to assure reliable local power generation, we recommend the following immediate policy actions:

o Conduct a comprehensive inventory of existing micropower and other on-site generation.

o Set stringent standards governing the use of all existing micropower units operated in Texas.

o Ensure aggressive enforcement of standards and establish significant penalties for violation.

Additional Recommendations

In addition, many other specific policies could ensure that the move to local power generation leads to air quality benefits rather than a digression to polluting technologies. We recommend that Texas:

Establish standards and rules for micropower operation:

- Improve buyback rules to pay micropower operators the retail rate for electricity they send to the grid. Evaluate annually the value to the distribution system of the power fed to the grid, paying a premium for the excess electricity produced during peak demand times.
- Require that transmission grid operators draw on clean, efficient distributed generation power before similarly priced dirty installations. Air pollution emissions should be considered in decisions regarding which generators are used in times of excess power capacity.
- Ensure that diesel generators are only used for true emergency back-up power supply, and require emissions control equipment for all such generators. Back-up generators will continue to be a major pollution problem if they are left out of the regulatory picture.
- Require ultra low-sulfur diesel for all diesel engines in East Texas, on and

off-road, by 2006. Because most advanced diesel pollution control devices are sulfur-sensitive, such steps are essential to achieve further emissions reductions for diesel engines.

Promote the cleanest forms of micropower:

- Provide incentives for developers to include clean micropower at new residential or commercial construction projects. Since builders don't pay the ongoing energy costs of the units they build, they are reluctant to include energy saving measures that will increase the initial sale price of their buildings.
- Continue and expand the availability of financial incentives, including financing assistance, buy down programs, and grants, for the installation of clean micropower. As long as consumers are expected to shoulder the burden of the investment costs of new technology, the government should provide financial assistance.
- Require formal consideration of clean micropower as a potential least- cost alternative to transmission and distribution upgrades and a means of avoiding the cost of future environmental regulation.
- Provide incentives for the trade-in and upgrade of polluting micropower installations. The Texas Emission Reduction Plan, passed during the last legislative session, provides incentives to add pollution control devices for off-road diesel vehicles. This program should be modified to include payments for generators and other semi-stationary sources.
- Expand funding for clean micropower technology advancement. State research and development programs can target the most promising clean micropower technology options. Public money for the development of these technologies would be a good investment for the long-term health of the state economy.

Clear hurdles to the implementation of clean micropower:

- Develop incentive tariffs and reduced standby and exit fees for clean micropower installations. This would address financial disincentives in utility relationships with micropower operators.
- Standardize insurance requirements and develop policies to assure that small consumers can afford to interconnect to the grid.

The adoption of these recommendations will promote a vital distributed generation system that reduces the negative public health impacts associated with diesel and other dirty micropower technologies.

APPENDIX A: INVENTORIED MICROPOWER IN DALLAS

Table 6. Fossil Fuel-Based Micropower Units in the Dallas/Fort Worth Metropolitan Area with Records Available at the TCEQ

			Emissions (tons/yr)					
Company	**City**	**Capacity (kW)**	**CO**	**NO_x**	**PM**	**SO_2**	**VOC**	**fuel**
Abbott Laboratories	Irving	477	5.6	7.3	na	na	0.1	D
Abbott Laboratories	Irving	619	2.1	8.0	na	na	0.4	D
Abbott Laboratories	Irving	354	2.1	5.2	na	na	0.0	D
Abbott Laboratories	Irving	477	5.6	7.3	na	na	0.1	D
Abbott Laboratories	Irving	619	2.1	8.0	na	na	0.4	D
City of Garland Water Utility Dept	Garland	na	na	na	na	na	na	na
City of Garland Water Utility Dept	Garland	na	na	na	na	na	na	na
City of Garland Water Utility Dept	Garland	na	na	na	na	na	na	na
DSC Corp	Plano	na	6.4	7.3	0.3	0.1	0.2	D
DSC Corp	Plano	na	6.4	7.3	0.3	0.1	0.2	D
DSC Corp	Plano	na	na	na	na	na	na	na
DSC Corp	Plano	na	na	na	na	na	na	na
Eagle Mountain Int'l Church	Neward	784	7.8	8.7	na	na	na	G
Eagle Mountain Int'l Church	Neward	784	7.8	8.7	na	na	na	G
Eagle Mountain Int'l Church	Neward	784	7.8	8.7	na	na	na	G
Eagle Mountain Int'l Church	Neward	784	7.8	8.7	na	na	na	G
GE Accessory Serv-Grand Prairie	Grand Prairie	321	2.6	7.2	na	1.1	0.1	D
GE Accessory Serv-Grand Prairie	Grand Prairie	321	2.6	7.2	na	1.1	0.1	na
Halliburton Energy Services	Fort Worth	485	7.2	32.4	na	10.9	1.0	G
Interactive Manufacturing	Garland	na	0.02	0.1	0.01	0.01	0.01	D
Interactive Manufacturing	Garland	na	0.03	0.1	0.01	0.01	0.01	D
Interactive Manufacturing	Garland	na	0.02	0.1	0.01	0.01	0.01	D
JPS Health Network		261	na	0.9	na	na	na	D
JPS Health Network		560	0.1	1.9	na	0.4	na	D
JPS Health Network		746	1.2	4.2	0.4	0.4	na	D
JPS Health Network		597	1.0	4.6	0.3	0.3	na	D
JPS Health Network		597	1.0	4.6	0.3	0.3	na	D
JPS Health Network		634	1.1	4.9	0.4	0.3	na	D
JPS Health Network		634	1.1	4.9	0.4	0.3	na	D
JPS Health Network		933	1.5	26.7	na	na	na	D
JPS Health Network		933	1.5	26.7	na	na	na	D

Company	City	Capacity (kW)	CO	Emissions (tons/yr) NOx	PM	SO_2	VOC	fuel
JPS Health Network		933	1.5	26.7	na	na	na	D
JPS Health Network		933	1.5	26.7	na	na	na	D
LH Lacy Company	Arlington	414	1.0	11.0	na	na	na	D
LH Lacy Company	Coppell	na	0.3	5.3	na	0.5	0.3	D
LH Lacy Company	Coppell	na	0.3	5.3	na	0.5	0.3	D
LH Lacy Company	Frisco	na	1.6	14.8	na	1.7	2.0	D
Lockheed Martin Tactical Aircraft	Fort Worth	na	0.9	0.5	na	na	na	na
Lone Star Acquisitions	Flower Mound	na	0.1	0.4	0.03	0.03	na	D
Lone Star Acquisitions	Flower Mound	na	0.1	0.4	0.03	0.03	na	D
Lone Star Pipeline Co	Ennis	na	na	na	na	na	na	G
Mattel Toys	Fort Worth	30	na	na	na	na	na	na
Mitchell Energy	Rhome	na	4.0	17.0	na	na	9.0	G
Mitchell Gas Services	Justin	na	na	na	na	na	na	na
MRS The Ink Co	Dallas	na	3.6	16.5	na	1.1	1.6	D
MRS The Ink Co	Dallas	na	3.6	16.5	na	1.1	1.6	D
Ratheon TI Systems	Richardson	na	2.6	9.8	na	1.0	na	D
Ratheon TI Systems	Richardson	na	2.6	9.8	na	1.0	na	D
Rosani Foods	Dallas	515	0.2	0.2	na	na	na	G
Solar Turbines	Desoto	na	na	na	na	na	na	D
Solar Turbines	Desoto	na	na	na	na	na	na	na
SPM Flow Control	Fort Worth	na	1.7	3.9	na	na	na	D
SPM Flow Control	Fort Worth	na	1.7	8.0	na	na	na	D
SPM Flow Control	Fort Worth	na	1.7	3.9	na	na	na	D
SPM Flow Control	Fort Worth	na	1.7	8.0	na	na	na	D
Stone Bennet Corp	Carrollton	597	na	na	na	na	na	D
Trinity Forge	Mansfield	234	na	na	na	na	na	na
TU Electric	Dallas	1,576	0.7	2.2	0.3	0.4	0.1	D
TOTAL		**17,933**	**113**	**399**	**3**	**23**	**17**	

na: Data not available **D:** Diesel **G:** Natural gas **e:** Estimated, based on stated emission rate.[64]

Methodology for Diesel Inventory

The data in Appendices A and B and Table 3 was compiled from various sources of information maintained by the Texas Commission on Environmental Quality (TCEQ). At present, it is the most thorough examination of micropower units in the Dallas/Fort Worth and Houston areas.

The list of micropower units was derived from three sources:

- A query of the TCEQ's Information Resources Division of facilities that applied for exemptions from permitting regulations. Until 1996, emergency generators fell under Standard Exemption 5 and non-emergency units under Standard Exemption 6. The rules were updated in 1996 and are now termed Permit by Rule 106.511 and 106.512.
- A second query of specific SCC codes pertaining to emergency, standby, peaking, and diesel generators.
- A search of the TCEQ remote document server for diesel, emergency, and peaking generators.

Once the lists of companies and corresponding permit numbers were combined, the fuel type and emission levels were found by reviewing permits at the TCEQ and on the remote document server.

Appendix B: Inventoried Micropower in Houston

Table 7. Fossil Fuel-Based Micropower Units in the Houston Metropolitan Area with Records Available at the TCEQ

Company	City	Capacity (kW)	Emissions (tons/yr) CO	NO_x	PM	SO_2	VOC	fuel
3 Tec Energy	Huffman	na	9.0	6.0	na	na	1.0	na
Acacia Natural Gas	Brookshire	na	61.0	na	na	na	na	na
Acacia Natural Gas	Magnolia	596	na	na	na	na	na	na
Acacia Natural Gas	Magnolia	895	na	na	na	na	na	na
Acacia Natural Gas	Magnolia	895	na	na	na	na	na	na
Acacia Natural Gas	Magnolia	91	na	na	na	na	na	na
Acacia Natural Gas	Magnolia	545	na	na	na	na	na	na
Acacia Natural Gas	Magnolia	546	na	na	na	na	na	na
Acacia Natural Gas	Magnolia	546	na	na	na	na	na	na
Acacia Natural Gas	Magnolia	582	na	na	na	na	na	na
Amercian Nat'l Power	Houston	na	0.9e	3.3e	0.1	0.1	0.2e	D
Amercian Nat'l Power	Houston	na	0.9e	3.3e	0.1	0.1	0.2e	D
American Exploration Co	Labelle	198	na	na	na	na	na	na
Amoco Gas Co	Texas City	na	na	na	na	na	na	G
Anadarko Petroleum	Beaumont	na	na	na	na	na	na	na
Apache Corp	High Island	na	na	na	na	na	na	na
Apache Corp	Houston	596	na	na	na	na	na	na
Aubrey S. Labuff & Assoc Constr	Houston	na	na	na	na	na	na	na
Ausimont USA	Orange	na	0.7e	3.0e	0.1	0.1	0.6e	D
Ausimont USA	Orange	na	0.7e	3.0e	0.1	0.1	0.6e	D
Bledsoe Petro Corp	Dallas	298	na	na	na	na	na	na
Cherry Crushed Concrete	Houston	na	0.1e	8.0	0.2	1.3	1.0	D
Chocolate Bayou Water Co	Alvin	na	28.0	8.0	na	na	na	na
Chocolate Bayou Water Co	Alvin	na	28.0	8.0	na	na	na	na
Chocolate Bayou Water Co	Alvin	na	28.0	8.0	na	na	na	na
Coastal Markets	Missouri City	na	na	na	na	na	na	na
Compressor Systems	Votaw	246	na	na	na	na	na	na
Cross Timbers Operating	Friendswood	na	na	na	na	na	na	na
Dow Chemical	Freeport	na	0.3e	1.2e	0.03	0.03	0.2e	D
Dow Chemical	Freeport	na	0.3e	1.2e	0.03	0.03	0.2e	D
Duke Energy Field Services	Beaumont	na	0.5e	0.3e	na	na	0.3e	D
Duke Energy Field Services	Beaumont	na	0.5e	0.3e	na	na	0.3e	G
Duke Energy Field Services	Nederland	na	28.0	2.0	na	0.03	1.0	G
Duke Energy Field Services	Nederland	na	28.0	2.0	na	0.03	1.0	G
Duke Energy Field Services	Nederland	na	28.0	2.0	na	0.03	1.0	na
Duke Energy Field Services	Nederland	na	28.0	2.0	na	0.03	1.0	na
Dynegy Mid Stream Services	Mont Belvieu	160	0.1e	0.3e	0.01	0.01	0.1e	D
Dynegy Mid Stream Services	Mont Belvieu	160	0.1e	0.3e	0.01	0.01	0.1e	D
Eastex Gas Storage & Exchange	Spring	91	na	na	na	na	na	na
EI Du Pont de Nemours	La Porte	112	2.0	1.0	0.2	0.00	0.4e	D
Engineered Asphalt Products	Houston	na	na	na	na	na	na	na
Enron Oil & Gas	Houston	763	11.8	8.0	na	na	na	na
Enterprise Products Operating	Mont Belvieu	na	na	na	na	na	na	na

Company	City	Capacity (kW)	Emissions (tons/yr) CO	NO_x	PM	SO_2	VOC	fuel
Equilon Pipeline Co	Mont Belvieu	na	na	na	na	na	na	na
Exxon Chemical Co	Baytown	na	0.6e	1.0	0.1	0.1	0.5e	D
Exxon Chemical Co	Baytown	na	0.6e	1.0	0.1	0.1	0.5e	D
Exxon Chemical Co	Baytown	na	0.8e	1.0	0.03	0.1	0.2e	D
Exxon Chemical Co	Baytown	na	0.8e	1.0	0.03	0.1	0.2e	D
Exxon Chemical Co	Baytown	na	0.4e	2.0e	0.1	0.1	0.3e	D
Exxon Chemical Co	Baytown	na	0.4e	2.0e	0.1	0.1	0.3e	D
Exxon Chemical Co	Baytown	na	0.4e	1.7e	0.2	0.2	0.3e	D
Exxon Chemical Co	Baytown	na	0.4e	1.7e	0.2	0.2	0.3e	D
Exxon Co	Katy	2,461	2.0	na	na	na	na	na
Exxon Mobil	Pasadena	na	7.0	na	na	na	na	na
Exxon Mobil	Pasadena	809	na	na	na	na	na	na
Exxon Mobil	Pasadena	809	na	na	na	na	na	na
Friede-Goldman Offshore	Orange	na	na	na	na	na	na	na
Friede-Goldman Offshore	Orange	na	na	na	na	na	na	na
Friede-Goldman Offshore	Sabine Pass	na	na	na	na	na	na	na
GB Biosciences	Houston	na	0.2e	0.9e	0.02	0.02	0.2e	D
GB Biosciences	Houston	na	0.2e	0.9e	0.02	0.02	0.2e	D
GB Biosciences	Houston	na	0.4e	1.8e	0.02	0.02	0.3e	D
GB Biosciences	Houston	na	0.4e	1.8e	0.02	0.02	0.3e	D
GB Biosciences	Houston	470	0.7e	3.5e	0.2	0.2	0.5e	D
GB Biosciences	Houston	470	0.7e	3.5e	0.2	0.2	0.5e	D
GB Biosciences	Houston	470	0.2e	0.8e	0.01	0.1	0.5e	D
GB Biosciences	Houston	470	0.2e	0.8e	0.01	0.1	0.5e	D
General Electric Packaged Pwr	Houston	557	6.0	1.0	1.7	1.6	0.1e	D
General Electric Packaged Pwr	Houston	557	6.0	1.0	1.7	1.6	0.1e	D
General Electric Packaged Pwr	Houston	1,507	24.0	3.0	4.5	2.7	0.3e	D
General Electric Packaged Pwr	Houston	1,507	24.0	3.0	4.5	2.7	0.3e	D
Goldking Production Co	Baytown	45	na	na	na	na	na	na
Goldking Production Co	Baytown	47	na	na	na	na	na	na
Goldking Production Co	Baytown	334	12.0	8.0	na	na	4.0	na
Hampshire Chemical	Deer Park	na	na	na	na	na	na	D
Hanover Company	Pearland	na	na	na	na	na	na	na
Hardy Oil & Gas USA	Beaumont	na	na	na	na	na	na	na
Hilcorp Energy	Beaumont	na	na	na	na	na	na	na
Hilcorp Energy	Beaumont	492	25.0	12.0	na	na	6.0	na
Hilcorp Energy	Houston	298	11.0	10.0	na	na	10.0	na
Hilcorp Energy	Sweeney	na	19.0	2.0	0.1	na	5.0	na
Hilcorp Energy	Sweeney	944	19.0	2.0	na	na	na	na
Hilcorp Energy	Sweeney	298	11.0	10.0	na	na	na	na
Hilcorp Energy	Sweeney	298	11.0	1.0	na	na	3.0	na
Hilcorp Energy	Sweeney	298	19.0	2.0	na	na	na	na
Hilcorp Energy	Sweeney	944	19.0	2.0	na	na	na	na
Hilcorp Energy	Sweeny	944	0.3e	0.4e	na	na	0.1e	G
Hilcorp Energy	Sweeny	944	0.3e	0.4e	na	na	0.1e	G
Hilcorp Energy	Sweeny	944	0.3e	0.4e	na	na	0.1e	G
Hilcorp Energy	Sweeny	944	0.3e	0.4e	na	na	0.1e	G
Hilcorp Energy	Sweeny	944	0.3e	0.4e	na	na	0.1e	G
Hilcorp Energy	Sweeny	944	0.3e	0.4e	na	na	0.1e	G
Hilcorp Energy	Sweeny	52	0.3e	1.0	na	na	0.1e	G
Hilcorp Energy	Sweeny	52	0.3e	1.0	na	na	0.1e	G

Company	City	Capacity (kW)	CO	Emissions (tons/yr) NO$_x$	PM	SO_2	VOC	fuel
Hilcorp Energy	Sweeny	522	0.3e	3.0	na	na	0.1e	G
Hilcorp Energy	Sweeny	522	0.3e	3.0	na	na	0.1e	G
Hilcorp Energy	Sweeny	74	0.5e	7.0	na	na	0.2e	na
Hilcorp Energy	Sweeny	74	0.5e	7.0	na	na	0.2e	na
Hilcorp Energy	Sweeny	74	0.5e	7.0	na	na	0.2e	na
Hilcorp Energy	Sweeny	74	0.5e	7.0	na	na	0.2e	na
Hilcorp Energy	Sweeny	74	0.5e	7.0	na	na	0.2e	na
Hilcorp Energy	Sweeny	74	0.5e	7.0	na	na	0.2e	na
Hilcorp Energy	Sweeny	74	0.5e	7.0	na	na	0.2e	na
Hilcorp Energy	Sweeny	74	0.5e	7.0	na	na	0.2e	na
Hilcorp Energy	Sweeny	91	0.5e	7.0	na	na	0.2e	na
Hilcorp Energy	Sweeny	91	0.5e	7.0	na	na	0.2e	na
Hilcorp Energy	Sweeny	522	0.5e	8.0	na	na	0.2e	na
Hilcorp Energy	Sweeny	596	0.5e	8.0	na	na	0.2e	na
Hilcorp Energy	Sweeny	522	0.5e	8.0	na	na	0.2e	na
Hilcorp Energy	Sweeny	596	0.5e	8.0	na	na	0.2e	na
Houston Pipe Line Hydrocarbons	Silsbee	na	na	na	na	na	na	na
Houston Pipe Line Hydrocarbons	Silsbee	na	na	na	na	na	na	na
Hunt Oil Co	Sour Lake	na	na	na	na	na	na	na
Huntsman Chemical	Pasadena	na	0.01e	0.03e	0.01	na	na	D
Hydrocarbon Training & Dev	Houston	30	6.0	3.0	na	na	na	G
ISK Biosciences	Houston	na	0.4e	1.8e	0.02	0.02	0.3e	D
ISK Biosciences	Houston	na	0.3e	1.2e	0.01	0.01	0.2e	D
ISK Biosciences	Houston	na	0.4e	1.8e	0.02	0.02	0.3e	D
KCS Resources	Cypress	na	14.0	9.0	17.4	na	na	na
Lone Star Pipeline Co	Katy	na	na	na	na	na	na	na
Mariner Energy	Beaumont	74	17.0	10.0	na	na	2.0	na
Mariner Energy	Beaumont	74	17.0	10.0	na	na	2.0	na
Market Hub Partners	Liberty	na	0.4e	1.8e	0.1	0.1	0.3e	D
Market Hub Partners	Liberty	na	0.4e	1.8e	0.1	0.1	0.3e	D
M-I Drilling Fluids	Galveston	172	na	na	na	na	na	na
M-I Drilling Fluids	Galveston	172	na	na	na	na	na	na
M-I Drilling Fluids	Galveston	172	na	na	na	na	na	na
M-I Drilling Fluids	Galveston	172	na	na	na	na	na	na
Mitchell Energy	Galveston	198	na	2.0	na	na	na	na
Moss Bluff Gas Storage Systems	Liberty	110	na	na	na	na	na	na
Motiva Enterprises	Port Arthur	na	na	na	na	na	na	na
National Oil Well	Galena Park	na	3.4	15.7	na	1.0	5.9	na
National Oil Well	Houston	na	0.2e	0.8e	1.8	0.1	0.1e	D
National Oil Well	Houston	na	0.2e	0.8e	1.8	0.1	0.1e	D
New Park Shipbuilding & Repair	Houston	na	8.0	10.0	na	0.01	3.0	na
Nicolas K. Barco Co	Port Arthur	492	2.0	1.0	0.3	2.1	0.3e	D
Nicolas K. Barco Co	Port Arthur	492	2.0	1.0	0.3	2.1	0.3e	D
North Central Oil	Manvel	74	na	na	na	na	na	na
Oasis Pipeline Co	Katy	466	na	na	na	na	na	na
Oasis Pipeline Co	Katy	310	na	na	na	na	na	na
Oasis Pipeline Co	Katy	310	na	na	na	na	na	na
Occidental Chemical	La Porte	na	1.2	1.0e	0.03	0.1	0.1e	D
Ocean Energy	Clear Lake	168	2.0	24.0	na	na	na	na
Ocean Energy	Seabrook	na	4.1	4.0	na	na	1.0	na
On Fiber Houston	Houston	205	na	na	na	na	na	D

Company	City	Capacity (kW)	CO	Emissions (tons/yr) NO_x	PM	SO_2	VOC	fuel
Oryx Energy	Stowell	492	na	na	na	na	na	na
Oryx Energy	Stowell	596	na	na	na	na	na	na
Pennzoil Petroleum	Hankamer	654	na	na	na	na	na	na
Petro Hunt Corp	Winnie	na	na	na	na	na	na	na
Petrolite Corp	Pasadena	na	na	na	0.01	0.01	na	na
PG&E Gas Transmission	Katy	na	na	na	na	na	na	na
PG&E Gas Transmission	Katy	na	na	na	na	na	na	na
Phillips Petroleum	Wallis	307	11.0	7.0	na	na	3.0	na
Phillips Pipe Line	Pasadena	na	na	na	na	na	na	D
Phillips Pipe Line	Pasadena	na	na	na	na	na	na	D
Pioneer South Central	Brookshire	400	na	7.0	0.1	1.3	na	D
Pioneer South Central	Brookshire	400	4.0	7.0	0.1	1.3	na	D
Pioneer South Central	Brookshire	400	na	7.0	0.1	1.3	na	D
Quantum Chemical	La Porte	186	0.3e	3.0	0.2	0.2	0.1e	D
Quintana Petroleum	Rosenberg	na	na	na	na	na	na	na
Reliant Energy Field Services	Houston	242	9.0	na	na	na	na	G
Rohm & Haas Texas	Deer Park	na	0.8e	3.7e	0.1	0.1	0.7e	D
Rohm & Haas Texas	Deer Park	na	0.8e	3.7e	0.1	0.1	0.7e	D
Rollings Environmental Services		932	0.1e	0.4e	0.1	0.1	0.02e	D
Rollings Environmental Services		932	0.1e	0.4e	0.1	0.1	0.02e	D
Rollings Environmental Services		932	0.1e	0.4e	0.1	0.1	0.02e	D
Rollings Environmental Services		932	na	0.4e	0.1	0.1	0.02e	D
S&S Energy Products	Channelview	na	na	1.0	0.02	0.01	na	G
Sabine Pipe Line Co	Port Neches	na	na	na	na	na	na	na
Safety Kleen Deer Park	Deer Park	932	0.1e	0.4e	0.1	0.1	0.02e	D
Safety Kleen Deer Park	Deer Park	932	0.1e	0.4e	0.1	0.1	0.02e	D
Safety Kleen Deer Park	Deer Park	932	0.1e	0.4e	0.1	0.1	0.02e	D
Safety Kleen Deer Park	Deer Park	932	0.1e	0.4e	0.1	0.1	0.02e	D
Safety Kleen Deer Park	Deer Park	932	0.1e	0.4e	0.1	0.1	0.02e	D
Safety Kleen Deer Park	Deer Park	932	0.1e	0.4e	0.1	0.1	0.02e	D
Safety Kleen Deer Park	Deer Park	932	0.1e	0.4e	0.1	0.1	0.02e	D
Santa Fe Energy Resources	Deckers Prairie	67	5.0	7.0	na	na	na	na
Seagull Energy E&P	Seabrook	168	2.6	24.0	na	na	1.0	na
Shell Oil	Deer Park	354	17.0	14.0	2.6	3.7	0.01e	D
Smith International	Houston	na	0.2e	1.1e	na	na	0.2e	D
Smith International	Houston	na	0.2e	1.1e	na	na	0.2e	D
Smith International	Houston	na	0.2e	1.1e	na	na	0.2e	D
Smith International	Houston	na	0.2e	1.0e	0.01	0.01	0.2e	D
Smith International	Houston	na	na	na	0.0	na	0.2e	D
Smith International	Houston	447	0.6	3.0	0.2	0.2	0.5e	D
Smith Production	Kountze	298	na	na	na	na	na	na
Smith Production	Kountze	246	na	na	na	na	na	na
Smith Production	Raywood	22	na	na	na	na	na	na
Smith Production	Raywood	332	na	na	na	na	na	na
Smith Production	Raywood	447	na	na	na	na	na	na
Smith Production	Raywood	447	na	na	na	na	na	na
Sonat Texas Gathering Co	Sabine Pass	na	na	na	na	na	na	na
Southwestern Gas Pipeline	Magnolia	91	3.0	1.0	na	na	na	na
Teco	Houston	na	2.0	32.9e	12.1	4.4	1.7e	D
Teco	Houston	na	2.0	32.9e	12.1	4.4	1.7e	G
Tejas Gas Pipeline Co	Port Neches	91	na	na	na	na	na	na

Company	City	Capacity (kW)	Emissions (tons/yr) CO	NO_x	PM	SO_2	VOC	fuel
Tejas Gas Pipeline Co	Port Neches	91	na	na	na	na	na	na
Texaco Exploration & Production	Humble	74	5.0	7.0	0.02	na	na	na
Texaco Exploration & Production	Humble	na	11.0	11.0	0.3	0.02	0.4	na
Texaco Exploration & Production	Humble	na	11.0	11.0	0.3	0.02	0.4	na
Texaco Exploration & Production	Jersey Village	596	14.1	10.0	na	0.01	1.0	na
Texaco Exploration & Production	Jersey Village	522	na	11.0	na	na	na	na
Texaco Exploration & Production	Jersey Village	na	na	na	na	na	na	na
Texaco Exploration & Production	Jersey Village	na	na	na	na	na	na	na
Texaco Exploration & Production	Port Neches	205	na	na	na	na	na	na
Texas Instruments	Stafford	na	0.4e	0.3e	0.01	0.01	0.01e	D
Texas Instruments	Stafford	na	0.4e	0.3e	0.01	0.01	0.01e	D
Texas Instruments	Stafford	na	1.3e	4.0	0.3	0.3	1.0e	D
Texas Instruments	Stafford	na	1.3e	4.0	0.3	0.3	1.0e	D
Texas Meridian Resources Exploration	Liverpool	60	na	na	na	na	na	na
Thermal Energy Cooperative	Houston	1,678	na	na	na	na	na	D
Thermal Energy Cooperative	Houston	1,678	na	na	na	na	na	D
Thermal Energy Cooperative	Houston	1,678	na	na	na	na	na	D
Torch Operating Co	Dayton	168	na	na	na	na	na	na
Torch Operating Co	Dayton	246	na	na	na	na	na	na
Tri-Union Development	Alvin	na	na	na	na	na	na	na
Tri-Union Development	Alvin	124	na	na	na	na	na	na
Tri-Union Development	Alvin	124	na	na	na	na	na	na
Trunkline Gas Co	Houston	242	2.0	2.0	na	na	na	G
TU Electric	Dallas	157	2.2e	2.0	0.3	0.4	0.5e	D
United States Gypsum	Galena Park	na	0.2e	0.9e	0.2	0.2	0.2e	D
United States Gypsum	Galena Park	na	0.2e	0.9e	0.2	0.2	0.2e	D
US Department of Energy	Winnie	na	0.02e	0.1e	0.01	0.01	0.01e	D
US Department of Energy	Winnie	na	0.02e	0.1e	0.01	0.01	0.01e	D
US Department of Energy	Winnie	60	0.1e	0.4e	0.01	0.01	0.1e	D
US Department of Energy	Winnie	60	0.1e	0.4e	0.01	0.01	0.1e	D
US Department of Energy	Winnie	671	1.1e	5.1e	0.03	0.7	0.3e	D
US Department of Energy	Winnie	671	1.1e	5.1e	0.03	0.7	0.3e	D
Vastar Resources	High Island	na	25.8	19.0	na	na	na	na
Vastar Resources	Vidor	291	0.6	3.0	0.2	0.2	0.3e	D
Vintage Petroleum	Baytown	86	na	9.0	na	na	na	G
Vintage Petroleum	Pasadena	38	9.0	9.0	na	na	2.0	na
Vintage Petroleum	Pasadena	51	9.0	14.0	na	na	2.0	na
Wagner Oil	Orange	384	14.0	9.0	na	na	na	na
Wagner Oil	Orange	139	34.0	35.0	na	na	na	na
Weeks Exploration Co	High Island	545	na	na	na	na	na	na
Winnie Pipeline Co	Magnolia	895	na	na	na	na	na	na
TOTAL		**63,386**	**763.2**	**556.7**	**67.5**	**38.7**	**57.7**	

na: Data not available

D: Diesel

G: Natural gas

e: Estimated, based on stated emission rate.[65]

Appendix C: Alternative Fuels

Several non-traditional fuels have been developed that can replace pure fossil fuels in some combustion engines, microturbines, Stirling engines, and fuel cells. While some of these fuels may hold promise for reducing emissions from electricity generation, most of them involve levels of health risk similar to those of traditional fuels.

Biodiesel is a fuel that is made from vegetable oils or animal fats. This is the "bio" part, which can be used alone, but is usually mixed with conventional petroleum diesel fuel at a ratio of 20-30% "bio" to 70-80% diesel.[66] The fuel operates in a conventional combustion engine like a diesel generator. Compared to regular diesel, biodiesel has reduced emissions of CO, SO_2, and particulate matter, but has increased NO_x and soluble CO_2 emissions.

Propane, also called Liquefied Petroleum Gas (LPG), is formed as a by-product of processing natural gas and refining crude oil. Propane usage emits no aromatic compounds, benzene or particulates. Engines that are optimized for propane have lower CO_2 emissions than diesel generators. Propane can be used as a substitute for diesel fuel in internal combustion engines.

Ethanol is made from the fermentation of sugars or starches in grains, agricultural feedstocks and agroforestry products. Ethanol is mixed with gasoline in different percentages to be used as a fuel.

Methanol is predominantly made from steam reforming of natural gas. It can also be made from feedstocks of coal or biomass, but currently these are not as economical. Like ethanol, methanol is mixed with gasoline to be used as a fuel. In these gasoline mixtures, both are referred to as gasohol and are designed for vehicle use.

Biomass describes many types of technologies to turn agricultural materials and waste into energy. Some are unacceptably harmful to the environment while others provide a net benefit to the environment. The use of biomass in fuel cells, microturbines and Stirling engines is still being researched.

P Series Fuels are blends of methyltetrahydrofuran (MTHF), ethanol and hydrocarbons. Currently MTHF is produced from biomass or petroleum feedstocks.

APPENDIX D: GLOSSARY

Back-up generators (BUGs)
Emergency power generators used to avoid potential power interruptions caused by malfunctioning power plants, natural disasters, or demand overloads on the electric grid.[67]

British thermal unit (Btu)
The standard measure of heat energy, equal to the amount of energy needed to raise the temperature of one pound of water by one degree Fahrenheit at sea level. It takes about 2,000 Btus to make a pot of coffee.

California Air Resources Board (CARB)
The regulatory agency that ensures California's compliance with the Clean Air Act. CARB has done more than any other state environmental agency to inventory micropower resources and measure their effects.

Carbon monoxide (CO)
An air pollutant produced by burning organic matter such as oil, natural gas, fuel, wood and charcoal. Motor vehicles produce 67% of the man-made CO that is released into the atmosphere.

Carbon dioxide (CO_2)
A greenhouse gas, produced by burning organic matter such as oil, natural gas, fuel, wood and charcoal.

Combined heat and power (CHP)
A power generation system that uses waste heat to heat water, rooms and buildings; provide air conditioning or refrigeration; or provide steam to generate more electricity.

Distributed generation (DG)
Energy production that occurs near the place where it is used. This term is used interchangeably with "micropower" throughout this report.

Emergency standby generators
Often referred to as "back-up generators" or BUGs, these are generators that operate on a temporary basis as back-up power supplies in the event of power outages.

Fuel cell
An energy production technology that creates electricity and heat through the chemical reaction of combining hydrogen and oxygen to make water.

Kilowatt-hour (kWh)
The most commonly-used unit of measure telling the amount of electricity consumed over time, equal to one kilowatt of electricity supplied for one hour. A typical household consumes 500 kWh in an average month.

Megawatt (MW)
One thousand kilowatts (1,000 kW) or one million watts. One megawatt is enough energy to power 1,000 average Massachusetts homes.

Megawatt-hour (MWh)
One thousand kilowatt-hours, or an amount of electricity that would supply the monthly power needs of a typical home having an electric hot water system.

Microturbine
A new micropower technology based on the same technology as a jet engine although much reduced in size and improved with advanced components and software.

Net metering
A system for metering electricity consumption that subtracts the amount of power fed back into the grid by a micropower unit from the amount that is drawn from the grid.

Nitrogen oxides (NO_X)
The chemicals responsible for giving smog its brown appearance. NO_X contributes to the formation of ozone, production of particulate matter pollution and acid rain.

Particulate matter (PM)
An air pollutant made up of soot and dust particles that are smaller than the diameter of a human hair.

Peak load or peak demand
The electric load that corresponds to a maximum level of electric demand in a specified time period. Peak periods during the day usually occur in the morning hours from 6 to 9 a.m. and during the afternoons from 4 to about 8 or 9 p.m. The afternoon peak demand periods are usually higher, and they are highest during summer months when air-conditioning use is the highest.

Photovoltaic (PV) panel
Also known as a solar panel, PVs convert sunlight directly into electricity using semiconductor technology.

Prime generators
Generators used on a regular basis to supplement energy from the power grid.

Portable generators
Generators that are moved from location to location to provide power (motor vehicles and engines used to propel equipment are not considered portable generators).

Sulfur oxides (SO_X)
Air pollutants produced by the burning of fossil fuels. Large emitters of SO_X include motor vehicles, refineries and power plants. SO_X contributes significantly to acid rain.

Texas Commission on Environmental Quality (TCEQ)
Texas's regulatory agency that ensures compliance with the Clean Air Act. Until September 1, 2002, this agency was called the Texas Natural Resource Conservation Commission (TNRCC).

Volatile organic compounds (VOCs)
A class of reactive organic gases that contribute to the formation of ozone and smog. Motor vehicles, refineries and power plants are the primary source of VOCs.

Wind turbine
An energy generation technology in which the kinetic energy of the wind is converted to mechanical power, which in turn drives the electrical generator and produces an electrical current.

NOTES

1. Throughout this report, we use the terms "micropower" and "distributed generation" synonymously.

2. Formerly known as the Texas Natural Resource Conservation Commission (TNRCC). The agency changed its name effective September 1, 2002.

3. Micropower should not be confused with the "peaker plants" that are much in the news recently. Although both are small electricity generating plants, peakers are generators operated by utilities and independent power producers that are used only during peak demand times. They are typically 50-100 MW. Micropower units are normally not operated by utilities, and are typically in the 2 kW to 1 MW range, with some as high as 10 MW.

4. David Morris, *Seeing the Light: Regaining Control of Our Electricity System* (Minneapolis: Institute for Local Self-Reliance, 2001), 54.

5. Electric Reliability Council of Texas, *Report on Existing and Potential Electric System Constraints and Needs within the ERCOT Region*, 1 October 2001.

6. Texas Public Power Association newsletter, May 2002.

7. See note 4.

8. Energy Nexus Group, *Performance and Cost Trajectories of Clean Distributed Generation Technologies*, 29 May 2002.

9. Regulatory Assistance Project, *Model Regulations for the Output of Specified Air Emissions from Smaller-Scale Electric Generation Resources: Model Rule and Technical Support Documents*, November 2001, Appendix B.

10. Ibid.

11. Ibid.

12. Many studies have established the links between these pollutants and their health effects, including D.W. Dockery et al, "An Association between Air Pollution and Mortality in Six U.S. Cities," *New England Journal of Medicine*, 1993. For a good overview of the health effects of power plant pollution, see Clean Air Task Force, *Death, Disease & Dirty Power*, October 2000.

13. See New York Shines, *New York Consumer Guide to Buying a Solar Electric System*, available at www.nyshines.org/pvguide.pdf; California Public Interest Research Group, *Affordable, Reliable Renewables: The Pathway to California's Sustainable Energy Future*, July 2001; and California Public Interest Research Group, *Predictably Unpredictable: Volatility in Future Energy Supply and Price from California's Over-Dependence on Natural Gas*, September 2001, available at www.calpirg.org.

14. U.S. Department of Energy (DOE), Office of Utility Technologies, *Renewable Energy Technology Characterizations*, December 1997.

15. PV has an average availability factor of 96%: Sacramento Municipal Utility District, *Sustained Orderly Development of PV*, downloaded from www.ttcorp.com/upvg/4.5doc/4.5mwsmd.htm, 4 June 2001.

16. John Makeig, "UT Exhibits Solar Energy System: Panels Atop School's Center Tower Will Power 6-Story Garage," *The Houston Chronicle*, 17 September 1998.

17. Ibid.

18. Texas Million Solar Roofs Partnership, "Case Studies," downloaded from www.texasmillionsolarroofs.org/casestudies.html, 19 July 2002.

19. University of Texas, *Energy Management Plan*, June 2002.

20. Ibid.

21. See note 16.

22. U.S. DOE, *Quick Facts about Wind Energy*, downloaded from www.eren.doe.gov/wind/web.html, 15 July 2001.

23. Danish Wind Turbine Manufacturer's Association, *Windpower FAQs*, downloaded from www.windpower.dk/faqs.html, 25 May 2001.

24. Lester Brown et al, *State of the World 2001* (NY: W.W. Norton, 2001), 94.

25. American Wind Energy Association, *California Electricity Crisis Spurs Sales of Home Wind Energy Systems* (press release), 13 February 2001. Wind turbines have an average availability factor of 98%: U.S. DOE, Office of Utility Technologies, *Renewable Energy Technology Characterizations*, December 1997.

26. Bergey Wind Power, "Laredo Community College, Laredo, Texas," downloaded from www.bergey.com/examples/laredo/html, 24 July 2002.

27. Ibid.

28. Sunline, *Clean Fuels*, downloaded from www.sunline.org/clean_fuels/clean_fuels/cf_frameset.html, 31 August 2001.

29. Public Utilities Commission of Texas, *Staff White Paper on Stationary Fuel Cells for Power Generation* (revised draft for public comment), 6 May 2002.

30. Larry Alford, Austin Energy, personal communication, 25 July 2002.

31. Austin Energy, *Austin Energy Eyes Fuel Cell Business*, 16 July 2002.

32. See note 30.

33. Charlie Greenberg, "City Debuts Its First Fuel Cell Generator," *The Daily Texan*, 17 July 2002.

34. U.S. Combined Heat and Power Association, *Combined Heat and Power: Distributed Generation Applications that Save Power, Reduce Costs, and Improve Energy Security*, downloaded from www.nemw.org/uschpa/papers.htm, 17 August 2001.

35. American Council for an Energy-Efficient Economy, *The Role of CHP in Addressing Texas's Need for Pollution Reduction and Growth in Energy Demand*, July 2001.

36. Requirements are listed in TAC§106.512.

37. See Appendix A for sources. Since not all units reported values for capacity and emissions, values not reported are estimated based on the averages of the units that did report values. Units with no reported capacity were assumed to be 487 kW, the average of those units reporting a capacity value. The estimated total emissions is weighted by capacity – calculating average emissions per kW of those units with a reported emission level and applying that average to those units with no reported emission level.

38. Extrapolation of California data from California Air Resources Board (CARB), *Diesel Risk Reduction Plan*, *Appendix II*, October 2000. Number of non-agricultural generators translated per capita. Number of agricultural generators translated by ratio of gross state product of farming sector (DOC, Bureau of Economic Data, Regional Accounts Data, 2000). Emissions figures are based on engine characteristics of each category or subcategory of diesel-fueled engine, the number of each of these types of engines, and average operating hours as reported to local air districts in California.

39. CARB, *Diesel Risk Reduction Plan*, *Appendix II*, October 2000.

40. State numbers are in the previous section. An estimated 371,000 tons of NOx and 16.7 million tons of CO2 are emitted from diesel generators nationwide (Virinder Singh, Renewable Energy Policy Project, *Blending Wind and Solar into the Diesel Generator Market*, Winter 2001).

41. Emission rates from Distributed Utility Associates, prepared for the California Air Resources Board, *Air Pollution Emissions Impacts Associated with Economic Market Potential of Distributed Generation in California*, June 2000. Operating rates as reported by CARB, *Diesel Risk Reduction Plan*, *Appendix II*, October 2000.

42. 330 kW average diesel generator size estimate from analysis of the 2001 Diesel and Turbine Worldwide Annual Power Generation Survey by Power Systems Research, 2001.

43. Number of generators is the per capita equivalent of California data for non-agricultural prime and emergency back-up generators from CARB, *Diesel Risk Reduction Plan*, *Appendix II*, October 2000. Estimated capacity is based on an average capacity of 330 kW.

44. New York State Energy Research and Development Authority, *Task 4: Survey of Backup Units in Nassau and Suffolk Counties*, 2002.

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46. Nancy Ryan, Kate Larsen, and Peter Black, Environmental Defense, *Smaller, Closer, Dirtier: Diesel Backup Generators in California*, August 2002.

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48. State and Territorial Air Pollution Program Administrators and the Association of Local Air Pollution Control Officials, "Cancer Risk from Diesel Particulate: National and Metropolitan Area Estimates for the United States," 15 March 2000.

49. CARB, *Attachment to Letter on Emergency Generators: Air Pollution Emissions from Electricity Generation*, 21 February 2001. Based on 70-year exposure.

50. See note 46.

51. A. Peters et al, "Increased Particulate Air Pollution and the Triggering of Myocardial Infarction," *Circulation* 103 (23), 12 June 2001. At-risk populations are considered to be children, athletes, people with respiratory disease, and the elderly.

52. City of Houston, Office of the Mayor, *Mayor Lee P. Brown Releases Results of Sonoma Air Quality Study* (press release), 4 May 1999.

53. W. James Gauderman et al, *Association Between Air Pollution and Lung Function Growth in Southern California Children*, 2 May 2000.

54. CARB and Office of Environmental Health Hazard Assessment, *Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant*, 22 April 1998.

55. See note 9. Micropower figures represent emissions from units with no emissions treatment, which is typical of most current micropower facilities.

56. Nathanael Greene and Roel Hammerschlang, "Small and Clean Is Beautiful: Exploring the Emissions of Distributed Generation and Pollution Prevention Policies," *Electricity Journal*, 2000.

57. Mark Delucchi, Propane Education and Research Council, *LPG for Forklifts: A Fuelcycle Analysis of Emissions of Urban Air Pollutants and Greenhouse Gases* (press release), 17 September 1999.

58. See note 39.

59. Union of Concerned Scientists, *Rolling Smokestacks: Cleaning Up America's Trucks and Buses*, October 2000.

60. Seth Dunn, Worldwatch Institute, *Micropower: The Next Electrical Era*, July 2000.

61. See note 8.

62. See note 60.

63. See note 8.

64. Annual emissions in tons/yr were not reported for these generators, but emission rates in lbs/hr were reported. An annual emissions estimate was calculated using the average ratio for all generators reporting both emission rates and annual emissions.

65. Ibid.

66. National Biodiesel Board, *Biodiesel Frequently Asked Questions*, downloaded from www.biodiesel.org/general/faq.htm, 22 August 2001.

67. Thanks to the California Energy Commission (www.energy.ca.gov/glossary) for many of these definitions.