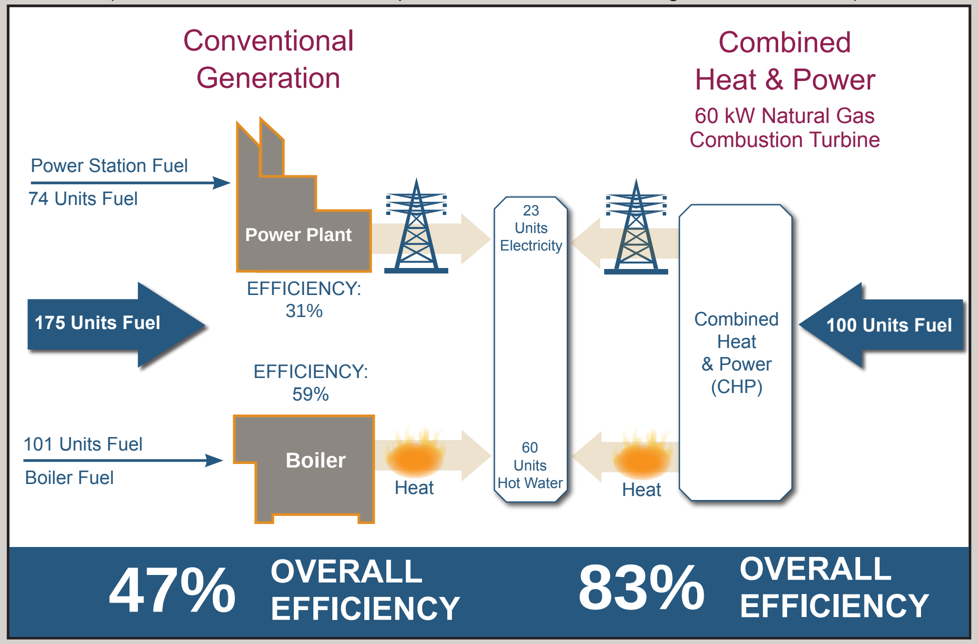
Cogeneration Efficiency Advantages for EPA's Region 9 Laboratory

(Modified from EPA's 2005 Output-based Environmental Regulations Factsheet)



Graphical representation is only an estimate and assumes that all of the heat produced by the cogeneration unit is used by the facility, and that the unit will provide approximately 80 percent of the facility's hot water needs annually.

The 60-kilowatt (kW) cogeneration unit installed at the Region 9 Laboratory is 57 percent more efficient than equipment that produces electricity and heat separately. While separate production requires 175 units of fuel to produce a given amount of heat and electricity, the new cogeneration unit only requires 100 units of fuel.

Facility Statistics

Facility Type:	Laboratory
Construction:	Mechanical upgrades
Location:	Richmond, California
Total Facility Area:	44,950 gross square feet (GSF)
Estimated Personnel:	44 persons
Fiscal Year (FY) 2004 Energy Use:	14,787,109,635 British thermal units (Btus) per year 328,968 Btus per GSF per year
Projected Energy Use:	11,687,150,750 Btus per year 260,003 Btus per GSF per year

Energy and Cost Savings

EPA expects this innovative upgrade package to translate into significant energy savings and reduced utility costs. In addition to the savings from reducing the laboratory's energy demand by approximately 21 percent, Pacific Gas & Electric (PG&E) provides the natural gas used in the combustion engine at a reduced rate, due to its use in an onsite generation system.

Projected Savings At-a-Glance

Energy Savings (MMBtu/year)	Cost Savings ($/year)
Natural Gas	
1,474.6 MMBtu*	$24,455**
Electricity	
1,678.7 MMBtu***	$65,801
Total Annual Savings	
3153.3 MMBtu	**$90,256**

MMBtu=million British thermal units

* The increased energy efficiency of the new boilers will reduce natural gas consumption at the laboratory.

** As a cogeneration facility, EPA's Region 9 Laboratory is entitled to a transmission and distribution (T&D) line discount from PG&E for its purchased natural gas. Cost savings reflect this discount and the increased efficiency of the new boiler units.

*** The cogeneration unit is predicted to replace more than 25 percent of the electricity purchased from the utility.

The project has also received support from PG&E directly. In March 2001, the California Public Utility Commission launched the Self-Generation Incentive Program, which requires all public California electric utilities to provide financial incentives to customers installing onsite generation systems that provide all or a portion of their energy needs. With the installation of this cogeneration unit, PG&E provided a $60,000 rebate toward the cost of the system.

All in all, the entire facility upgrade is expected to be fully paid by the utility rebate and day-to-day cost savings within three to seven years (depending on energy prices).

This project would not have been possible without the coordinated efforts of EPA Region 9; EPA's Office of Administration and Resources Management (OARM); EPA's Office of Administrative Services (OAS); EPA's Facilities Management and Services Division (FMSD); EPA's Architecture, Engineering and Asset Management Branch (AEAMB); EPA's Sustainable Facilities Practices Branch (SFPB); the Lawrence Berkeley National Laboratory; Summit Associates; Tecogen, Inc.; Ted Jacobs Engineering Group, Inc.; and Wareham Properties.

For more information on energy conservation efforts at EPA facilities, visit **www.epa.gov/greeningepa**.

Printed on recycled paper with 30 percent postconsumer content.

Cogeneration at Work

EPA Region 9 Laboratory Richmond, California

The U.S. Environmental Protection Agency (EPA) is leading by example in reducing the energy demand of its Region 9 Laboratory by approximately 21 percent. In 2005, EPA completed three major building upgrades:

- A natural gas-fired cogeneration unit to produce electricity and hot water on site.
- Two small, efficient boilers to replace an oversized one.
- A series of control upgrades for its heating, ventilation, and air conditioning (HVAC) system.

EPA expects these new systems to pay for themselves through annual savings of more than $90,000 per year and a one-time rebate from the local California utility of $60,000.

What Is Cogeneration?

Central to EPA's package of efficiency upgrades was the installation of a natural gas cogeneration unit. Cogeneration, which is also referred to as combined heat and power (CHP), involves the generation of electricity and the capture and use of the associated heat energy byproducts.

With the installation of a 60-kW-rated combustion engine that is integrated into the laboratory's heating system, EPA uses natural gas to generate electricity on site for more than 25 percent of the laboratory's electricity needs.

The process of converting natural gas into electricity produces a significant amount of heat, in addition to reducing the building's electrical load on the local grid. To make use of this otherwise wasted heat energy, a bundle of water-filled coils absorbs the engine's heat output to make hot water for the building's hydronic heating system. In a hydronic heating system, hot water is transported throughout the building via pipes in the floors and walls that release their heat to the walls and air as they cool.

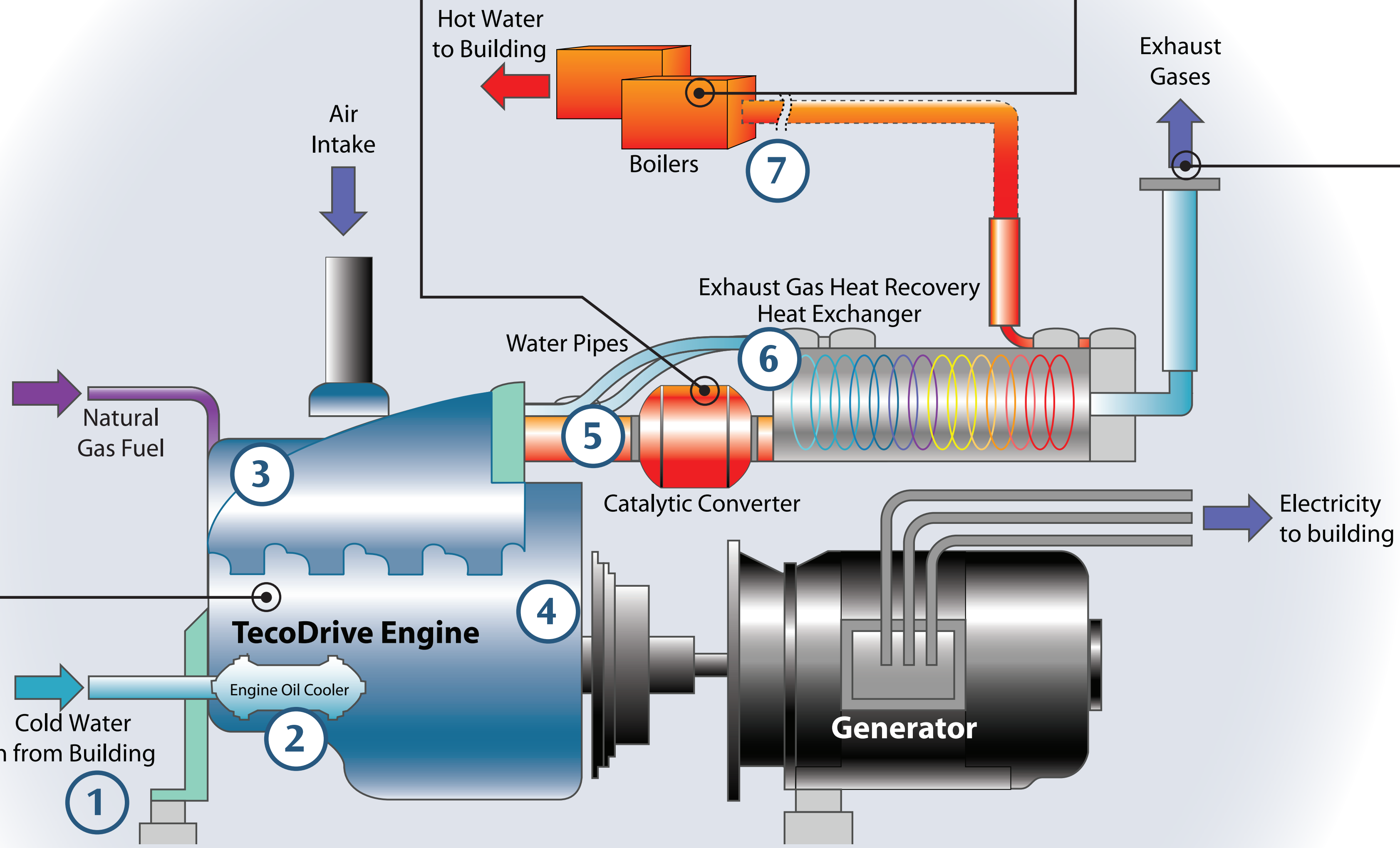
See the cogeneration diagram at right for more information.

Catalytic Converter and Exhaust Gas Heat Exchanger.
These systems reduce air pollutants in the exhaust gas to negligible amounts and transfer the heat energy of the air exhaust to water used for heating the building.

Smaller Boilers.
Two 83 percent efficient 2.4 million Btu boilers replaced one 8 million Btu oversized boiler that was operating below 60 percent efficiency. The new boilers provide additional hot water for building heat when the cogeneration waste heat is not sufficient.

Boiler Exhaust System/Roof-mounted Dry Cooler Unit.
The two large stacks release exhaust from the boilers when operating. The square dry cooler unit rejects waste heat from the cogeneration system, if it is not needed to heat the building. Hot water from the exhaust gas heat exchanger is directed up the vertical pipes in the roof, cooled via the fan on the underside of the unit, and sent back down to the start of cogeneration system to be recycled through again.

Cogeneration Unit.
The black pipe on the front left of the unit is the natural gas feed line. The vertical white, insulated pipes can transport water to the roof and back if heat energy is not needed in the building.



Photos courtesy of Summit Associates and Lawrence Berkeley National Laboratory

Cogeneration Step-by-Step

1. Cold water (~170° F) from the building's heating system enters the cogeneration unit at approximately 22 gallons per minute.
2. The cold building water is first used to cool the engine oil/lubricant needed to keep the engine running properly. It is then fed to the engine jacket and up to the exhaust gas heat exchanger.
3. Natural gas is fed into the engine to fuel the cogeneration system. It is purchased from the utility at a reduced rate because it is being used for onsite generation.
4. Natural gas is used to power the engine, which turns the shaft in the generator, creating electricity. This unit produces 60 kW of electricity.
5. Hot exhaust (~1100 to 1200° F) from the engine is directed through the catalytic converter to reduce emissions of carbon monoxide (CO), nitrogen oxides (NO_x), and total hydrocarbons (THC) by more than 90 percent.
6. The cleaned exhaust gas (~1100° F) is sent into the heat recovery/heat exchanger, where it heats the cold building water to 200° to 220° F and reduces the air exhaust temperature to 100° F or less.
7. If needed, hot water from the exhaust gas heat exchanger is combined with boiler-generated hot water, to meet the heat load of the building, and then sent through the building's hydronic heating system. The cogeneration unit is expected to produce enough hot water to meet approximately 80 percent of the building's heating needs.