GPRA Representation of the Distributed Energy and Electric Reliability (DEER) Program

The DEER Program encompasses many technologies and markets. The GPRA benefits were estimated by focusing on gas-fired combined heat and power (CHP) systems within building and industrial applications. Distributed generation (DG) applications that are motivated by the need for electric reliability will be primarily systems that produce only electricity and are used in back-up mode. We currently do not have the analytical tools to asses this market. Its absence from the benefits estimates may result in an underestimation of DG capacity, although not the energy or emission savings because these systems run for few hours per year and generally have similar or lower efficiencies than larger central station plants. To the extent that the central grid relies on DG for emergency power, avoided central station capacity may be underestimated as well.

Combined heat and power systems produce both useful thermal heat and electricity. Their economics depend on the amount of thermal heat needed at the site, the electricity usage at the site, the price of the input fuel, and the value of the electricity. If the end-use customer is making the investment, the electricity value will depend on the customer avoided purchases at the electricity retail price, and possibly the amount of excess electricity sold off-site at prevailing wholesale electricity prices. Using the average electricity price is a simplification that may overlook the requirement to continue paying some type of flat distribution charge, even though less electricity is purchased from the utility. If a vertically integrated electric utility is making the investment, the value is from avoided generation, transmission and distribution (T&D) costs. The distributed systems would be placed strategically in the grid to avoid T&D expansion costs.

The NEMS-GPRA04 framework uses a cashflow model to evaluate the DG technologies within the building sector. Assuming a 20 percent down payment, debt and interest payments are computed over a loan period of 20 years, along with associated taxes and tax benefits. Annual fixed maintenance costs are also included. Fuel costs are computed based on the delivered cost of natural gas and the technology efficiency. Netted against the fuel cost is the value of the useful waste heat produced as computed based on the delivered natural gas price, the thermal efficiency of the CHP system and the internal thermal load. The value of the electricity produced is then subtracted from these costs to determine the cash flow. The value of electricity is equal to the larger of the electricity produced (assuming 7125 hours of operation) and the internal electricity demand multiplied by the delivered electricity price. Any electricity produced in excess of internal needs is assumed to be sold to the grid at the wholesale power rate. The number of years until positive cash flow is reached determines the market share in new buildings[1]. The market share, as shown below, drops off sharply as the number of years increases to reflect the high rates of return generally expected for energy related projects by commercial building owners. The market share for existing buildings is assumed to be a fraction of the share for new.

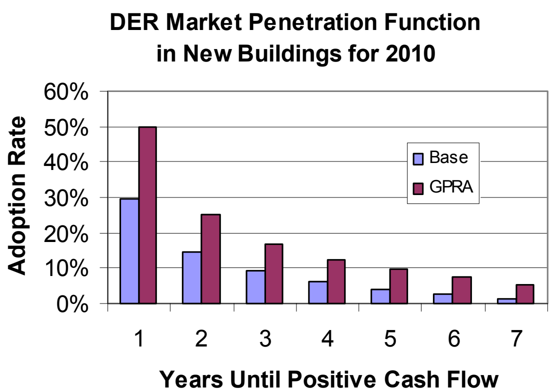
The analysis is performed for each of 11 building types in 9 regions. Even so, this is a fairly high level of aggregation, and therefore the model does not capture the niche markets that DG may fill. The current version also does not take into account the electricity and thermal seasonal and diurnal load shapes. It therefore may overestimate the value of both products by assuming that the CHP systems runs at full operation most of the time and that the electricity and heat can be used continuously. On the other hand, the DG systems are represented in discrete sizes, and some average building loads are too small to use the heat and electricity produced by the minimum 100 kW system, which makes the DG systems uneconomic.

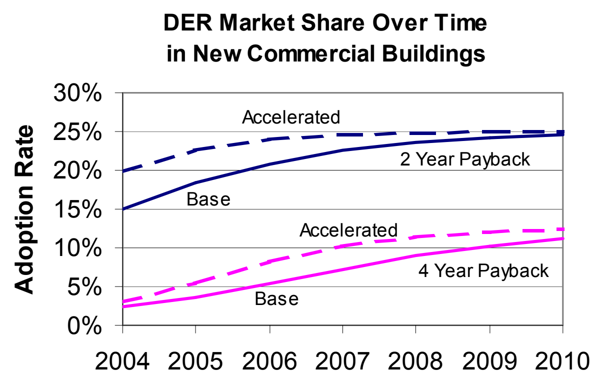
[1] With the accelerated depreciation positive cash is more likely to be reached sooner, although in some cases, the project can return to being uneconomic once the tax benefits are used.

The DEER program facilitates the development of the DG market by improving the technology characteristics (lowering costs, improving efficiency, and reducing environmental emissions) and by removing barriers to adoption and consumer acceptance. Thus the benefits are estimated based on the impact of improved technology and greater market penetration.

The Baseline used for the GPRA analysis already includes some DG technological advancement[2]. It was beyond the scope and schedule for this year's analysis to separate how much of the Baseline improvements might stem from government R&D efforts, and therefore should be removed. As a result, the GPRA benefits may be underestimated for the smaller commercial sector systems. To test the impact, we performed a sensitivity test taking out these improvements for the commercial sector CHP technologies. At the extreme of static year 2000 commercial CHO technology characteristics, DG capacity decreases by roughly 2 GW from the baseline. Although not in the AEO2002, the Baseline also assumes that small combined heat and power systems receive favorable tax treatment in terms of accelerated depreciation.

The DEER program's impact on consumer adoption rates was represented in several ways. The maximum market share that can be achieved in new buildings was increased from 30 percent in the Baseline to 50 percent in the GPRA case. The graph on the left below shows how the ultimate market share for new buildings varies by payback year. In addition, there is an adoption rate parameter that was accelerated to reflect faster market maturity in the GPRA case, as shown in the graph to the right.



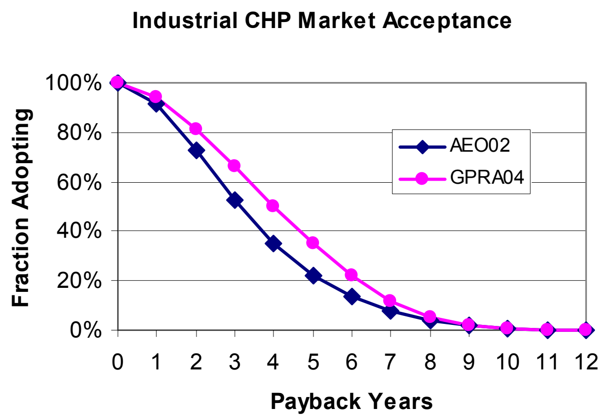


The market share for the existing building stock is tied to the market share computed for new buildings. The baseline assumption is that the existing stock share is one-fiftieth of the new share, while in the GPRA case the existing share is increased gradually from one-fiftieth to one-thirtieth of the new share. The share for the existing stock of buildings is considerably smaller than the market share for new buildings, because the entire existing stock will not make investments in CHP in a single year.

An economic competition for CHP systems is also performed in the industrial sector. All of the industrial CHP technologies improve over time in the GPRA case compared to the Baseline. The technology characteristics for the smaller internal combustion systems were take from the draft EERE Technology Characteristics report[3], while the larger system improvements are the intended EIA assumptions[4]. For the industrial CHP systems, as well as the for commercial sector, it was assumed that the DEER program will

[2] The Annual Energy Outlook 2002 assumes improved CHP technologies in the commercial sector. The input files for the industrial sector CHP systems show improvements as well, but a coding error led to these being unused and the technology characteristics remain at their year 2000 values.
[3] Add source.
[4] The assumptions in the AEO2002 input files as described in footnote 2.

enhance consumer acceptance and lower hurdles to adoption. This was reflected in the model by shifting the function determining the adoption rates as a function of payback years.



The incremental DG capacity and generation that results from this representation of the DEER program activities is shown in the table below, along with the projected total quantities. Of the 25 GW of incremental capacity, roughly half of the increase is expected from commercial building applications and half from generally larger industrial applications. The DG increase in the building sector is proportionally much larger, because there is currently relatively little DG in this sector.

In the Baseline case, the commercial sector is projected to satisfy roughly 3 percent of its total electricity demand with distributed CHP generation and the industrial sector 15 percent. With the DEER program, the share rises to 8 percent in the commercial sector and 20 percent in the industrial sector.

Distributed Combined Heat and Power	Capacity (GW)			Generation (BkWh)		
	2005	2010	2020	2005	2010	2020
Baseline						
Buildings	1.3	2.3	7.4	9	16	53
Industry	29.0	33.0	41.2	173	202	259
Total*	30.3	35.2	48.5	183	218	312
GPRA Case						
Buildings	2.1	5.4	20.3	15	39	146
Industry	30.5	37.3	53.2	184	233	347
Total*	32.6	42.7	73.6	199	272	493
Incremental						
Buildings	0.8	3.2	13.0	6	22	93
Industry	1.5	4.3	12.1	11	31	88
Total*	2.3	7.4	25.0	17	54	180

* excludes non-traditional large QF cogenerators

The DEER program benefits are projected within the integrated modeling framework, so that the impact of the program will be reflected in the rest of the energy system. As a result of increased investments in DG, electricity purchases from the commercial and industrial sectors are reduced, and additional electricity is sold wholesale to the grid. The central electricity generation industry responds by reducing production from the most expensive plants operating in each region, and over time by building fewer central station plants in the face of lower demand. Retirements are relatively unaffected, with only 2 GW of additional capacity retired by 2020 in the GPRA case. Roughly 27 GW of central station investments are avoided by the additional DG. In the Baseline, roughly 90 percent of new utility and IPP additions from 2005 to 2020 are projected to be natural gas fired, so roughly 90 percent of those avoided investments are natural gas fired.

In total, distributed generation makes up roughly 12 percent of new capacity additions from 2005 to 2020 in the Baseline. This share increases to 18 percent in the GPRA case. For the later period of just 2015 to 2020, the distributed share rises from 16 percent in the Baseline to 26 percent in the GPRA case.

The energy and carbon emission reduction benefits that stem from distributed generation are computed as the decrease in traditional central station non-renewable energy consumption and associated carbon emissions net of the energy and emissions from the DG. The central station generation reductions are from a mix of existing plants and avoided new plants. Over time, the facilities that are used in the Baseline become more efficient as the gas combined cycle and combustion turbine technologies continue to improve. As a result the energy and emission savings from the central grid decline per kilowatt-hour. For example, in 2010 the average non-renewable energy avoided is at a rate of 9500 Btu/kWh, and by 2020 the value is reduced to 7800 Btu/kWh.

The benefits estimates for the High Temperature Superconductivity (HTS) program, another component of the DEER Program, were based on an analysis performed by a contractor for the program office. The estimates provided of kilowatt-hour reductions from HTS generators, transformers, cables, and motors were represented in NEMS by reducing T&D losses.

FY04 GPRA Benefits Estimates for DEER* (NEMS-GPRA04)

	2005	2010	2020
Capacity (GW)	2.3	7.4	25.0
Generation (GWh)	16.7	53.8	180.1
Energy Savings (quads)	0.08	0.19	0.46
Oil Savings (quads)	0.00	0.01	0.02
Carbon Savings (MMT)	1.4	3.4	8.5
Energy Expenditure Savings (B2000$)	0.7	3.1	9.0

* Includes all credit for increased fuel cells although some sharing with the Hydrogen Program may occur.