

Eight Distribution Planning Opportunities

Sensitivity Analysis

Discussion Document

Distribution Planning Working Group

Massachusetts Distributed Generation Collaborative

November 8, 2005



Agenda

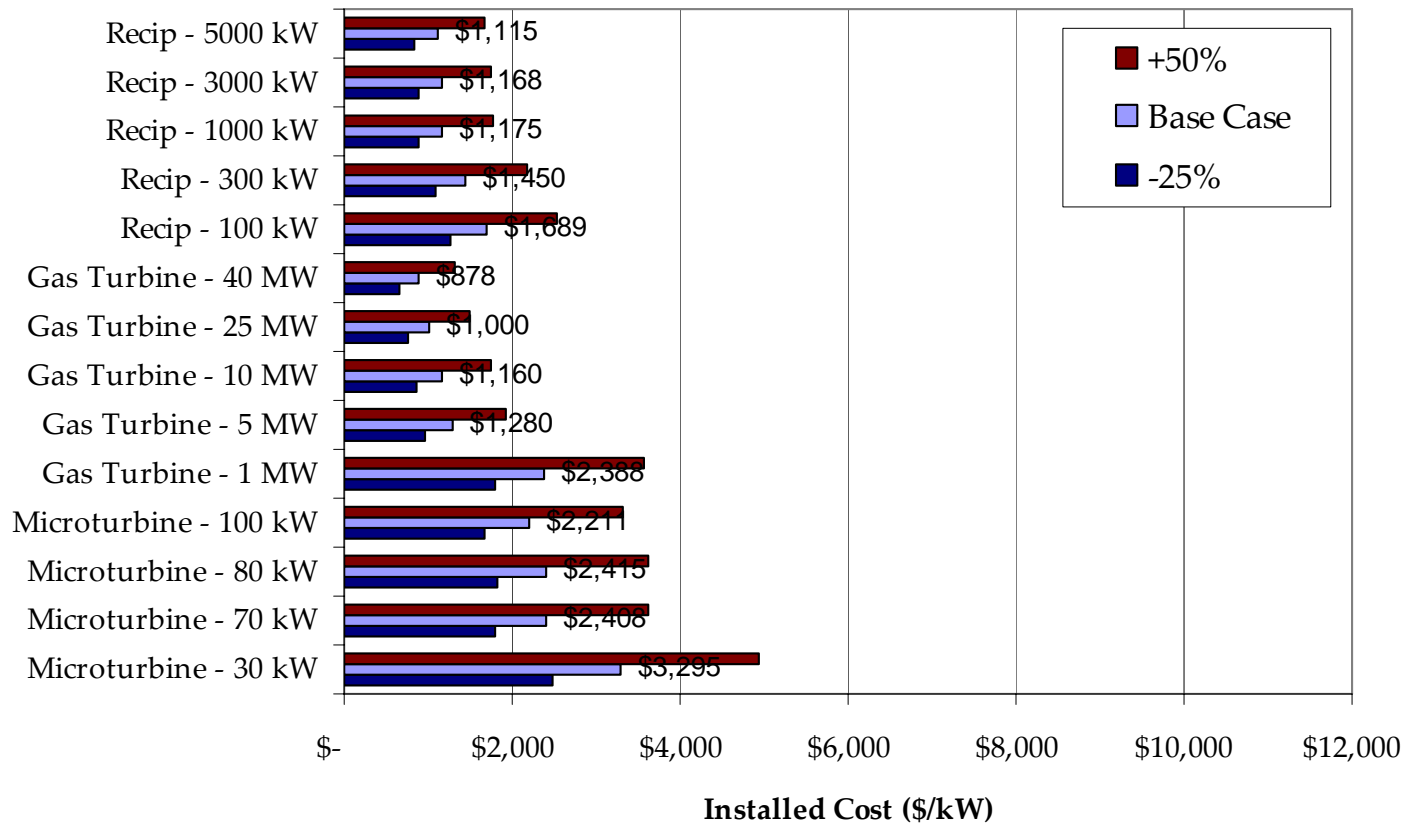
- I. Customer Case Sensitivities
- II. Benefits Beyond Deferral
- III. Utility Case Sensitivities
- IV. Active Case/Customer Ownership Sensitivities
- V. Next Steps

There are three major sensitivities that we have examined for the Customer Ownership Cases.

- Customer Ownership Cases
 - Electric and gas prices for Jan 1, 2005 to Dec 31, 2005 (For some gas utilities the Nov & Dec cost of gas is estimated) **Sensitivity – Varied electric and natural gas supply costs -25% to +50%.**
 - The DG performance parameters are obtained from the NREL report, Gas-Fired Distributed Energy Resource Technology Characterizations, November 2003 **Modified Assumptions: Installed and O&M costs vary depending on the scope of the plant equipment, geographical area, competitive market conditions, special site requirements, prevailing labor rates, amongst other factors. Based on feedback from participants of the Massachusetts DG Collaborative, the "typical" values provided in the NREL report (Gas-Fired Distributed Energy Resource Technology Characterizations, November 2003) are increased by 25%. Sensitivities – Varied installed and O&M costs -25% to +50%**
 - Active Distributed Generation: There is now a one-time incentive payment in year 1 corresponding to annual deferral savings were determined from the utility DG module. The NPV of the savings from 2006 to 2015 was determined for each opportunity. This was then divided by the capacity shortfall in 2015 to determine the value of the one-time incentive payment, \$/kW. **Modified Assumption – savings is divided by 1.5 times the capacity shortfall to cover the reliability needs and the administration fee. Sensitivity – Varied the incentive payments by different lengths of deferral.**

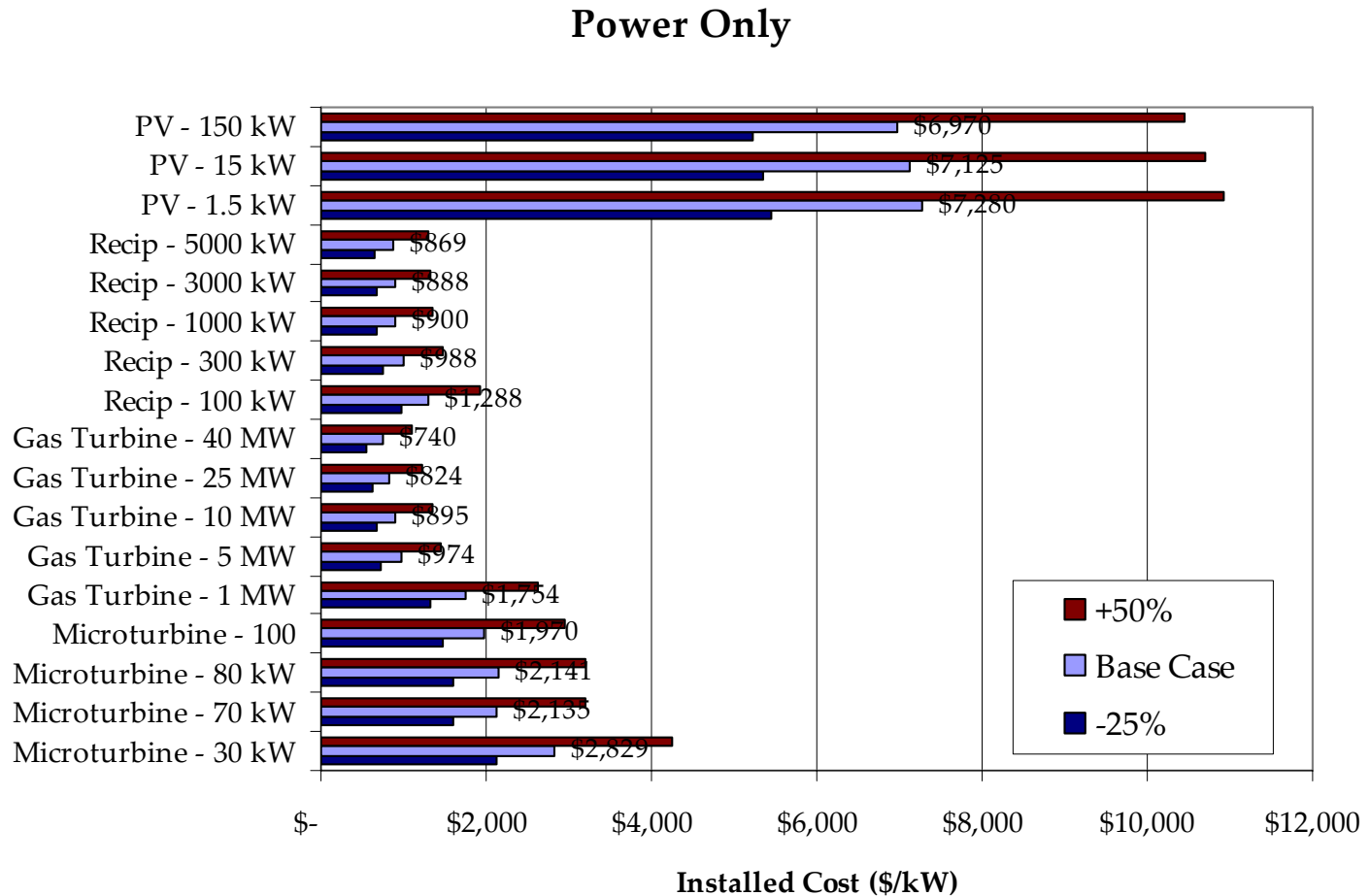
Our sensitivity analysis includes varying the installed costs of the DG equipment.

CHP



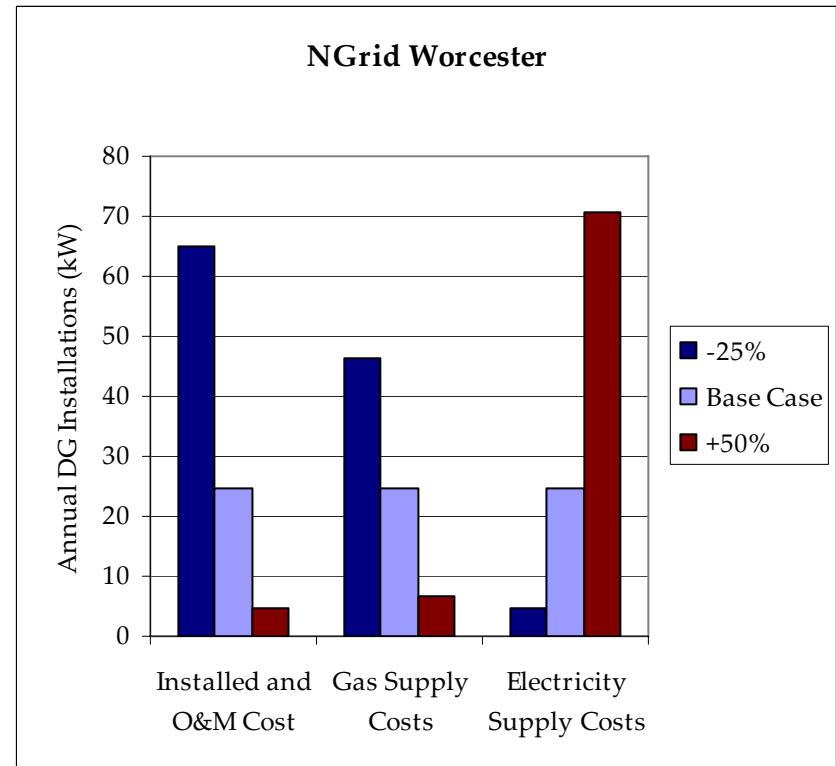
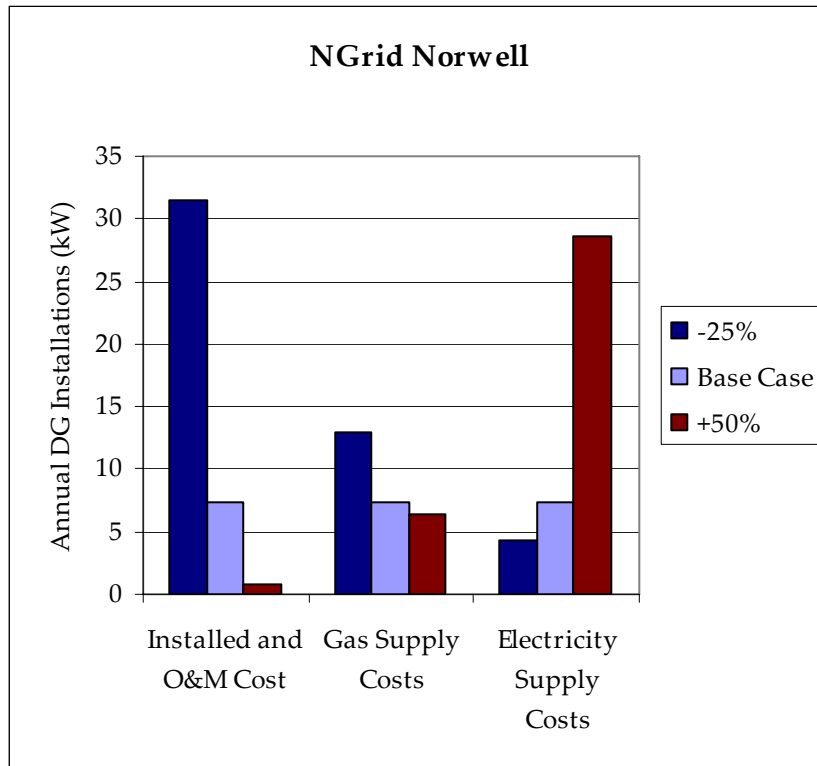
Note: The values provided on the chart represent the "Base Case" installed costs -- 25% greater than the Nov 2003 NREL Report, **Gas-Fired Distributed Energy Resource Technology Characterizations** (http://www.masstech.org/renewableenergy/public_policy/DG/resources/2003-11_gasDER_tech-char_NREL-34783.pdf)

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Note: The values provided on the chart represent the "Base Case" installed costs -- 25% greater than the Nov 2003 NREL Report, **Gas-Fired Distributed Energy Resource Technology Characterizations** (http://www.masstech.org/renewableenergy/public_policy/DG/resources/2003-11_gasDER_tech-char_NREL-34783.pdf)

The installation and O&M costs and the cost of the electricity are the most sensitive parameters in the NGrid Opportunities.

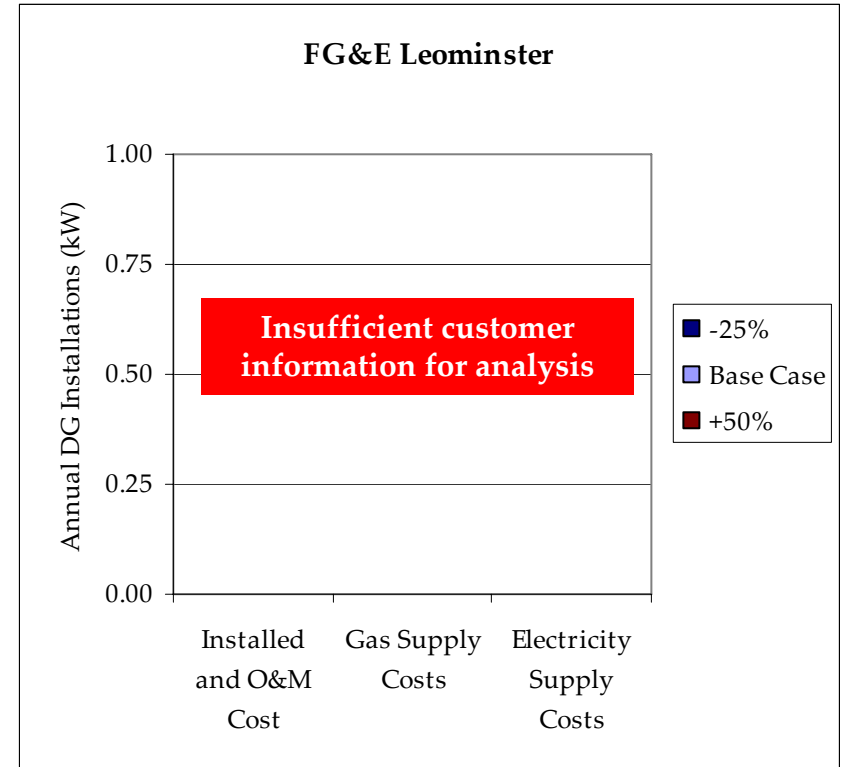
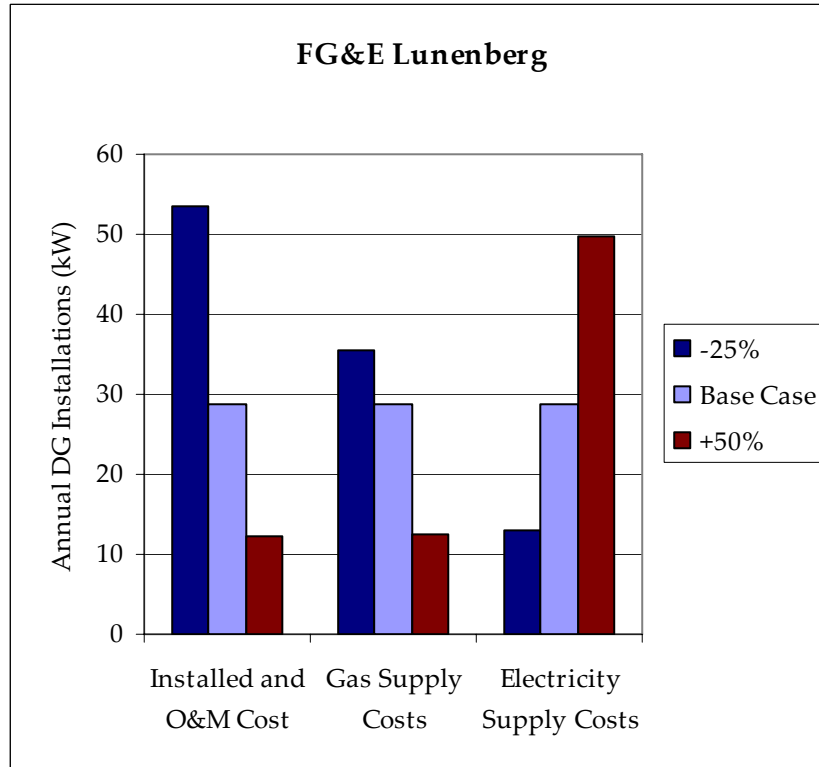


Results shown for the Status Quo/Customer Ownership Case

Base Case Assumptions:

- Installed and O&M costs - NREL report (Gas-Fired Distributed Energy Resource Technology Characterizations, November 2003) are increased by 25%
- Gas Supply Costs – gas prices for Jan 1, 2005 to Dec 31, 2005 (For some gas utilities Nov & Dec cost is estimated)
- Electric Supply Costs – electric prices for Jan 1, 2005 to Dec 31, 2005

The Lunenberg opportunity is most sensitive to the installed and O&M costs.

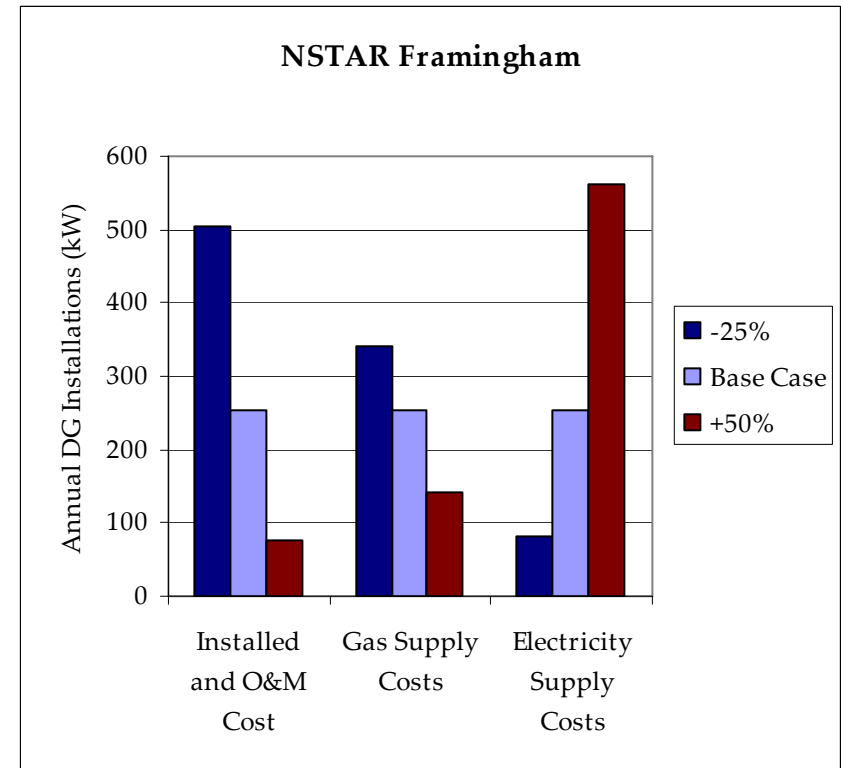
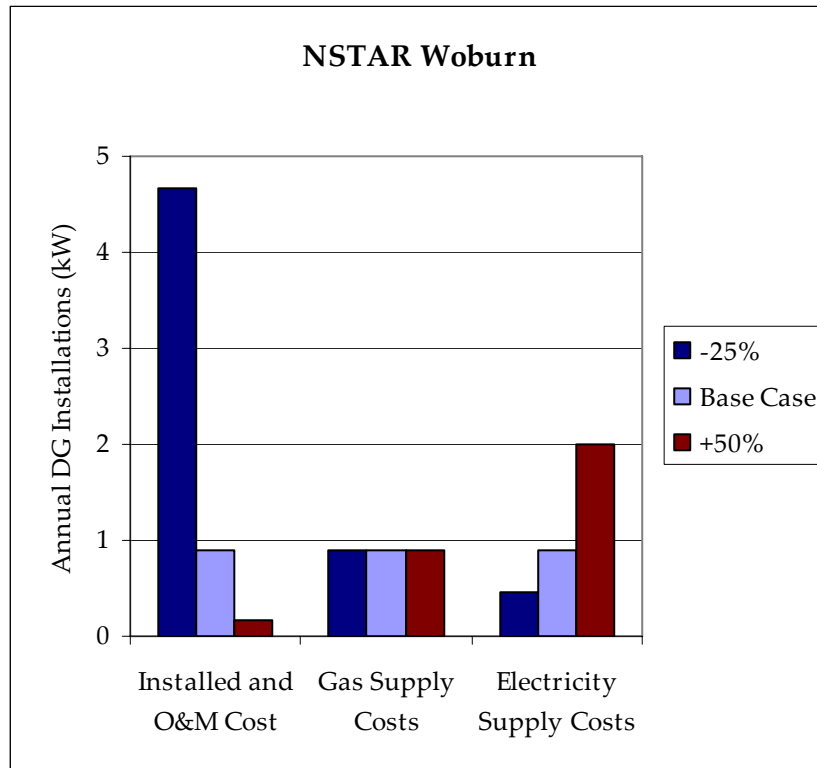


Results shown for the Status Quo/Customer Ownership Case

Base Case Assumptions:

- Installed and O&M costs - NREL report (Gas-Fired Distributed Energy Resource Technology Characterizations, November 2003) are increased by 25%
- Gas Supply Costs – gas prices for Jan 1, 2005 to Dec 31, 2005 (For some gas utilities Nov & Dec cost is estimated)
- Electric Supply Costs – electric prices for Jan 1, 2005 to Dec 31, 2005

The installation and O&M costs are the most sensitive parameters in the Woburn Opportunity; the cost of electricity is the most sensitive in the Framingham Opportunity.

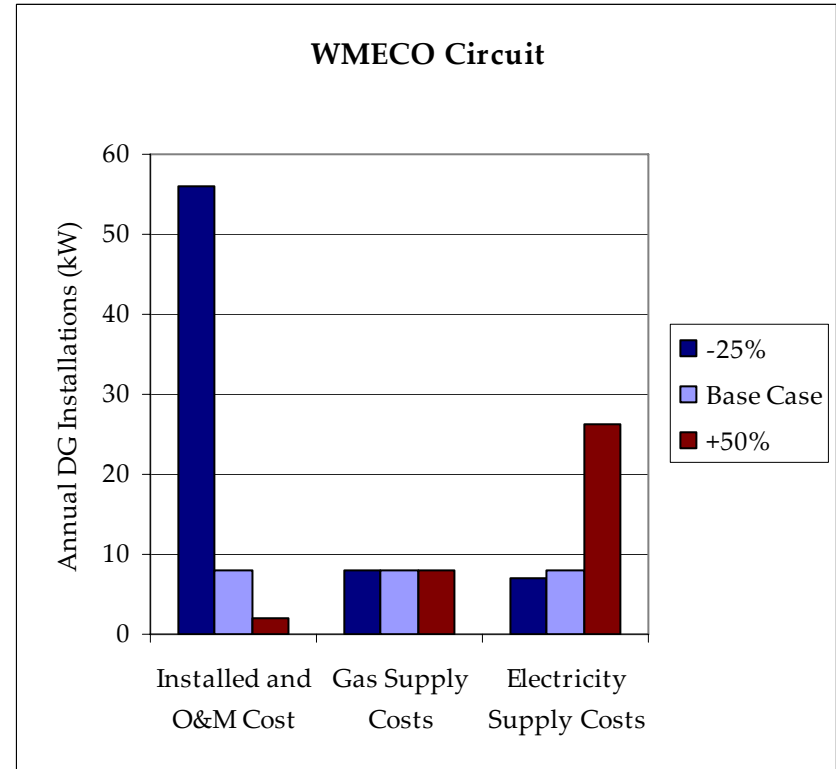
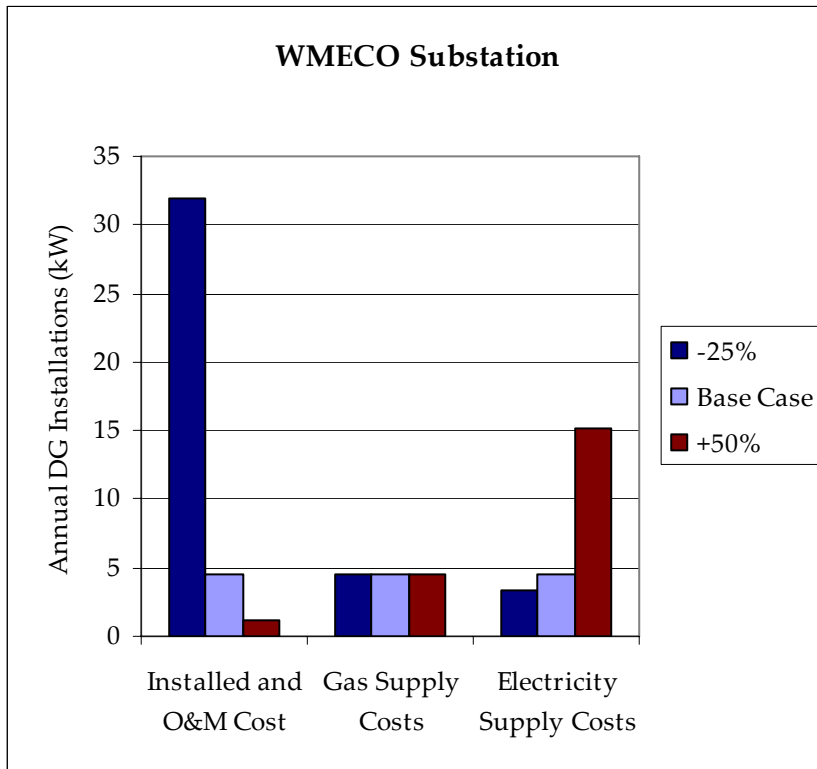


Results shown for the Status Quo/Customer Ownership Case

Base Case Assumptions:

- Installed and O&M costs - NREL report (Gas-Fired Distributed Energy Resource Technology Characterizations, November 2003) are increased by 25%
- Gas Supply Costs – gas prices for Jan 1, 2005 to Dec 31, 2005 (For some gas utilities Nov & Dec cost is estimated)
- Electric Supply Costs – electric prices for Jan 1, 2005 to Dec 31, 2005

The installation and O&M costs are the most sensitive parameter in both WMECO Opportunities.



Results shown for the Status Quo/Customer Ownership Case

Base Case Assumptions:

- Installed and O&M costs - NREL report (Gas-Fired Distributed Energy Resource Technology Characterizations, November 2003) are increased by 25%
- Gas Supply Costs – gas prices for Jan 1, 2005 to Dec 31, 2005 (For some gas utilities Nov & Dec cost is estimated)
- Electric Supply Costs – electric prices for Jan 1, 2005 to Dec 31, 2005

We have also examined the sensitivity for several of the Utility Ownership assumptions.

A. Utility Model

1. Last year of NPV analysis is 2015 (to coincide with prior utility economic case studies) – Note that shorter (or longer) timeframes could alter results **Modified Methodology – Deferral period determined when savings switch from positive to negative**
2. Utilities are allowed to own small, distributed generation **Sensitivity – Analyzed Leasing Option**
3. **Annual growth: Sensitivity – varied load growth rates**
4. Most utility ownership cases include installation of diesels w/o emission control systems (Range: \$400 - \$600/kW) **Verified Assumptions**

The Navigant Utility Ownership model is using a relatively stringent measure of reliability.

- Navigant Model uses Peak Reliability Threshold to determine the DG solution
 - Peak Reliability Threshold = Peak Hour Load Unserved/Peak Load
- Peak Reliability Threshold is different from other reliability and should not necessarily be compared to:
 - ASAI (Average System Availability Index)
 - SAIDI (Average Outage Duration per Customer)
 - Average Equipment Availability Factor
- The Navigant Model calculates ASAI. Calculated ASAI is typically much higher than Peak Reliability Threshold.

Shorter deferrals are more attractive for the Utility Ownership case.

Case Data			10 Year Deferral		Defer if Annual NPV is Positive	
Case No.	Utility	Year	Deferral Years	Net NPV	Deferral Years	Net NPV
1	WMECO - Circuit	2008	10	\$ (104,390)	3	\$ 112,060
2	WMECO - Substation	2009	10	\$ 1,295,454	7	\$ 1,295,454
3	FG&E - Lunenburg	2007	10	\$ (490,904)	2	\$ 83,460
4	FG&E - Leominster	2006	10	\$ 177,964	10	\$ 177,964
5	NGRID - Worcester	2009	10	\$ (378,016)	2	\$ 46,069
6	NGRID - Norwell	2006	10	\$ (424,754)	2	\$ 10,616
7	NSTAR - Woburn	2006	10	\$ (65,983)	2	\$ 5,100
8	NSTAR - Framingham	2006	10	\$ (262,252)	2	\$ 109,018

The leasing option is slightly less attractive than ownership.

Case Data			Utility Ownership		Utility Leasing	
Case No.	Utility	T&D Solution - Year	Deferral Years	Net NPV	Deferral Years	Net NPV
1	WMECO - Circuit	2008	3	\$ 112,060	3	\$ 81,875
2	WMECO - Substation	2009	7	\$ 1,295,454	7	\$ 1,126,573
3	FG&E - Lunenburg	2007	2	\$ 83,460	2	\$ 60,230
4	FG&E - Leominster	2006	10	\$ 177,964	10	\$ 153,504
5	NGRID - Worcester	2009	2	\$ 46,069	0	\$ -
6	NGRID - Norwell	2006	2	\$ 10,616	0	\$ -
7	NSTAR - Woburn	2006	2	\$ 5,100	2	\$ 1,052
8	NSTAR - Framingham	2006	2	\$ 109,018	1	\$ 92,177

Slower load growth makes the DG solution more attractive.

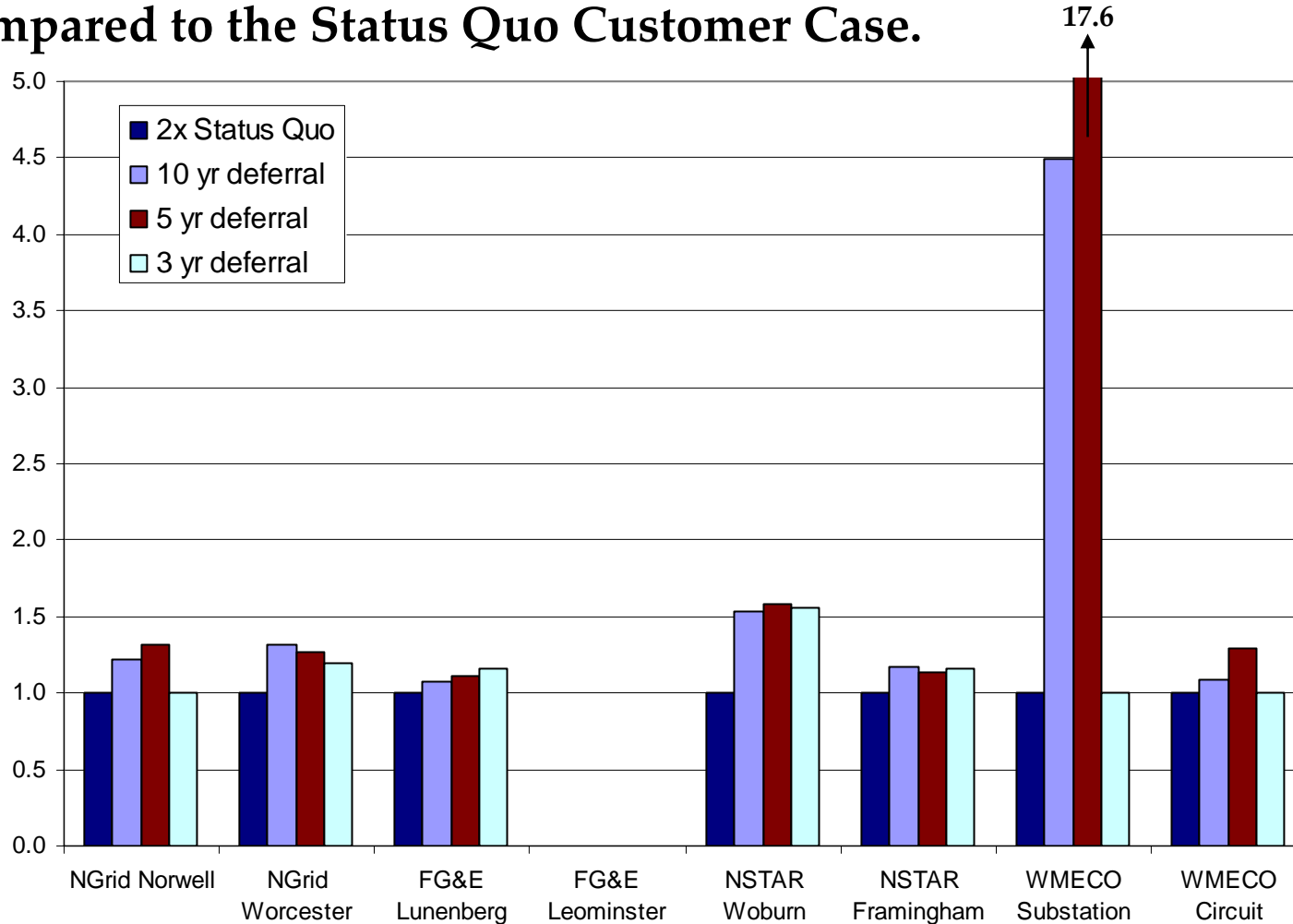
Case Data			Base Case Growth		Low Load Growth (-50% Base)	
Case No.	Utility	T&D Solution - Year	Deferral Years	Net NPV	Deferral Years	Net NPV
1	WMECO - Circuit	2008	3	\$ 112,060	4	\$ 172,981
2	WMECO - Substation	2009	7	\$ 1,295,454	7	\$ 1,403,389
3	FG&E - Lunenburg	2007	2	\$ 83,460	3	\$ 172,100
4	FG&E - Leominster	2006	10	\$ 177,964	10	\$ 177,964
5	NGRID - Worcester	2009	2	\$ 46,069	3	\$ 159,941
6	NGRID - Norwell	2006	2	\$ 10,616	3	\$ 26,793
7	NSTAR - Woburn	2006	2	\$ 5,100	3	\$ 14,427
8	NSTAR - Framingham	2006	2	\$ 109,018	3	\$ 188,557

Case Data			Utility Ownership		High Load Growth (+50% Base)	
Case No.	Utility	T&D Solution - Year	Deferral Years	Net NPV	Deferral Years	Net NPV
1	WMECO - Circuit	2008	3	\$ 112,060	2	\$ 45,431
2	WMECO - Substation	2009	7	\$ 1,295,454	7	\$ 1,240,688
3	FG&E - Lunenburg	2007	2	\$ 83,460	2	\$ 83,394
4	FG&E - Leominster	2006	10	\$ 177,964	10	\$ 177,964
5	NGRID - Worcester	2009	2	\$ 46,069	1	\$ 30,190
6	NGRID - Norwell	2006	2	\$ 10,616	2	\$ 7,883
7	NSTAR - Woburn	2006	2	\$ 5,100	2	\$ 5,099
8	NSTAR - Framingham	2006	2	\$ 109,018	1	\$ 92,177

- Active Distributed Generation:** There is now a one-time incentive payment in year 1 corresponding to annual deferral savings were determined from the utility DG module. The NPV of the savings from 2006 to 2015 was determined for each opportunity. This was then divided by the capacity shortfall in 2015 to determine the value of the one-time incentive payment, \$/kW. **Modified Assumption – savings is divided by 1.5 times the capacity shortfall to cover the reliability needs and the administration fee.**
Sensitivity – Varied the incentive payments by different lengths of deferral.

	NGRID Norwell	NGRID Worcester	FG&E Lunenburg	FG&E Leominster	NSTAR Woburn	NSTAR Framingham	WMECO Circuit	WMECO Substation
3-Yr	\$ -	\$ 143	\$ 215	\$ 1,669	\$ 208	\$ 124	\$ -	\$ -
5-Yr	\$ 127	\$ 191	\$ 146	\$ 2,544	\$ 218	\$ 112	\$ 228	\$ 1,351
10-Yr	\$ 90	\$ 234	\$ 100	\$ 4,027	\$ 197	\$ 134	\$ 96	\$ 503

Incentive payments calculated based on different deferral periods are compared to the Status Quo Customer Case.



Note: The status quo customer case is normalized to compare to the active customer cases by multiplying annual installations by 2. This effectively changes the 10 year market adoption in the status quo case, to the 5 year market adoption in the active customer case. In the status quo case there is no incentive payment. The incentive payments in each opportunity above correspond to the table on the previous page.