FILED WITH
Executive Secretary
January 25, 2013
IOWA UTILITIES BOARD

Appendix L

IPL 2012 Integrated Resource Plan

A copy of IPL's 2012 Integrated Resource Plan, as filed with the Board on November 14, 2012, in Docket Nos. GCU-2012-0001/RPU-2012-0003, is included in this appendix in support of IPL's Energy Efficiency Plan in Docket No. EEP-2012-0001.

TABLE OF CONTENTS

SECTION	CONTENTS		PAGE
1	**INTRODUCTION**		**1-1**
	1.0	The IPL System	1-1
	1.1	Overview of Plan Development	1-2
	1.2	Future Industry Considerations	1-3
	1.3	Orders by the Iowa Utilities Board (IUB) Affecting IPL's Resource Plan	1-4
2	**LOAD FORECAST**		**2-1**
	2.0	Overview of the Load Forecast	2-1
	2.1	Summary Results	2-2
	2.2	IPL Energy Forecast	2-4
	2.3	IPL Demand Forecast	2-8
	2.4	Income Scenarios	2-10
	2.5	Illustration of Implicit DSM	2-12
3	**DEMAND-SIDE MANAGEMENT**		**3-1**
	3.0	Background	3-1
4	**DISTRIBUTED GENERATION**		**4-1**
	4.0	Distributed Generation Potential	4-1
	Appendix 4A, Distributed/Onsite Generation Options - Iowa October 9, 2001		
	Appendix 4B, Distributive/Onsite Generation Technical Potential, Iowa Estimate		
	Appendix 4C, Distributive/Onsite Generation Technical Potential,		

TABLE OF CONTENTS

SECTION	CONTENTS		PAGE
		Minnesota Estimate	
	Appendix 4D, Distributed/Onsite Generation Options - Minnesota June 11, 2003		
	Appendix 4E, Distributed Generation Assessment – Update Minnesota February 13, 2009		
	Appendix 4F, Distributed Generation Assessment – Update Minnesota September 27, 2010		
5	**RESOURCE ALTERNATIVES**		**5-1**
	5.0	Supply-Side Alternatives	5-1
	5.1	Demand-Side Alternatives	5-10
	5.2	Future Resource Alternatives	5-10
	Appendix 5A, Wind Farm Historical Actual Data Summary		
	Appendix 5B, 2010 Power Station Characterization Study		
	Appendix 5C, Alternative Resource Characteristics		
	Appendix 5D, Change Rates for Key Economic Variables		
6	**RESOURCE PLAN**		**6-1**
	6.0	Overview of Analyses	6-1
	6.1	Proposed Plan	6-3
	6.2	Transmission Congestion	6-5
	6.3	EGEAS Assumptions	6-7
	6.4	Scenarios	6-22
	6.5	Robustness of Proposed Plan	6-31
	Appendix 6A, Load and Capability Graph – Before		

TABLE OF CONTENTS

SECTION	CONTENTS	PAGE
	Resource Additions	
	Appendix 6B, Fuel Costs (CONFIDENTIAL)	
	Appendix 6C, IPL's Existing Generating Units, Purchases and Sales (CONFIDENTIAL)	
	Appendix 6D, Projected Costs and Operating Parameters of Tier 1 and Tier 2 Units (CONFIDENTIAL)	
	Appendix 6E, Reference Case Production Costs (CONFIDENTIAL)	
	Appendix 6F, Scenario Expansion Plans Base Set (Plan 1)	
	Appendix 6G, Scenario Cost Summary Base Set (Plan 1)	
	Appendix 6H, Scenario Expansion Plans Retirement Sensitivity (Plan 2 and Plan 3)	
	Appendix 6I, Scenario Cost Summary Retirement Sensitivity (Plan 2 and Plan 3)	
	Appendix 6J, Load and Capability Graph – After Resource Additions	
	Appendix 6K, Intermediate Steam Unit Repair Costs (CONFIDENTIAL)	
	Appendix 6L, Peaking Unit Repair Costs (CONFIDENTIAL)	
7	**ACTION PLAN**	**7-1**
	7.0 General	7-1
	7.1 Demand-Side Management Activities	7-1
	7.2 Supply-Side Activities	7-2
	7.3 Renewable Activities	7-3

TABLE OF CONTENTS

SECTION	CONTENTS		PAGE
	7.4	Transmission Activities	7-5
	7.5	Environmental Activities	7-5
	7.6	Environmental Regulatory and Related Initiatives	7-17
	7.7	Other Actions	7-24
	Appendix 7A, IPL's Renewable Energy Position		
	Appendix 7B, IPL's Renewable Energy Production		
	Appendix 7C, IPL's C-BED Annual Report		
8	**PUBLIC INTEREST CONSIDERATIONS**		**8-1**
	8.0	Overall Factors	8-1
	8.1	Specific Factors	8-4
	8.2	Considerations of the Proposed Plan	8-4
9	**SUMMARY**		**9-1**
	9.0	The IPL System	9-1
	9.1	Overview of Plan Development	9-2
	9.2	Supply-side Resource Options	9-3
	9.3	Demand-side Resource Options	9-4
	9.4	Resource Plan	9-4
	9.5	Upcoming Resource Activities	9-5
	9.6	Effect on Electric Rates	9-8
	Appendix 9A, Load and Capability Table – Before Resource Additions		
	Appendix 9B, Scenario Cost Summary		

TABLE OF CONTENTS

SECTION	CONTENTS	PAGE
	Base Set (Plan 1)	
	Appendix 9C, Scenario Cost Summary Retirement Sensitivity (Plan 2 and Plan 3)	
	Appendix 9D, Reference Case Expansion Plan	
	Appendix 9E, IPL's Renewable Energy Position	
	Appendix 9F, IPL's Renewable Energy Production	
10	**LOAD & CAPABILITY DATA**	**10-1**
	10.0 Load & Capability Table	10-1
	10.1 Capacity Ratings	10-1
	10.2 Generating Unit Data	10-1
	Appendix 10A, 2012-2027 IPL Load and Capability Table - After Resource Additions	
	Appendix 10B, 2012-2027 IPL Load and Capability Table - Before Resource Additions	
	Appendix 10C, IPL Planning Resource Credit (PRC) Ratings	
	Appendix 10D, IPL Generating Unit Data	

INTRODUCTION

This is the 2012 Electric Resource Plan of Interstate Power and Light Company (IPL or Company), a regulated utility company of Alliant Energy Corporation (Alliant Energy). IPL's 2012 Electric Resource Plan is being filed with the State of Iowa as an update to IPL's 2010 Electric Resource Plan.

1.0 The IPL System

IPL is a regulated utility company that provides electricity and natural gas to retail customers in two mid-western states. Today, IPL serves more than 500,000 electric customers and more than 200,000 natural gas customers in over 100 counties in Iowa and Minnesota. IPL's electric customers currently have an adjusted net internal demand of 2,761 MW, which is projected to grow 350 MW over the next 15 years. Of IPL's electric retail customers, Iowa accounts for approximately 92 percent, and Minnesota approximately eight percent. IPL's Illinois retail load was sold in February 2007 but is still being served today by IPL as a wholesale load to Jo-Carroll Energy. Note that the forecast used in this 2012 Electric Resource Plan assumes loss of Jo-Carroll in 2014, which is approximately 65-70 MW.

IPL's service territory encompasses approximately 54,000 square miles, including over 22,000 miles of electric distribution line and over 5,000 miles of natural-gas transmission and distribution main. IPL currently owns all or portions of generating facilities located in both Iowa and Minnesota. These owned units produce approximately 2,430 Planning Resource Credits (PRC's) towards The Midwest Independent Transmission System Operator (MISO) Module E Resource Adequacy requirements. IPL's portfolio includes base load plants which operate year round and are fueled with coal. IPL's portfolio also includes intermediate or combined cycle

units, such as the Emery Generating Station, which provide load following capability and are primarily fueled with natural gas. Combustion turbines and diesel generators at various locations throughout IPL's system provide supplemental energy at points throughout the year when demand is highest. IPL also recently installed in late 2009 a 200 MW wind farm, Whispering Willow Wind Farm - East, in Franklin County, Iowa, which IPL owns and operates. In addition to owned generation, IPL has purchased power contracts for approximately 250 MW from various wind resources as well as for approximately 400 MW from a nuclear plant, the Duane Arnold Energy Center. IPL delivers the energy and exceptional service that our customers and communities count on – safely, efficiently and responsibly.

1.1 Overview of Plan Development

The process used in developing this plan begins with the system load forecast. This forecast includes the needs of all firm IPL customers. The system load forecast plus a reserve requirement is matched against existing capacity to determine IPL's preliminary resource needs. By using the Electric Generation Expansion Analysis System (EGEAS) computer model, all combinations of existing resources and modeled future resource alternatives are considered when determining the optimal expansion plan. Renewable alternatives, Demand-Side Management (DSM) programs and conventional supply-side units are all considered in the resource planning process. The objective function within EGEAS is to minimize the cumulative present worth of revenue requirements for the 15-year planning period plus a 35-year extension period, while maintaining the Midwest Independent System Operator (MISO) planning reserve margin (PRM_{ucap}) of 3.81 percent in each year. However, system reliability and financial risks must also be considered. The ultimate goal is to minimize cost, maximize reliability and minimize risk. Given reasonable assumptions and after careful consideration of costs, reliability and risks, a reference case is constructed.

Once a reference case is determined, IPL develops additional scenarios or sensitivities by changing various input assumptions. Some of the scenarios are regulatory requirements, while IPL creates others by varying key input assumptions to provide supplemental insight. Examples of sensitivities include changes to:

- Load forecast
- Market economy energy availability
- Renewable requirements
- Carbon monetization
- Fuel costs
- Capital costs

1.2 Future Industry Considerations

With regard to this study, IPL maintains that it is important to consider changes and potential future changes affecting the electric utility industry before making resource decisions. Currently, one of the biggest issues affecting resource planning is the uncertainty surrounding potential greenhouse gas regulation. IPL recognizes potential future greenhouse gas regulation as a significant issue and takes this consideration very seriously by subsequently modeling different carbon dioxide (CO_2) cost scenarios within its 2012 Electric Resource Plan. One of the CO_2 cost scenarios was developed by Wood Mackenzie, with whom IPL contracts for several of its other Resource Plan projections, including but not limited to coal, natural gas and market power prices. Two other CO_2 price projections were established in Minnesota Docket No. E-999/CI-07-1199, Order Establishing Estimate of Future Carbon Dioxide Regulation Costs. These three CO_2 cost scenarios are further described in Section 6.3.3.

Potential future greenhouse gas regulation introduces risks that must be considered before a utility commits to a resource planning decision. When the outcome of greenhouse gas regulation is determined, the affects on resource planning will become clearer. In the meantime however, the result for resource planning is that while future needs can be projected and considered, investing in future resources can only be done when the risk is supported by a reasonable expectation of a fair and timely return on investment.

1.3 Orders by the Iowa Utilities Board (IUB) Affecting IPL's Resource Plan

On August 7, 2012 IPL filed an amendment in Iowa Utilities Board re-organization Docket Number SPU-2005-0015 to continue purchasing power and energy from NextEra's Duane Arnold Energy Center (DAEC) for 2014 through 2025. This filing was docketed and a procedural schedule was set on August 23, 2012 and modified on September 10, 2012. A hearing was set for December 17, 2012. IPL expects a decision in this docket in early 2013.

LOAD FORECAST

2.0 Overview of the Load Forecast

IPL maintains forecasts of both demand and energy for financial planning, regulatory compliance, and optimization of the generation portfolio. Sales are classified by revenue class, which is used for FERC and corporate financial reporting. Discussion of the forecasts used in this IRP can be found as follows:

- Section 2.1 – Summary
- Section 2.2 – IPL Energy forecasts
- Section 2.3 – IPL Demand forecast
- Section 2.4 – Income Scenarios
- Section 2.5 – Illustration of Implicit DSM

2.1 Summary

Figures 2.1.1 and 2.1.2 provide a graphical representation of each forecast. Table 2.1.1 summarizes IPL's annual energy forecast, and Table 2.1.2 summarizes IPL's Adjusted Net Internal Demand forecast.

Figure 2.1.1
IPL Energy Forecast

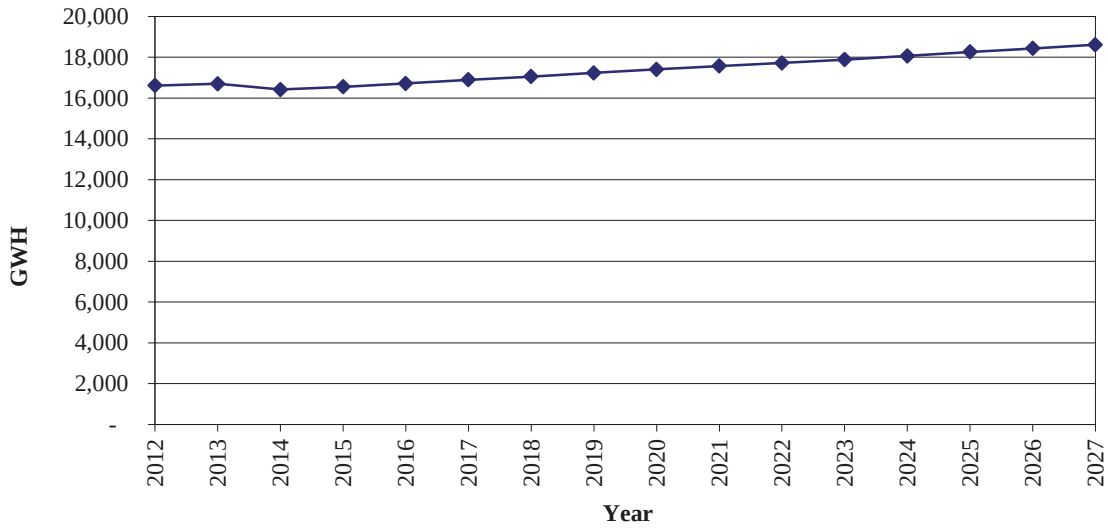


Figure 2.1.2
IPL Peak Forecast
Adjusted Net Internal Demand

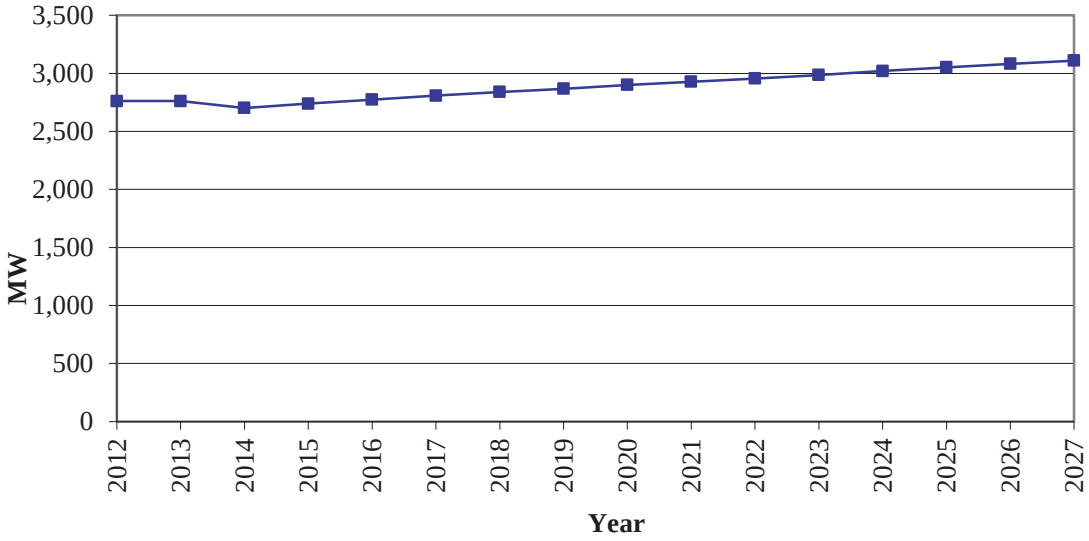


Table 2.1.1
IPL Annual Energy Forecast (GWH)

Year	IPL
2012	16,612
2013	16,702
2014	16,415
2015	16,554
2016	16,715
2017	16,897
2018	17,056
2019	17,235
2020	17,405
2021	17,572
2022	17,719
2023	17,883
2024	18,068
2025	18,258
2026	18,430
2027	18,614

Table 2.1.2
IPL Peak Forecast (MW)
Adjusted Net Internal Demand

Year	IPL
2012	2,760.8
2013	2,761.8
2014	2,702.5
2015	2,738.9
2016	2,774.2
2017	2,807.7
2018	2,840.1
2019	2,867.6
2020	2,900.1
2021	2,927.6
2022	2,955.2
2023	2,985.6
2024	3,020.0
2025	3,052.4
2026	3,081.8
2027	3,110.3

2.2 IPL Energy Forecast

2.2.1 Overview

The IPL energy forecast starts with a trended short term forecast of the number of customers. Forecasted customers are multiplied by the results from a short term regression model of use per customer and compared with recent historical sales by class. Next, a long term energy forecast is developed using forecasted customer counts and a regression model of annual use per customer. The long term model is then compared to other energy forecasts. Finally, the growth rates estimated in the short term and long term are reconciled in a two year transition period.

2.2.2 Data

- Sales and customers – For the short term model, IPL uses monthly billed data since 2001. For long term sales, IPL uses annual sales and customers from the FERC FORM 1.
- Weather is measured using Heating Degree Days (HDD) and Cooling Degree Days (CDD) and matched to the sales on a route level. Normal is defined as the 20 year rolling average, based on weather reported from Cedar Rapids Airport.
- Economic data comes from third party vendor, IHS Global Insight, unless otherwise stated.

2.2.3 Methods

2.2.3.1 Short Term Energy Forecast Method

The IPL short term forecasted sales are based on regression analysis of monthly use per customer by revenue class. Variables included in the regression models include weather, economic, and various indicator variables. The forecast of monthly customer counts is based on historical trends. Results from the statistical customer usage model are multiplied by the forecasted number of customers and adjusted based on historical calendar month sales and changes in large customer loads. Forecasts of IPL's smaller classes are also added. Finally, estimated losses are applied to arrive at the short term energy forecast.

2.2.3.2 Long Term Energy Forecast Method

To forecast long term energy, regression analysis is performed on annual class level sales per customer. Regression variables include weather, economic variables, price, and indicator variables. The forecasted customer count is based on historical annual customer trends and is multiplied by the forecasted use per customer. The Industrial class is adjusted based on known large customer changes and smaller classes such as street lighting are added to the forecast. Next the annual growth rate from the long term model is determined. The growth rate for the third and fourth year, 2014 and 2015 in the current IRP, transition from the short term to the long term and the long term growth rate is applied annually beginning with the fifth year. Estimated losses are applied to arrive at annual Energy Forecast.

2.2.4 Results

2.2.4.1 Short Term Energy Results

The final, class level, short term energy forecasts are the statistical regression results with any necessary adjustments. Forecasted Short term Energy by Class is presented in Table 2.2.4.1.

Table 2.2.4.1
Annual Short Term Forecasted Energy by Class (GWh)

Year	Residential	Commercial	Industrial	St. Lights	Pub. Auth.	Resale	Co. use	Losses	Total
2012	4,116	3,926	7,015	56	28	427	25	1,020	16,612
2013	4,128	3,962	7,048	56	28	430	25	1,026	16,702

2.2.4.2 Long Term Energy Results

Long Term Forecasted Energy, as modeled, is found in the file “Results 11-21-11.xls”. Finally, the growth rates are reviewed and adjusted in the file “2012 Allocation (05.18.12) -TS.xlsx.” Since it is the growth rates from the long term model that are applied, the class level growth rates are shown in Table 2.2.4.2 below.

Table 2.2.4.2
Annual Long Term Energy Forecasted Growth Rates

Year	Residential	Commercial	Industrial	St. Lights	Pub. Auth.	Resale	Co. use	Losses	Total
2014	0.5%	1.0%	0.7%	0.0%	0.0%	-88.1%	0.0%	-1.7%	-1.7%
2015	0.7%	1.1%	0.8%	0.0%	0.0%	1.6%	0.0%	0.8%	0.8%
2016	0.9%	1.2%	0.9%	0.0%	0.0%	1.6%	0.0%	1.0%	1.0%
2017	0.9%	1.3%	1.1%	0.0%	0.0%	1.0%	0.0%	1.1%	1.1%
2018	0.7%	1.3%	0.9%	0.0%	0.0%	1.0%	0.0%	0.9%	0.9%
2019	0.9%	1.3%	1.0%	0.0%	0.0%	1.0%	0.0%	1.0%	1.1%
2020	0.8%	1.3%	0.9%	0.0%	0.0%	1.0%	0.0%	0.9%	1.0%
2021	0.8%	1.3%	0.9%	0.0%	0.0%	1.0%	0.0%	0.9%	1.0%
2022	0.6%	1.3%	0.7%	0.0%	0.0%	1.0%	0.0%	0.7%	0.8%
2023	0.7%	1.3%	0.8%	0.0%	0.0%	1.0%	0.0%	0.9%	0.9%
2024	0.9%	1.3%	1.0%	0.0%	0.0%	1.0%	0.0%	1.0%	1.0%
2025	0.9%	1.3%	1.0%	0.0%	0.0%	1.0%	0.0%	1.0%	1.1%
2026	0.7%	1.3%	0.9%	0.0%	0.0%	1.0%	0.0%	0.9%	0.9%
2027	0.8%	1.3%	0.9%	0.0%	0.0%	1.0%	0.0%	1.0%	1.0%

2.2.4.3 Confidence Intervals

To estimate the confidence interval of each statistically modeled class, the upper and lower bound of each confidence interval for each class from the long term model was multiplied by the forecasted number of customers. The difference from the originally forecasted energy is represented below as the confidence interval. These are presented below in tables 2.2.4.3. The Large Industrial, Lighting, Municipal Pumping, Resale, and Company Use classes are not statistically modeled so no confidence intervals were computed.

Table 2.2.4.3
95% Confidence Intervals IPL Energy Models

Year	Residential +/- GWH	Commercial +/- GWH	Industrial +/- GWH
2012	150	156	397
2013	159	164	409
2014	175	176	430
2015	179	183	443
2016	181	188	453
2017	184	192	460
2018	185	195	466
2019	187	199	474
2020	189	203	480
2021	191	206	487
2022	192	208	491
2023	193	211	497
2024	196	216	505
2025	198	220	514
2026	200	224	521
2027	202	228	529

2.3 IPL Demand Forecast

2.3.1 Overview

There are several definitions of demand. Internal Demand is the highest observed load. IPL reduces the Internal Demand by the Interruptible and Direct Load Control (DLC) to arrive at Firm Peak, which is used for forecasting. For planning purposes, the Firm Peak is adjusted by the diversity with CIPCO to arrive at Adjusted Net Internal Demand which is used in the EGEAS analysis.

2.3.2 Method

To forecast demand, IPL forecasts some of its largest customers individually. The remaining customers are forecast using regression analysis. Variables included in the regression include weather, income, summer-time price of electricity and an indicator of the addition of the Union Electric territory. Next, forecasted interruptible load is added. Finally, interruptible load and diversity is subtracted to arrive at Adjusted Net Internal Demand.

2.3.3 Data

- Peak demand is measured at the time of the IPL firm peak.
- Large Customer demand is at the time of the system peak and is forecasted independently.
- Weather is an index of temperatures, humidity, and CDD on the day of and days leading up to the peak day.
- Prices are average real IPL prices based on IPL revenues and sales and adjusted for inflation.
- Income is based on IHS Global Insight data.

2.3.4 Results

2.3.4.1 Demand Model Results

Table 2.3.4.1
Forecasts of Demand Components (MWs)

Year	Internal Demand	Interruptible	DLC	Firm Peak	Diversity	Adj. Net Internal Demand
2012	3,053.5	243.0	33.0	2,777.5	16.7	2,760.8
2013	3,056.8	245.0	33.3	2,778.5	16.7	2,761.8
2014	2,999.4	247.0	33.7	2,718.8	16.3	2,702.5
2015	3,039.4	250.0	34.0	2,755.4	16.5	2,738.9
2016	3,077.3	252.0	34.3	2,790.9	16.7	2,774.2
2017	3,114.3	255.0	34.7	2,824.6	16.9	2,807.7
2018	3,149.2	257.0	35.0	2,857.2	17.1	2,840.1
2019	3,180.3	260.0	35.4	2,884.9	17.3	2,867.6
2020	3,216.3	263.0	35.7	2,917.6	17.5	2,900.1
2021	3,246.4	265.0	36.1	2,945.3	17.7	2,927.6
2022	3,277.4	268.0	36.5	2,973.0	17.8	2,955.2
2023	3,311.4	271.0	36.8	3,003.6	18.0	2,985.6
2024	3,348.4	273.0	37.2	3,038.2	18.2	3,020.0
2025	3,384.3	276.0	37.6	3,070.8	18.4	3,052.4
2026	3,417.3	279.0	37.9	3,100.4	18.6	3,081.8
2027	3,449.4	282.0	38.3	3,129.1	18.8	3,110.3

2.3.4.2 Demand Confidence Interval

To illustrate the forecast range stemming from historical variation from the model, the 95% confidence interval for the demand forecast is listed below.

Table 2.3.4.2
95% Confidence Interval
Adjusted Net Internal Demand (MWs)

Year	High	Base	Low
2012	2,540.9	2,760.8	3,001.7
2013	2,538.0	2,761.8	3,007.5
2014	2,471.8	2,702.5	2,957.0
2015	2,501.3	2,738.9	2,999.3
2016	2,530.7	2,774.2	3,042.5
2017	2,558.3	2,807.7	3,081.9
2018	2,584.8	2,840.1	3,122.2
2019	2,606.5	2,867.6	3,155.7
2020	2,632.1	2,900.1	3,194.9
2021	2,654.7	2,927.6	3,229.4
2022	2,677.3	2,955.2	3,262.8
2023	2,700.9	2,985.6	3,301.2
2024	2,727.4	3,020.0	3,345.3
2025	2,752.0	3,052.4	3,385.6
2026	2,775.5	3,081.8	3,422.8
2027	2,797.2	3,110.3	3,459.2

2.4 Income Scenarios

2.4.1 Overview

IPL performed two scenarios for each forecast. These two scenarios included a 0.5% increase (50 basis points) and a - 0.5% decrease in Iowa Gross State Product and Personal Income Per Capita above and below, respectively, the base case assumption for each year.

2.4.2 Method

For each model the economic variable was adjusted for the forecasted period.

2.4.3 Data

With the exception of the economic variables, the data is the same as the data used in the base model.

2.4.4 Results

The results of these analyses on the energy and peak forecasts are shown in Table 2.4.4.1 and Table 2.4.4.2 respectively.

Table 2.4.4.1
Energy Income Scenarios (GWH)

Year	High	Base	Low
2012	16,641	16,612	16,583
2013	16,752	16,702	16,652
2014	16,498	16,415	16,332
2015	16,671	16,554	16,438
2016	16,866	16,715	16,566
2017	17,078	16,897	16,718
2018	17,268	17,056	16,848
2019	17,479	17,235	16,997
2020	17,682	17,405	17,136
2021	17,883	17,572	17,271
2022	18,064	17,719	17,387
2023	18,263	17,883	17,518
2024	18,486	18,068	17,669
2025	18,717	18,258	17,824
2026	18,927	18,430	17,960
2027	19,152	18,614	18,107

Table 2.4.4.2
Peak (Adjusted Net Internal Demand)
Income Scenarios (MW)

Year	High	Base	Low
2012	2,765.8	2760.8	2755.9
2013	2,771.7	2761.8	2753.0
2014	2,717.2	2702.5	2688.8
2015	2,757.5	2738.9	2719.2
2016	2,799.6	2774.2	2749.7
2017	2,837.0	2807.7	2777.3
2018	2,875.2	2840.1	2804.9
2019	2,908.6	2867.6	2827.5
2020	2,945.9	2900.1	2854.2
2021	2,979.3	2927.6	2875.8
2022	3,012.7	2955.2	2897.5
2023	3,050.0	2985.6	2923.2
2024	3,090.2	3020.0	2951.7
2025	3,128.4	3052.4	2977.2
2026	3,164.7	3081.8	3000.8
2027	3,199.1	3110.3	3022.5

2.5 Illustration of implicit DSM

IPL does not use Demand Side Management (DSM) as a separate input to the forecast, as the DSM program has been in place for a number of years. Historical actual sales data include the DSM programs in effect at the time, so IPL's regression analysis includes DSM implicitly. To illustrate the DSM assumption in the forecast, IPL created the following comparison which relies on a number of assumptions to estimate the DSM impacts including:

- Program life – IPL assumes DSM programs last 12 years before a customer needs to replace the appliance.
- Free riders – IPL assumes no free riders.
- Replacement option- IPL assumes 33% of program participants will continue to purchase efficient equipment without reapplying for rebates. This is referred to as Option B in IPL's work papers.

The estimated impact of assuming implicit DSM in the forecast instead of using planned DSM is shown in Tables 2.5.1 and Table 2.5.2

TABLE 2.5.1
Comparison of Implicit and Planned DSM (MWh)

Calendar Year	Implicit DSM	Planned DSM	Difference	Percent Difference in Native Requirements
2012	1,882,016	1,882,016	-	0.0%
2013	1,968,718	2,034,235	65,517	0.4%
2014	2,055,420	2,194,166	138,746	0.8%
2015	2,142,122	2,342,446	200,325	1.2%
2016	2,228,824	2,491,469	262,646	1.6%
2017	2,315,526	2,626,408	310,882	1.8%
2018	2,402,228	2,755,239	353,011	2.1%
2019	2,488,930	2,882,181	393,251	2.3%
2020	2,575,632	3,014,414	438,782	2.5%
2021	2,662,334	3,108,916	446,582	2.5%
2022	2,749,036	3,214,500	465,464	2.6%
2023	2,835,738	3,299,617	463,879	2.6%
2024	2,922,440	3,376,988	454,548	2.5%
2025	3,009,142	3,448,960	439,819	2.4%
2026	3,095,844	3,520,957	425,114	2.3%
2027	3,182,546	3,592,957	410,411	2.2%

TABLE 2.5.2
Comparison of Forecasts with Implicit or No DSM (MWh)

Calendar Year	Native Requirements (P&E 5-23-12)	Implicit DSM	No DSM
2012	16,612,247	1,882,016	18,494,263
2013	16,701,947	1,968,718	18,670,665
2014	16,414,834	2,055,420	18,470,254
2015	16,554,033	2,142,122	18,696,154
2016	16,715,303	2,228,824	18,944,127
2017	16,896,627	2,315,526	19,212,153
2018	17,055,911	2,402,228	19,458,139
2019	17,235,285	2,488,930	19,724,214
2020	17,404,739	2,575,632	19,980,371
2021	17,571,631	2,662,334	20,233,965
2022	17,718,782	2,749,036	20,467,818
2023	17,882,578	2,835,738	20,718,316
2024	18,067,581	2,922,440	20,990,020
2025	18,258,350	3,009,142	21,267,492
2026	18,429,764	3,095,844	21,525,608
2027	18,613,575	3,182,546	21,796,121

DEMAND-SIDE MANAGEMENT

3.0 Background

IPL(IA) and IPL(MN) implement conservation programs/projects in Iowa and Minnesota. These programs have been offered since the early 1990s. IPL(IA) conducts energy conservation programs in Iowa according to the plan approved by the IUB in Docket No. EEP-08-1 pursuant to 199 Iowa Administrative Code Chapter 35. This Docket represents the Plan in Iowa that has been in place since January 1, 2009. A new Iowa plan will be filed at the end of 2012. IPL(IA) achieved energy savings of 191,378,014 kWh and 307,906 kW, compared to the goal of 154,000,101 kWh and 323,183 kW.

IPL(MN) has been filing Electric Conservation Improvement Plans (ECIPs) biennially until the most recent plan with the Minnesota Office of Energy Security, now the Division of Energy Resources, in the Department of Commerce (Department) since 1991. The most recently approved IPL(MN) ECIP (Department Docket No. E-001/CIP-09-636) was filed with the Department on May 29, 2009, and was approved by the Deputy Commissioner of the Department on November 23, 2009. It is a three year plan, addressing the years 2010-2012. A new Minnesota plan was filed June 1, 2012 and is in the approval process with the Department. In 2011, IPL(MN) achieved energy savings of 7,223,947 kWh and 1,173 kW in its Minnesota CIP plan. This compares to a goal of 12,422,858 kWh and 1,198 kW at the meter.

Additional information on DSM activities, especially those related to IPL(MN), can be found in IPL's 2010 Electric Resource Plan, Section 3. The demand and energy forecast used in the 2012 Electric Resource Plan are net of existing and ongoing conservation programs. This implicit DSM is illustrated in Section 2.5.

DISTRIBUTED GENERATION

4.0 Distributed Generation Potential

IPL has analyzed the key inputs underlying the Distributed Generation (DG) potential provided in previous IPL Electric Resource Plans and concludes that the DG potential in those plans is still applicable for IPL's 2012 Electric Resource Plan. The remainder of Section 4.0 provides a summary of the analysis that leads to IPL's conclusion.

The initial estimate of DG potential was done using a screening model developed by GDS Associates, Inc., for IPL's 2001 Electric Resource Plan. The complete 2001 study is found in Appendix 4A. The estimate of Iowa DG potential in this study is found in Appendix 4B and the estimate of Minnesota potential in the study is found in Appendix 4C. A 2003 GDS update of DG potential focused on Minnesota only and is included in Appendix 4D. An update issued by GDS in 2009 that examined key cost assumptions underlying the potential study is found in Appendix 4E. Most recently, GDS provided an update in September, 2010, of its 2009 report. The 2010 update is presented in Appendix 4F. The rationale for the 2009 and 2010 updates is to determine if the various economic drivers that have an impact on project economic viability have changed significantly such that DG potential has changed from the 2001/2003 studies.

The summary tables for 2001 Minnesota and Iowa DG potential and 2003 Minnesota only DG potential are provided below in Tables 4.1 and 4.2, respectively.

Table 4.1: IPL Distributed Generation Potential (payback of five years or less) – 2001

Technical Potential Category	IOWA		MINNESOTA	
	10% kW	100% kW	10% kW	100% kW
Total Distributed Generation Potential	7,392	73,918	160	1,602
Combined Heat & Power Only (Cogeneration)	7,392	73,918	160	1,602

Table 4.2: IPL-MN Distributed Generation Potential – 2003

	10% Participation Rate		25% Participation Rate		100% Participation Rate	
	5 Year Payback	**10 Year Payback**	**5 Year Payback**	**10 Year Payback**	**5 Year Payback**	**10 Year Payback**
Total DG Potential (MW)	5.3	13.5	13.2	33.7	52.6	134.8

The 2003 analysis indicated 33 times greater DG potential (52.6 MW vs. 1.6 MW) in the five year or less payback category than did the report for the 2001 Electric Resource Plan, with almost 60 percent of that attributable to wind energy.

A key input that underlies the 2003 analysis is DG equipment cost. GDS reports in the 2010 study that the installed "per kW" cost for most technologies included in the 2003 study have increased significantly. These increases are shown in Table 4.3 below.

Table 4.3: Distributed Generation Installed Cost
(Source: 2010 GDS Update, Table 2)

Manufacturer and Model	2003 ($/kW)	2010 ($/kW)	% Change
Solar			
Generic 1kW PV	$10,000	$8,568	-14.32%
Wind Turbines			
Fuhrlander FL100	$1,750	$3,800	117.14%
Fuhrlander FL250	$1,500	$1,960	30.67%
Bergey BWC XL.1-24	$3,500	$5,670	62.00%
Zephyr (GE) 1.5 SLE	$1,500	$1,933	28.87%
Bio-Gas Microturbines			
Capstone C30	$2,200	$6,600	200%
Captstone C60	$1,900	$3,600	89%
Natural Gas MicroTurbines			
Capstone C30	$3,500	$2,520	-28%

Similarly, GDS also reports in the 2010 study that the cost of fuel used by combined heat and power (CHP) has increased significantly since the 2001/2003 studies were completed. These increases are shown in Table 4.4 below.

Table 4.4: Distributed Generation Fuel Costs
(Source: 2010 GDS Update, Table 1)

Fuel Type (units)	2003 Cost Estimate	2010 Cost Estimate	% Change
Diesel ($/gal)	$1.07	$3.020	182.2%
Biodiesel ($/gal)	$1.32	$3.120	136.36%
Natural Gas ($/therm)	$0.502	$0.673	34.1%

Based on the results of the 2010 GDS study, it would appear that the potential for DG projects may have decreased somewhat since the 2001 and 2003 studies were completed since the installed costs and fuel costs have risen significantly.

However, GDS found two other economic drivers have changed in favor of DG projects, suggesting that the potential for DG projects may not have declined as much as indicated immediately above. The two factors are government subsidies and new technologies.

The emergence of new or expanded federal and state subsidies since 2003 is considerable. There are three areas that GDS cites in its 2010 study. First, in May of 2010, the Minnesota Office of Energy Security (OES) launched a Residential Small Wind Rebate Program. The program closely mirrors the Residential Solar Rebate Program, another buy-down offered by the OES to reduce the initial cost of grid connected photovoltaic technologies. Through the program, residential customers can receive a rebate of 35 percent of the total installed cost, up to $10,000, of wind turbines with capacity equal or below 35 kW. Second, the Wind and Biomass Renewable Electricity Production Credit (REPC), known also as the Wind Energy Production Tax Credit (PTC) has been significantly restructured as a result of American Recovery and Reinvestment Act

(ARRA) of 2009. Previously, eligible businesses received a federal tax credit of $0.18 for each kWh produced by a qualified renewable energy resource. Businesses eligible for the PTC program now have the option of receiving the Business Energy Investment Tax Credit (ITC) or a grant from the US Treasury through the Renewable Energy Grant program instead of taking the PTC for new installations. The ITC allows businesses installing qualified renewable distributed generation technologies to receive a corporate tax credit of 30 percent of installed cost for solar, fuel cells, and small wind, geothermal, microturbines and combined heat and power. Third, the Minnesota Agricultural Improvement Loan Program has expanded since 2009. This program allows Minnesota residents, domestic family-farm corporations or family-farm partnerships to secure loans through the Minnesota Rural Finance Authority (RFA) for improvements to agricultural facilities, including wind energy systems less than 1 MW. The RFA coordinates the loan with individual financial institutions and now lends 45 percent (up to $300,000) of the principal at a 4.5 interest rate. Previously, RFA participation in the loan was capped at $200,000.

There are some Minnesota subsidies, however, that are less attractive than they were at the time of the 2003 update. The PV Solar Rebate program offered by the Minnesota Department of Commerce is still active, but all funds are reserved and new applications are placed on a waiting list. This represents a substantial change as the 2003 evaluation included this program in the potential model with the assumption of an incentive of $2,000 per kW up to a maximum of $8,000 per project. Similarly, The Climate Change Fuel Cell Buy Down Program, which was included in the 2003 model, is no longer active and would be removed from an update to the potential model.

The other economic driver that has changed in favor of DG projects is the emergence of new technologies. GDS in the 2010 update provided economic information for new DG technologies

that were not included in the 2001 and 2003 reports. These new potential DG technologies are identified in Table 4.5 below.

Table 4.5: New Distributed Generation Technologies since 2003 Update (Source: 2010 GDS Update, Table 3)

DG Manufacturer and Model	Electrical Capacity	Variable O&M costs ($/kWh)	Installed Cost ($/kW)
Solar Photovoltaic			
Generic PV	2 kW	$0.001	$8,500
Generic PV	4 kW	$0.001	$8,250
Sunny Boy ASE 300	8 kW	$0.001	$6,000
Power Light Shell Solar	32 kW	$0.001	$9,356
Generic PV	50 kW	$0.001	$6,200
Generic PV	200 kW	$0.001	$5,000
Biomass CHP			
Emery Energy Company*	75 kW	$0.011	$12,350.00
Entropic Energy*	250 kW	$0.011	$3,000 to $5,000
Wind Power			
EWS	50 kW	$0.025	$2,600
Vestas V80	1,800 kW	$0.005	$1,200
Vestas V90 & V112	3 MW	$0.005	$1,915
Dish/Sterling Concentrated			
Infinia PowerDish*	3 kW	$0.04	$4,850
SES Systems*	10 kW or 25 kW	$0.04	$10,000
Concentrated Photovoltaics			
Cool Earth Solar*	.5 kW	-	$1,000
Soliant Energy SE-500X	0.335 kW	-	$5,500
Combustion Turbines (with Heat Recovery)			
Solar	up to 15 MW	$0.0096	$1,000 to $1,200
Kawasaki Gas Turbines	650 kW to 18 MW	$0.0096	$1,000 to $1,200
Rolls-Royce	2.2 to 51.2 MW	$0.0096	$1,000 to $1,200
Vericor Power Systems	500 kW to 50 MW	$0.0096	$1,000 to $1,200
*Denotes technologies currently in development			

A third factor auguring for a higher DG potential now versus the time of the 2003 update is a growing interest in the identification and development of biogas-to-energy projects among organizations and companies in IPL's service territory. These opportunities include collection

and distribution of landfill gas, development of anaerobic digesters for the collection of gas (including other benefits), and implementation of gasifier systems (using organic materials as the feedstock) for the manufacturing of "syngas." IPL has been meeting with customers who generate waste products that can be used as ingredients for anaerobic digesters to determine if the development of a biogas project is feasible. IPL has also conducted biogas (digesters and landfill gas systems) training seminars around the country that are designed to educate companies on how to identify and develop biogas projects. An IPL technical support project manager has worked with the Minnesota Project in a consultative role to increase the awareness of biogas projects in Minnesota (www.mnproject.org).

Consequently, factors such as greater state and federal subsidies, the emergence of new technologies and a heightened customer interest and awareness of DG suggest a higher DG potential. However, IPL sees little evidence of material DG capacities being installed. In contrast, IPL does see evidence that the costs of installing and operating DG have risen considerably since 2003. In conclusion, IPL believes the information provided in the 2001 and 2003 reports is still fundamentally applicable for IPL's 2012 Electric Resource Plan.

APPENDIX 4A

Distributed/Onsite Generation Options

Identification and Assessment Project

October 9, 2001

Prepared by:

GDS Associates, Inc.

GDS Associates, Inc.
Engineers and Consultants

DISTRIBUTED/ONSITE GENERATION OPTIONS IDENTIFICATION AND ASSESSMENT PROJECT - IOWA -

PREPARED FOR

ALLIANT ENERGY CORPORATE SERVICES, INC.

OCTOBER 9, 2001

TABLE OF CONTENTS

INTRODUCTION 1

SUMMARY OF RESULTS 1
Technologies Assessed 2
Customer Sectors/Building Type Categories 4
Distributed/Onsite Generation Screening Model 5
Prioritized Ranking 5

METHODOLOGY 10
Secondary Research 10
Distributed/Onsite Generation Screening Model Development 13
Customer Group/Technology Screening and Prioritization 14

ATTACHMENT 1 - Distributed Generation Technologies

ATTACHMENT 2 - Distributed/Onsite Generation Screening Model

ATTACHMENT 3 - Detailed Model Output and Sorted Results

Acknowledgements and Qualifications:

GDS would like to acknowledge the following individuals for their significant efforts and contributions in completing this project under extremely tight time schedules: Harvey Dorn (Alliant Energy); Jason Hines (Black Brook Energy); and Scott Albert, Tom Rooney and Bruce Bennett (GDS Associates). The technologies identified, screened and prioritize in this report, and the model developed to perform these screenings will provide Alliant with useful information to help target customer groups and technology types for more detailed, site-specific evaluation. Many simplifying assumptions were used in development of this report and the associated screening model. Neither GDS Associates nor Black Brook Energy make any warranty, express or implied, or assumes any legal liability of responsibility for the accuracy, completeness, or usefulness of any data, information, method, product or process disclosed in this document, or represents that its use will not infringe any privately owned rights including but not limited to, patents, trademarks or copyrights.

INTRODUCTION

This report summarizes results from secondary research, model development, and technology screening efforts performed by GDS Associates, Inc. to assess and prioritize the potential for customer-sited/distributed generation for all customer classes within Alliant Energy Corporate Services' Iowa distribution utilities' service territories. GDS Associates was contracted to help Alliant identify and rank the potential for customer-sited generation at typical residential, small and large commercial, industrial and agricultural customer locations.

In addition to performing secondary research to collect critical information and operating characteristics on potentially viable, commercially available distributed/onsite generation technology types, a major component of this project was the development of a spreadsheet model ("calculator") for use in determining the cost effectiveness of various customer-sited generation applications. The calculator was then used to assess the potential for onsite generation by customer group based on typical Iowa customer load profiles. In total, 227 unique scenarios yielded positive payback results. As a follow-on to this project, the calculator was designed to be used by Alliant's field representatives as a screening tool for individual customers.

A brief summary of results is presented below. This summary is followed by a discussion of the methodologies used by GDS when performing its work. Write-ups on a number of potentially viable distributed generation technologies are provided in Attachment 1 of this report. Attachment 2 presents a detailed description of GDS' distributed/onsite generation screening model along with copies of key input, output and relevant data sheets. An electronic copy of the actual model is being sent via email as a separate document. Attachment 3 presents a number of prioritized lists derived from the model's output (these lists sort the paybacks of each distributed/onsite generation technology scenario in terms of customer group, longest to shortest payback, and by technology). A listing of the raw data from each technology and customer group model scenario screen is also presented in Attachment 3.

SUMMARY OF RESULTS

Key result areas include: (1) identification of technologies assessed and characteristics of each technology; (2) a listing of customer groups and building types to be modeled as potential on-site generation candidates; (3) a distributed/onsite generation screening model; and (4) the prioritized ranking of potentially viable on-site/distributed generation applications showing potentially viable onsite generation technologies for each customer group reviewed. A presentation of results from each of these areas follows:

Technologies Assessed

Based upon GDS' knowledge and secondary data review, eight distributed generation technologies have been identified. As shown in Table 1, five of these technologies are considered to be commercially available (Reciprocating Engines, Microturbines, Fuel Cells, Wind Turbines, and Photovoltaic Modules), and three technologies are in various stages of demonstration and development (Concentrating Solar Power Systems, Stirling Engines, and Hybrid Systems). Please refer to Attachment 1 for more information on each technology. A summary of key operating characteristics and cost information is provided for each technology in Table 2.

Table 1: Technology Availability and Target Customer Sectors

Technology	Commercially Available*	Target Customer Sectors (for mature technologies)
Reciprocating Engines	Yes	Small and Large Commercial, Industrial, Agricultural
Microturbines	Yes	Small and Large Commercial, Agricultural
Fuel Cells	Yes	Small and Large Commercial, Industrial
Wind Turbines	Yes	Residential, Small and Large Commercial, Industrial, Agricultural
Photovoltaic Modules	Yes	Residential, Small and Large Commercial, Agricultural
Concentrating Solar Power	No	DG technology not mature
Stirling Engines	No	DG technology not mature
Hybrid Systems	No	DG technology not mature

* Note: Although microturbines and fuel cells are listed as commercially available, to date they are targeting niche markets and have not yet been mass-produced.

Table 2: Distributed Generation Technology Profile

Technology	Target Market Sectors	State of Development	Operation & Maintenance	Installed Cost Range ($/kW)	Operating Fuels	Electric Power Output Range	Thermal Output Range (Btu/kWh)	Operating Temp	Operation Specs.	Physical Plant Footprint (ft^2/kW)
Reciprocating Engines	Comm., Indust.	Commercially available.	Costs ~ $0.003-$0.015/kWh	$350-$1,200/kW	Natural gas Propane Gasoline Dual Fuel Diesel Heavy Oil	10 kW-10 MW @ 21% - 43% eff.	1,000 - 5,000	316°-500°F	1.0-45 psig	0.22-31
Mirocturbines	Res., Comm. & Agricultural greenhouses	Commercially available. Mass prod. expected soon. <1 MW	$0.005-$0.01 per kWh.	$600-$1,200/kW	Natural gas Propane Diesel Waste-Fuels	30-2000 kW @ 25-30 eff.	4,000-15,480	400°-635°F	3-100 psig	0.15-0.35
Fuel Cells	Low Temp: Res, Comm High Temp: Comm, Indus	Development, Testing and Demonstration	$0.005-$0.01/kWh (low-temp.)	$1,900-$3,500/kW (low-temp)	Natural gas Propane Butane Diesel	Low Temp: 2-250 kW @ 30-40% eff. High Temp: 100 - 1,000 kW @ 45 - 55% eff	PAFC: 3,500-8,000 PEM: 2,000-3,250 MCFC: 1,400-1,800 SOFC: 540-1,100	140°-250°F 135°-165°F 170°-710°F 350°-420°F	15-50 psig pipeline pressure 15-45 psig n/a	4 0.6-3.0 1-4 1.1-1.2
Wind Turbines	Res, Comm.	Commercially available.	$0.005/kWh-$0.02/kWh	$1,000/kW-$8,000/kW	<50kW: Wind >8mph >50kW: Wind>10mph	1-2,000 kW @ 25% eff	None	None	n/a	<50kW: 15-90 >50kW: 0.24-110
Photovoltaic Modules	Res, Comm.	Commercially available.	$0.001-0.004/kWh	$5,000-$10,000/kW	Global solar radiation (direct and diffuse)	10 watts to 100 kW	None	None	n/a	538
Concentrating Solar Power	Res, Small Comm.	Engineering and Development	Dish/engine type expected 6-10 hrs/year. 8,000 hrs between service.	$1,400/kW	Direct Solar Rad. And other supplemental heat.	25 kW to 80 MW.	6,800	150°F	300 W/m^2	160-269
Stirling Engines	Res, Small Comm.	Development, Testing and Demonstration	Costs: n/a. But less O&M required w/free-piston type	N/a	Any Heat Source Greater than 1832°F	<50 kW	n/a	n/a	n/a	n/a
Hybrid Systems	Res, Comm, Indust.	Development, Testing and Demonstration	Varies w/ technology	Varies w/ technology	Varies w/ technology	Varies w/ technology	Varies w/ technology	Varies w/ technology	Varies w/ technology	Varies w/ technology

Customer Sectors/Building Type Categories

Table 3 identifies the customer categories and building types that were considered for potential on-site generation candidates. Commercial and industrial categories were selected using SIC major industry group codes wherever applicable. Load profile information (average monthly kWh, kW, and fuel usage) was estimated for a "typical" customer within each of these categories using Alliant-specific customer data to the greatest extent possible. For modeling purposes, each building type was broken into sub-groups and applicable rate tariffs were identified.

Table 3 - Customer Sector/Building Type Categories

Customer Category/Type	Sub-Grouping	Applicable Rate Tariff
Residential - Single Family	Electric heat Gas heat	Residential Residential
Commercial - Assembly (SIC 84 - 86)	Large Small	Large Power & Lighting General Demand Metered
Commercial - Healthcare (SIC 80)	Large Medium Small	Large Power & Lighting Large Power & Lighting General Demand Metered
Commercial - Hotel/Motel (SIC 70)	Electric heat Gas heat	Large Power & Lighting Large Power & Lighting
Commercial – Business/Personal Services (SIC 71 – 79)	Large Small	Large Power & Lighting Large Power & Lighting
Commercial – Housing (SIC 65)	Large Small	Large Power & Lighting Large Power & Lighting
Commercial - Office (SIC 60 – 67)	Large Small	Large Power & Lighting General Demand Metered
Commercial – Management Services (SIC 87)	Large Small	Large Power & Lighting Large Power & Lighting
Commercial - Retail (SIC 52 - 59)	Large Medium Small	Large Power & Lighting Large Power & Lighting General Demand Metered
Commercial - School (SIC 82 - 83)	Large Medium Small	Large Power & Lighting Large Power & Lighting General Demand Metered
C/I – Utilities/Transportation (SIC 40-49)	Sewerage Warehouse Water Supply Cable TV	Large Power & Lighting Large Power & Lighting Large Power & Lighting General Demand Metered
C/I - Wholesale Trade (SIC 50 - 51)	Large Medium Small	Large Power & Lighting Large Power & Lighting Large Power & Lighting
C/I - Manufacturing (SIC 20 - 39)	Large Medium Small	Large Power & Lighting Large Power & Lighting Large Power & Lighting
C/I – Mining (SIC 12 - 14)	Large Small	Large Power & Lighting Large Power & Lighting
C/I – Nonclassifiable (SIC 99)	Large Small	Large Power & Lighting Large Power & Lighting
Agricultural - Dairy & Livestock (SIC 02)	Large Medium Small	Large Power & Lighting Large Power & Lighting Farm Rate
Government/Public Admin (SIC 91 - 97)	Large Medium Small	Large Power & Lighting Large Power & Lighting General

Distributed/Onsite Generation Screening Model

A screening model was created as a tool for Alliant Energy personnel to help assess the feasibility of distributed/onsite electric and combined heat and power generation potential at Iowa-specific residential, commercial, industrial and agricultural sites. The model is loaded with typical average monthly electricity and gas usage profiles for various customer facility types. Performance and cost information for different generation alternatives, as well as electricity rate tariffs currently in effect for Alliant's Iowa customers, are also included.

In order to utilize this model effectively, the user must enter applicable information into a "Model Input" worksheet for each customer type/facility to be evaluated. Key input areas include: Customer Information; Electrical Energy Cost; Heating Fuel Cost; Energy Usage; Generator Preferences; and Generator Fuel Cost. All areas requiring direct user input are shaded in blue. Brief instructions for user inputs are provided in *italics*, where needed, directly on the Model Input sheet itself. Please note: the reasonableness of results is dependent upon the user's understanding and interpretation of the customer's energy usage (*i.e.*, the accuracy of the customer's load profile) and the generation units (and associated technical data) selected to meet that usage.

The unit dispatch, financial and economic aspects of this model utilize basic/simplifying assumptions. Due to a wide range of customer operating situations and business structures, as well as the existence of varying renewable and distributed generation incentives, hourly load tracking, life cycle costing, and after-tax economics are not addressed in this current model. These items should be carefully addressed as part of a more detailed, site-specific evaluation prior to making any firm commitments or investment decisions.

A more detailed description of GDS' distributed/onsite generation screening (DOGS) model is presented in Attachment 2, along with copies of key input, output and relevant data sheets.

Prioritized Ranking

The screening model was used to run 2,150 separate scenarios to assess all unique combinations of customer category/technology type applications. Based on results from these customer application scenarios, a prioritized ranking was created. Results from this ranking are presented in the following multi-paged table. This table shows, the highest ranking (paybacks less than 20 years), potentially viable technologies for each customer type/subgroup. More detailed results and completed prioritized ranking lists are presented in Attachment 3.

Table 4 - Prioritized Ranking of Viable Technologies* - by Customer Subgroup

Customer Type/Sub-Group	Technology	Simple Payback (yrs)
Agricultural – Large	Wind Turbines - 660kw, 20% CF	18
Agricultural – Medium	None with under 20 year payback	N/A
Agricultural – Small	Recip/D - 11 kw, 90%CF/50%WH	11
C/I Manufacturing – Large	None with under 20 year payback	N/A
C/I Manufacturing – Medium	Wind Turbines - 660 kw, 20% CF	19
C/I Manufacturing – Small	Micro - 30 kw, 90%CF/50%WH	4
C/I Manufacturing – Small	Micro - 45 kw, 90%CF/50%WH	4
C/I Manufacturing – Small	Micro - 60 kw, 90%CF/50%WH	4
C/I Manufacturing – Small	Micro - 75 kw, 90%CF/50%WH	4
C/I Manufacturing – Small	Recip/D - 11 kw, 90%CF/50%WH	5
C/I Manufacturing – Small	Recip/D - 68 kw, 90%CF/50%WH	6
C/I Manufacturing – Small	Micro - 60 kw, 50%CF/50%WH	7
C/I Manufacturing – Small	Micro - 75 kw, 50%CF/50%WH	7
C/I Manufacturing – Small	Recip/NG - 10 kw, 90%CF/50%WH	8
C/I Manufacturing – Small	Micro - 30 kw, 50%CF/50%WH	8
C/I Manufacturing – Small	Micro - 45 kw, 50%CF/50%WH	8
C/I Manufacturing – Small	Recip/NG - 61 kw, 90%CF/50%WH	9
C/I Manufacturing – Small	Recip/D - 11 kw, 50%CF/50%WH	10
C/I Manufacturing – Small	Recip/D - 68 kw, 50%CF/50%WH	11
C/I Manufacturing – Small	Recip/NG - 10 kw, 50%CF/50%WH	17
C/I Manufacturing – Small	Recip/NG - 61 kw, 50%CF/50%WH	19
C/I Mining – Large	Wind Turbines - 660kw, 20% CF	14
C/I Mining – Small	Recip/D - 11 kw, 90%CF/50%WH	5
C/I Mining – Small	Recip/D - 68 kw, 90%CF/50%WH	5
C/I Mining – Small	Micro - 30 kw, 90%CF/50%WH	5
C/I Mining – Small	Micro - 45 kw, 90%CF/50%WH	5
C/I Mining – Small	Micro - 60 kw, 90%CF/50%WH	5
C/I Mining – Small	Micro - 60 kw, 50%CF/50%WH	8
C/I Mining – Small	Micro - 75 kw, 50%CF/50%WH	8
C/I Mining – Small	Recip/NG - 10 kw, 90%CF/50%WH	9
C/I Mining – Small	Recip/NG - 61 kw, 90%CF/50%WH	9
C/I Mining – Small	Micro - 30 kw, 50%CF/50%WH	9
C/I Mining – Small	Micro - 45 kw, 50%CF/50%WH	9
C/I Mining – Small	Recip/D - 11 kw, 50%CF/50%WH	10
C/I Mining – Small	Recip/D - 68 kw, 50%CF/50%WH	10
C/I Mining – Small	Recip/NG - 61 kw, 50%CF/50%WH	18
C/I Mining – Small	Recip/NG - 10 kw, 50%CF/50%WH	19
C/I Nonclassifiable – Large	Wind Turbines - 660kw, 20% CF	16

Customer Type/Sub-Group	Technology	Simple Payback (yrs)
C/I Nonclassifiable – Small	None with under 20 year payback	N/A
C/I Utilities/Transp. – Cable TV	Recip/D - 11 kw, 90%CF/50%WH	6
C/I Utilities/Transp. – Cable TV	Recip/NG - 10 kw, 90%CF/50%WH	10
C/I Utilities/Transp. – Cable TV	Recip/D - 11 kw, 50%CF/50%WH	13
C/I Utilities/Transp. - Sewerage	Wind Turbines - 660 kw, 20% CF	19
C/I Utilities/Transp. - Warehouse	Wind Turbines - 660 kw, 20% CF	10
C/I Utilities/Transp. – Water	None with under 20 year payback	N/A
C/I Wholesale Trade - Large	Wind Turbines - 660 kw, 20% CF	19
C/I Wholesale Trade - Medium	Wind Turbines - 10 kw, 20% CF	13
C/I Wholesale Trade - Small	Micro - 75 kw, 90%CF/50%WH	13
C/I Wholesale Trade - Small	Wind Turbines - 660 kw, 20% CF	14
Commercial Assembly - Large	Wind Turbines - 660 kw, 20% CF	15
Commercial Assembly - Small	Recip/D - 11kw, 90%CF/50%WH	9
Commercial Assembly - Small	Recip/D - 11kw, 50%CF/50%WH	20
Commercial Assembly - Small	Wind Turbines - 10 kw, 20% CF	20
Commercial Health Care - Large	Wind Turbines - 660 kw, 20% CF	13
Commercial Health Care - Medium	Wind Turbines - 660 kw, 20% CF	16
Commercial Health Care - Small	Recip/D - 11kw, 90%CF/50%WH	4
Commercial Health Care - Small	Recip/NG - 10kw, 90%CF/50%WH	5
Commercial Health Care - Small	Recip/D - 11kw, 50%CF/50%WH	7
Commercial Health Care - Small	Recip/NG - 10kw, 50%CF/50%WH	9
Commercial Health Care - Small	Wind Turbines - 10 kw, 20% CF	20
Commercial Hotel/Motel - Electric	Wind Turbines - 660 kw, 20% CF	16
Commercial Hotel/Motel - Gas	None with under 20 year payback	N/A
Commercial Housing - Large	Wind Turbines - 660 kw, 20% CF	16
Commercial Housing - Small	Wind Turbines - 660 kw, 20% CF	8
Commercial Housing - Small	Recip/D - 250 kw, 90%CF/50%WH	17
Commercial Mngmnt Services - Large	Wind Turbines - 660 kw, 20% CF	15

Customer Type/Sub-Group	Technology	Simple Payback (yrs)
Commercial Mngmnt Services - Small	Recip/D - 250kw, 90%CF/50%WH	4
Commercial Mngmnt Services - Small	Recip/D - 68kw, 90%CF/50%WH	5
Commercial Mngmnt Services - Small	Recip/NG - 255kw, 90%CF/50%WH	5
Commercial Mngmnt Services - Small	Recip/D - 250kw, 50%CF/50%WH	7
Commercial Mngmnt Services - Small	Recip/D - 11kw, 90%CF/50%WH	8
Commercial Mngmnt Services - Small	Recip/NG - 255kw, 50%CF/50%WH	10
Commercial Mngmnt Services - Small	Recip/NG - 61kw, 90%CF/50%WH	18
Commercial Mngmnt Services - Small	Wind Turbines - 10 kw, 20% CF	20
Commercial Office - Large	Wind Turbines - 660 kw, 20% CF	13
Commercial Office - Large	Micro - 75 kw, 90%CF/50%WH	16
Commercial Office - Small	Recip/D - 11kw, 90%CF/50%WH	4
Commercial Office - Small	Recip/NG - 10kw, 90%CF/50%WH	5
Commercial Office - Small	Recip/D - 11kw, 50%CF/50%WH	7
Commercial Office - Small	Recip/NG - 10kw, 50%CF/50%WH	10
Commercial Personal Srvcs - Large	Wind Turbines - 660 kw, 20% CF	15
Commercial Personal Srvcs - Small	Recip/D - 11kw, 90%CF/50%WH	4
Commercial Personal Srvcs - Small	Micro - 30 kw, 90%CF/50%WH	4
Commercial Personal Srvcs - Small	Micro - 45 kw, 90%CF/50%WH	4
Commercial Personal Srvcs - Small	Recip/NG - 10kw, 90%CF/50%WH	6
Commercial Personal Srvcs - Small	Micro - 30 kw, 50%CF/50%WH	7
Commercial Personal Srvcs - Small	Micro - 45 kw, 50%CF/50%WH	7
Commercial Personal Srvcs - Small	Micro - 60 kw, 50%CF/50%WH	7
Commercial Personal Srvcs - Small	Micro - 75 kw, 50%CF/50%WH	7
Commercial Personal Srvcs - Small	Recip/D - 11kw, 50%CF/50%WH	8
Commercial Personal Srvcs - Small	Micro - 30 kw, 90%CF/25%WH	8
Commercial Personal Srvcs - Small	Recip/NG - 10kw, 50%CF/50%WH	13
Commercial Personal Srvcs - Small	Wind Turbines - 10 kw, 20% CF	20
Commercial Retail - Large	Wind Turbines - 660 kw, 20% CF	18
Commercial Retail - Medium	Wind Turbines - 10 kw, 20% CF	17
Commercial Retail - Small	None with under 20 year payback.	N/A
Commercial Schools - Large	Wind Turbines - 660 kw, 20% CF	18
Commercial Schools - Medium	Wind Turbines - 660 kw, 20% CF	14
Commercial Schools - Small	Recip/D - 11 kw, 90%CF/50%WH	4
Commercial Schools - Small	Recip/NG - 10 kw, 90%CF/50%WH	5
Commercial Schools - Small	Recip/D - 11 kw, 50%CF/50%WH	7
Commercial Schools - Small	Recip/NG - 10 kw, 50%CF/50%WH	10
Government - Large	Wind Turbines - 660 kw, 20% CF	15

Customer Type/Sub-Group	Technology	Simple Payback (yrs)
Government - Medium	Micro - 75 kw, 90%CF/50%WH	19
Government - Small	Recip/D - 11 kw, 50%CF/50%WH	7
Government - Small	Recip/NG - 10 kw, 50%CF/50%WH	10
Government - Small	Wind Turbines - 10kw, 20% CF	20
Residential – Electric Heat	None with under 20 year payback.	N/A
Residential – Gas Heat	None with under 20 year payback.	N/A

* Wind and Photovoltaic technologies were identified as potentially viable in nearly all customer group categories. Although their payback periods were typically longer than 20 years, tax benefits (or other renewable resource incentives) could make these technologies competitive with the other unit types assessed.

METHODOLOGY

The work plan for this project grouped activities into three major categories: (1) Secondary Research; (2) Distributed/Onsite Generation Screening model Development; and (3) Customer Group/Technology Screening and Prioritization. The methodology used to perform each of these activities is described briefly below.

Secondary Research

This project included extensive secondary research activities to identify various applicable distributed generation technologies and key performance/cost input information for use in the spreadsheet assessment tool. Following is a list of the documents and data sources that were reviewed:

- Energy Info Source's Distributed Generation: Technologies, Opportunities, and Participants 2nd Edition – August 2001;
- California Alliance for Distributed Energy Resources' (CADER) Matrix for Distributed Energy Resource Technologies – 1997;
- CADER's Modeling and Planning Committee Report – Draft 7/14/97;
- Presentation: Combined Heat and Power (CHP): Applications of Distributed Power Overview of Opportunities and Market Prospects, Distributed Power Conference Washington, DC – 9/25/00; and,
- Several manufacturer's generator specifications.

Results from these document reviews were combined with GDS' own in-house knowledge and data sources leading to development of a number of technology summaries. Following a brief description of the technology, information was presented in these summaries to provide key model input data on: target market sectors, state of development, operation and maintenance costs and characteristics, installed cost ranges, operating fuels, electric power and thermal output ranges, and physical plant footprints. In total, eight potentially viable technologies were summarized:

- Reciprocating Engines;
- Micro-Turbines;
- Fuel Cells;
- Wind Turbines;
- Photovoltaic Modules;
- Concentrating Solar Power;
- Stirling Engines; and
- Hybrid Systems.

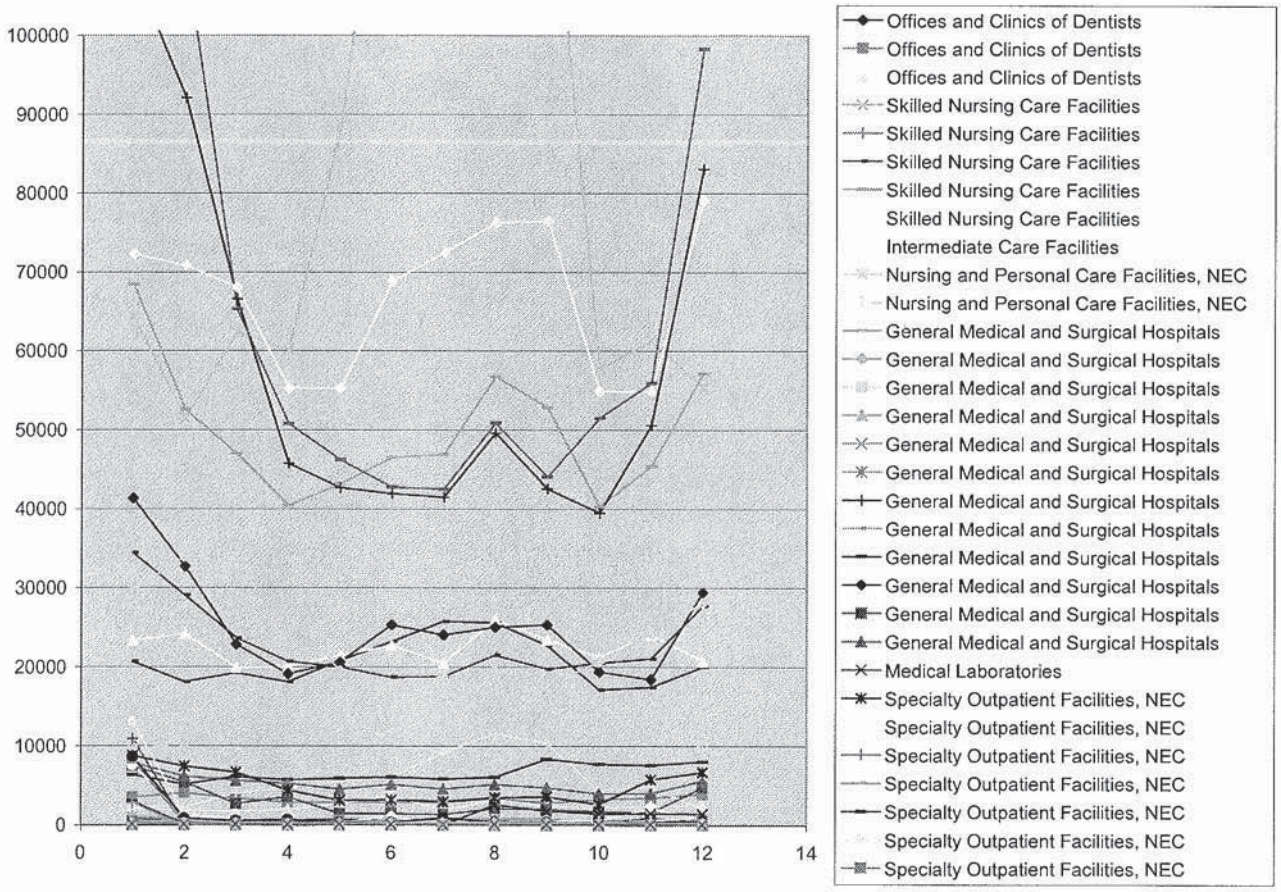
Documents and data sources were also reviewed to identify potential "calculator" tools for later evaluation and use as guides in development of GDS' customer-sited/distributed generation technology assessment and screening tool. Some of the more useful tools identified include:

- GDS in-house generation analysis spreadsheet information and related tools;
- D-Gen Pro – Designed by Architectural Energy Corp. for the Gas Research Institute, this model determines the economic feasibility of gas-fired distributed power generation and evaluates cost-effective applications of on-site power generation.
- GenSize '96 - Created by the Onan company, a generator manufacturer, to assist their customers in determining which Onan stationary, liquid cooled generator set configurations will meet the needs of a project's load requirements.
- QuickScreen - Designed under the auspices of the National Renewable Energy Laboratory, this screening tool attempts to identify the best distributed resource (DR) sites within a given electric utility and determine economic feasibility. This QuickScreen Beta version was developed to evaluate distributed photovoltaic (PV) generation, but future QuickScreen versions will include the capability to evaluate other distributed resources
- Other sample on-site cogeneration developer spreadsheet models used primarily for determining gen-set sizing for specific customer applications.

Finally, service territory rate tariffs and Alliant's Iowa-specific demographic information was collected from Company sources, along with average monthly energy (kWh), demand (kW) and fuel usage data. For commercial, industrial, agricultural and other non-residential (C/I/A/&NR) customer areas, this demographic information was sorted by SIC major industry codes and grouped into the customer sector/building type categories identified above in Table 3.

Typical load profiles were developed for each C/I/A/&NR building type by: (1) plotting the actual monthly average load profiles for all customers within each SIC major industry grouping; (2) viewing the graphical representations to identify any obvious usage patterns and obvious sub-groupings (large, medium and/or small); and (3) selecting a "typical" customer profile from within each sub-grouping to represent that customer/building type category. Figure 1 provides a sample of this load profile graphing and sub-group identification process.

FIGURE 1 - Sample Customer Load Profile Graph



In this graph of Alliant's Healthcare industry sector (SIC Code 80), it is easy to see that all customer load profiles share very similar shapes throughout the year. Also, this graph shows three distinct usage level groupings (*i.e.*, a high use group with average monthly energy ranging between 40,000 and 100,000 kWh; a medium usage group with average monthly energy ranging between 20,000 and 40,000 kWh; and a small use group showing a range of close to 0 and 20,000 average kWh per month). In this example a "typical" customer profile can be estimated by choosing a customer whose usage falls in the middle of each range.

Average monthly load profiles for "typical" Residential customers were developed using downloaded residential data files for the West-Central United States Region available through Regional Economic Research, Inc. (RER's) eShapes® publicly accessible database on their website at www.rer.com/eshapes. This information was then scaled to reflect Alliant-specific average residential customer usage.

Distributed/Onsite Generation Screening Model Development

The second major category of project activity was the development of a simple/flexible spreadsheet model that could be used to determine the cost effectiveness of various distributed/onsite generation applications and to assess the potential for onsite generation by customer group based on typical customer load profiles. This screening model was designed to allow for the calculation of simple paybacks for a multitude of technology and customer application scenarios so that results could be ranked and prioritized to identify Alliant's most likely candidates for onsite generation within each customer class. As a follow-on to this project, the calculator has been designed to be used by field representatives as a screening tool for individual customers.

A multi-stepped process was used in development of this distributed/onsite generation screening calculator. First, as part of the secondary research activities discussed above, GDS reviewed its existing models and in-house information base, along with identifying and assessing the functionality of a number of other publicly available models. A general conceptual model framework was then developed to best meet Alliant's stated needs. A summary of this framework is presented below:

Spreadsheet Model Framework:
The model will be an MS Excel 2000 workbook file divided into worksheets as follows:

Title Sheet (identifies spreadsheet and parties)

- GDS & Alliant Graphics
- Product/Model Title
- Date

Instructions (provides user with all the information needed to effectively run the model)
Text sheets to include information directed to user regarding:

- Purpose and intended use of model
- Instructions - how to use the model; both step-by-step instructions and prose guidance on input assumptions
- Qualifications of data tables included in model
- Qualifications/limitations of model output information

Inputs (user entered info sheet - the only non-write protected sheet)

- Customer and Facility identity information
- Facility Type/Characteristics (multi choice and user defined)
- Electricity Load and Fuel Usage (monthly kWh, kW, and btu values)
- Facility and Process Heat Requirements/Usage
- Rate Inputs (electric, gas, fuel oil - multi choice)

- On-Site Generation Technology Inputs (technology type, fuel source, installation costs, operating costs/characteristics, etc. - multi choice)

Summary (provides model results table for multiple technologies)

- A printable summary table with bottom line annual cost savings and simple payback for selected technology and application scenario

Data - Rates (rate and tariff data)

- Multi choice lookup table with actual tariff information for electricity and gas

Data - Technology (characteristics)

- Multi choice lookup table with information on several different DG prime mover technology characteristics and sub-tables with specific performance information for different installed capacities

Data - Customer/Facility Type (typical characteristics)

- Multi choice lookup table with usage pattern (monthly) information for several different customer types

Finally, based on this framework, a spreadsheet model was developed and tested to ensure proper functionality and suitable flexibility to meet technology assessment, customer group screening, prioritization and ultimate field representative's specific needs. A detailed description of the resulting screening model is presented in Attachment 2 of this report along with printouts of each input, output and datasheet page.

Customer Group/Technology Screening and Prioritization

The culminating set of activities associated with this project required: (1) determining which on-site generation technologies had potential for application within various customer groups; then (2) using the spreadsheet model to calculate a simple payback for each technology selected for installation at specific customer type locations; and finally, (3) for each customer type modeled, technologies were ranked, prioritized, and summarized to show those technologies most likely to be viable within specific customer categories. Each of these steps is summarized in more detail below.

Linking Technologies to Potentially Viable Customer Group Applications:

Based on results from our secondary research activities, combined with GDS' existing knowledge and data sources, a qualitative screen was performed on each of the initial

group of eight technologies. When performing this screening, the following Alliant measure screening criteria were used:[1]

- Distributed generation technology is not mature;
- Poor utility match due to demographics or other reasons;
- Better technology available (inferior unit); and
- Benefits and/or costs are not quantifiable.

Results from this screening were presented in Table 1, which showed those technologies most likely to have applicability within particular customer groups. These categorizations were subsequently reviewed and reasonably verified based on model screening results.

Simple Payback Calculations for Customer-Specific Applications, Ranking and Prioritization:

Various size combinations of appropriate technologies were analyzed for each customer group and building type using GDS' customer-sited/distributed generation technology analysis and screening tool. In total, 1,890 unique scenarios were run. Twenty-seven separate generator size and type configurations were evaluated for each of 35 individual customer sub groups at both a 90% and 50% capacity factor.[2] Where applicable, a maximum heat recovery value of 50% was also applied.

Alliant's Iowa-specific average customer load profile data and delivered costs for each typical customer group/building type were modeled along with critical installation cost and operating characteristics of the technologies being assessed. Resulting simple payback information was recorded for each scenario run so that technologies could be rank ordered and a prioritized list of potentially viable customer-sited generation applications could be created. Please refer to Table 4 for a summary of these prioritized results. Sorted details of the model outputs are included in Attachment 3.

[1] These criteria are consistent with Alliant's DSM qualitative screening criteria presented in Section 3.1.2 (DSM Chapter 3) of Alliant's Integrated Resource Plan filings.
[2] Capacity factors of 20% and 33% were used when assessing the potential viability of wind and photovoltaic, respectively.

ATTACHMENT 1 - Distributed Generation Technologies

Reciprocating Engines

Description: Reciprocating internal combustion (IC) engines are a widespread and well-known technology. Reciprocating engine generators offer relatively low installed cost, easy start-up, proven reliability with proper maintenance, good load following characteristics, and heat recovery potential.[i] Recent improvements to exhaust catalysts and control of combustion process have significantly reduced emissions of IC engines. Interconnection is a concern for IC engines and involves proper control equipment and in some cases a retrofit to allow diesel engines to switch to natural gas. Dual fuel conversion alleviates environmental emissions rules that would otherwise prevent diesel-based generators from running more than their permitted levels. IC units are well suited for standby, peaking, and intermediate applications and for combined heat and power in commercial and light industrial applications of less than 10 MW.[i]

Target Market Sectors: Small and Large Commercial, Industrial, Agricultural.

State of Development: Commercially available.

Operation & Maintenance: Costs for O&M typically run from $0.0075-$0.02/kWh.[ii] Although they require higher maintenance at more frequent intervals than gas turbines, advanced reciprocating engine systems only require major maintenance on an annual basis[iii].

Installed Cost Range ($/kW)[i]: Costs vary depending upon the site location, interconnection requirements, unit size and configuration. $150-$600/kW ($350-$1,200/kW for turn-key installation) and $30-$120/kW for interface/control equipment.

Operating Fuels *(ranked)*: 1)Natural gas, 2) Propane, 3) Gasoline, 4) Dual-Fuel natural gas/diesel, 4) Diesel, 5) Heavy Oil.

Electric Power Output Range: 10 kW – 10 MW @ 21% - 43% efficiency.

Thermal Output Range[iv]: 1,000 – 5,000 Btu/kWh @ 316°-500°F and 1.0-45 psig

Physical Plant Footprint[v]: 0.22-31 ft^2/kW

Sizes Modeled: Diesel Fueled: 11 kW; 27 kW; 68 kW; 250 kW; 725 kW; 2,000 kW
Natural Gas Fueled: 10 kW; 27 kW; 61 kW; 255 kW; 770 kW; 2,160 kW

Microturbines

Description: Using technology based upon jet engines, the microturbine generation uses a series of blades to increase air densities upon intake. This compressed air burns with a much higher efficiency than uncompressed air. Hot exhaust gases are recuperated and used to preheat the compressed intake air, further improving efficiencies to 26-32%. Although they require the use of highly durable bearing systems due to their high speeds (40K rpm+), microturbines involve fewer moving parts than other small-scale technologies. Their compact size and lightweight composition make them adaptable to many sites. When used with gasifiers, the microturbine may be run with lower cost liquid and solid fuels including waste fuels. The use of microturbines present opportunities for lower emission, lower cost and highly efficient on-site generation. It is expected that hybrid systems using a combination of microturbines and other technologies such as fuel cells will create even greater opportunities for efficient on-site generation.

Target Market Sectors: Residential, Small and Large Commercial and Agricultural (greenhouses).

State of Development: Now commercially available. However, high volume production is expected in the near future and expected to be the key technology aimed at the power producer market less than 1 megawatt.

Operation & Maintenance: O&M costs have been estimated at \$0.005-\$0.01 per kWh[i]. Due to simpler designs and fewer moving parts microturbines may require less maintenance than reciprocating engines. However, due to the newness of the technology, microturbine reliability is unproven in the commercial market. Therefore, accurately of estimated O&M costs cannot be confirmed.

The use of Gasifiers may lower operation costs by allowing the microturbine system to less expensive fuels. However, these fuels often contain contaminants that would only serve to reduce efficiency due to clean up expenses.

Installed Cost Range (\$/kW)[i]: Costs vary depending upon the site location, interconnection requirements, unit size and configuration. \$350-\$750/kW (\$600-\$1,200/kW for turn-key installation).

Operating Fuels: Natural Gas, Diesel, Propane, Waste-Fuels.

Electric Power Output Range: 30-2,000 kW @ 25-30 efficiency.

Thermal Output Range[iv]: 4,000-15,480 Btu/kWh @ 400°-635°F @ 3-100 psig

Physical Plant Footprint[v]: 0.15-0.35 ft^2/kW

Sizes Modeled: 30 kW; 45 kW; 60 kW; 75 kW; 508 kW; 848 kW; 1,961 kW

Fuel Cells

Description: Similar to battery power, fuel cell technology utilizes electrochemical processes to create DC electricity. Therefore, inverters must be used to modify the power to 60 Hz of AC power. The basic structure of a fuel cell power generation is the passage of hydrogen-rich fuels past an anode and air (Oxygen-O_2) over a cathode. Both electrodes are separated by an electrolyte made of varying materials. The type of electrolyte used determines the type of fuel cell technology. Fuels cells are either low-temperature: Phosphoric Acid (PAFC), Proton Exchange Membrane (PEM), Alkaline (AFC) and Direct Methanol (DMFC), or high-temperature: Molten Carbonate (MCFC) and Solid Oxide (SOFC). High-energy heat is produced by some fuel cell reactions and is available for CHP options.

Target Market Sectors: Large Commercial and Industrial applications are the best fit for high-temperature fuel cells, while low-temperature fuel cells are best suited for Residential and Small Commercial applications, Agricultural and to a lesser degree the Industrial market.

State of Development[i]: Having been under development for more than 20 years, PAFCs were the earliest in development and are commercially available. SOFC, MCFC and AFC technologies have been developed and currently being demonstrated. DMFC and PEM technologies are still being developed and tested.

Operation & Maintenance[i]: $0.005-$0.01/kWh (low-temperature fuel cells). Although fuel cells have no moving parts their integral support components (pumps, fans, etc.) may significantly add to the cost of maintenance and repair downtime. Also, required for high efficiency, costly stack replacement is needed at approximately every 40,000 hours of operation.

Installed Cost Range ($/kW)[i]: Costs vary depending upon the site location, interconnection requirements, unit size and configuration. Low-temperature fuel cells typically cost between $1,500-$3,000/kW (Turn-key costs for low-temperature fuel cells are approximately $1,900-$3,500/kW).

Operating Fuels[i]: A variety of hydrocarbon resources under steam pressure (reforming or gasification). Sources include: natural gas, propane, butane and diesel fuels.

Electric Power Output Range[i]: Low-temperature fuel cells typically produce 2-250 kW @ 30-40% efficiency. High-temperature fuel cells have an output range of 100-2,000 kW @ 45-55%.

Thermal Output Range[iv]: Thermal output varies by fuel cell type:
PAFC: 3,500-8,000 Btu/kWh @ 140°-250°F @ 15-50 psig.
PEM: 2,000-3,250 Btu/kWh @ 135°-165°F @ gas pipeline pressure.
MCFC: 1,400-1,800 Btu/kWh @ 170°-710°F @15-45 psig.

SOFC: 540-1,100 Btu/kWh @ 350°-420°F.

Physical Plant Footprint[iv]: Footprint requirements also vary by fuel cell type:
PAFC: 4 ft^2/kW
PEM: 0.6-3.0 ft^2/kW
MCFC: 1-4 ft^2/kW
SOFC: 1.1-1.2 ft^2/kW

Sizes Modeled: 200 kW; 250 kW; 1,000 kW; 2,000 kW

Wind Turbines

Description[i]: Large wind turbine generators are typically developed in arrays of several turbines spaced over a larger area. Commonly referred to as wind farms, these turbines produce clean power that can be used to offset the need for power generated at traditional fossil-fuel burning power plants. The power output is increased eight fold as wind speed doubles. Wind turbines are highly reliable and require little maintenance. Grid-connected turbines are equipped with pitch controls for maximizing the wind's aerodynamic energy and for "dumping" excess wind energy during periods of high wind velocities.

Smaller turbines can be used for battery charging or water pumps. They may provide a supplement to 5-15 HP diesel pumps for drinking water or irrigation. Larger turbines may be connected to the power grid, using needed energy on-site and sell excess electric power to the local utility through the power grid.

Target Market Sectors[i]: Residential, Small and Large Commercial, Industrial, and Agricultural.

State of Development[i]: Commercially available.

Operation & Maintenance[i]: $0.005/kWh to $0.02

Installed Cost Range ($/kW)[i]: Costs vary depending upon the site location, interconnection requirements, number and size of turbines. Between $1,000/kW and $8,000/kW is typical for wind turbines. With the extension of the Production Tax Credit (PTC) the end of calendar year 2001, wind energy is advancing and costs are decreasing.

Operating Fuels[i]: Wind velocities greater than 8 mph for turbines less than 50 kW and 10 mph for turbines greater than 50 kW.

Electric Power Output Range[i]: 10-2,000 kW @ 25% efficiency.

Thermal Output Range[iv]: None

Physical Plant Footprint[iv]: For wind turbine generators < 50 kW of installed capacity, a footprint of about 15-90ft^2/kW, and 0.24-110ft^2/kW for turbines > 50kW.

Sizes Modeled: 1 kW; 10 kW; 660 kW

Photovoltaic Modules

Description[i]: Photovoltaic (PV) technology converts solar energy into electric energy. Layered semiconductor materials such as silicon are used to release electrons into a circuit. Photons of light release electrons from the semiconductor creating an electrical current between a negatively charged layer and an adjacent positively charged layer. PV modules produce DC current requiring power conditioning for use in an AC system. Some packages provide 120VAC electricity off-grid and most are expandable by adding additional panels to the array. At about $0.20-0.30/kWh, the cost for generating electricity with PV modules is still too high to compete on the retail market. When the price of electricity generation through PV modules approaches $0.10/kWh this technology will present itself as a more competitive alternative.

These technologies typically compete on the merit of their environmental benefit and in certain environmentally sensitive or grid-isolated locations. However, grid-connected PV systems are becoming more prominent and provide assistance in relieving line loads and, due to their high coincidence with peak demand, provide opportunities for reducing peak demand on the existing power grid.

These systems are modular and may be increased in capacity simply by adding additional panels to the array.

Target Market Sectors[i]: Residential, Commercial and Agricultural.

State of Development[i]: PV technologies are commercially available and continue to be developed and demonstrated.

Operation & Maintenance[i]: $0.001-0.004/kWh

Installed Cost Range ($/kW)[i]: Costs vary depending upon the site location, interconnection requirements, number and size of solar arrays. $5,000-$10,000/kW is typical for a turnkey PV system.

Operating Fuels[i]: Solar resource known as insolation, or the amount of global (direct and diffuse) solar radiation available to the PV modules. Light intensity is dependent upon site latitude and climate. Insolation increases with proximity to the earth's equator.

Electric Power Output Range[i]: 10 watts to 100 kW

Thermal Output Range[iv]: None

Physical Plant Footprint[iv]: Approximately 538 ft^2/kW.

Sizes Modeled: 1 kW

Concentrating Solar Power

Description[i]: Concentrating solar power plants produce electric power by converting solar radiation into high-temperature energy by focusing the solar radiation using various mirrored configurations. The heat generated is channeled through a conventional generator. They may be sized for distributed generation or grid-connected power. The three main types of concentrating solar power systems are: parabolic troughs, central receiver systems and dish/engine systems. In any case, these systems use only the direct-beam sunlight (not the diffuse solar radiation created by reflection and refraction within the earth's atmosphere.

As a stand-alone unit requiring only a collector, receiver and an engine, the dish/engine system is the best suited concentrating solar power for distributed generation. Heat energy from the sun is converted to mechanical power through an engine (often the Stirling). The dish/engine system has the highest conversion efficiency of the solar technologies. Their modular design allows dish/engine systems to operate in remote locations or tied to a small-grid or end-of-line utility.

Some systems are designed with thermal storage capacity. The central receiver systems utilize concentrated sunlight to heat molten salt to produce conventional steam electricity generation. This molten salt may retain its heat for more than a day. This heat retainage increases the solar capacity factor from approximately 25% to 65%.

Target Market Sectors[i]: Commercial.

State of Development[i]: Dish/engine systems are considered to be the most advanced of the concentrating solar power systems, and are considered to be in their engineering development stages. Commercial availability is expected between 2003 and 2005.

Operation & Maintenance[i]: A dish/engine (Stirling) system may require between 6 and 10 hours of maintenance annually; and may operate for approximately 8,000 hours before any necessary intervention may be needed. Most dish/engine systems may only withstand moderate wind speeds and therefore need to be stowed when wind speeds reach certain levels (about 35 mph).

Installed Cost Range ($/kW)[iv]: Costs vary depending upon the site location, interconnection requirements, unit size and configuration. In 1995 a dish/engine (Stirling) was expected to cost between $2,600/kW and $4,000/kW, installed. However, it has been estimated that a hybrid dish/engine system could be as low as $1,400/kW.

Operating Fuels[i]: All concentrating solar power plants require direct solar radiation, and often include a supplemental source of generation (usually fossil fueled), and a means of efficiency enhancement (usually via the Sterling engine which requires a light gas such as helium or hydrogen).

Electric Power Output Range[i]: Individual parabolic trough systems could generate up to 80 MW of power. A central receiver system in California can generate approximately 10 MW of electricity. A dish/engine (Stirling) system may generate approximately 25 kW/module.

Thermal Output Range[iv]: A dish/engine concentrator using the Stirling has a potential thermal output of 6,800 Btu/kWh @ 150°F @ over 300 W/m^2.

Physical Plant Footprint[iv]: Approximately, 160-269 ft^2/kW for a dish/engine (Stirling) system. Ultimate sized depends upon the number of individual collectors and configuration.

Stirling Engines

Description[i]: Used most commonly to enhance efficiencies of other DG technologies, the Stirling engine is an external combustion engine that uses heat to expand a light gas (helium or hydrogen) to move pistons to power electricity generators. This technology is used most often in concert with the dish/engine concentrator solar power technologies.

The Stirling engine in its piston/crank form has been in existence since the late 1800's, but has not been commercially produced for over 50 years. Over that time span a more advanced free-piston design has presented itself as a viable option for micro-generation. The free-piston Stirling uses a linear alternator, which restricts their power output to less than 50 kW. However, this matches the desired output for micro-generation. The use of wear-free gas bearings and mechanical springs allow the close fitting pistons to produce high mechanical efficiency and a long equipment life.

Target Market Sectors[i]: Residential, Small Commercial and Agricultural.

State of Development[i]: There are several contracts in effect in the United States, Canada and Europe to design, develop and demonstrate Stirling engines for residential use. These systems may produce about 3kW of back-up power.

Operation & Maintenance[i]: Free-piston linear alternator Stirlings have superseded the crank-driven Stirling reducing the level of wear within the working components of the external combustion engine.

Installed Cost Range ($/kW)[i]: Actual costs were not available but vary depending upon the site location, interconnection requirements, unit size and configuration.

Operating Fuels[i]: STM Power, Inc. offers its 25kW PowerUnit which can operate on a wide range of various fuels including: flare gas, coal methane, natural gas, propane, diesel, kerosene, fuel oil, light crude oil, gasoline, landfill gas, biogas, or other heat source greater than 1832°F. Other heat sources include: solar heat, industrial waste heat.

Electric Power Output Range[i]: < 50 kW.

Thermal Output Range[iv]: Not available.

Physical Plant Footprint[iv]: Not available.

Hybrid Systems

Description[i]: Hybrid systems are combined cycle applications employed to gain a higher level of generation efficiency than each individual technology could produce on its own. For example, combining fuel cells with reciprocating engines or mircroturbines allow a higher efficiency from the fuel cells alone. The most common hybrid systems use the Stirling engine.

Target Market Sectors[i]: Residential, Commercial, Industrial and Agricultural.

State of Development[i]: Most hybrid systems are in the planning stages. However, there are some cases of fuel cell/engine combined cycle that have been developed and demonstrated. Planning is underway for the design of a solid oxide fuel cell / microturbine hybrid capable of producing 300 kW of power. The prototype would assist in defining a hybrid product for entry to the commercial market. Commercial availability of most hybrid technologies are not expected within the next few years.

Operation & Maintenance[i]: Varies depending upon technologies employed.

Installed Cost Range ($/kW)[i]: Varies depending upon technologies employed.

Operating Fuels[i]: Varies depending upon technologies employed.

Electric Power Output Range[i]: Varies depending upon technologies employed.

Thermal Output Range[iv]: Varies depending upon technologies employed.

Physical Plant Footprint[iv]: Varies depending upon technologies employed.

ATTACHMENT 2 - Distributed/Onsite Generation Screening Model

PLEASE REFER TO EXCEL WORKBOOK ATTACHED ELECTRONICALLY TO THIS REPORT
(Screening Model-Distributed Onsite Generation v1 093001.xls)

EACH WORKSHEET WITHIN THE MODEL IS FORMATTED FOR DIRECT PRINTOUT SO THAT PAGES CAN BE INSERTED HERE IN THIS REPORT

Seven separate worksheets are included in this summary spreadsheet as follows:

1) Cover: a one-page cover/title sheet for the model;

2) Instructions: a one-page explanation of the model's usage;

3) Model Input: a one page user input sheet;

4) Model Results: a one-page summary of key model outputs;

5) Data - Customer Profiles: a four-page listing of usage profiles (kWh, kW, and gas) by typical customer type - 35 separate customer types included;

6) Data - Technology: a one-page listing of key technology information (6 different general technology types and 27 specific unit configurations are identified: Reciprocating Engine Generator Sets - Diesel Fueled; Reciprocating Engine Generator Sets - Natural Gas Fueled; Microturbines - Natural Gas Fueled; Fuel Cells - Natural Gas Fueled; Wind Turbines; and Photovoltaic); and

7) Data- Rates: a three-page listing/summary of Alliant's Iowa rate tariffs.

8) five-page listing of technology and payback results for each scenario that yielded positive outcomes, presented in the order in which the scenarios were run.

ATTACHMENT 3 - Detailed Model Output and Sorted Results

PLEASE REFER TO EXCEL WORKBOOK ATTACHED ELECTRONICALLY TO THIS REPORT
(Summary-Distributed Onsite Generation Screening 093001.xls)

EACH WORKSHEET WITHIN THE SUMMARY IS FORMATTED FOR DIRECT PRINTOUT SO THAT PAGES CAN BE INSERTED HERE IN THIS REPORT

Four separate worksheets are included in this summary spreadsheet as follows:

9) Group-Payback Ranking: a six-page prioritized list sorted by customer group and sub-sorted by quickest to longest payback;

10) Payback-Technology Ranking: a seven-page prioritized list sorted by quickest to longest payback and sub-sorted by technology type;

11) Technology-Payback Ranking: a six-page prioritized list sorted by technology and sub-sorted by quickest to longest payback; and

12) Raw Data Summary: a five-page listing of technology and payback results for each scenario that yielded positive outcomes, presented in the order in which the scenarios were run.

[i] Distributed Generation: Technologies, Opportunities, and Participants 2nd Edition, Energy Info Source, August 2001.
[ii] Industrial Applications for Micropower: A Market Assessment, Resource Dynamics Corporation, 1999.
[iii] Energy Efficiency and Renewable Energy Network, U.S. Department of Energy, Advanced Reciprocating Engine Systems Program, http://www.eren.doe.gov/der, 2001.
[iv] Matrix for Distributed Energy Resource Technologies, California Alliance for Distributed Energy Resources (CADER), 1997.
[v] Distributed Generation Summary, www.distributed-generation.com, Resource Dynamics Corporation, 2001.

Appendix 4B

Distributive/Onsite Generation Technical Potential

Iowa Estimate

5 years or less payback