

Final Report – Volume I

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# **Assessment of Energy and Capacity Savings Potential in Iowa**

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Prepared for the Iowa Utility Association

February 2008

In Collaboration with Summit Blue Consulting, Nexant, Inc., A-TEC  
Energy Corporation, and Britt/Makela Group



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We are especially grateful to Jack Clark of the Iowa Utility Association for coordinating this large and complex effort. His hard work, attention to detail, and facilitation skills allowed us to complete this study on time and on budget.



# Executive Summary

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## Overview

Quantec, LLC, in collaboration with Nexant, Inc., Summit Blue Consulting, A-TEC Energy Corporation, and the Britt/Makela Group, was retained by the Iowa Utility Association to conduct an assessment of technical and economic opportunities for electric and gas energy-efficiency and renewable resources in the service territories of the Association's three investor-owned utility members, namely Alliant Energy Corporation (Alliant), Aquila, Inc. (Aquila), and MidAmerican Energy Company (MidAmerican).<sup>1</sup>

Chapter 35 of the 1999 Iowa Administrative Code (199 IAC 35) sets forth the Iowa Utility Board (IUB) rules to implement legislation enacted in 1990 and modified in 1996 requiring the Utilities to provide energy-efficiency programs for their customers. The current rules with respect to this assessment became effective on February 17, 1999.

The goals of this project, as specified in the request for proposals (January 31, 2007), included:

1. Conduct primary market research to collect data on energy-efficiency measures including, but not limited to, current saturations and market adoption trends, and other key inputs for the technical assessment.
2. Develop estimates of “technical” and “economic” potentials for electric energy-efficiency and peak capacity reduction, natural gas energy efficiency, and select renewable resources<sup>2</sup> for all major end uses in various customer sectors (including the low-income segment or the residential class) by construction vintage for each of the utilities.<sup>3</sup>
3. Investigate the implications of certain provisions of the Federal Energy Policy Act of 2005 (EPACT), particularly raising equipment efficiency standards and implementation of demand response programs.
4. Review best practices for the delivery and verification of savings from the deployment of technical resources identified in this study to inform future program planning design and evaluation, including the low-income programs.
5. Assess the trends in new construction energy code compliance in the residential sector and determine the effects of non-compliance on energy savings potentials.

This study addressed each of these objectives. Specifically, the Quantec team conducted a substantial primary data collection effort in order to provide both utility-specific and Iowa-

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<sup>1</sup> Atmos Energy Corporation received a waiver from the Iowa Utilities Board (IUB) not to participate in the study.

<sup>2</sup> Non-renewable dispersed generation (e.g. Combined Heat & Power) was considered outside the scope of this study.

<sup>3</sup> The assessment of economic potential was added to the scope of work when the contract was awarded to the Quantec Team in May 2007.

specific inputs for the technical and economic potential estimates. In addition, the 2005 EPACT provisions were incorporated into the potential estimates, as known changes in federal standards effectively raised the baseline efficiency standards and, in some cases, lowered the potential estimates. The best practices research included a benchmarking study to compare utility impacts vs. spending, plus focused on the various approaches for incorporating freeridership and spillover effects into net-to-gross estimates, with a recommendation for how these effects should be examined in Iowa. Finally, Volume III contains the results of the code compliance study. This stand-alone study was initiated in late 2007 in order to allow a large enough inventory of homes that were required to meet the 2006 IECC, which was not fully enforced in Iowa until April 2007.

## Methodology

This general methodology is best described as a combination “top-down/bottom-up” approach. The top-down methodology component begins with the most current utility load forecasts, decomposes them into their constituent customer sector, customer segment, and end-use components. The bottom-up component considers the potential technical impacts of various demand-side and supplemental resource technologies, measures, and practices on each end use, which are then estimated based on engineering calculations, taking into account fuel shares, current market saturations, technical feasibility, and costs. These unique impacts are aggregated to produce estimates of resource potential at the end-use, customer sector, and service territory levels. In many ways, the approach is analogous to generating two alternative load forecasts at the end-use level (one with and one without DSM and supplemental resources) and calculating resource potential as the difference between the two forecasts.

Separate assessments of technical and economic potential for residential, commercial, and industrial sectors were made for each utility, split by fuel type. Within each utility’s sector-level assessment, the study further distinguished among customer segments or facility types and their respective applicable end uses. In total, the analysis assessed the technical and economic potential for 304 *unique* electric and 152 *unique* gas energy-efficiency measures. These measures are primarily composed of technologies that are currently available on the market. Within the 10-year span of this study, it is likely new, unanticipated, measures will gain market acceptance, changing the overall potential.

To ensure an accurate representation of the Iowa market for use in modeling the energy and capacity savings potential, the data collection efforts included over 840 telephone and 380 on-site surveys of residential and non-residential customers, trade allies and contractors. In addition to the comprehensive primary data collection efforts, the study relied on other data sources, including utility database mining, Dun and Bradstreet business segment data, and various secondary sources such as studies conducted by other utilities and energy-efficiency agencies around the country and third-party studies conducted by private research organizations, state and federal agencies. Finally, the study relied on a substantial amount of utility data, including customer counts, electric and gas sales, system hourly load shapes, sales and demand forecasts, historical demand and efficiency achievements, and avoided costs.

## Summary of Results

### Energy Efficiency

Table 1 and Table 2 show 2018 baseline sales (the end of the 10-year planning horizon) and potential by utility and sector, respectively. As shown, the results of this study indicate 9,767 GWh of technically feasible electric energy-efficiency potential by 2018. Approximately 6,800 GWh of these resources are cost-effective at an average levelized per-unit cost of 3 cents/kWh. The identified economic potential amounts to 17% of forecast load in 2018 and over 1,500 MW of peak demand reduction.

These savings are based on forecasts of future consumption absent any utility program activities. While consumption forecasts account for the past savings each utility has acquired, the estimated potential is inclusive of—not in addition to—current or forecasted program savings.

Technical and economic potential are a function of baseline sales, but are roughly comparable when analyzing in percentage terms. Differences in technical potential as a percent of baseline sales are driven by differences in the distribution of customers by segment and other utility-specific customer characteristics. In addition to these differences, the economic potential varies due to differences in utility avoided costs.

**Table 1. Technical and Economic Electric Energy-Efficiency Potential (GWh in 2018) by Utility**

Utility	Baseline Sales	Technical Potential	Technical Potential as % of Baseline	Economic Potential	Economic Potential as % of Baseline	Economic as % of Technical	Economic Potential (MW)	Average Levelized Cost
Alliant	18,250	4,453	24%	3,304	18%	74%	662	\$0.03
MidAmerican	21,329	5,314	25%	3,473	16%	65%	875	\$0.03
Total	39,580	9,767	25%	6,777	17%	69%	1,537	\$0.03

Each sector's technical and economic potentials are given in Table 2. The residential sector represents the largest portion of both the total technical and economic potentials at 51% and 47%, respectively. The commercial sector is the second largest contributor to the technical potential, but because industrial improvements are highly cost-effective, it becomes the smallest contributor to the economic potential at about 23% (Table 2).

**Table 2. Technical and Economic Electric Energy-Efficiency Potential (GWh in 2018) by Sector (Alliant and MidAmerican)**

Sector	Baseline Sales	Technical Potential	Technical Potential as % of Baseline	Economic Potential	Economic Potential as % of Baseline	Economic as % of Technical	Economic Potential (MW)	Average Levelized Cost
Residential	10,819	4,937	46%	3,215	30%	65%	997	\$0.04
Commercial	9,086	2,695	30%	1,563	17%	58%	270	\$0.03
Industrial	19,675	2,136	11%	1,999	10%	94%	270	\$0.01
Total	39,580	9,767	25%	6,777	17%	69%	1,537	\$0.03

Table 3 and Table 4 show 2018 baseline sales and potential by sector and utility, respectively, for natural gas efficiency potential. As shown, the results of this study indicate over 40,000,000 decatherms of technically feasible gas energy-efficiency potential by 2018, the end of the 10-year planning horizon. Approximately 28,500,000 decatherms of these resources are cost-effective at an average levelized per-unit cost of 44 cents/therm. The identified economic potential amount to 27% of forecast load in 2018 and over 1,500 peak day decatherms.

As with electric potential, technical, and economic potential are a function of baseline sales, but they are roughly comparable across utilities when analyzing in percentage terms. Differences are again driven by utility customer characteristics and avoided costs.

**Table 3. Technical and Economic Gas Energy-Efficiency Potential (Thousand decatherms in 2018) by Utility**

Utility	Baseline Sales	Technical Potential	Technical Potential as % of Baseline	Economic Potential	Economic Potential as % of Baseline	Economic as % of Technical	Economic Potential (Peak day decatherms)	Average Levelized Cost
Alliant	27,484	10,600	39%	7,683	28%	72%	88,822	\$0.45
Aquila	16,307	6,556	40%	4,842	30%	74%	58,990	\$0.55
MidAm	61,704	23,497	38%	16,039	26%	68%	197,144	\$0.40
Total	105,495	40,653	39%	28,564	27%	70%	344,855	\$0.44

Each sector's technical and economic potentials are given in Table 4. As with electric potential, the residential sector represents the largest portion of both the total technical and economic potential (about 65% of each). Almost all the remaining potential lies in the commercial sector, with a small portion (897,000 decatherms) in industrial (Table 4).

**Table 4. Technical and Economic Gas Energy-Efficiency Potential  
(Thousand decatherms in 2018) by Sector (Alliant, Aquila, and MidAmerican)**

Sector	Baseline Sales	Technical Potential	Technical Potential as % of Baseline	Economic Potential	Economic Potential as % of Baseline	Economic as % of Technical	Economic Potential (Peak day decatherms)	Average Levelized Cost
Residential	65,968	26,532	40%	18,654	28%	70%	248,713	\$0.44
Commercial	34,475	13,224	38%	9,013	26%	68%	93,784	\$0.48
Industrial	5,052	897	18%	897	18%	100%	2,459	\$0.07
<b>Total</b>	<b>105,495</b>	<b>40,653</b>	<b>39%</b>	<b>28,564</b>	<b>27%</b>	<b>70%</b>	<b>344,955</b>	<b>\$0.44</b>

***Demand Response***

Table 5 and Table 6 report estimated resource potential for all demand response resources for the residential, commercial, and industrial sectors for Alliant and MidAmerican. Market potential is highest in the industrial sector due to the interruptible program. Note, however, that the analysis does not account for program interactions and overlap, and thus the total technical and market potential estimates are provided as examples only, but are not fully attainable.

**Table 5. Alliant Energy  
Technical and Market Potential (MW in 2018)**

Sector	2018 Sector Peak	2018 Technical Potential	2018 Market Potential	Market Acceptance as % of 2018 Sector Peak
Residential	988	590	71	9%
Commercial	970	602	70	9%
Industrial	1475	1195	262	21%
<b>Total</b>	<b>3434</b>	<b>2388</b>	<b>403</b>	<b>14%</b>

Note: Individual results may not sum to total due to rounding.

Note: Interactions between programs has not been taken into account.

Note: DLC RES AC has been eliminated from these potential results to account for complete overlap with DLC RES AC and water heating.

**Table 6. MidAmerican Energy  
Technical and Market Potential (MW in 2018)**

Sector	2018 Sector Peak	2018 Technical Potential	2018 Market Potential	Market Acceptance as % of 2018 Sector Peak
Residential	1,367	809	97	9%
Commercial	964	388	38	5%
Industrial	1,516	868	159	13%
<b>Total</b>	<b>3,846</b>	<b>2,065</b>	<b>295</b>	<b>10%</b>

Note: Individual results may not sum to total due to rounding

Note: Interactions between programs has not been taken into account

Table 7 displays the market potential and per-unit (\$/kW-year) costs by the various demand response programs examined as part of this study. The largest potential is for interruptible tariffs and residential direct load controls. Real-time pricing and critical peak pricing (both C&I programs) are estimated to be the least expensive options, with a levelized cost of \$11/kW-year for Alliant, while critical peak pricing and demand bidding are the least expensive options for MidAmerican, with a levelized cost of \$19/kW-year and \$17/kW-year, respectively. These results also do not account for program interactions and overlap.

**Table 7. Levelized Costs and Market Potential (MW in 2018)**

Levelized Cost	Alliant Energy		MidAmerican Energy	
	Market Potential (MW)	Levelized Cost (\$/kW)	Market Potential (MW)	Levelized Cost (\$/kW)
<b>Direct Load Control (DLC)</b>				
Residential (A/C only)	48	\$55	66	\$56
Residential (A/C and WH)	53	\$62	72	\$63
Small Commercial (A/C)	1	\$96	1	\$81
Medium to Large Commercial	1	\$119	1	\$169
<b>Thermal Energy Storage (TES)</b>	1	\$135	1	\$150
<b>Interruptible Tariffs</b>	291	\$45	170	\$26
<b>Demand Bidding</b>	18	\$14	15	\$17
<b>TOU Rates</b>	7	\$38	10	\$87
<b>Critical Peak Pricing (CPP)</b>				
Residential	11	\$95	15	\$95
C&I	11	\$11	9	\$19
<b>Real-Time Pricing (RTP)</b>	9	\$11	---	---

### **Renewable Resources**

In addition to traditional energy-efficiency resources, this report includes an analysis of two classes of renewable resources: active (dispersed generation) and passive (energy-efficiency) resources. Active resources, loosely defined as “dispersed generation” (DG), include energy-based resources of biomass and three “clean generation” (non-combustion) resources: building photovoltaics (on-site solar), small hydro, and small wind. Passive resources fall into two broad categories: passive solar building design and renewable efficiency measures.

For DG resources, market potential represents the portion of technical potential that might actually be installed. It should be realized that not all these resources are economic, but, nonetheless, may be installed by customers willing to accept long payback times. For passive efficiency measures, the economic potential is provided, as determined for other energy-efficiency resources.

The market potential for all renewable resources is shown in Table 8 for DG renewable resources savings and in Table 9 for passive resources. Compared to the technical potential of DG resources, this potential is significantly less due to economic considerations, low awareness of technologies, and other permitting or interconnection concerns (details are provided in the results

sections, below). Among the DG resources, biomass energy composes the largest percentage of market potential (155 GWh), followed by small wind (103 GWh), and PV (25 GWh). The percentage of technical potential economic for passive efficiency resources is 97% of electric (453 GWh) and 88% of gas (644 thousand DTh).

**Table 8. Market Potential for DG Renewable Resources (2018)**

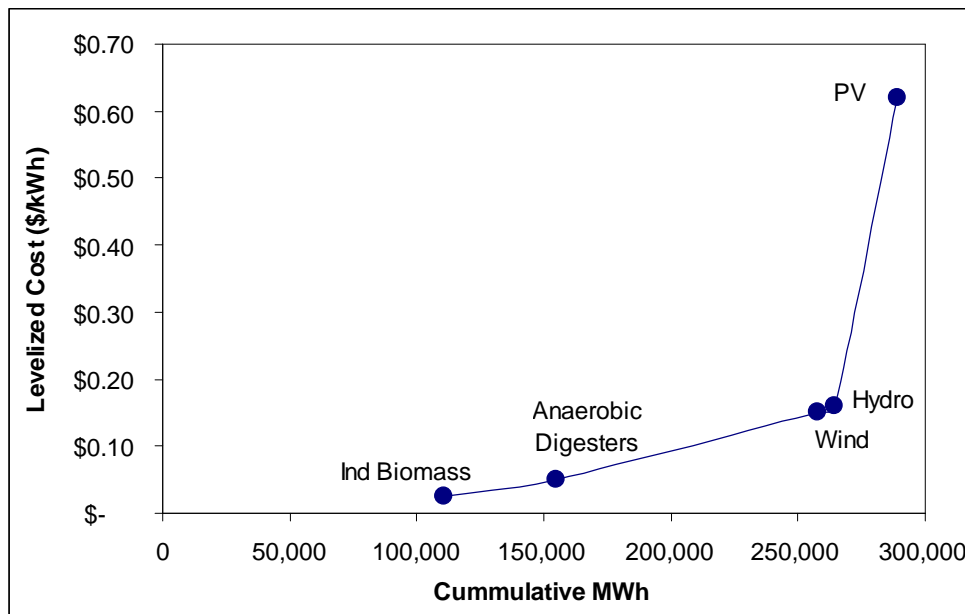
Resource	Potential (GWh)	Percent of Potential
Biomass Energy	155	54%
Building Photovoltaics	25	8%
Small Hydro	7	2%
Small Wind	103	36%
Total	290	100%

**Table 9. Economic Potential for Passive Renewable Resources by Fuel (2018)**

Resource	Potential
Electric passive efficiency resources	453 GWh
Gas passive efficiency resources	643,806 Dth

Figure 1 presents the cumulative supply curve for all DG resources. Biomass Energy is broken into potential from Industrial Biomass (direct combustion) and Anaerobic Digesters (biogas combustion).

**Figure 1. Cumulative Supply Curve for Dispersed Generation Renewable Resources (2018)**



## Planning Considerations

Resource potential studies are important means of developing reasonably reliable estimates of the magnitude, costs, and timing of demand-side management resources and, as such, serve as a critical first step in a utility's resource planning process. The results of these studies also help guide and inform the program development process.

These studies are also complex undertakings, requiring compilation of a large amount of data from multiple sources, and a number of pivotal assumptions about future technological trends, market conditions, and consumer behavior. For example, the assessment of the *technical* potential is inherently a static analysis and assumes "frozen" efficiencies for all baseline technologies. Estimates of *economic* potentials similarly depend on assumed technology costs and on determinants of the utility's avoided costs, particularly for fuel prices.

Clearly, the emergence of new technologies and enhancements to existing ones will affect the potentials for all types of demand-side management, and fluctuations in avoided costs will directly affect the expected future value of these resources. The results of this study are also sensitive to changes in macro-economic conditions and structural changes, such as fluctuations in energy prices, the institution of more stringent energy codes and standards, or the imposition of a carbon tax. The findings of this study, therefore, should be considered "indicative" rather than "conclusive." Inevitably, much of the data used in this study will have to be updated, and many of its assumptions will need to be revisited periodically.

Resource potential assessment objectives differ from those of program design and product development in that they seek to provide estimates of technically feasible and cost-effective energy-efficiency opportunities. They are useful in understanding not only the amounts of available opportunities, but the sectors and end uses where they might be concentrated. Yet, they provide little information or guidance as to *how* and by *what means* the identified resource potential might be deployed. The potential for many identified resources might be realized through legislative action to institute efficiency codes and standards. Consumer education or market transformation initiatives can also serve as an effective means of promoting energy efficiency.

Finally, the scope of this study was limited to analyzing technical and economic potentials only. Except in the case of renewables and demand response options, no attempt was made to account for the effects of market barriers, which tend to impede the penetration of energy-efficiency technologies and programs. Once the effects of such barriers are accounted for, amounts of realistically *achievable* potential are likely to be lower than that suggested by the economic potential.