

## Summary of EM&V Studies reviewed for Power Management Software for Networked PCs.

NOTE: This summary was included the original version of the work paper under section 1.4 EM&V, Market Potential and Other Studies, and forms the basis for the savings calculations.

There are many vendor case study reports available on the achieved savings of different PCPM Network Software products, including several on the Energy Star website, but few independent and in-depth reviews. E Source reported in a November 2004 technology report the results from two instrumented evaluations of Verdiem Corporation's Surveyor Network Energy Manager.<sup>1</sup> According to the E Source report, Puget Sound Energy (PSE) determined the annual savings of 17 PCs with LCD monitors to be close to 176 kWh per computer. The second instrumented evaluation that E Source reported on was conducted by Southern California Edison (SCE) as part of a preliminary pilot evaluation.

The SCE pilot instrumented 10 PCs with CRT monitors before and after PM enforcement. The estimated annual energy savings approached 323 kWh per computer. Several of the CRTs in the SCE evaluation were large 21-inch monitors which in part explain the larger annual savings. Also, the larger SCE savings are in part due to a corporate policy to have employees logoff networked computers and leave them on so that updates can be "pushed" to them at night through the network. Both instrumented evaluations came within a few percentage points of the values obtained using PCPM Network Software. Neither of the two instrumented evaluations reported a demand reduction. SCE's follow-up full scale evaluation of the Surveyor software, with hourly reporting capability, installed the application on 120 computers across multiple departments and locations. The final data analysis and draft report for this evaluation are currently underway as part of SCE's Emerging Technologies Program.

In report LBNL-1096E, dated September 2008, LBNL estimated a national potential energy savings of 71 TWh of site energy in the year 2030 for PCPM software technology in commercial buildings.<sup>2</sup> This LBNL report estimates the PCPM software annual unit savings at 99 kWh for displays and monitors and 137 kWh for PCs and workstations, for a total annual unit savings of 236 kWh.<sup>3</sup> The LBNL-1093E report indicates that these savings estimates were weight-averaged according to the 2002 estimated national energy consumption given in a report prepared by TIAX for the U.S. Department of Energy (DOE) in 2004.<sup>4</sup> The LBNL-1096E report provides no unit savings estimates for demand reduction. The report cites 4 years as the PCPM software measure "lifetime" based on the "lifetime" value used for computer monitors.<sup>5</sup>

The TIAX 2004 report provides a discussion of PCPM network software and the assumptions used to derive the energy savings potential estimates.<sup>6</sup> The TIAX report presents the unit energy consumption (UEC) values for computer desktops and workstations, as well as for 15" and 17" CRT and LCD monitors. The report presents two different savings strategies for networked computers:

- **Auto Sleep:** Monitors and PCs enter a hibernate state instead of "off" during weekend and nighttime periods; and
- **Auto Off:** All devices enter the "off" state during weekend and nighttime periods.

The TIAX 2004 report states that networked-enacted PM settings have the potential to reduce desktop PC and monitor annual energy usage by close to 60%, and cites national annual energy savings potential of 27 TkWh for the Auto Off strategy and 18 TkWh for the Auto Sleep strategy. This gap between the two strategies has decreased due to lower sleep mode power draws in newer desktop computers.<sup>7</sup> Using the report's UEC values for a desktop computer and 17" LCD monitor yield unit energy savings of 245 kWh/year for the Auto Off strategy, and 163 kWh/year for the Auto Sleep strategy. The TIAX report indicates that peak demand reduction potential is small, stating in its' measure summary that most PCs are in use during peak demand periods.<sup>8</sup>

In June 2007, Intel Corporation released a white paper entitled "Designing for Energy Efficiency." In this document, Intel presents power draw values for typical power states: maximum, idle, sleep, and off. The white paper also presents annual energy usage estimates for typical computer configurations both with and without PM.<sup>9</sup> Intel estimates that a typical baseline configuration without PM enabled would consume 423 kWh/year, and 173 kWh/year with PM enabled. Thus, the Intel estimated unit energy savings are 250 kWh/year. The Intel white paper does not provide a value for peak demand reduction.

In 2001, the Northwest Energy Efficiency Alliance (NEEA) formed a public/private partnership with Verdiem Corporation to commercialize the Surveyor Network Energy Manager software. Quantec, LLC produced two market progress evaluation reports for the NEEA regarding the Surveyor software looking at such issues as market potential and barriers, competitive environment, business model, marketing, savings validation, and cost effectiveness.<sup>10,11</sup> The first market progress evaluation report from March 2003, discusses Quantec's in-house validation of an early version of the Surveyor software in their Portland offices on 17 computers, desktops and laptops, with CRT monitors. The resulting estimated unit savings in Quantec's office ranged from negative energy savings to 107 kWh/year.<sup>12</sup> At another site identified as an EZConserve – now Verdiem – Premier Evaluation Partner, Quantec reported that unit savings again varied from none to 141 kWh/year. The report cites several reasons and limitations to account for the low results:<sup>13</sup>

- Metering and Logging Technology Issues,
- Limited Number of Computers Monitored,
- Failure of Some Computers to Enter the Stand-by Power Mode,
- Early Version of the Surveyor Software,
- Short Time Period for Monitoring, and
- Sample Bias and Contamination – Existing PM and Employee Behavior.

In an attempt to represent more "typical" baseline conditions, Quantec adjusted the potential unit savings estimate for the two sites to 165 kWh/year.<sup>14</sup> In addition, the report summarizes the NEEA cost-effectiveness assumptions for the Surveyor software.<sup>15</sup> Table 1 lists the relevant cost-effectiveness assumptions.

**Table 1.** NEEA 2003 Cost-Effectiveness Assumptions for Surveyor Network Energy Manager.

<b>Surveyor Cost</b>	<b>\$15/unit with replacement cost in 5 years</b>
<b>Installation Cost</b>	\$2.50/unit
<b>Life of Measure</b>	10 years
<b>Annual O&amp;M Costs</b>	None assumed
<b>Market Size</b>	>3.2 million in 2010
<b>Units Sold in Pacific Northwest</b>	~452,000 by 2010 or ~14% market saturation
<b>Annual Energy Savings</b>	200 kWh/unit

The NEEA documented the derivation of their deemed unit energy savings in a white paper that may be found embedded in the Attachments section. The methodology is based on the February 2001 report LBNL-45917, “Electricity Used by Office Equipment and Network Equipment in the U.S.: Detailed Report and Appendices.” The white paper estimates a unit energy savings of 213 kWh/year which the NEEA conservatively reduces to 200 kWh/year for their cost-effectiveness assumptions.

The second market progress evaluation report (MPER) on the Surveyor software for the NEEA from January 2005 discusses several studies that provided a more in-depth examination.<sup>16</sup> Two of the results presented are the instrumented evaluations at Puget Sound Energy and Southern California Edison, already mentioned as part of the E Source 2004 Tech report. The second MPER report provides an in-depth discussion of the monitoring study that Quantec performed at the Puget Sound Energy offices along with the derivation of the annual energy savings per workstation of 176.2 kWh/year. At the Issaquah School District, Quantec initially estimates the total unit annual energy savings per workstation to be 253 kWh/year, but revises it downward in a footnote to 211 kWh/year to account for summer vacations. At the Portland Metro Government offices, Quantec estimated the total annual energy savings per workstation at 33.8 kWh/year. The report indicates that the baseline conditions account for the low result: employees would be on their computers at this site during working hours, and few computers and monitors left on at night, weekends, and holidays.

The second MPER also presents the findings from an evaluation at the Queensborough Community College in Bayside, New York – also summarized in the E Source 2004 Tech Report – sponsored by the New York Power Authority. This evaluation used the Surveyor software and Verdiem’s estimates to arrive at unit annual energy savings of 129 kWh/year for the administrative office computers, and 317 kWh/year for the academic computer labs. Lastly, the second MPER presents the results of the British Columbia Hydro Power Smart Partner Demonstration program at the Robert Batemen Secondary School – also in the E Source 2004 Tech Report – using the Surveyor software. The software was installed on 19 computers and monitored for a one-week period in April 2003, yielding an estimated annual energy savings of

253 kWh/year per computer. Quantec attributed the wide savings variations among the evaluations summarized in the second MPER to a few specific “drivers.”<sup>17</sup>

- Length of the Study Period,
- Number of Computers Monitored,
- Type of Computers Monitored, and
- Baseline Practices and Compliance.

In the second MPER, the NEEA cost-effectiveness assumptions mirror the 2003 values with the exception of the costs. Table 2 summarizes the revised NEEA cost-effectiveness assumptions for the Surveyor software.<sup>18</sup>

**Table 2.** NEEA 2005 Revised Cost-Effectiveness Assumptions.

<b>Surveyor Cost</b>	<b>\$10.00/unit for large sites (6% of sales), \$15.00/unit for medium sites (24%), \$20.00/unit for small sites (70%). Average cost was \$18.00/unit.</b>
<b>Installation Cost</b>	\$5.00/unit

The NEEA continued to assume the unit energy savings at 200 kWh/year in the second MPER, but noted that “... given the increasing market share of flat panel monitors, savings per work station should be reduced after the next two to three years by at least 10%.”<sup>19</sup> Neither the first MPER nor the second MPER present any estimate for peak demand reduction.

An evaluation report for the San Diego Gas & Electric’s 2004-2005 Local Energy Savers Program lists a PCPM Network Software measure under the name of “Plug Load Sensors.”<sup>20</sup> The program targeted this measure to school districts and rebated on 12,000 Surveyor Network Energy Manager software licenses.<sup>21</sup> Quantec collected Surveyor reports from three program participants, and Table 3 summarizes the estimated unit energy savings for those participants.<sup>22</sup> Quantec noted in the evaluation that they did not have access to the type of computers and monitors that were included in the Surveyor reports.<sup>23</sup> This introduces a higher level of uncertainty on the power state values used in the Surveyor reports and the estimated unit energy savings derived from those reports. The Energy Savers Program assumed that there was no demand reduction associated with the measure, and Quantec did not attempt to estimate a value from the Surveyor reports.

**Table 3.** Estimated Unit Energy Savings From the SDG&E Energy Savers Program.

<b>Participant No.</b>	<b>No. of Licenses</b>	<b>Business Type</b>	<b>Estimated Savings per Workstation</b>	<b>Methodology</b>
1	4,530	School District	133 kWh/year	Based on the delta of a 37-day pre-enforcement baseline monitoring period and a 26-week post-enforcement period.
2	1,859	School District	168 kWh/year	Baseline data were not available, so assumed same pre-enforcement

				consumption of Participant 1, took delta from 46-day post-enforcement period.
3	350	Office of Education	235 kWh/year	Based on the delta of a control group of 72 clients vs. a “10 pm shutdown group” of 240 clients during a 59-day period.
<b>Totals:</b>	<b>6,739</b>	<b>Weighted Average Savings:</b>		<b>148 kWh/year</b>

The PCPM Network Software measure was also found among the measures of one of the constituent programs in the evaluation report for Southern California Edison’s 2004-2005 IDEEA Program.<sup>24</sup> The measure was part of the Community College District Retrofit Program. The report indicates that the Surveyor Network Energy Manager software was installed at one of the Los Angeles Community College District (LACCD) campuses. Quantec indicated in the report that “... the customer failed to provide the implementation contractor or evaluation team with a post-installation inventory of PC-related equipment impacted by this installation. As a result, the evaluation team developed ex-post savings estimates based on the equipment identified by the implementation contractor during pre-installation audits.”<sup>25</sup> Quantec states that given the lack of cooperation from the campus, they relied on secondary research alone for the energy savings analysis.<sup>26</sup> Quantec recommended claiming zero peak demand savings<sup>27</sup> and using an average unit energy savings value of 196 kWh/year based on the Surveyor results for Queensborough Community College – summarized in both E Source 2004 and NEEA’s second MPER.<sup>28</sup> However, the recommended weighted average value in the report was calculated incorrectly. The correct weighted average value, based on the distribution of administrative and academic computers at Site 5, should have been 249 kWh/year calculated as follows:

$$\begin{aligned}
 \text{AvgSavings} &= \frac{\text{NumberAdminComputers} \times \text{AdminComputerSavings} + \text{NumberAcademicComputers} \times \text{AcademicComputerSavings}}{\text{TotalNumberofComputers}} \\
 &= \frac{716 \times 129 + 1,267 \times 317}{716 + 1,267} \approx 249 \text{ kWh/year}
 \end{aligned}$$

Hence, the original 234 kWh/year ex-ante estimate the Community College District Retrofit Program had assumed was more conservative than the evaluator’s final recommendation based on secondary research.

Finally, two of SCE’s 2006-2008 Partnership Programs – the UC CSU Partnership and the Community Colleges Partnership – promoted and installed PCPM Network Software measures. The adjusted unit energy savings for CSU San Bernardino were 137 kWh/year. The unit energy savings for Cerritos College were estimated at 314 kWh/year for networked PCs and 44.5 kWh/year for Macs. There are no peak demand reduction claims.

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- <sup>1</sup> Dan Greenburg, Platts Research & Consulting (now E Source), “Network Power Management Software, Saving Energy by Remote Control,” Tech Report ER-04-15, November 2004, pages 7, 8, 11, and 12.
  - <sup>2</sup> Ernest Orlando Lawrence Berkeley National Laboratory (LBNL), “U.S. Building Sector Energy Efficiency Potential,” LBNL-1096E, Rich Brown, Sam Borgeson, Jon Koomey, and Peter Biermayer, September 2008, Tables 2 and 4, pages 3 and 5.
  - <sup>3</sup> Ibid, Table 5, page 8.
  - <sup>4</sup> Kurt W. Roth, Gerald R. Larocque, and Jonathan Kleinman, “Energy Consumption by Office and Telecommunications Equipment in Commercial Buildings, Volume II: Energy Savings Potential,” TIAX LLC for the U.S. Department of Energy, Building Technology Program, December 2004.
  - <sup>5</sup> LBNL-1096E, Note C2, page 10.
  - <sup>6</sup> Roth et al., December 2004, pages 4-77 to 4-86.
  - <sup>7</sup> Ibid, page 4-83.
  - <sup>8</sup> Ibid, Table 4-41, page 4-78.
  - <sup>9</sup> Intel Corporation, “Designing for Energy Efficiency,” White Paper for the Intel® 3 Series Chipset, June 2007, page 11.
  - <sup>10</sup> Quantec, LLC, “Market Progress Evaluation Report, EZ Conserve, No. 1,” Report #E03-110, prepared for the Northwest Energy Efficiency Alliance, March 2003.
  - <sup>11</sup> Quantec, LLC, “Surveyor Network Energy Manager, Market Progress Evaluation Report, No. 2,” Report #E05-136, prepared for the Northwest Energy Efficiency Alliance, January 19, 2005.
  - <sup>12</sup> Quantec 2003, page V-7.
  - <sup>13</sup> Ibid, page V-8 and VII-3 to VII-4.
  - <sup>14</sup> Ibid, page VII-4.
  - <sup>15</sup> Ibid, page VI-1.
  - <sup>16</sup> Quantec 2005, page V-1 through V-14.
  - <sup>17</sup> Ibid, page V-13.
  - <sup>18</sup> Ibid, page VI-1 and VI-2.

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19 Ibid, page VI-3.

20 Quantec, LLC, “San Diego Gas & Electric 2004-2005 Local Energy Savers Program Evaluation Report,” Study ID: SDG0212, Program Number: 1315-04, prepared for San Diego Gas & Electric, July 31, 2006, p<sup>age</sup> 5.

21 Ibid, page 7.

22 Ibid, Table 11, page 18.

23 Ibid, page 17.

24 Quantec, LLC, “Southern California Edison 2004-2005 IDEEA Constituent Program Evaluations, Final Report, Volume 1,” Study ID: SCE0234.01, prepared for Southern California Edison, June 2008, page 5-1.

25 Ibid, page 5-18.

26 Ibid, page 5-26.

27 Ibid, page 5-27.

28 Ibid, pages 5-26 and 5-28