Equipoise Consulting, Inc.

Evaluation

Project Management

Errata Report for

Evaluation of the Agricultural Pumping Efficiency Program I (CPUC Project 230-02ABCD)

Submitted by:

Equipoise Consulting Incorporated

In association with

Vanward Consulting
Ridge & Associates, and
California AgQuest Consulting Inc,

March 10, 2006

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1 Executive Summary

In 2002, the California Irrigation Technology (CIT) Agricultural Pumping Efficiency Program I (APEP-I) was awarded funding from the California Public Utilities Commission (CPUC) to provide an incentive-based energy efficiency program for Program Years (PY) 2002 and PY2003. The program implementer received no-cost extensions to provide services under this program through December 31, 2005.

Timing issues surrounding data collection and evaluation report deadlines resulted in a final report on this program being filed on June 17, 2004 (see www.CALMAC.org ; searchable database, search on CIT0001.01). This errata report updates the energy impacts to include all pump repairs paid prior to the end of the program. As such, no background on the program is provided herein. The reader is referred to the final report on the CALMAC website for further evaluation information on the program.

1.1 Verification Results

The program met its statewide goal of 5,000 pump tests, having completed 6,193 pump tests by December 2005, although the SoCalGas service territory had fewer tests than planned. The program fell short on the number of pump repairs paid for by the program, however the average repair provided a higher savings than planned.

1.2 Impact Evaluation Results

There were 298 repairs of electric pumps paid for under the program through December 31, 2005. The total energy impacts from these repairs are shown in Exhibit 1.1. The default net-to-gross ratio (NTGR) of 0.75 was applied to the gross impact values to obtain net impacts. The average net electrical energy impact per pump repair was 32,757 kWh.

Exhibit 1.1
Electric Energy Impacts

	Total	PG&E	SCE	SDG&E	SoCalGas
Number of Pump Repairs					
Goal	436	345	75	16	-
Through 12/31/03	*61*	*53*	*3*	*5*	-
Since 12/31/03	*237*	*180*	*50*	*7*	-
Total APEP- I	298	233	53	12	-
Gross kWh Impact					
Goal	13,734,000	10,867,500	2,362,500	504,000	-
Through 12/31/03	*3,963,196*	*3,558,319*	*34,522*	*370,354*	-
Since 12/31/03	*9,052,239*	*7,205,354*	*1,715,100*	*131,784*	-
Total APEP- I	13,015,434	10,763,673	1,749,623	502,138	-
Net kWh Impact					
Goal	10,300,500	8,150,625	1,771,875	378,000	-
Through 12/31/03	*2,972,397*	*2,668,739*	*25,892*	*277,766*	-
Since 12/31/03	*6,789,179*	*5,404,016*	*1,286,325*	*98,838*	-
Total APEP- I	9,761,576	8,072,755	1,312,217	376,604	-
Percent of Net Impacts					
Through 12/31/03	*28.9%*	*32.7%*	*1.5%*	*73.5%*	-
Since 12/31/03	*65.9%*	*66.3%*	*72.6%*	*26.1%*	-
Total APEP- I	94.8%	99.0%	74.1%	99.6%	-

Note: Values through 12/31/03 have been updated since the Impact Report dated 6/17/04.

There were 13 repairs of natural gas pumps paid for under the program through December 31, 2005, fewer than the program goal. However, the total energy impacts from these repairs exceeded program goals by more than 70 percent, as shown in Exhibit 1.2. The average net energy impact per pump repair was 14,336 therms for natural gas powered pumps.

Exhibit 1.2
Therm Energy Impacts

	Total	PG&E	SCE	SDG&E	SoCalGas
Number of Pump Repairs					
Goal	64	25	-	4	35
Through 12/31/03	*1*	*0*	-	*0*	*1*
Since 12/31/03	*12*	*4*	-	*0*	*8*
Total APEP- I	13	4	-	0	9
Gross Therm Impact					
Goal	144,000	56,250	-	9,000	78,750
Through 12/31/03	-	-	-	-	-
Since 12/31/03	*248,489*	*59,516*	-	-	*188,973*
Total APEP- I	248,489	59,516	-	-	188,973
Net Therm Impact					
Goal	108,000	42,188	-	6,750	59,063
Through 12/31/03	-	-	-	-	-
Since 12/31/03	*186,367*	*44,637*	-	-	*141,729*
Total APEP- I	186,367	44,637	-	-	141,729
Percent of Net Impacts					
Through 12/31/03	*0.0%*	*0.0%*	-	*0.0%*	*0.0%*
Since 12/31/03	*172.6%*	*105.8%*	-	*0.0%*	*240.0%*
Total APEP- I	172.6%	105.8%	-	0.0%	240.0%

Note: Values through 12/31/03 were first presented in the Impact Report dated 6/17/04.

1.3 Conclusions and Recommendations

The APEP-I program provided California 95 percent of the net expected electric savings and 173 percent of the expected natural gas savings. There was a lag between the pump tests and the pump repairs with two-thirds of the pump tests taking place in 2002 or 2003, but eighty percent of the repairs occurring in 2004 or 2005. While not all the pump repairs had pump tests through the program (14 percent used an outside vendor for the pump tests), this data also indicates that around five percent of those who received a pump test performed a pump repair. On average, program participants received 30 percent of the cost of the pump repair. The average pump repair cost $12,525.

It is recommended that any agricultural program be provided a long time window to effect energy impacts. The lag between testing and repairs shows that a two year period was inadequate for pump repairs and is most likely indicative of the decision making process in the agricultural market.

2 *Overview*

In 2002, the California Irrigation Technology (CIT) Agricultural Pumping Efficiency Program I (APEP-I) was awarded funding from the California Public Utilities Commission (CPUC) to provide an incentive-based energy efficiency program for Program Years (PY) 2002 and PY2003.

Due to contractual issues beyond the control of the APEP-I, the program began on October 1, 2002. The original end date was slated for December, 2003. However, as many programs began late in 2002 (due to similar contractual issues), upon request, the CPUC provided program extensions. The APEP-I program requested and received two extensions.[1] The official end date for PY2002 and PY2003 funding was December 31, 2005. According to the decision, reporting was to be completed by December 31, 2005 as well.

Timing issues surrounding data collection and evaluation report deadlines resulted in a final report being provided on June 17, 2004. (see www.CALMAC.org ; searchable database, search on CIT0001.01) This errata report updates the energy impacts to include all pump repairs paid prior to the end of the program. As such, no background on the program is provided herein. The reader is referred to the final report on the CALMAC website for further evaluation information on the program.

2.1 Evaluation Approach

Equipoise Consulting Inc., in conjunction with California AgQuest Consulting Inc., Ridge & Associates, and Vanward Consulting (the Team), were chosen through a competitive process to evaluate the APEP-I. All evaluations in this time period had to address CPUC required objectives as well as specific EM&V components. There were items specifically outlined by the CPUC in the Energy Efficiency Policy Manual (EEPM)[2]. These EEPM objectives and components are presented first in order to make it clear at the outset how the evaluation addressed each of them.

2.1.1 CPUC Stipulated Items

The CPUC required that a set of eight overall objectives as well as specific EM&V components be addressed in each evaluation. These eight objectives are listed in Exhibit 2.1, along with how the evaluation met the objective.

[1] ALJ Malcolm rulings 6/3/04 and 4/18/05.

[2] California Public Utilities Commission. (2001) *"Energy Efficiency Policy Manual."* Prepared by the Energy Division of the California Public Utilities Commission.

Exhibit 2.1
CPUC Evaluation Objects

CPUC Objective	***How evaluation met this objective***
Measuring level of energy and peak demand savings achieved.	*The Team used IPMVP Option A to measure the energy impact of the program. No peak demand impacts were expected and peak demand savings were not assessed.*
Measuring cost-effectiveness (except information-only)	*The evaluation used the quarterly reports to track the pump test repairs.*
Providing up-front market assessments and baseline analysis, especially for new programs	*Since market assessments had been completed within the last five years for this sector, a market assessment or baseline analysis was not done as a part of this evaluation.*
Providing ongoing feedback and corrective and constructive guidance regarding the implementation of programs.	*The Team provided communication, both orally and via email, to the program manager as needed.*
Measuring indicators of the effectiveness of specific programs, including testing of the assumptions that underlie the program theory and approach.	*The program theory was articulated to identify possible indicators of immediate, intermediate, and long-range outcomes. An evaluability assessment was done to determine the desirability and feasibility of obtaining these indicator data in light of the stated program objectives.*
Assessing the overall levels of performance and success of programs.	*The Team assessed the extent to which the program achieved its stated objectives through the various areas of the program evaluation.*
Informing decisions regarding compensation and final payments. (except information-only)	*The Team tracked the total kWh impact in comparison to the planned kWh objectives for the program. The information for the total program is provided in this errata report.*
Helping to assess whether there is a continuing need for the program.	*The Team used all the information gathered during this evaluation to help assess the need for this program in the future.*

EM&V Components for the Pump Repairs

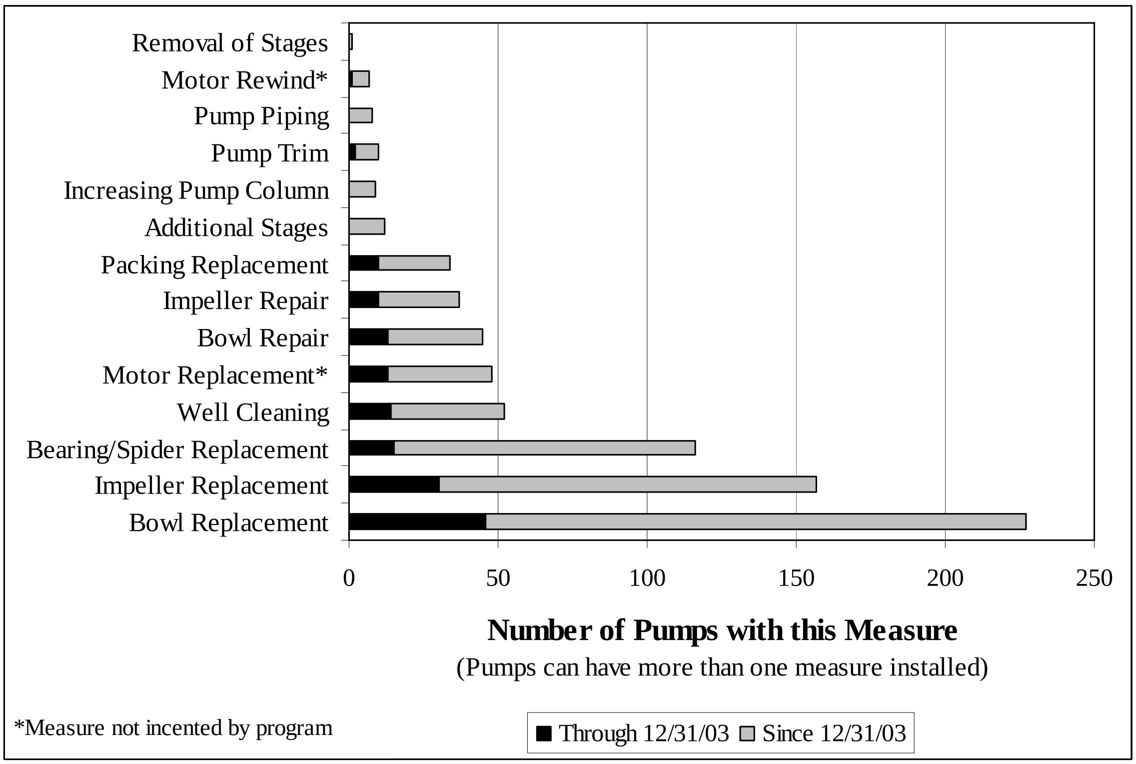
<u>Baseline Information</u>

For the energy component of the program, the baseline is defined as the state of the customer's pump before program participation. The pre-repair pump tests provide all necessary data on this state before participation. The baseline information on awareness and knowledge of growers and water agencies are covered in the previous evaluation reports and are documented in the References Section of the July 2004 final report.

Energy Efficiency Measure Information

The APEP-I provided incentives for measures that improved the efficiency of pumping systems. The measures ranged from new pump bowls to cleaning the well. Exhibit 2.2 shows the measures installed through the APEP-I as of December 31, 2003 as black bars (provided in the July 2004 final report) and since that date as gray bars. As can be noted from this exhibit, a single pump repair could consist of multiple measures at one time (i.e., a pump repair could have both an impeller and bowl replacement).

Exhibit 2.2
Energy Efficiency Measures Installed by the APEP-I Program



Measurement and Verification Approach

The measurement and verification of the pump repair measures was done through database and paper documentation review of a sample of the repairs paid in each quarter. The number of pump repairs verified by this method was randomly chosen to provide the evaluation team with a 95% confidence level (± 5%) that there were no errors in the database and that the pump repair occurred. No onsite audits were feasible for these measures due to the nature of the measure.

A default net-to-gross ratio that was stated in the program implementation plan (0.75) was applied to estimate the final evaluation net energy impacts. No net-to-gross analysis occurred in this evaluation.

Evaluation Approach

The evaluation approach used primary data collection from program staff and program participants to determine how the program was doing and what impacts resulted from the program actions. Pump test customers, pump repair customers, and pump repair companies were surveyed by telephone while APEP-I staff were interviewed in person. Onsite audits were performed to collect information on the mobile energy centers and the interaction of the program with the Irrigation Training Facility in Chico. During the MEC onsite audits, participant surveys were collected. The approach is fully detailed in the final report. This errata report used the evaluation approach indicated in Section 4 of this report.

3 Data Collection

The evaluation team used the data from the program tracking database to calculate the energy impacts for the pump repairs that had occurred as of the time the program encumbered funds. Verification covered all pump tests and pump repairs paid under the PY2002/2003 program. Following the procedure outlined in Section 4.1, the evaluation team requested and verified the data as indicated in Exhibit 3.1.

Exhibit 3.1
Data Points for Verification

	APEP I Pump Tests		APEP I Pump Repairs	
Verification Period	**N of Population**	**N of Verification**	**N of Population**	**N of Verification**
Through 12/31/03	4,132	263	62	50
Since 12/31/03	2,061	93	249	70
Program Total	**6,193**	**356**	**311**	**120**

Analysis of the energy impacts of the 249 pump repairs since 12/31/03 took place in late 2005. Ten data points from before 12/31/03 were re-evaluated at that time as well. The energy impacts in this report were calculated using all 311 data points shown above and represent the total impacts of the PY2002/2003 program.

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4 Evaluation Method

This section provides the impact evaluation method used in this errata report. While the overall evaluation of the program was comprehensive, this errata report only provides the energy impact results of the program.

4.1 Incentive Component Verification

The program provided incentives to undertake a capital investment and make a change to pumping equipment. Since energy savings were generated, a measurement and verification assessment was required. A second part of the incentive component included incentives provided directly to pump test companies in order to offset the cost of a customer's pump test. While there were no energy impacts from these tests, a verification of the payment interaction was performed by the evaluation team.

During the PY2002/2003 program implementation and again at the end of 2005, the evaluation team received the program tracking database from the program manager. From that data, a sample size was calculated based on the population of tests and repairs in that quarter. The sample was pulled using the following assumptions:

- Results of verification would be accurate at the 95th percentile,
- Expected percentage of valid occurrences in the population set to 90% (conservative value),
- Finite population correction factor used.

The following algorithms were used to calculate the sample size:

$$nsample = \frac{t^2 * p * (1 - p)}{d^2} \quad (1)$$

$$nfinite = \frac{nsample}{\left(1 + \frac{nsample}{N}\right)} \quad (2)$$

where:

t	=	1.645 (95% confidence level for a one-tailed test with infinite degrees of freedom).
p	=	expected percentage of valid occurrences in the population (0.9).
d	=	desired level of accuracy (0.05).
N	=	population size.
Nsample	=	required sample size without the finite population correction.
Nfinite	=	required sample with finite population correction.

For the sampled records, the evaluation team assessed the total number of cells within each database table that contained data, provided a subjective indicator of the importance of the data for both program and evaluation purposes, and subjective comments on the data populating the cells for each variable.

Once the electronic verification of the data was completed, ten records from the sampled group were randomly selected for visual verification of hardcopy documentation. The visual verification for the pump tests used four items: 1) invoice from the pump tester that was associated with this test, 2) a record with a signature of the recipient that indicated they received the test results, 3) a picture of the test site, and 4) the site access agreement. The visual verification for the pump repair used five items: 1) application with the signature included, 2) paid invoice and notice of project completion, 3) pre-repair pump test, 4) post-repair pump test, and 5) payment authorization. (Specific population numbers and points requested for verification are shown in Exhibit 3.1.)

4.2 Energy Impact

The CPUC had stipulated that measurement and verification of local programs must adhere to guidelines in the International Performance Measurement and Verification Protocol (IPMVP). For the APEP-I, Option A of the IPMVP was the most appropriate approach to use. This is called the Partially Measured Retrofit Isolation approach in which savings are determined by partial field measurement of the energy use of the system to which an energy conservation measure (ECM) is applied. It is an engineering calculation using post-retrofit measurements and stipulations. In this case, the pre- and post-retrofit pump tests[3] supplied the majority of the parameters of the energy savings with billing data used to obtain estimated annual energy savings. The billing data were the stipulated parameter within this option.

It must be realized that the IPMVP is a set of protocols that outline requirements for sites, not for entire programs. Under these guidelines, each grower who implements an energy saving measure affecting the pump would be required to have a post-retrofit pump test. Since this occurred as part of the program implementation, no deviation was found from IPMVP Option A.

There were two algorithms used in the measurement of the energy savings. The main algorithm used to calculate energy savings from the pump repairs is shown in Exhibit 4.1.

Exhibit 4.1
Program Energy Impact Algorithm

$$\text{Program Impact} = \sum_{i=1}^{j} kWh_{12\ \text{months},\ i} * \left(1 - \frac{OPE_{pre,\ i}}{OPE_{post,\ i}}\right)$$

Where:

j = number of pump repair participants.

kWh = 12 months of pre-repair billing data from the pump - obtained from the grower. This value would be therms in the case of a natural gas engine pump.

OPE = operating pump efficiency, pre and post, from pump tests on that pump.

There were some pump repair sites where an OPE could not be determined. For example, one site's well could not be sounded. While the OPE could not be calculated, another value (the kWh/acre foot of water pumped) was provided from the pre-retrofit and post-retrofit tests. For these type of sites, the algorithm shown in Exhibit 4.2 was used. About 7 percent of the pump

[3] The program paid for either the pre- or post-repair pump test, but not both, although both tests were required.

repairs analyzed in late 2005 used this alternate method of calculating energy impacts. Additionally, a comment field in the program database indicated that about four percent of the repairs had changed the motor horsepower of the pump. The use of the main algorithm (Exhibit 4.1) does not adequately capture the impact of the horsepower change and the decision was made to use the alternate algorithm to estimate savings for these repairs (Exhibit 4.2).

Exhibit 4.2
Alternate Energy Impact Algorithm

$$AF_i = \frac{kWh_{i,pre}}{\left(\frac{kWh}{AF}\right)_{i,pre}}$$

$$kWh_{i,post} = AF_i * \frac{kWh}{AF}_{i,post}$$

$$kWh\ Impact_i = kWh_{i,pre} - kWh_{i,post}$$

Where:

- i = pump repair site.
- kWh_{pre} = 12 months of billing data from the pump, this data obtained from the grower.
- kWh/AF = pre and post values from pump test.

There were 10 repairs analyzed and reported upon in the previous report that had estimated the kWh use of the pump, as actual billing data was not available before the repair (there were 62 repairs analyzed for the previous report). The program had tracked these sites and updated the use to actual kWh use after the repair. As such, these 10 repairs were re-analyzed using the updated value.

In twelve cases, the 12 months of billing data was obtained after the repair (the ten cases just discussed and two others from this current analysis sequence). Application of the main algorithm was inappropriate. For these twelve repairs, Exhibit 4.2 was applied, only a back-calculation of the kWh use before the repair was made using the kWh/AF values from the pump tests. As such, the post-repair kWh was known and the pre-repair kWh was estimated to calculate the impact.

5 Results and Conclusions

This section covers the results of the analysis as well as conclusions and recommendations from the evaluation.

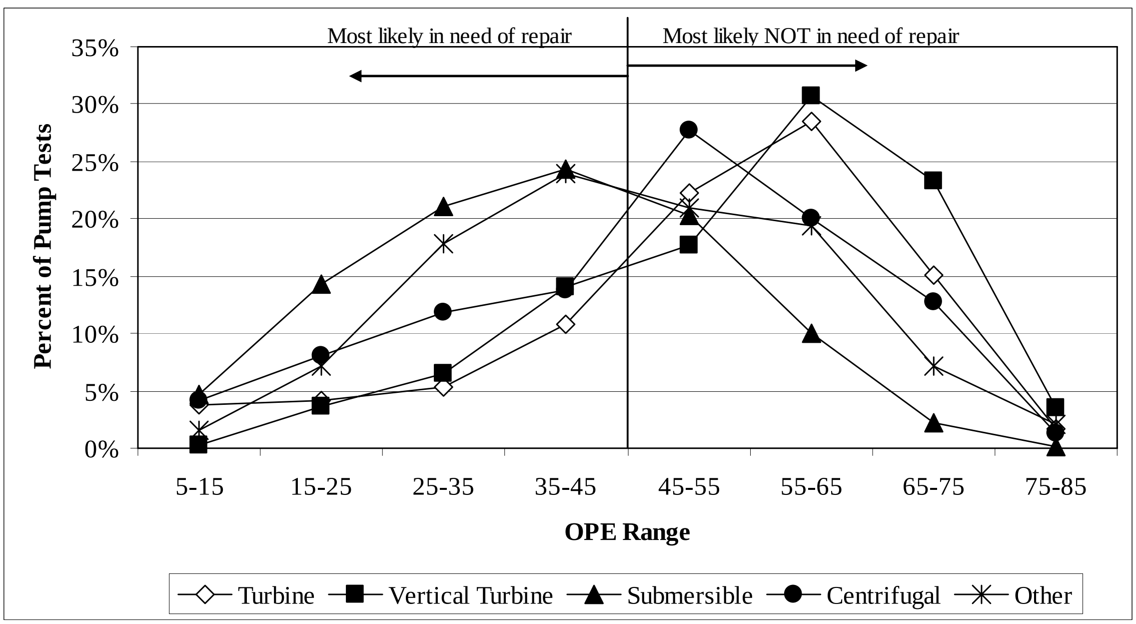
5.1 Verification of Savings

No inconsistencies were found in the database or hard copy information by the verification process. This was a very thorough database that was kept up-to-date by the program. The hard copy documentation requested by the evaluation team was promptly supplied, clearly labeled and easy to follow. Any questions that arose during the verification process were quickly and satisfactorily answered by program staff.

Plant efficiency data from pump tests were analyzed to determine the percentage of pumps tested that appeared to be in need of repair.

As shown in Exhibit 3.1, there were 6,193 pump tests through the APEP-I from program inception to the end of 2005. Exhibit 5.1 shows the percentage of the tests by OPE bin.

Exhibit 5.1
Pump Test OPE



*Only pump types with an OPE greater than 5 included in chart. N=5,800.

One indication of the need for a pump repair for most types of pumps is an OPE less than 45. Submersible pumps may need a repair at an OPE of 35. Based on those criteria, about one third of the pumps tested and shown in Exhibit 5.1 appear to be in need of a repair. However, larger pumps (greater than 200 hp) may be in need of a repair if the OPE is even 5 percent lower than what is considered the ideal OPE because large pumps generally run longer and a small difference in OPE can make a large cost difference (ideal OPE was provided in the APEP-I database and varied from 42 to 75). Also, if the pump is more than 25 percent lower than the ideal OPE, a pump repair is probably needed. The data were analyzed further using these criteria (i.e., if greater than 200 hp and OPE not within 5 percent of the ideal OPE, or if less than 200 hp and OPE not within 25 percent of the ideal OPE) and are shown in Exhibit 5.2.

Exhibit 5.2
Tested Pumps In Need of Repair

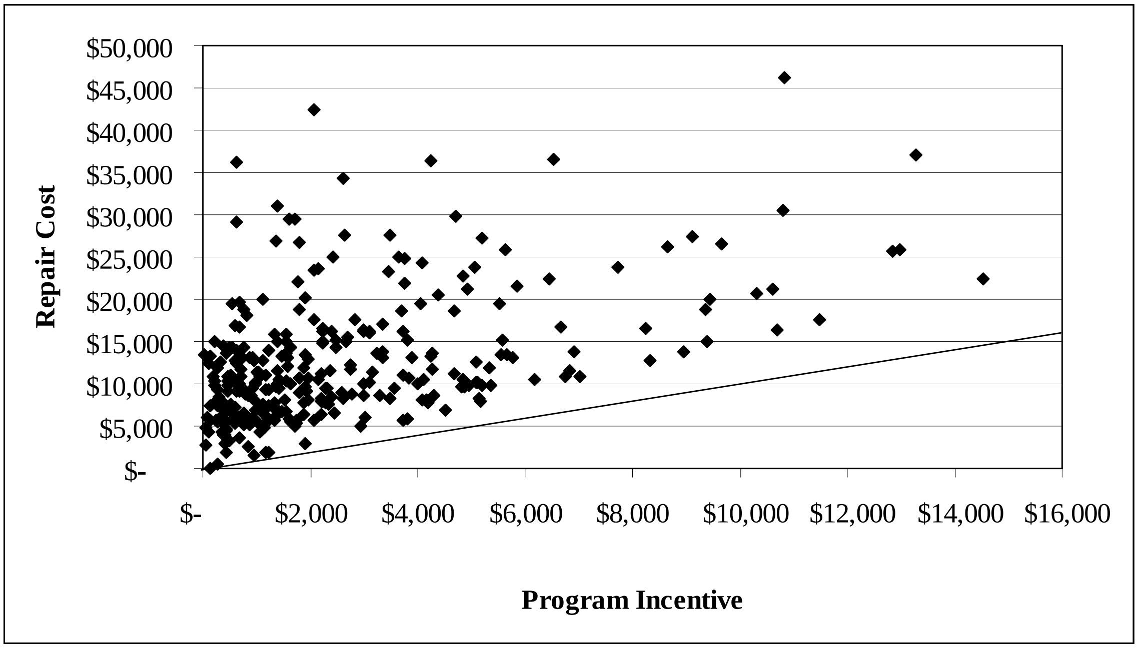
HP	Pump Probably Needs Repair			% Needing Repair
	Yes	No	Unknown*	
0-25	1183	254	108	77%
30-50	910	411	99	64%
60-75	625	422	106	54%
80-100	406	230	96	55%
110-125	267	150	42	58%
130-150	86	53	90	38%
152-200	124	64	89	45%
204-250	87	14	95	44%
275-300	49	3	27	62%
320-400	22	6	10	58%
450-600	5	1	22	18%
630-1000	3	0	29	0%
All HP	3767	1608	813	61%

*not all pumps were able to calculate an OPE, so this analysis could not occur on these particular pumps.

Exhibit 5.2 indicates that 61 percent of pumps could probably benefit from a pump repair. It is often speculated that pump repairs are not done, even when customers think they are needed, due to the capital cost of the work. The APEP-I database contained the actual project cost for each of the 311 pump repairs with incentive payments. When one outlier is removed (a single site with a pump repair cost of $214,000[4]) the average cost for a pump repair done for program participants was $12,525, with a standard deviation of $7,463. The median cost was $10,600. The incentive typically covered 30 percent of the project cost. Exhibit 5.3 shows the scatter plot of the pump repair costs to the incentive grant.

[4] This was a 300 hp propeller pump retrofit. The very large pump was 54 inches in diameter and pumped 74,000 GPM.

Exhibit 5.3
Cost of Repair versus Program Incentive Grant



5.2 Pump Tests

As shown in Exhibit 5.4, the program completed 6,193 pump tests. This exceeded the number of tests planned for the state, although the program fell short of the SoCalGas service territory specific goal.

Exhibit 5.4
Pump Tests Performed

	Total	PG&E	SCE	SDG&E	SoCalGas
Number of Pump Tests					
Goal	5,000	4,200	-	283	517
Through 12/31/03	*4,132*	*3,991*	-	*111*	*30*
Since 12/31/03	*2,061*	*1,716*	-	*192*	*153*
Total APEP- I	6,193	5,707	-	303	183
Percent of Goal					
Through 12/31/03	*82.6%*	*95.0%*	-	*39.2%*	*5.8%*
Since 12/31/03	*41.2%*	*40.9%*	-	*67.8%*	*29.6%*
Total APEP- I	123.9%	135.9%	-	107.1%	35.4%

Note: Values through 12/31/03 were first presented in the Impact Report dated 6/17/04.

Exhibit 5.5 shows an expected lag between when a pump test occurs and when a pump repair is performed. Two-thirds of the pump tests took place in 2002 or 2003, but eighty percent of the repairs occurred in 2004 or 2005. While not all the pump repairs had pump tests through the program (14 percent used an outside vendor for the pump tests), this data also indicates that around five percent of those who received a pump test performed a pump repair.

Exhibit 5.5
Number of Pump Tests per Pump Repair

	Total	PG&E	SCE	SDG&E	SoCalGas
Number of Pump Tests					
Through 12/31/03	*4,132*	*3,991*	-	*111*	*30*
Since 12/31/03	*2,061*	*1,716*	-	*192*	*153*
Total APEP- I	6,193	5,707	-	303	183
Number of Pump Repairs					
Through 12/31/03	*62*	*53*	*3*	*5*	*1*
Since 12/31/03	*249*	*184*	*50*	*7*	*8*
Total APEP- I	311	237	53	12	9
Number of Pump Tests per Pump Repair					
Through 12/31/03	*67*	*75*	-	*22*	*30*
Since 12/31/03	*8*	*9*	-	*27*	*19*
Total APEP- I	20	24	-	25	20

Note: Values through 12/31/03 were first presented in the Impact Report dated 6/17/04.

5.3 Impact Results

There are energy impacts from the pump repairs and program impacts on awareness or knowledge. The energy impacts are discussed in this errata report while the findings on program impacts on awareness or knowledge are in the previous report.

5.3.1 Energy Impacts

There were 298 repairs of electric pumps paid for under the program through December 31, 2005. The total energy impacts from these repairs are shown in Exhibit 5.6. The default net-to-gross ratio (NTGR) of 0.75 was applied to the gross impact values. The average net electric energy impact per pump repair was 32,757 kWh.

Exhibit 5.6
Electric Energy Impacts

	Total	PG&E	SCE	SDG&E	SoCalGas
Number of Pump Repairs					
Goal	436	345	75	16	-
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There were 13 repairs of natural gas pumps paid for under the program through December 31, 2005, fewer than the program goal. However, the total energy impacts from these repairs exceeded program goals by more than 70 percent,. The average net energy impact per pump repair was 14,336 therms. The energy impacts from these repairs are shown in Exhibit 5.7

Exhibit 5.7
Therm Energy Impacts

	Total	PG&E	SCE	SDG&E	SoCalGas
Number of Pump Repairs					
Goal	64	25	-	4	35
Through 12/31/03	*1*	*0*	-	*0*	*1*
Since 12/31/03	*12*	*4*	-	*0*	*8*
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Gross Therm Impact					
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Goal	108,000	42,188	-	6,750	59,063
Through 12/31/03	-	-	-	-	-
Since 12/31/03	*186,367*	*44,637*	-	-	*141,729*
Total APEP- I	186,367	44,637	-	-	141,729
Percent of Net Impacts					
Through 12/31/03	*0.0%*	*0.0%*	-	*0.0%*	*0.0%*
Since 12/31/03	*172.6%*	*105.8%*	-	*0.0%*	*240.0%*
Total APEP- I	172.6%	105.8%	-	0.0%	240.0%

Note: Values through 12/31/03 were first presented in the Impact Report dated 6/17/04.

5.4 Conclusions and Recommendations

The APEP-I program provided California 95 percent of the net expected electric savings and 173 percent of the expected natural gas savings. There was a lag between the pump tests and the pump repairs with two-thirds of the pump tests taking place in 2002 or 2003, but eighty percent of the repairs occurring in 2004 or 2005. While not all the pump repairs had pump tests through the program (14 percent used an outside vendor for the pump tests), this data also indicates that around five percent of those who received a pump test performed a pump repair. On average, program participants received 30 percent of the cost of the pump repair. The average pump repair cost $12,528.

It is recommended that any agricultural program be provided a long time window to effect energy impacts. The lag between testing and repairs shows that a two year period was inadequate for pump repairs and is most likely indicative of the decision making process in the agricultural market.