



IRRIGATION
TRAINING AND
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CENTER

Irrigation District Energy Survey *Final Report*



California Energy Commission
Public Interest Energy Research (PIER) Program

January 2008

Technical Report

**IRRIGATION
TRAINING AND
RESEARCH
CENTER**

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Irrigation Training and Research Center
January 2008

ACKNOWLEDGEMENTS

The Irrigation Training and Research Center would like to thank the following cooperating irrigation and reclamation districts for their time and effort.

Agricultural Water District	First Name	Last Name	Position
Arvin-Edison WSD	Mr. Steve	Lewis	Staff Engineer
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Colusa County Water District	Mr. Lee	Emrick	District Manager
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Delano-Earlimart Irrigation District	Mr. Dale	Brogan	District Manager
Feather Water District	Mr. Dan	Duncan	President
Fresno Irrigation District	Mr. Bill	Stretch	Chief Engineer
Glenn-Colusa Irrigation District	Mr. Thad	Bettner	General Manager
James Irrigation District	Mr. John	Mallyon	District Manager
Lost Hills Water District	Mr. Phillip	Nixon	Manager
Meridian Farms Water Co.	Mr. Dan	Ruiz	Manager
Natomas Central Mutual Water Co	Mr. Fred	Schantz	Assistant General Manager
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Tea Pot Dome Water District	Mr. Keith	Norris	Manager
Tulelake Irrigation District	Mr. Gerald	Pyle	Assistant Manager
West Stanislaus Irrigation District	Mr. Ron	Roos	Manager
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Westside Water District	Mr. Mike	Britton	General Manager
Wheeler Ridge-Maricopa WSD	Mr. Robert	Kunde	Asst. Engineer Manager

EXECUTIVE SUMMARY

This survey was completed by the Irrigation Training and Research Center (ITRC) of Cal Poly State University, San Luis Obispo on behalf of the California Energy Commission Public Interest Energy Research (PIER) Program. The goal of the survey was to establish a benchmark for the present status of the pumping systems used by agricultural water districts in California and to determine the districts' needs. The needs discussed involve technical assistance, research, grant and low-interest loan funding, and district-related policy issues. Thirty agricultural water districts were selected for the survey. These districts were selected based on energy use per acre of irrigated area, size, geographic location, and distribution infrastructure.

Common Answers

To complete the surveys, ITRC visited each participating district and asked the survey questions verbally. Most of the questions were discussion-based to encourage open answers (rather than multiple choice). The hope of the open discussion was to ignite innovative ideas and allow free, out-of-the-box thinking to develop. Even with open discussions, the districts' answers revealed trends in ideas and concerns. Some of these include:

Research Needs

- Time-of-use water meters
- Low-head hydro generation technology
- Solar generation
- Technical assistance on how to improve energy efficiency and reduce peak load
- More efficient pump impeller/bowl design
- Improved flow measurement in constrained areas
- Water conservation research and education at the district and farm levels

Policy Concerns

- Solar program grants are only for less than 1 MW of generation per meter
- SMUD does not accept irrigation districts for agriculture tariff
- Place-of-use restrictions are too strict
- Districts want more information about carbon credits

Grants, Rebates, and Low Interest Loans

- Since the CEC APLRP for Irrigation Districts administered by ITRC ended in 2004, most districts surveyed have done minimal or no significant projects to reduce energy demands or shift load other than regular maintenance. Many of the districts that participated in the program now have new energy conservation and peak load reduction ideas but do not have sufficient funds to complete them. Ideas include:
 - District peak load reduction (increase storage, pumping capacity, SCADA, etc.)
 - Pump testing and pump repair rebates
 - On-farm peak load reduction programs
 - On-farm water conservation
 - Solar rebates or grants

Current Status

Pump and electricity use characteristics of the districts surveyed are listed in **Table ES-1**.

Table ES-1. Summary of the pumping characteristics of the 30 districts surveyed

	Combined Total
Total Number of Pumps	2,045
Total Nominal Connected Horsepower (HP)	456,700
Total Average Electricity Use (MWh) per Year	656,800

Results from the survey indicate the following trends are common in participating districts:

- **Figure ES-1** shows the breakdown for the pump categories discussed in the survey. Questions were asked regarding four pump categories: deep well pumps, shallow well drain pumps, surface supply pumps, and surface drain pumps. No districts claimed to utilize shallow well drain pumps, so these are not discussed.

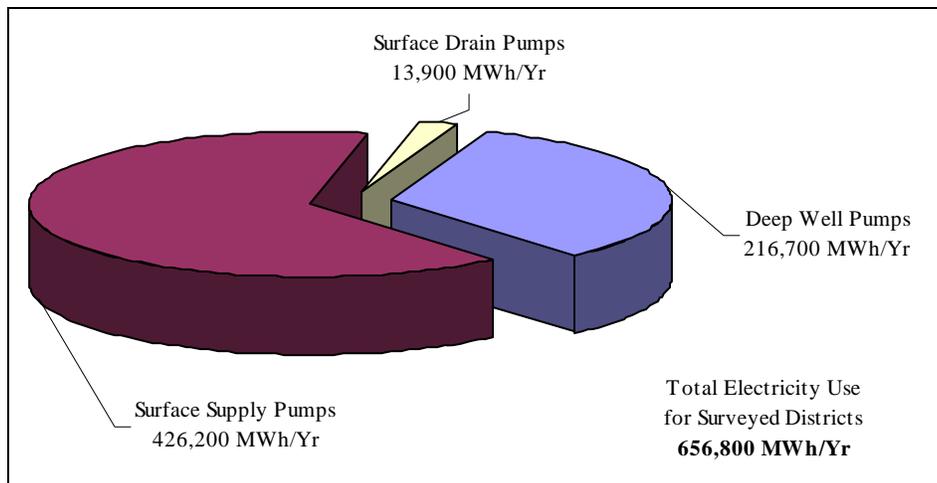


Figure ES-1. Breakdown of electricity use by pumping type for the surveyed districts

- Pump efficiencies stated by district personnel came out close to the overall average irrigation district pump efficiencies from over 1,100 pump tests conducted for the CEC APLRP for Irrigation Districts (statewide pumping plant efficiency of 57.2% (Burt and Howes, 2005)). Not surprisingly, the stated pump efficiency for drain pumps was lower than the other categories (**Figure ES-2**). Most districts recognize that they focus more maintenance efforts on supply pumps because these are more critical from an operations standpoint.

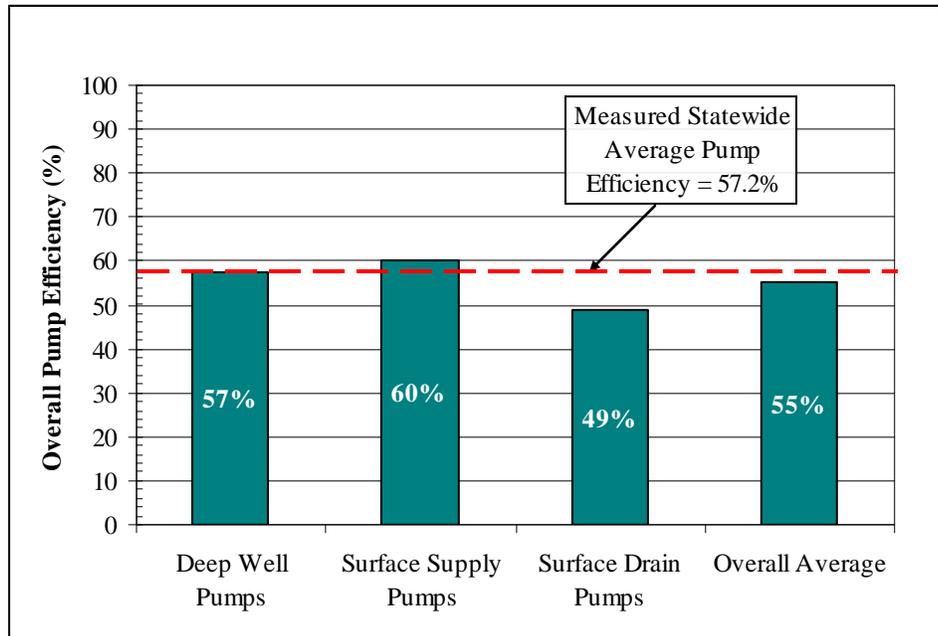


Figure ES-2. District-stated pumping plant efficiencies

- One of the major unsolicited comments heard often during the surveys dealt with PG&E’s service. A number of districts complained about how long it is taking PG&E to set up new service in the field. On average, it seems to take PG&E two years to establish a new connection from the time it is requested to the time it is completed.
- When asked for common day-to-day challenges regarding pumps, the most frequent response was keeping the pumps operational. It was not that the pumps or motors failed often; but when they did the results could be nearly catastrophic. The second most common answer was copper thieves stealing the electrical wire. This seems to be a significant problem for districts (at least those not utilizing 2,300 Volt service).
- When asked about future challenges the districts foresee, the most common answer was keeping pumping costs down.

Future Plans

Overall, the districts surveyed expect a significant increase in load and electricity needs in the next 5-10 years. In fact, nearly 75% of the districts surveyed expect an increase in load and electricity use. Some of the reasons for this expected increase include:

- Increased demand from permanent crops or increased crop acreage
- Increased groundwater pumping for conjunctive use or groundwater banking returns
- Districts taking over landowner wells

Some districts stated that they expected a decrease in load or energy use or both. Some of the reasons given included:

- Increasing pumping efficiencies
- Urbanization decreasing crop acreage
- Reconfiguring pumping systems
- Water conservation efforts by water users and districts

Table ES-2 shows the expected increase in connected load and electricity usage by the surveyed districts per year in 5-10 years.

Table ES-2. Expected increase in pump connected load and electricity use by the survey districts

	Total
How much more kW in the next 5-10 years?	51,995
How much more MWh in the next 5-10 years?	388,510

A number of the districts surveyed, especially those on the west side of the San Joaquin and Sacramento Valleys, expect increased crop demands from an increase in permanent crop acreage and in some cases an increase in overall acreage. Past studies conducted by the ITRC indicated that districts on the east side and middle of the two valleys are seeing a decrease in cropped acreage due to urbanization. It may be that farming is moving away from the lower areas that are typically gravity fed to higher areas that require increased pumping and typically have poor soils for growing crops. This is a significant event in terms of electricity demands in the future, as **Table ES-2** indicates.

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AGRICULTURAL WATER DISTRICT ENERGY SURVEY

Background

The Irrigation Training and Research Center (ITRC) of California Polytechnic State University, San Luis Obispo has prepared this report under contract with California Energy Commission (CEC)'s PIER Program. ITRC has provided technical assistance to agricultural water agencies throughout the western U.S. on a broad range of issues including water and energy conservation, improved water delivery service, and acting as administrator for the highly successful CEC Agricultural Peak Load Reduction Program (APLRP).

The goal of this survey was to determine the present status, and current and future needs, of irrigation districts in regard to energy use for agricultural irrigation water pumping. For districts that pump water (surface or ground), electricity is typically the districts' largest expense. Over the years districts have found innovative ways to reduce power costs, which in turn reduce the cost of water to their farmers. This report will summarize some of these innovations as well as present ideas that districts would like to research or implement but may need financial assistance in order to make feasible.



Figure 1. Berrenda Mesa Water District's 9,900 HP (10 pumps total) pump station. With the CEC APLRP the district was able to curtail 4.67 MW of peak energy use, but in the past 2 years the increased demand from additional cropped acreage has led to more on-peak pumping.

District Selection

ITRC surveyed thirty agricultural water agencies (water districts) throughout California that had significant pumping. Districts were selected based on previous energy use estimates used in the *California Agricultural Water Electrical Energy Requirements* (Burt et al, 2003) prepared for the CEC. Selection criteria included:

1. High kilowatt-hour (kWh) electricity use per acre of irrigated area
2. District size – district sizes were selected so that ideas from both small and large districts could be incorporated
3. Varying reasons for pump use – surface water, groundwater, drainwater, etc.
4. Location – selected districts were spread out from the Oregon-California border to the base of the Grapevine in Kern County.

Table 1 lists the districts that participated in the survey and their approximate irrigated acreage. The 30 agricultural water districts surveyed serve approximately 1,900,000 irrigated acres of the total of approximately 9,000,000 irrigated acres in California.

Table 1. List of participating districts and approximate irrigated acreage

Agricultural Water District	Approximate Irrigated Acres
Westlands Water District	530,000
Fresno ID	163,000
Semitropic WSD	143,000
Glenn-Colusa Irrigation Dist	134,000
Arvin-Edison Water Storage District	107,000
Wheeler-Maricopa WSD	90,000
Tulelake Irrigation District	64,000
North Kern WSD	60,000
Lost Hills WD	56,000
Delano-Earlimart ID	55,000
Reclamation District 108	50,000
San Luis Canal Company	47,000
Berrenda Mesa WD	46,000
San Luis Water District	45,000
Colusa Co. WD	41,000
Belridge Water District	39,000
Panoche Water District	37,000
Orange Cove Irrigation District	27,000
Natomas Central Mutual Water Co	26,000
Corcoran ID	22,000
James Irrigation District	22,000
West Stanislaus ID	22,000
Banta-Carbona ID	16,000
Princeton-Codora-Glenn ID	12,000
Provident Irrigation District	12,000
Meridian Farms W C	8,000
Westside Water District	8,000
Feather Water District	7,000
Pacheco Water District	4,000
Tea Pot Dome Water District	3,000
Total	1,896,000

Figure 2 shows the locations of the participating districts.

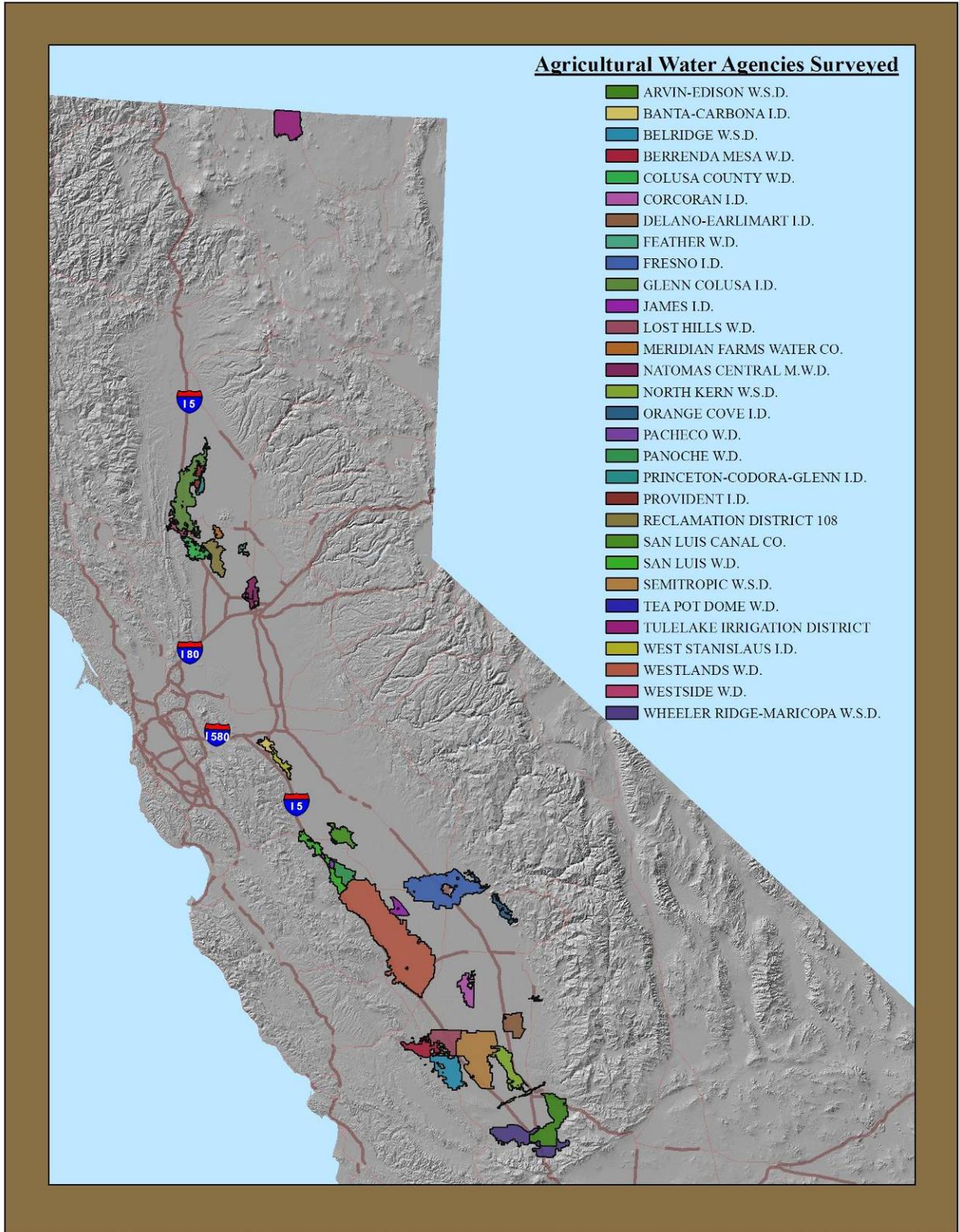


Figure 2. Districts participating in energy survey

SURVEY RESULTS

Unlike many surveys, the questions in this energy survey were not multiple choice or yes/no (see **Attachment A**). Most of the questions were meant to begin a discussion and keep it focused. This allowed district managers and key personnel to share their thoughts openly and not feel limited to a few, pre-determined choices. A portion of the survey asked specific infrastructure and energy use related questions (e.g. How many surface water lift pumps does the district have?), which can be statistically summarized.

Most of the answers were district-specific and required more of a discussion than a statistical analysis. The Energy Survey results are presented in the sections outlined below:

- District-recommended research focus
- Districts' suggestions for grants, rebates, and low interest loans
- Policy issues that could reduce energy demands
- Current pumping infrastructure and maintenance
- Plans for the near future
- Successful past projects

District-Recommended Research Focus

Even though this was an open discussion there were a few research needs that multiple districts addressed or that were innovative enough to warrant mention. The following items are in no specific order:

Time-of-use water meters: Currently, water meters typically totalize the volume of water delivered to a water user, which is manually recorded on a weekly or monthly basis. A water meter that could record and store water use by time of day would allow districts to price water differently for on-peak versus off-peak hours.

Low-head hydro generation technology: Generation in general was a common theme among water district managers that participated in the survey. A number of managers would be interested in installing low-head hydro generators for locations with a significant drop, if the technology was cost-effective. Past experience by a number of districts with different low-head hydro generators suggests that the technology needs more research.

Solar generation: Solar energy was one of the most common issues discussed among districts. It will be discussed in following sections as well. From a research perspective, making the technology more cost-effective is the key issue, whether that means more generation per unit solar panel area or simply building the panels for lower cost.

Energy Studies: While districts have some ideas about energy conservation and peak load reduction, the average district may not have time or funding to investigate them. A program is needed where technical assistance can be provided on a district-by-district basis to determine the most effective methods of energy conservation and peak load reduction. Possible topics include:

- Checks to see if pump/motor combinations are correct.
- Technical assistance to determine what projects would be most cost-effective in shifting away from peak load pumping.

More efficient pump impeller/bowl design: With new technology, including more comprehensive computer models, some districts wonder if there could be a more efficient bowl or impeller design.

Flow measurement in constrained areas: District pump stations were not always designed with sufficient straight unobstructed discharge pipe to obtain an accurate flow measurement during a pump test. This prevents some districts from being able to accurately check their pump efficiencies. With further research it could be possible to design a flow measurement strategy that could more accurately measure flows.

Water conservation: On-farm and district water conservation is directly linked to irrigation district pumping. Energy-saving ideas include cost-effective canal seepage reduction, improved irrigation systems, tailwater return systems, canal automation, SCADA, and regulating reservoirs that can limit pumped water losses. Improved education of irrigation methods, technology, and proper operation on-farm would be a benefit.

The following table shows a number of research issues that districts felt would be beneficial to look at. Also shown are the number of districts that mentioned each item.

Table 2. Research issues brought up during the survey

Research Idea	Count
Technical assistance to individual irrigation district to determine peak load reduction projects, analysis of pump/motor combinations to determine if they are the most appropriate, overall energy analysis, feasibility studies, etc.	5
Low head hydro-generation	5
Time-of-use water meters	3
Higher efficiency pumps	3
Research technology that would allow the district to analyze the distribution of demands through the district's load monitoring system, and to enable the prediction of when peak loads will occur.	2
Reduced canal seepage	2
Improved flow measurement in constrained areas	2
Improved water conservation techniques	2
Float assemblies to allow growers to go off-peak and decrease waste	1
The ability of districts with rice to switch to off-peak	1
VFDs in areas with a lack of storage at the ends of pipelines and a high degree of slopes	1
Ways to keep the Feather River water levels higher at low flows	1

Grants, Rebates, and Low Interest Loans

This section of the survey had the highest number of responses. Irrigation districts typically do not have the capital to invest in large-scale electricity efficiency or peak load reduction programs. In many cases, especially in lower head pumping situations, the payback time is greater than 10 years, making many projects economically infeasible.

A number of interviewed districts had participated in the CEC APLRP in some way. Many districts received rebates to have their pumps tested, repaired, or both. Others participated in the peak load reduction portion, which may have included adding reservoir storage, or installing a SCADA system so that pumps could be managed more easily.

Since the CEC APLRP for Irrigation Districts ended in 2004, most districts surveyed have done minimal or no significant projects to reduce energy demands or shift load other than regular maintenance. Many districts have older pumps and motors that require significant maintenance and rebuilding. This takes up a majority of the districts' annual budgets for maintenance, leaving little funding for proactive solutions.

Nearly every interviewed district that participated in the CEC APLRP for Irrigation Districts asked if another similar program was coming up. While many districts know about the California Public Utilities Commission/PG&E pump testing and repair rebate program, most do not utilize it.

The following responses were common among district managers:

Pump testing and pump repair rebates: A program is needed that is built for the needs of irrigation districts. Issues such as having to estimate individual pump power consumption when a single meter reads multiple pumps or districts using WAPA or project power need to be incorporated into the program.

District peak load reduction: Issues that require significant capital investment also require grants and low interest loans. These projects include:

- Increasing storage at the ends of pipelines
- Increasing pumping capacity to pump the same volume in 18 hours instead of 24.
- Installing larger diameter pipe in several areas.
- Implementing supervisory control and data acquisition (SCADA) systems to effectively operate the irrigation system for peak load reduction

On-farm peak load reduction: Some districts are interested in acting as an administrator for grants and low interest loans to their growers to encourage the installation of irrigation systems with larger capacities so that the farmers can operate off-peak, resulting in the district operating less during the peak period.

On-farm water conservation: Limiting water losses on-farm directly impacts district energy use. Items such as tailwater return systems and irrigation methods with high distribution uniformities may be beneficial. Both of these examples require additional pumping pressure, but may result in a net positive in some districts.

Solar rebates or grants: Over a third of the districts surveyed stated that they either have looked into or wanted to look into adding solar generation of some type into their operation. However, the cost of solar has limited their installation.

Table 3 shows common projects that the districts would like to see grants, rebates, and low interest loans for.

Table 3. Projects for which districts would like grants, rebates and low interest loans

Grant, Rebate, Low Interest Loan Needs	Count
Pump efficiency test and repair rebates specifically for irrigation districts that is inclusive for WAPA, project power, and water users in utilities other than PG&E	21
Reservoir storage and increase pumping and pipeline capacities	14
Solar incentives	11
SCADA and telemetry for remote monitoring and control	5
Grants to farmers for improved irrigation systems, tailwater returns, larger system capacities so they can go off-peak.	5
VFDs for improved operation and energy efficiency	3
Incentives for farmers to go off-peak. Grants for TOU meters, infrastructure, research and pilot programs	3
Expanded TOU program with additional deep wells for off-peak operation	2
Grants to encourage using larger pipelines to reduce friction	2
Recycled drain water utilized at a lower lift than supply water so that the drain water does not have to be lifted out of the district.	2
Irrigation system evaluations	2
District infrastructure improvements to increase water delivery service so farmers do not switch to groundwater when installing drip and microspray systems	2
Premium high efficiency motors	2
Conjunctive use through water banking to increase GW levels	1

Policy Issues

In general, policy issues were not as high a priority as the first two categories of the survey. Policy issues that were discussed ranged from dealing with the local utility to dealing with the state government.

Solar program grants are only for less than 1 MW of generation per meter: Some districts have a single meter to measure multiple pumps, an entire pump station, or even the entire district. Semitropic WSD has a single meter that accounts for all of the pumping in the district. The district would like to install a number of solar arrays to offset this pumping. However, the district is not eligible for grants because the size of all of the arrays combined would be greater than 1 MW. (For more information on the California Solar Incentive (CSI) program see http://www.pge.com/about_us/environment/solar/CSI_Incentives.html.)

SMUD does not accept irrigation districts for agriculture tariff: Sacramento Municipal Utility District does not accept a local water company for an agriculture electricity rate tariff even though the water agency supplies only irrigation water to agriculture. The water agency is considered a commercial industry. All other major utilities allow agricultural water agencies to utilize agricultural electricity rate tariffs.

Place-of-use restrictions: In today’s water industry flexibility is key to both water and energy conservation. This is especially true in regions that are in the middle of water transfers, groundwater banking, and conjunctive use projects. Steve Lewis of Arvin-Edison Water Storage District presented this issue to CEC on June 21, 2005 (California Energy Commission, 2005). To summarize the actual situation that Mr. Lewis presented:

In 2004, the district was banking water in its facilities (allowing water to percolate into the soil) from Friant-Kern Canal while at the same time pumping water 35 feet away to return it to Metropolitan Water District. The infrastructure exists to trade the water that would have percolated for the water that was being pumped; however, place of use restrictions dictate that CVP water cannot flow to Los Angeles. Since the pumping requirement at the banking facilities is about 1,000 kWh/acre-foot it would have saved a significant amount of energy to substitute the water.

Perhaps a No Harm No Foul clause could be implemented in the place-of-use restriction to update the rules to reflect the needs of water agencies.

Carbon credits: Carbon credits are becoming a big topic in the discussion of global warming. For example, what is the cost of decreased water allocation on carbon (carbon dioxide specifically) uptake? Reduced water allocation can lead to reduced cropping (fallowing) or vegetative health leading to less carbon being consumed. Districts are asking if industries associated with agriculture – specifically, the farms themselves – should be given a positive carbon credit since the crops they grow take carbon out of the air.

Table 4. District policy concerns

Expanded water user education on good water management is needed
Solar program grants only allow <1MW of generation per meter
Place-of-use issues – Federal regulators make it difficult to switch federal water for state water. For example, MWD called on previously banked water while Friant was banking excess water. Because of federal regulations, the districts were pumping water and banking it at the same time in the same location.
Reduced demand charges have been helpful. Reducing the peak demand charge more could encourage less peak usage (once a district has to use the power during the peak they figure they might as well use it more since they are already paying the demand charge)
SMUD does not allow irrigation districts to use agricultural rates
ITRC should continue to be funded – It is the only resource that has experience with the full range of irrigation industry from farm to the district level, and expertise in energy and water conservation
A 3-year tariff for power costs is not long enough to complete an accurate cost/benefit analysis for projects.
PG&E has recently discontinued credit for power factor improvements so the district has no incentive to improve power factor if they are not going to add more capacitors.

Current District Pumping and Maintenance

This section of the survey was numerically based so that simple statistics can be used to summarize the results. The districts were asked the present status of their pumping facilities. Pumping facilities were broken into three categories (originally there were four categories; however, none of the districts surveyed classified any well pumps as drain well pumps):

- 1) **Deep groundwater well pumps:** This is any groundwater pumping for irrigation use by the district. It excludes pumping to maintain groundwater levels.
- 2) **Surface supply pumps:** This includes lift pumps and booster pumps within a district for irrigation water use. This category excludes pumping directly out of drains.
- 3) **Surface drain pumps:** These pumps pump drain water out of drains. They could pump drain water into irrigation canals or pipelines but once it enters the irrigation system the pumping is then done by surface supply pumps.

Table 5 shows the basic pump information gathered. The total average electricity use is for an average water year. **Table 5** indicates that the 30 irrigation districts have over 450,000 HP of nominal connected load in the system. The nominal horsepower is also called the nameplate horsepower.

Table 5. Basic pump data gathered from the 30 irrigation districts

	Deep Well Pumps	Surface Supply Pumps	Surface Drain Pumps	Total	Number of Districts that did not know
Total Number of Pumps	646	1,199	200	2,045	0
Pump Efficiencies Checked Per Year	226	185	2	413	0
Total Nominal Connected Horsepower	149,200	296,400	11,100	456,700	0
Total Average Electricity Use (MWh/Year)	216,700	426,200	13,900	656,800	1

In some cases districts surveyed did not know a value in the survey. For example, in **Table 5** one district that pumped surface water did not know or even have an estimate of how many kilowatt-hours (kWh) of electricity it used over a typical year. In this case, the district received power from the USBR and the electricity bill was incorporated into the water bill. The district did not summarize the electricity usage separately. Other districts had varying reasons for being unable to answer certain questions.

Table 6 summarizes the districts’ stated average pump efficiencies. From over 1,100 pump tests conducted in irrigation districts throughout California through the CEC Agricultural Peak Load Reduction Program administered by ITRC, the average pump efficiency for pumps tested in irrigation districts throughout California was 57.5% (Burt and Howes, 2005).

Table 6. Average stated pumping plant efficiencies by pump category

	Deep Well Pumps	Surface Supply Pumps	Surface Drain Pumps	Overall Average	Number of Districts that did not know
Average Stated Pumping Plant Efficiency (%)	57	60	49	55	7

Age of Pumps

Figure 3 shows the age of the pump installations as a percentage of the total pumps in each category. This figure indicates that there have been few new surface supply pumps installed in the last two decades. However, there has been a significant number of groundwater wells installed recently and drain pumps installed between 6 and 25 years ago.

The recent increase in groundwater wells is due to the emphasis on conjunctive use throughout the state. The 5-year drought from 1989 to 1993 brought about a significant amount of new pumps since that time. The drought created severe surface water shortages, forcing districts to pump from the groundwater to supply water users.

In addition, districts have been encouraged over the past several decades to reduce the spill leaving district boundaries. Drain pumps have been installed to help recycle this water.

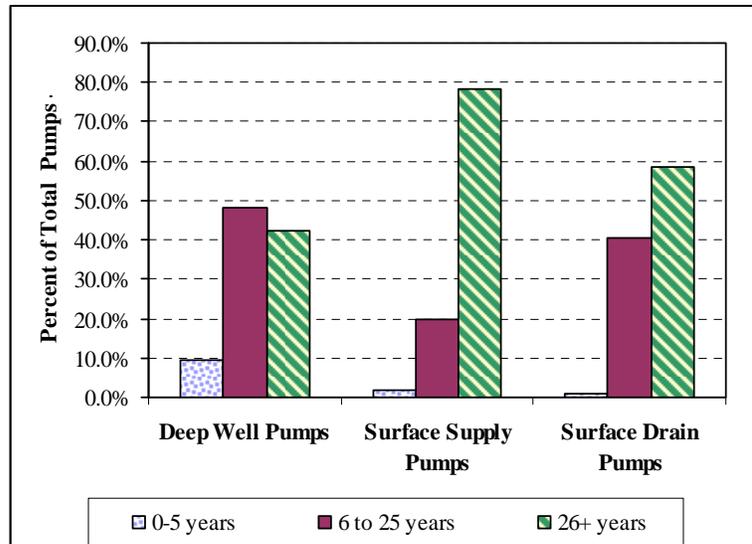


Figure 3. Relative pump age for each pump category

Rebuilt Pumps

The following table shows the number of pumps that the districts estimate are rebuilt per year. Also shown is the percentage of total pumps in each category rebuilt per year.

Table 7. Number of pumps the districts estimate are rebuilt per year

	Deep Well Pumps	Surface Supply Pumps	Surface Drain Pumps	Total
Number of pumps rebuilt per year	18	145	11	175
Percentage of pumps rebuilt per year	3%	12%	6%	9%

A higher percentage of surface water pumps are repaired. This may be because:

- i) A higher percentage are older (**Figure 3**)
- ii) Failure is more catastrophic to district operations than a pump failing in one of the other two categories.

Table 8 indicates different aspects that have been incorporated into district pumping operations. The last row shows the number of engines that are used by the 30 districts. Most of these engines are being used instead of electric motors because there is no electric service near the pump site.

Table 8. Aspects incorporated in the pumping operations

	Deep Well Pumps	Surface Supply Pumps	Surface Drain Pumps	Total
Total number of pumps repeated from Table 5	646	1,199	200	2,045

Number of				
premium motors	70	79	1	150
variable frequency drives	8	51	1	60
remotely monitored pumps	17	559	26	602
automated operations	59	615	48	722
remote manual on/off	0	504	0	504
diesel/natural gas engines	14	2	2	18

There are higher numbers of premium motors on deep well pumps, most likely because a higher percentage of the pumps are new (<25 years old) and the energy demands per volume of water pumped (e.g. kWh/AF) is typically much higher compared to the other categories. Therefore, the nominal increase in efficiency using the premium motor results in greater monetary savings with deep well pumping than with lower lift pumping.

Automation, variable frequency drives (VFDs), remote control, and telemetry seem to be applied mostly to surface supply pumps. This is expected because the surface supply pumps are the most critical when it comes to supplying water users. In most cases operations will not be significantly impacted if a drain or deep well pump fails. If a surface supply pump fails the results could damage crops in a large section of the district. The incorporation of automation and VFDs allow districts to operate their irrigation systems more consistently and with greater flexibility, providing their water users with improved service. In some cases VFDs have been installed so that pump bypasses can be abandoned.

Another possible reason for the high numbers of automated, remotely controlled and monitored surface water pumps is that districts have a significant number of pumps to operate simultaneously. Supervisory control and data acquisition (SCADA) systems (a broad term that incorporates telemetry, remote control/monitoring, and automation) have saved districts a significant amount of money and have reduced pollution by reducing the amount of time district personnel have to spend driving around to monitor and make adjustments (ITRC, 2002).

Annual Maintenance

The basic annual maintenance program is similar at every district and typically includes:

- Lubricating the bearings
- Changing the oil (usually multiple times per year)
- Listening for vibrations and strange noises (typically daily or weekly)
- Making sure that the drippers on oil lubricated pumps are working (daily)

However, some districts have more advanced maintenance as shown in **Table 9**. Some districts meticulously record volumes of water pumped and monthly energy usage for each pump station in the district (in some cases the districts use their SCADA systems to record actual amperage and flow rates in real-time). The districts trend this information to determine when a drop off occurs, which would indicate a problem.

A couple of districts utilize thermal imaging equipment to diagnose panel and motor problems as part of their annual maintenance program. Others have an electrician check their electrical panels for problems. Replacing the motor packing, or dipping and baking the motors, have been incorporated into regular programs for a couple of districts, although they do not do this to every motor each year.

Table 9. Some interesting maintenance tasks utilized by districts

Maintenance	Number of Districts
Trending flows and load over the year	8
Check electrical	8
Thermal imaging	3
Replace packing, or dip and bake motors	3

Table 10. Top 5 reasons for pump repairs (districts sometime gave multiple answers)

Reason for Repair	Number of Districts
Failure	15
Wear and tear	9
Low efficiencies	9
Vibration/balance/excessive noise	9
Drop off in production	6

Districts were asked if they had a power management program. This question was included to gauge how the district managers would respond. Most asked what “power management program” meant. Once it was explained that there was no specific definition, many managers outlined the type of energy-related management they conduct. The following items were commonly reported:

1. Recording and tracking monthly electricity records as well as pumping plant output and using these trends to make operational decisions.
2. Participating in Demand Response Programs (ISO).
3. Tracking electrical loads in real-time along with flow rates and water levels to get real-time pump efficiencies and making decisions on which pumps to run based on those with the highest efficiencies.
4. Operating off-peak.

Joint Power Authorities

Districts were asked whether they belonged to a Joint Power Authority. Currently there seem to be two major power authorities active among the surveyed districts. A third power authority that is not active is called the Southern San Joaquin Power Authority. The two active power authorities are:

East Side Power Authority (ESPA)

Members include: Delano-Earlimart ID, Lindsay-Strathmore ID, Terra Bella ID, Rag Gulch ID, and Kern-Tulare ID.

Benefit: Reduced power cost – Pool CVP power allocation then utilize it over a larger area (multiple districts). This allows the districts to purchase power when they need extra, or sell it when they have excess.

Power and Water Resources Pooling Authority – PWRPA

Members include: Westlands WD, Glenn-Colusa ID, Banta Carbona ID, West Stanislaus ID, Provident ID, Princeton-Codora-Glenn ID, James ID, RD 108, Arvin-Edison WSD, Sonoma County W.A., Santa Clara Valley W.A., Lower Tule River ID, Byron-Bethany ID, The West Side ID, Cawelo WD

Benefit: Pool energy resources (WAPA and project power) and distribute them among members to keep electricity costs down. The Authority can also buy and sell resources on the market to decrease power costs for its members. According to the PWRPA website, “The Power and Water Resources Pooling Authority (PWRPA) is a Joint Powers Authority comprised of 15 public water purveyors that organized in 2004 under California State law to collectively manage individual power assets and loads... Although principally formed to coordinate power supplies, these districts and agencies recognize the interchangeability of water management and power requirements; accordingly, as the name reflects, the participants envision alternative water-management options and potential exchanges as a potentially significant role for the Authority.” (www.pwrpa.org)

Plans for the Near Future

For the survey, the “near future” was limited to the next five years. A number of districts have already installed all of the automation, SCADA, and VFDs that they feel are needed at least in terms of pumping. Other districts have no plans because of either limited budget or lack of interest. The lack of interest could be due to limited knowledge of how a specific technology could impact their district’s operation. Overall, districts that have a significant amount of pumping are typically progressive when it comes to new technology because managers and boards are always trying to save their farmers money.

The following table lists the number of items the 30 districts surveyed plan on installing in the next 5 years. Real-time power monitoring and other SCADA system components are a significant portion of planned future investment. Districts understand the importance of operating at the highest possible efficiencies and the capability of remotely monitoring and controlling pump operations to ensure that the most efficient pumps are used.

Table 11. Planned improvements in the next 5 years – number of units involved

New Equipment Planned	Deep Well Pumps	Surface Supply Pumps	Surface Drain Pumps	Total	Number of Districts saying “Maybe”
Automation	1	90	43	134	2
Conversion to engines	0	0	0	0	0
Power factor improvement	0	0	0	0	2
Power monitoring (real-time)	221	95	42	358	4
Remote manual on/off	80	119	43	242	2
Remote monitoring	334	110	43	487	2
VFDs (new)	3	96	0	99	2
Well cleaning/maintenance	98	0	0	98	3

In general, the power consumption and load is expected to increase for these 30 irrigation districts. Some districts expect a drop in consumptive use because of increased urbanization or improved efficiencies. More districts, however, expect to increase both connected load and consumption due to increased cropped acreage, increase in permanent crops, and an expected need to pump more groundwater because of limited surface water supplies.

Table 12. Kilowatt and MWh change expected in the 30 districts over the next 5-10 years

	Deep Well Pumps	Surface Supply Pumps	Surface Drain Pumps	Total	Number of Districts Expecting Decreases (kW or kWh)	Number of Districts Expecting Increases (kW or kWh)
How much more kW in the next 5-10 years in each category?	41,914	9,811	270	51,995	3	22
How much more MWh in the next 5-10 years in each category?	381,000	7,500	0.0	388,500	5	20

At the same time that energy consumption is expected to increase, every district surveyed expects the electricity and demand charges to increase, though none attempted to estimate by how much.

Successful Past Projects

Table 13 lists interesting improvements that districts have implemented over the past 5-15 years in regard to pumping and electricity use. Many districts understand that there is a connection between water use efficiency on-farm and energy use by the district. They also understand that in many cases water use efficiency on-farm requires energy input from the farmer. However, water conservation is the main goal in most California irrigation districts – with a higher percentage than energy conservation.

Table 13. Innovative pump and electricity usage ideas implemented by districts

Description	Benefits
Joining a Power Authority (20 districts in the state; 10 of the 30 visited)	Estimated savings of \$0.02/kWh
Adding solar, hydro, and natural gas generation	2-3 MW
Participating in the CEC Ag Peak Load Reduction Program for Irrigation Districts administered by ITRC <ul style="list-style-type: none"> - For Peak Load Reduction Grants - For Pump Testing and Repair Rebates 	<ul style="list-style-type: none"> - Over 15 MW of Peak Load Reduction between the surveyed districts - Over 20 MW of load in ISO demand response with APLRP assistance - 476 pump tests among 13 of the surveyed districts - 182 pump repairs among 10 of the surveyed districts
Encouraging farmers to go to off-peak pumping	Less on-peak power utilized
Improving water delivery service to farmers by installing float assemblies to maintain a constant water delivery pressure with variable pressures from the district pipeline and variable flow rates taken by the farmers	Shifting away from peak pumping as farmers begin utilizing off-peak water deliveries.
Placing restrictions on the amount of tailwater leaving rice fields. Districts provide incentives for farmers to put in a restriction at the end of their field, limiting the flow of tailwater.	Reduced supply water pumping as well as pumping of the drain water back into the system downstream.
Installing SCADA and telemetry	Reduced operational spills, the time district operators must drive to physically monitor the system, etc.
Installing Variable Frequency Drives (VFD)	Saved energy due to VFDs installed to replace flow bypass and throttling valves.
Encouraging on-farm water conservation through low interest loans for improved irrigation systems and tailwater return systems	Grants provided by districts of up to \$500 per acre and low interest loans at around 3% interest for qualifying projects.
Becoming operationally aware of energy demands and trying to minimize costs when possible	Reduced energy demands and on-peak load through better energy management

CONCLUSION

There are some basic conclusions that can be made from this survey:

- Districts throughout California share the stated goal of reducing power costs in any economical way possible.
- Electricity is on the forefront of operations and management concerns in most districts that require a significant amount of pumping. Interestingly, this is a relatively new development. Districts see no end to energy shortages. They are trying to minimize the impacts of future crises and the resulting increases in electricity costs. However, water conservation is considered more important than energy conservation.
- The districts have plans to reduce peak load and improve energy efficiencies but with limited budgets these will be slow to materialize. With incentives through grants, rebates, and low interest loans these projects could be completed within a much faster time frame, providing benefits to not only the districts but also to the entire state. However, care must be taken to design these programs so that they are a benefit, not a hindrance, to the districts.

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ATTACHMENT A
***Irrigation District Electricity Status, Needs,
and Suggestions Survey***

Irrigation District Electricity Status, Needs, and Suggestions Survey

August 6, 2007

by
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805-756-2379

on behalf of
California Energy Commission's
Public Interest Energy Research (PIER)

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Cal Poly ITRC staff person:	
Irrigation District	
Contact Information	
Person	
Title	
Phone number	
e-mail, if available	
Address 1	
Address 2	
City	
Zip Code	

The primary purpose of this survey is to identify research, assistance, and policy needs related to electrical energy usage by irrigation districts.

Therefore, we are looking for 3 things from each participating district:

1. Ideas on research, assistance (grants), and policy changes.
2. An understanding of what the present pumping situation is.
3. An understanding of what direction the pumping programs will move

District Ideas on Research, Grants, and Policy Changes
What are your ideas on the needs for the following, related to specific topics?

<u>Topics</u>	<u>Research</u>	<u>Grants/Low Interest Loans</u>	<u>Policies</u>
Time-of-Use (peak load)			
Improving efficiency			
Reducing total kWh			
Saving money			
Other (describe)			
Other (describe)			
Other (describe)			

Present Status

	<u>Deep Well Pumps</u>	<u>Drainage Well Pumps</u>	<u>Surface Supply/booster Pumps</u>	<u>Surface Drain Pumps</u>
Number of pumps				
Number of pumps that have their efficiency checked per year				
Total HP in each category				
Total kWh in each category				
Avg. Pumping Plant Eff., %				
Years of age (# of Pumps)				
0-5 years old				
6 to 25 years old				
26+ years old				
# of pumps rebuilt/yr				
# of Premium motors				
# of VFDs				
# remotely monitored				
# of automatic				
# of remote manual on/off				
# of engines				
Typical voltages				
Typical type of motor				

Present Status (continued)	
What is the typical annual maintenance program?	
What is the major reason for rebuilding or repairing pumps?	
Does the district have a power management program?	
What percentage of the total grower turnouts today could go to time-of-use rates if they wanted? (whether they use booster pumps or not)	
Power cost, \$/kWh	
Power cost, standby \$/kW (and demand charge \$/kW if different)	
Does the district belong to a Joint Power Authority? If Yes,	
- Name and other members - What is the benefit? - What kinds of assistance does the authority need and challenges does it face?	

When thinking about pumps, what are the biggest:

Day-to-day challenges?	
Future challenges?	

Future. Plans for the next 5 years.

How many pumps does the district plan to apply the following to?

	<u>Deep Well Pumps</u>	<u>Drainage Well Pumps</u>	<u>Surface Supply/booster Pumps</u>	<u>Surface Drain Pumps</u>
Power Factor improvement				
VFDs (new)				
Well Cleaning/maintenance				
Power Monitoring (real-time)				
Automation				
Remote manual on/off				
Remote monitoring				
Conversion to engines				
Estimated change in Future Usage				
How much more or less kW in the next 5-10 years in each category?				
Why?				
How much more or less kWh in the next 5-10 years in each category?				
Why?				
Are there any plans that include working with some type of district/farmer program to enable farmers to use time-of-use?				

What do you think will happen to power in the future?

	<u>0-5 yrs</u>	<u>6-10 yrs</u>	<u>11-15 yrs</u>
Cost, \$/kw-hr			
Standby \$/kw			
# of brownouts/yr			

Other restrictions

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Past

What things has the district done with electricity or power recently to improve things?

Previous 0-5 yrs

Previous 6-10 yrs

Previous 11-15 yrs

Have those things been successful?

This report was prepared as part of CEC Contract Number 500-06-040.

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