Comments Before the California Water Commission
Regarding Agricultural Water Conservation
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by

Peter Canessa
on behalf of the Center for Irrigation Technology, California State University, Fresno

The Center for Irrigation Technology (CIT) is involved in a number of initiatives addressing water management, in California and throughout the world. These include the Advanced Pumping Efficiency Program, the California Water Institute, the International Center for Water Technology, the Agricultural Water/Energy Center, the Water, Energy, and Technology Center, and the Wateright website. Today I will talk about three of our perspectives, extension education, applied field research with emerging technologies, and development of integrated water management plans.

I will start my remarks by noting the connection between water use and energy use, and through energy use, a connection to greenhouse gases and air quality. The California Public Utilities Commission (CPUC) is clearly concerned with this connection, referring to it as the "water/energy nexus". They are particularly interested in the concept of the "embedded energy" of delivered water. Embedded energy is the energy needed to deliver water to the point of use. It is separate from the energy involved in the actual use of that water (e.g., energy for heating or to pressurize an irrigation system). Thus, to the extent that delivered water is conserved, both the use-required energy and the embedded energy are conserved. The CPUC is in the midst of developing a strategy for implementing programs that directly address water conservation as a means of effective energy conservation.

The Advanced Pumping Efficiency Program (APEP), in operation since 2001, is managed by CIT on behalf of Pacific Gas and Electric Company (PG&E) with funding from the CPUC. For 2013-2014 alone, APEP has provided for over 6,900 pump efficiency tests and 382 pump retrofit projects, with 79 more retrofits approved. We estimate some 30,000,000 kiloWatt-hours of energy to be saved in the first year after these retrofits. Now, APEP is fundamentally concerned with improving pumping plant efficiency through education, subsidized pump tests, and cash incentives for retrofit of inefficient pumps. However, its educational message has always had two parts, 1) get good equipment in field, which includes minimizing the energy required per unit water delivered, and 2) manage the equipment correctly, which includes minimizing the total amount of water pumped.

Recognizing our long understanding of the connection between water use and energy use, PG&E has also provided major funding to CIT for the development of an Agricultural Water/Energy Center on the campus at Fresno State engaged in two main activities, 1) expanded extension education and 2)

identification of emerging technologies. For the current 2013-2014 program cycle, CIT has presented over 50 seminars on various subjects including irrigation scheduling, maintenance of drip irrigation, pumping basics, variable frequency drives applied to pumping systems, chemigation and fertigation, and drought strategies. The response from the agricultural community has been robust and is in large part attributable to the increasing severity of the drought. Extension education will always be important as there are many proven options for improving water management and farmers need unbiased information as to identifying appropriate solutions and implementing them correctly.

Education as to current water management products and processes is important. But policy-makers also understand the importance of identifying and nurturing new technologies. One type of technology that we are investigating is improved audit tools for irrigation systems. The first step in improving a given situation is to benchmark current performance, which allows for identification of potential improvements and some idea of the benefit/cost ratio for those improvements. CIT managed a pilot project in summer 2013 investigating the concept of what we term the Combined Evaluation. The Combined Evaluation occurs when a pump efficiency test is performed in conjunction with an evaluation of the irrigation system hardware and the system's management. This type of analysis allows the audit team to investigate all opportunities for water and energy conservation, as well as demand management opportunities (when applied to electric-powered pumps). These opportunities include improving pumping plant efficiency, reducing total pressure requirements, reducing the amount of water pumped, and moving operations to off-peak hours. The end result of an evaluation can be presented to the farmer as a simple spreadsheet that shows current and potential performance, while also identifying dollar savings associated with improvements. An example is seen in Figure 1.

Results from 37 evaluations included the following:

- 13 of the evaluations involved fields that had their irrigation systems evaluated previously. The average improvement in Distribution Uniformity was 11%, indicating the value of irrigation system evaluations.
- 14 fields were seen to have excess pressure in the system with total cost savings in the range of 33% on average.
- The average cost savings for all sites, including the effects of water conservation, improved pumping efficiency, appropriate system pressure, and optimum demand management was 23%.

Noting that this was a pilot-level effort, the cooperators for this project would be considered to be "self-selecting actors", that is, they are growers that have an above-average interest in improving performance. Thus, these results would seem to indicate a large potential for improvements state-wide.

> *It is important to point out that the water savings identified during this project were for the individual field applications. As has been stated many times, savings in water applications on individual fields do not necessarily result in water that can be reallocated to other purposes. Please refer to "Agricultural Water Use in California: A 2011 Update (A Staff Report of the Center*

for Irrigation Technology) for an in-depth discussion at http://www.californiawater.org/cwi/docs/CIT_AWU_REPORT_v2.pdf.

	Current Performance	Potential Performance	Savings	Notes
Pumped Water (per acre-foot applied basis)	1.00	0.88	0.12	Improve scheduling- assume an improvement from 75% IE to 85% IE - reduce water applications by 12%
Overall Pumping Efficiency (%)	45	62		Improve OPE as per pump test cost analysis
Total Dynamic Head (feet)	166	169		Reduce TDH by removing throttling valve at pump discharge (but gain some due to increased flow/drawdown from well)
kWh/Acre-foot (energy intensity)	378	279	99	kWh/AF = 102.41 x TDH / OPE
$/kWh	$0.160	$0.120	$0.04	Move to off-peak operations
TOTAL kWh USAGE (per acre-foot applied)	378	246	132	
ENERGY COST (per acre-foot applied)	$60	$29	$31	52% savings

Figure 1 - Example of spreadsheet developed as the result of a Combined Evaluation

Another type of emerging technology is development of protocols to interpret continuous streams of operating data from various aspects of irrigated agriculture. These data streams can include water flow, pipeline pressure, energy use, soil moisture, plant moisture, soil temperature, soil electrical conductivity, and all standard weather measurements that allow for calculations of reference evapotranspiration.

An example product that we are currently evaluating is the "Pump Monitor" system, developed and marketed by PowWow Energy of Sunnyvale. This is an analysis system that uses the continuous energy-use data from utility SmartMeters in order to identify anomalous operational situations. In the simplest

configurations this is intended to identify leaks in an irrigation system. However, in one of their cooperating sites one anomaly turned out to be a malfunctioning utility transformer.

PowWow Energy is continually evolving their product for more complex situations. This includes adding more data streams, and also "point source" data such as aerial imagery or a pump efficiency test, to their analysis system in order to identify other types of problems as they occur or develop additional information such as total water pumped.

Another concept that CIT will be investigating is what we call "Closed Loop Irrigation Scheduling". This is a system that starts with a weather-based estimate of crop water requirements. Then, flow, and pressure meters if appropriate, will indicate if the intended amount of water is actually being applied. Finally, a soil or plant-based moisture measurement will "close the loop". If the moisture measurement is not tracking correctly, the question is whether the estimate of water needs is wrong or the irrigation system, and/or management of the system, is malfunctioning. The capability is there for all of the components of the system to supply measurements continually and relay them to a computer.

The key idea for both of these concepts, the Pump Monitor and Closed Loop Irrigation Scheduling, is that technology now allows us to develop any amount and type of data imaginable and transmit it in electronic form to a central location- the question is "can this data be interpreted and converted, in an appropriate time-frame, to usable information and delivered to the farmer?"

My final remarks concern development of effective water management policies. The California Water Institute (CWI), another of Fresno State's water initiatives, has been very involved with development of integrated water management strategies including formal “Integrated Regional Water Management Plans” (IRWMP). The support activity by CWI for Plan development is a follow-up to the efforts of the California Partnership for the San Joaquin Valley that resulted in a strategic issues list; with water management as one of the Partnership's key issues.

The Institute has also provided custom strategies to assist in adopting or implementing new water management processes. Recent examples include assisting a San Joaquin Valley irrigation district with communicating the value of recycled water to their water users as part of its supply portfolio and helping a Valley irrigated area develop a new subsurface drainage management plan that offers a range of management practices from recycling to zero liquid discharge.

Current work by the Institute includes assisting in the development of groundwater ordinances in two San Joaquin Valley counties facing subsidence, overdraft and new agricultural irrigation in areas that were not previously irrigated. The ordinance strategies include conforming them to the extent feasible with the recently signed new groundwater law inasmuch as the law identifies counties as the responsible entity for areas with no current “groundwater sustainability agency”. Failure by the counties to act could eventually lead to default implementation of the new law by the State.

Many counties are under pressure to adopt either more comprehensive ordinances or various moratoriums to address falling water tables and other issues exacerbated by the current drought. The responses can be creative. Legislation has just been passed and signed by the Governor that allows for the creation of a water management agency for the Paso Robles Groundwater Basin in San Luis Obispo County. This includes a hybrid governance structure that allows for a nine member Board of Directors consisting of two Directors elected by large landowners (owning 400 acres or more), two by medium-sized landowners (owning 40 to 400 acres), two by small landowners (owning less than 40 acres), and three by all registered voters in the basin. The governance structure is the result of extensive negotiations by the different constituent groups overlaying the Basin, which include both large and small wineries and vineyards, other localized agriculture, rural homeowners dependent on wells for their water, golf courses, and municipalities, including the cities of Paso Robles and Atascadero. It is an attempt to ensure that all interests are protected.

In ending my remarks, our aid in helping various entities create long-term plans for managing such a critical resource as water, as well as observance of other's efforts, has shown us the folly of simplistic solutions. We are especially concerned with third-party effects, not only in identifying those that have occurred, or are occurring presently, but also predicting what can happen if current water use patterns are modified in a haphazard or rash manner. To circle back I note again the CPUC's interest in the water/energy nexus, with the attendant connection to air quality and greenhouse gas emissions. It is clear that while a severe drought, such as the one now confronting California, may require difficult choices in the short-term, we must continue to be aware of the long-term interrelationships among the various resource management problems.

Peter Canessa holds a Masters degree in Irrigation and Drainage Engineering and is a registered Agricultural Engineer in California. His expertise is in agricultural water and energy management, education, and computer software. He has taught Agricultural Water Management at both Cal Poly, San Luis Obispo and CSU Fresno. He worked at the Superior Farming Company in the late 1970's when that group was pioneering large-scale drip irrigation and computerized irrigation scheduling in the San Joaquin Valley. As a consultant he has worked with several irrigation districts to develop water conservation programs; with both farming and irrigation district groups in Australia to improve water management; with several major manufacturers of irrigation equipment to develop irrigation system design software; with PG&E for 10 years in support of their agricultural energy efficiency programs; with the San Diego County Water Authority in support of the historic San Diego-Imperial Irrigation District water transfer; and with Washington State University for development of a manual of best management practices for water quality protection. He is currently Program Manager for the Advanced Pumping Efficiency Program (APEP) at the Center for Irrigation Technology on the campus of CSU, Fresno. APEP, in operation since 2002, is implemented on behalf of PG&E with funding from the Public Purpose Programs charge under the auspices of the California Public Utilities Commission (see www.pumpefficiency.org).