# West Coast Diesel Emissions Reduction Collaborative

## The Diesel-Electric Pumping Efficiency Program

Working with leaders from government, the private sector, and environmental groups the West Coast Diesel Emissions Reduction Collaborative (Collaborative) brings attention to the need for additional funding for diesel emissions reduction on the West Coast and encourages voluntary and incentive based projects that reduce diesel emissions. The Collaborative is focused on projects that are regional in scope, leverage funds from a variety of sources, result in real measurable reductions/results, and create momentum for future diesel emissions reductions. This document describes a potential diesel emissions reduction project in the agricultural sector: **The Diesel-Electric Pumping Efficiency Program**
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### Project at a Glance

Both PG&E and SCE have filed applications with the California Public Utilities Commission (CPUC) for a tariff designed to encourage agriculturalists that are now using diesel engines to power water pumps to switch to electric power. The proposed tariff offers a subsidized energy charge as well as reduced demand charges and reduced charges for new lines. It is noted that although the tariff will help in reducing diesel emissions it may detrimentally affect the electric grid in terms of increased load during peak periods.

The proposed Diesel-Electric Pumping Efficiency Program (DEPEP) would specifically address those pumps being converted to electric energy under the proposed tariff. Its primary purpose is to encourage pumpers to participate in the tariff by helping to ensure that the pumps being converted are at least as efficient as the state-wide average (currently about 53% for turbine pumps). Although the tariff requires a pump efficiency test after the conversion, it does not specify a required efficiency. A secondary purpose is to improve water management.

The proposed DEPEP will provide subsidized pump efficiency tests and incentive rebates for retrofit and repair of inefficient pumps resulting in:

1. 1000 pump tests (measuring overall pumping plant efficiency; flow rates, total dynamic head, annual hours of operation, use of plant, pumping cost analysis, etc.)
   - Indicating current situation in field aiding future efforts by EPA, et al
   - Providing objective information to clients for benefit/cost ratio of system retrofit

2. 150 pump retrofit projects

3. Educational seminars per year – these will be done in conjunction with an existing pump efficiency program, the Agricultural Pumping Efficiency Program (APEP). Their impacts are unknown. However, the evaluation, verification, and measurement study performed for an existing pumping efficiency program indicates that those attending APEP educational seminars found it a valuable experience ("Draft Report for Evaluation of the Agricultural Pumping Efficiency Program – CPUC Project 230-02", Equipose Consulting, Inc., April 2004). If partnered correctly (with pump repair companies, engine distributors, water conservation groups, etc.) they can also be a valuable marketing tool.
   - Unknown impact on water management
   - Unknown impact on pump selection/maintenance

## Problem Statement

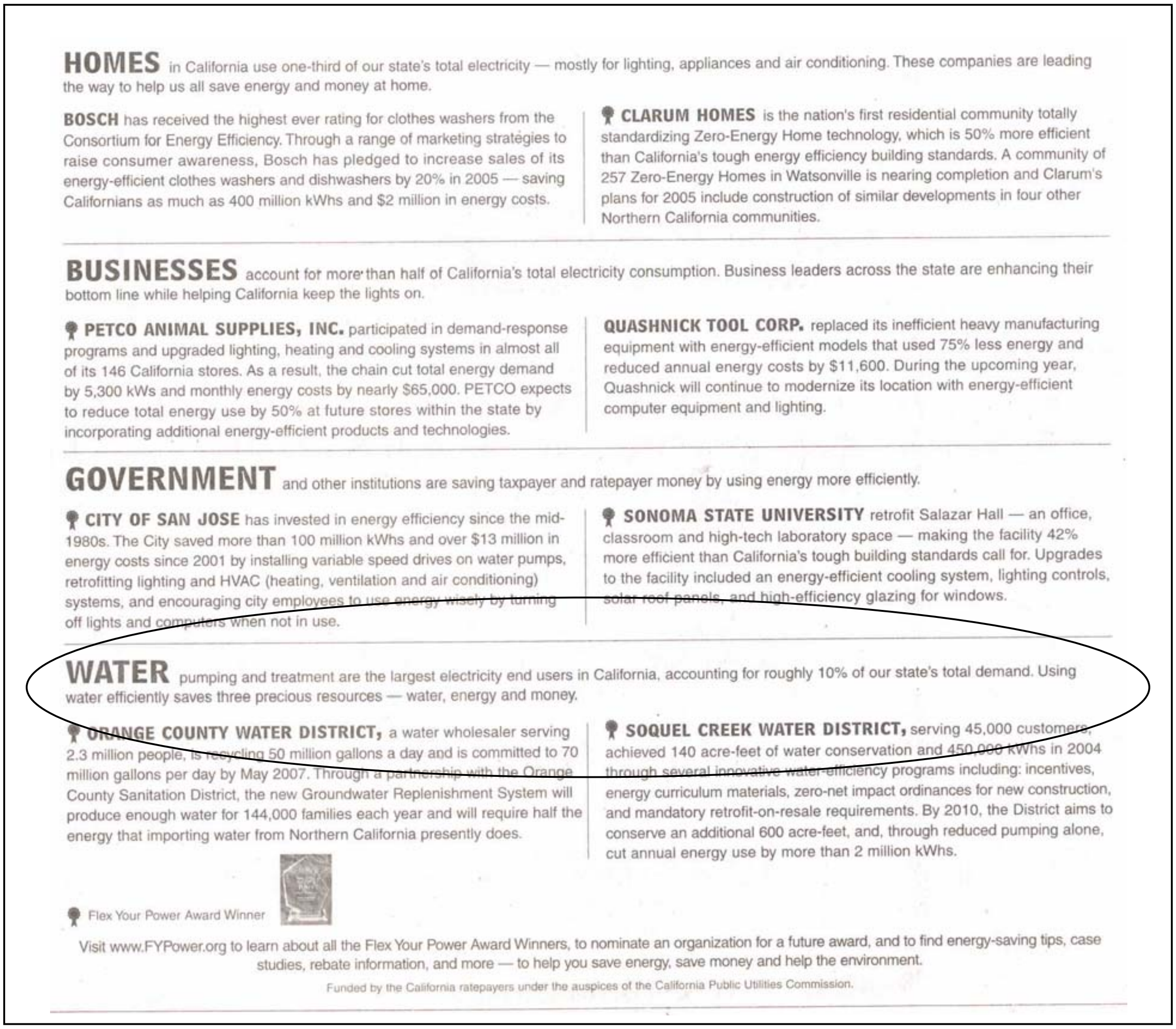
The following is excerpted from pages 2 and 3 of "Application of PACIFIC GAS AND ELECTRIC COMPANY for Rate and Line Extension Incentives for Conversion of Stationary Agricultural Internal Combustion Equipment to Electric Service", submitted to the California Public Utilities Commission on November 9, 2004 by Pacific Gas & Electric Company. It fully expresses the emissions problem to be addressed by the proposed tariff.

> "The San Joaquin and Sacramento Valleys are subjected to heavy amounts of pollutants, ranking with the Los Angeles basin as one of the most polluted air regions in the nation. While there are many sources of air pollution, irrigation pumps (primarily diesel) are a significant contributor to the poor air quality of these Valleys. The California Air Resources Board (CARB) estimates that there are approximately 8,200 diesel irrigation pumps in California, with approximately 5,700 located in the San Joaquin and Sacramento Valley Federal Air Quality Non-Attainment areas.
>
> "According to CARB, during the 2003 summer in the San Joaquin and Sacramento Valley air basins, diesel-powered irrigation pump engines emitted 33 tons per day of oxides of nitrogen ($NO_x$) or 23 percent of the total $NO_x$ emissions from stationary fuel combustion sources in the region. Further, CARB estimates that during the 2003 summer in the central valley, diesel pumps were responsible for approximately 31 percent of the Reactive Organic Gases (ROG) emitted from stationary fuel combustion sources in the Valley.
>
> "Together, in the presence of sunlight, $NO_x$ and ROGs form low-level ozone. Ozone is a major component of "smog," which affects human health, vegetation, and materials. In humans, ozone can lead to respiratory distress, including heavy coughing, throat irritation, and breathing difficulty. Ozone also damages vegetation. Studies have shown reductions of up to 20 percent in yields of some agricultural crops. CARB estimates that the San Joaquin Valley Air Basin's agricultural crop losses due to exposure to ozone exceed $150 million. According to the National Park Service, up to half the Ponderosa and Jeffrey Pine in the Sierra Nevada Mountains show ozone injury. Ozone also damages various materials widely used in commerce, such as rubber, cotton, nylon, polyester, dyes, paints and coatings. Hot, summer days when ozone levels are highest are also days when water pumping and associated diesel engine use is high. More than 3 million people in the Valley breathe unhealthy air one day out of three in the summer because of excessive ozone levels.
>
> "CARB estimates that in 2003, diesel-powered irrigation pumps were responsible for 17 percent of particulate matter (PM) emissions from stationary fuel combustion sources in the region. It is estimated that PM accounts for 70 percent of the known cancer risk that is attributable to exposure to toxic air pollutants in California."

Note that the above quote uses the term diesel-powered "irrigation pumps" throughout. It should be emphasized that diesel fuel consumption depends on the entire irrigation pumping <u>plant</u>, which consists of the engine, transmission system, and pump. To the extent of inefficiencies in the transmission system and pump, diesel fuel consumption is increased just as much as inefficiencies in the internal combustion engine.

As well, management of that plant is all important. Diesel fuel consumption is increased to the extent that the irrigation pumping plant is run excessively due to incorrect management of water in the field, regardless of the efficiency of the plant or any one component. The interrelationship between water efficiency and energy efficiency is fully recognized throughout the state. Figure 1 is a portion of a newspaper ad run on behalf of the "Flex Your Power" campaign to improve electric energy use in the state (San Luis Obispo Telegram-Tribune, December 5, 2004, page A-9). Note the statements within the section titled "Water" (emphasis added):

> "…pumping and treatment are the largest electricity end users in California, accounting for roughly 10% of our state's total demand. Using water efficiently saves three precious resources – water, energy, and money."



**HOMES** in California use one-third of our state's total electricity — mostly for lighting, appliances and air conditioning. These companies are leading the way to help us all save energy and money at home.

**BOSCH** has received the highest ever rating for clothes washers from the Consortium for Energy Efficiency. Through a range of marketing strategies to raise consumer awareness, Bosch has pledged to increase sales of its energy-efficient clothes washers and dishwashers by 20% in 2005 — saving Californians as much as 400 million kWhs and $2 million in energy costs.

**CLARUM HOMES** is the nation's first residential community totally standardizing Zero-Energy Home technology, which is 50% more efficient than California's tough energy efficiency building standards. A community of 257 Zero-Energy Homes in Watsonville is nearing completion and Clarum's plans for 2005 include construction of similar developments in four other Northern California communities.

**BUSINESSES** account for more than half of California's total electricity consumption. Business leaders across the state are enhancing their bottom line while helping California keep the lights on.

**PETCO ANIMAL SUPPLIES, INC.** participated in demand-response programs and upgraded lighting, heating and cooling systems in almost all of its 146 California stores. As a result, the chain cut total energy demand by 5,300 kWs and monthly energy costs by nearly $65,000. PETCO expects to reduce total energy use by 50% at future stores within the state by incorporating additional energy-efficient products and technologies.

**QUASHNICK TOOL CORP.** replaced its inefficient heavy manufacturing equipment with energy-efficient models that used 75% less energy and reduced annual energy costs by $11,600. During the upcoming year, Quashnick will continue to modernize its location with energy-efficient computer equipment and lighting.

**GOVERNMENT** and other institutions are saving taxpayer and ratepayer money by using energy more efficiently.

**CITY OF SAN JOSE** has invested in energy efficiency since the mid-1980s. The City saved more than 100 million kWhs and over $13 million in energy costs since 2001 by installing variable speed drives on water pumps, retrofitting lighting and HVAC (heating, ventilation and air conditioning) systems, and encouraging city employees to use energy wisely by turning off lights and computers when not in use.

**SONOMA STATE UNIVERSITY** retrofit Salazar Hall — an office, classroom and high-tech laboratory space — making the facility 42% more efficient than California's tough building standards call for. Upgrades to the facility included an energy-efficient cooling system, lighting controls, solar roof panels, and high-efficiency glazing for windows.

**WATER** pumping and treatment are the largest electricity end users in California, accounting for roughly 10% of our state's total demand. Using water efficiently saves three precious resources — water, energy and money.

**ORANGE COUNTY WATER DISTRICT,** a water wholesaler serving 2.3 million people, is recycling 50 million gallons a day and is committed to 70 million gallons per day by May 2007. Through a partnership with the Orange County Sanitation District, the new Groundwater Replenishment System will produce enough water for 144,000 families each year and will require half the energy that importing water from Northern California presently does.

**SOQUEL CREEK WATER DISTRICT,** serving 45,000 customers, achieved 140 acre-feet of water conservation and 450,000 kWhs in 2004 through several innovative water-efficiency programs including: incentives, energy curriculum materials, zero-net impact ordinances for new construction, and mandatory retrofit-on-resale requirements. By 2010, the District aims to conserve an additional 600 acre-feet, and, through reduced pumping alone, cut annual energy use by more than 2 million kWhs.

Flex Your Power Award Winner

Visit www.FYPower.org to learn about all the Flex Your Power Award Winners, to nominate an organization for a future award, and to find energy-saving tips, case studies, rebate information, and more — to help you save energy, save money and help the environment.

Funded by the California ratepayers under the auspices of the California Public Utilities Commission.

**Figure 1 – Flex Your Power newspaper ad (San Luis Obispo Telegram-Tribune, December 5, 2004, page A-9)**

It is noted again the close relationship to air quality concerns that the proposed new tariffs represent**. However, it would be wrong for an effort designed to improve air quality to result in inefficient pumping plants being connected to the electric grid, which is also an impacted resource in California.** The proposed Diesel-Electric Pumping Efficiency Program has the twin objectives of:

1. Ensuring that a high efficiency irrigation pumping plant is in place.

2. Ensuring correct management of that pumping plant.

Both of these objectives work to reduce electric energy use in the agricultural sector.

Also, to the extent that water management in agriculture is improved, the water resources management problem in California is reduced. Note that this affects both water quality as well as water quantity issues since improved irrigation practices reduce prime transport mechanisms (excessive deep percolation or surface runoff) for non point source pollutants.

## Proposed Actions

The objectives of DEPEP are:

1. Ensure that a high efficiency irrigation pumping plant is in place.

2. Ensure correct management of that pumping plant.

In fulfilling these objectives it seeks to achieve the goal of ensuring minimal impact on the electric grid due to the proposed tariff and reducing electricity use in production agriculture and turf irrigation. Since part of the education message is improved water management in order to reduce pumping, DEPEP also addresses water conservation (and by implication, water quality) issues.

The proposed site for DEPEP is the PG&E and SCE service areas in the Sacramento and San Joaquin Valleys of California. These valleys are targeted by the proposed tariff as they are now rated in “severe non-attainment” for air quality standards.

This program is planned to run for two years with the following timeline:

1. Contract Execution – Winter
2. Development of DEPEP management based on APEP resources – Winter
3. Commissioning of DEPEP database – Winter
4. Selection of participating pump test companies – Winter
5. Marketing – Spring
6. Start pump testing – Spring
7. Start applications for pump retrofit/repair – Late Summer
8. Continue operations through the second year
9. Final Report – Twenty-six months from contract execution

## Anticipated Benefits

DEPEP addresses three critical resource management problems with one program:

1. Energy – Through audits of energy-using equipment, education as to hardware options and management, and targeted incentives for improvement, DEPEP seeks to reduce electricity use.

2. Air Quality – Hopefully the presence of DEPEP will encourage more pumpers to take advantage of the new tariff.

3. Water Conservation (and by implication, water quality) – Correct management of irrigation pumps includes correct water management. Improving irrigation efficiency (which then reduces a prime transport mechanism for non point source pollution) results in less water pumped and less fuel used.

As such there should be a significant opportunity to leverage funding from appropriate local, state, and federal agencies. Synergy can occur as program administration, overhead, and marketing costs are shared among the various agencies.

The proposed DEPEP will provide subsidized pump efficiency tests and incentive rebates for retrofit and repair of inefficient pumps resulting in:

1. 1000 pump tests (measuring overall pumping plant efficiency; flow rates, total dynamic head, annual hours of operation, use of plant, pumping cost analysis, etc.)
- Indicating current situation in field aiding future efforts by EPA, et al
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- Unknown impact on water management
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## Estimated Costs

This program will run for two years, in conjunction with the current Agricultural Pumping Efficiency Program (APEP). Thus, overhead costs are minimal and education, although offered through the proposed DEPEP program, is completely paid for by APEP. Marketing is minimized since the target audience is automatically identified by the decision to participate in the tariff.

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| | Quantity | Cost | Program Total |
|---|---|---|---|
| ADMINISTRATION AND OVERHEAD | | | |
| Salaries | | | $40,000 |
| Benefits | | | $28,000 |
| Overhead (acct., insurance, legal, rent, travel, etc.) | | | $220,000 |
| **TOTAL ADMINISTRATION AND OVERHEAD (27%)** | | | **$288,000** |
| **MARKETING AND OUTREACH (1%)** | | | **$10,000** |
| FIELD IMPLEMENTATION | | | |
| Pump Test Subsidy | 1000 | $200 | $200,000 |
| Pump Retrofit/Repair Incentive Rebate | 150 | $3,500 | $525,000 |
| Education (in conjunction with APEP | | | $0 |
| Rebate and Pump Test Review | | | $27,500 |
| **TOTAL FIELD IMPLEMENTATION (72%)** | | | **$752,500** |
| **TOTAL TWO-YEAR PROGRAM COST** | | | **$1,050,500** |

## Collaborative Partners

CIT will be solely responsible for development and implementation of the program. However, a strong component of DEPEP will be program marketing and delivery through “trade allies”. These are the pump test and pump repair companies that are in the field and have established communication links with the target audience. (Note that the extensive quality control procedures developed for the existing APEP will be in place to ensure accurate pump tests for the proposed DEPEP.)

Key personnel for this program will be David Zoldoske, Director of the Center for Irrigation Technology and Peter Canessa, Program Manager. Their resumes follow:

**DAVID F. ZOLDOSKE – Director, Center for Irrigation Technology**

ADDRESS

5370 North Chestnut Avenue – M/S OF 18
California State University, Fresno
Fresno, CA 93740
(559) 278-2066
david_zoldoske@csufresno.edu

AREAS OF EXPERTISE

- Program Leadership
- Educational Opportunities
- Analytic Studies
- Grants and Contracts Management

EDUCATION

| | | |
|---|---|---|
| EdD, Education (Leadership) | University of La Verne | La Verne, CA |
| MS, Agriculture (Economics) | California State University, Fresno | Fresno, CA |
| BS, Agricultural Business | California State University, Fresno | Fresno, CA |

EXPERIENCE

1994- Present **Director (70%)**, Center for Irrigation Technology (CIT), California State University, Fresno. Requires administrating all aspects of the management of the Center including: planning and budgeting (currently at 12 million dollars); promotion and public relations with community and industry; liaison with advisory board; provide educational opportunities to the public, development of contract projects for applied research, supervision of staff and research; training and publications efforts.

2000- Present **Associate Director (20%)**, California Water Institute, California State University, Fresno. Given the charge from Proposition 13 to develop the Water Institute. Activities include developing partnerships with three sister CSU campuses, working with campus president to secure funding from CSU Chancellor's office, obtain building space, hire and supervise staff, allocate and fund campus research projects, and create advisory board.

2002 - Present **Interim Director (10%)**, International Center for Water Technology, California State University, Fresno. Working directly with approximately 40 flow technology companies in the San Joaquin Valley to secure funding for a proposed 35 million dollar technology building on campus. Responsibilities include establishing an interim industry board, project leadership, and providing liaison between the community and the University.

1990 - 1993 **Assistant Director**, Center for Irrigation Technology (CIT), California State University, Fresno. Specific duties include developing educational programs for the irrigation industry, promotion of Center activities, developing grant and contract proposals, supervision of staff and students positions supporting the Director's duties as required, and performing special projects as assigned.

1986 - 1990 **Hydraulic Lab Manager**, Center for Irrigation Technology (CIT), California State University, Fresno. Responsible for the operations of the internationally recognized research laboratory, including program development, liaison with private sector clientele, educational efforts, and supervision of staff and students positions.

1983 - 1985 **Research Technician**, Center for Irrigation Technology (CIT), California State University, Fresno. Worked primarily in laboratory and field research and providing technical support to farming enterprise. Assisted faculty and graduate students in conducting field trials and research.

HONORS AND RECOGNITION

Recognized nationally as one of 18 Environmental Stewards and Innovators in the Golf Industry by the Golfweek's Superintendent NEWS, October 26th, 2001.

Honorary Life Membership in the American Society of Irrigation Consultants, May 2001.

National Water and Energy Conservation Award presented to CIT by the Irrigation Association, 1998.

Roy Williams Memorial Award presented to CIT for service to the industry by the American Society of Irrigation Consultants, 1996.

Edwin J. Hunter Industry Achievement Award presented to CIT for service to the industry by Hunter Industries, 1994.

PROFESSIONAL ACTIVITIES

Current President of the Irrigation Association

Elected Vice-President (2002) by the membership of the Irrigation Association. responsible for approval and expenditures of the annual 2.3 million dollar association budget. This includes oversight for performance of executive director and staff.

Elected President (2002) by the membership of the American Society of Agronomy, California Chapter.

Advisory Board Member for the American Vineyard magazine, Lawn & Landscape magazine and Irrigation Journal magazine. Also serve as a frequent columnist for the California Grower magazine.

Member, Irrigation Association Long Range Planning Council, July 1994, to November 1995. Council is responsible for identifying and recommending long-term goals and objectives to the Board of Directors of Irrigation Association.

USA delegate to ISO / TC23 / SC18 Committee, Tel Aviv, Israel, October 1993. In association with the American National Standards Institute (ANSI), represented the USA position in developing international irrigation standards.

USA delegate to ISO / TC23 / SC18 Committee, Aix En Provence, France, September 1991. In association with the American National Standards Institute (ANSI), represented the USA position in developing international irrigation standards.

INTERNATIONAL INVITATIONS

Project Director for the Zimbabwe Irrigation Technology Center, Harare, Zimbabwe. Completed contract for design, training, and development of testing and research facility, Nov./Dec., 1996.

Visiting Scholar to the Dzhambul Institute for Irrigation, Land Reclamation and Civil Engineering (DICI), located in Dzhambul, Kazakhstan, USSR. Agreement made to develop joint irrigation demonstration and educational plots in Dzhambul region, May 1991.

Keynote Address to the Fourth International Micro-Irrigation Congress, Albury-Wadonga, Australia. Presentation on The Role of an Independent Test Laboratory in Micro-Irrigation". October 23 - 28, 1988

PUBLICATIONS

Over 80 publications with references available upon request.

**PETER CANESSA, P.E. –Program Manager**

ADDRESS

665 Asilo
Arroyo Grande, CA 93420
(866) 473-0847
pcanessa@charter.net – e-mail
http://webpages.charter.net/pwcanessa/index.htm - personal web site

## EDUCATION

- Bachelor of Science - Industrial Engineering, California Polytechnic State University, San Luis Obispo, 1972 (with Honors)
- Master of Science - Irrigation and Drainage Engineering, Utah State University, Logan, 1977
- Additional post-graduate studies, Utah State University, 1983-1984

## EXPERTISE

- Agricultural Water, Water Quality, and Energy Management
- Microcomputer Applications for Business and Engineering
- Education (extension or classroom)

## PARTIAL LIST OF CLIENTS/PROJECTS

Center for Irrigation Technology, Fresno State University (1999 to present)

- content development and improvements to irrigation scheduling system for the WATERIGHT web site (www.wateright.org)
- development of seepage assessment vehicle utilizing geo-referenced electro-magnetic inductance instrumentation
- teaching of Agricultural Water Resources Management in California
- program design and management - Agricultural Peak Load Reduction Program, an incentive rebate program funded by Senate Bill 5x (2001) through the California Energy Commission (funded to $11,700,000)
- program design and management – Agricultural Pumping Efficiency Program, an information and incentive rebate program funded through the Public Goods Charge under the auspices of the California Public Utilities Commission (funded to $8,500,000 in total)

Narromine Irrigation Board, Narromine, NSW, Australia (1999 to 2001)

- development of an Action Plan to guide improvements in the irrigation district's operations to address seepage control, water measurement accuracy, energy use, and on-farm efficiency

Macquarie River Food & Fibre, Macquarie Valley Landcare Group, and New South Wales Agriculture, Dubbo, NSW, Australia (1998 to 2001)

- implementation of an irrigation management evaluation/improvement program

San Diego County Water Authority, San Diego, CA (1996 to 2002)

- investigations to identify water conservation opportunities and implementation costs in Imperial Irrigation District in support of on-going negotiations between SDCWA and IID for a potential long-term water transfer agreement

Pacific Gas & Electric Company, San Francisco, CA (1991 to 2002)

- presentation of educational seminars for Agricultural Account Representatives concerning recognition and analysis of energy efficiency projects in irrigation systems
- development of revised Financial Incentives Application process
- development of new Incentive products
- preparation and review of Incentive Applications for validity
- co-author of analysis of Kerman, CA, Photovoltaic Site for agricultural production systems
- analyses of selected measures of the energy efficiency program for agricultural power-users, including gated and transfer pipelines, low-pressure sprinkler nozzles, surge-valves, time-clocks, variable frequency drives, micro-irrigation, and automatic pump re-starters for irrigation systems, plate-coolers and heat-exchangers for dairies, and thermal curtains for greenhouses
- technical advisor for measurement and evaluation studies of the Agricultural Incentive Program's gross and net energy savings for 1994 through 1997
- initialdevelopment of new construction standards for dairies in support of the "Savings by Design" energy efficiency program

Monterey County Water Resources Agency, Salinas, CA (1991 - 1998)

- preparation of draft Nitrate Management Program document (addressing groundwater contamination)
- evaluation of different methods for groundwater extraction reporting
- feasibility study of using Agricultural Commissioner's Office pesticide-use data for preparation of summary land/water-use statistics in Salinas Valley
- review of the Agency's Water Conservation Plan
- Consultant to CH2M-Hill, Inc. (a consultant to the US Bureau of Reclamation) during the 1991 MCWRA-Bureau of Reclamation Joint Land-Use Survey, responsible for the development of a Salinas Valley crop calendar, identification of common crop rotations, and preliminary estimates of crop water use; development of crop water demand simulation programming for estimating average annual net and gross water demands as well as serving as database for the crop calendars, rotations, climatic information, and crop water use estimates

Washington State University, Pullman, WA (1993 - 1997)

- Project Coordinator writing/publicizing a Best Management Practices manual addressing non-point source pollution for irrigated agriculture in Washington State under a joint Washington State Department of Ecology/ WSU Cooperative Extension project (goto http://cru84.cahe.wsu.edu/cgi-bin/pubs/EM4885.html to download a copy)

California Energy Commission, Sacramento, CA (1992)

- co-author with Kurt Schulbach, University of California Cooperative Extension, of position paper discussing possible responses to higher electrical energy costs by Central Coast agriculture

Irrigation Training and Research Center, California Polytechnic State University, San Luis Obispo (1991 - 1993)

- co-author of Irrigation and Drainage in the Grassland Area of the Westside of the San Joaquin Valley by Dr. Charles Burt, R. Walker, P. Canessa, K. Robison, a study funded by the Central Valley Regional Water Quality Control Board (contract 1-078-150-1)
- co-author of Irrigation Efficiencies in Parts of the Selenium Drainage Area on the West Side of the San Joaquin Valley by Dr. Charles Burt, P. Canessa, J. Parrish, a study funded by the CVRWQCB (agreement #45902062)

California Polytechnic State University at San Luis Obispo, Agricultural Engineering Department (1991-1993 and 1980-1982)

- Lecturer in agricultural water management, irrigation science and irrigation system design

Central California Irrigation District, Los Banos, CA (1990-1991)

- Water Conservation Coordinator for the eight Grasslands area water districts (a project funded by the California Department of Water Resources) - development and implementation of the area's first formal water conservation program including preparation, dissemination, and presentation of educational materials, a weekly newspaper column, and the monthly New Irrigator newsletter

Westlands Water District, Fresno, CA (1987-1991)

- Project Advisor performing irrigation system efficiency evaluations under the California Department of Water Resources/Westlands Water District/Westside Resource Conservation District-sponsored Water Management and Drainage Reduction programs
- development of ICE, the Irrigation Cost Evaluator- programming for rapid analysis of alternative irrigation system's benefits and costs
- rewrite and further development of the District's Water Conservation Handbook

Also...

Irrigation Engineer, Superior Farming Company, Bakersfield, CA (1977-1980)

- irrigation system design, installation, and maintenance (fully automated drip, automated surface, tailwater return systems, level basins, high and low-pressure pumping plants)
- irrigation scheduling (computer program development, neutron probe operation, field consultations)

*(Superior Farming was a 38,000 acre, fully diversified, extremely modern farm with operations in the central and southern San Joaquin Valley, the Coachella Valley, and Tucson, Arizona. Superior Farming was a leader in the development and adaptation of modern water management including micro-irrigation, computerized water-budget irrigation scheduling, and linear sprinklers. By 1980, Superior had well over 15,000 acres in drip and was using neutron probes, on-site weather stations and an on-site IBM 32 computer for irrigation scheduling and irrigation system design)*

## MEMBER

- American Society of Agricultural Engineers
- United States Committee on Irrigation and Drainage
- California Irrigation Institute

## More Information on the Collaborative and Contacts

The West Coast Diesel Emissions Reduction Collaborative is made up of federal government agencies from the U.S., Canada and Mexico, and state and local governments and non-profit and private sector partners from California, Oregon, Washington, Alaska and British Columbia. The Collaborative's purpose is to bring attention to the need for additional funding for diesel emissions on the West Coast, support voluntary diesel emissions reductions, create a forum for information sharing among diesel emissions reductions advocates, and leverage significant new resources to expand voluntary diesel emissions reductions efforts.

The goal of the Collaborative is to leverage over $100 million in new federal funds for diesel emissions reductions projects per year for 5 years to reduce emissions from the most polluting diesel sources in the most impacted communities and significantly improve air quality and public health. By targeting the higher polluting engines with the most cost effective strategies, we estimate that the benefits of this investment will significantly outweigh the costs.

For more information on the Diesel-Electric Pumping Efficiency Program, contact:

Peter Canessa
pcanessa@csufresno.edu
(866) 473-0847

Center for Irrigation Technology
David Zoldoske, Director
david_zoldoske@csufresno.edu
(559) 278-2066
5370 North Chestnut Ave – M/S OF18
Fresno, CA 93740
.

For more information on the Collaborative in general, go to www.epa.gov/air/westcoastdiesel or contact Peter Murchie, murchie.peter@epa.gov or Michelle Roos, roos.michelle@epa.gov.

**Appendix A – Background for NOx/PM10 savings calculations for an irrigation pump repair – written December 2003 by John Weddington, Center for Irrigation Technology**

An analysis of the existing APEP pump repair rebate database for electric motor pump repairs was performed for 41 large pumps (75 to 300 hp) that had efficiency tests before and after the repair. The electric pumps are used as a model for diesel irrigation pumping conditions. Table 1 contains a summary of this program:

**Table 1: Electric Pump Repair Statistics, 41 pumps from 75 to 300 hp**

| | OPE | Post-driver OPE | Input HP | GPM | Total Head | Kw-hrs per Acre-ft | Hrs Operation | Annual kw-hrs | Ac-ft Pumped |
|---|---|---|---|---|---|---|---|---|---|
| **Before** | 38 | 42 | 116 | 893 | 274 | 695 | 3,238 | 280,141 | 403 |
| **After** | 65 | 70 | 134 | 1,372 | 316 | 445 | 1,751 | 179,648 | 403 |

The useful life of a pump under good conditions is estimated at about 15,000 hours. At the rate of utilization indicated by these 41 pumps, the pump end and other rotating components should be replaced after about 6 years of operation. A common practice for low use electric pumps is to wait until the pump totally deteriorates (either mechanical breakage, or so low in output that it is not worth running). High use pumps, such as these electrics, are repaired when an economic threshold is reached that allows payback of repair costs from energy savings within a period of 2 to 3 years. The purpose of the "incentive" grant is to encourage a repair prior to breakage or excessive consumption of energy. The payback period is thus moved ahead for the farmer, thereby saving energy and producing related benefits for the individual farmer and the general public. The statistics for the electric repair incentive grants are presented in Table 2:

**Table 2: Model for An Average Electric Repair Rebate (400 acre-ft of pumpage per year)**

| Year | Post-Driver OPE | Annual Hours of operation | Annual Energy Usage kw-hrs | Potential Energy Savings kw-hrs | Annual Cost of Energy $/ kw-hrs (1) | Annual Energy $ Savings |
|---|---|---|---|---|---|---|
| **0** | 0.70 | 1,751 | 174,415 | 0 | $20,476 | $0 |
| **1** | 0.65 | 1,962 | 191,109 | 16,694 | $22,436 | $1,960 |
| **2** | 0.60 | 2,182 | 207,803 | 33,388 | $24,396 | $3,920 |
| **3** | 0.56 | 2,412 | 224,497 | 50,082 | $26,356 | $5,880 |
| **4** | 0.51 | 2,654 | 241,191 | 66,776 | $28,316 | $7,840 |
| **5** | 0.46 | 2,907 | 257,885 | 83,470 | $30,276 | $9,799 |
| **6** | 0.42 | 3,173 | 274,579 | 100,164 | $32,236 | $11,759 |
| **Total:** | | 17,042 | 1,571,479 | 350,574 | $184,492 | $41,157 |

**1) Average Cost per kW-hr for AG5B in PG&E is $0.1174 (PGE rate schedule, 2001 on)**

Average Incentive Grant Payment for a Pump (75-300 hp): $5,800
Cost per mega-watt savings: $23 (Assumes pump repaired after 8,300 hours)
Incentive rebate cost as a per cent of effective life energy cost: 3.14%

While many diesel irrigation pumps are similar in horsepower requirements (Cal EPA), it is unknown how many diesel irrigation pumps follow this model. Diesels are unique in the sense that owners can regain some of their lost capacity by speeding up the pump. When this occurs, horsepower, fuel usage, and emission increases are cubed compared to the RPM increase. It is likely that the comparison between these electric repairs and typical diesel pumping plants underestimates the benefits that can be achieved from an incentive repair program because of two reasons: 1) testing services are not widely available for diesel pumps, and owners are generally unsuspecting of pump problems and inefficiencies; 2) revving the diesel motor can allow an owner to "get by" for more years, whereas electric motor pumps that have lost their capacity restrict the number of acres that can be farmed and force a repair.

In the case of air quality, an incentive grant towards a repair would encourage a farmer to make a repair of a worn pump now rather than basing a decision on fuel and operational cost savings. Thus, the high efficiency cycle is started earlier than the 15,000 hour useful life cycle period (typically, sometime after 8,000 hours of use) when the post-driver efficiency is less than 50%. The farmer's overall costs, in theory, would stay about the same, because while he is saving on fuel and operational costs, he is repairing the pump at a more accelerated rate than without the incentive grant, thus incurring extra repair costs.

Further, an added benefit would be to reduce the total hours of engine time to deliver the same amount of water. This would tend to keep the engine burning more efficiently, as engine repairs would be less frequent. Fewer overhauls would be required, and the engine would last more years, a benefit to both the farmer and the environment.

Based on the model in the table (patterned after the electric motor pump repairs), the following projection is made:

**Table 3: Typical Diesel Pump Repair Cycle (400 acre-ft of pumpage per year:15,000 to 20,000 total hrs )**

| | Pump | | | Energy | | Emissions | | | | Diesel Fuel | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Post Engine OPE | Annual Hours | Post Engine BHP | Annual Usage bhp-hrs | Savings | N0x Output Tons (1) | N0x Savings | PM10 Output Tons (2) | PM10 Savings | Use gal. (3) | Annual Cost, $1/gal. | Savings, Dollars |
| **0** | 0.70 | 1,751 | 123 | 216,265 | 0 | 1.64 | 0.00 | 0.09 | 0.00 | 12,310 | $12,310 | $0 |
| **1** | 0.65 | 1,962 | 121 | 236,965 | 20,700 | 1.80 | 0.16 | 0.10 | 0.01 | 13,489 | $13,489 | $1,178 |
| **2** | 0.60 | 2,182 | 118 | 257,665 | 41,399 | 1.96 | 0.31 | 0.11 | 0.02 | 14,667 | $14,667 | $2,357 |
| **3** | 0.56 | 2,412 | 115 | 278,364 | 62,099 | 2.12 | 0.47 | 0.12 | 0.03 | 15,845 | $15,845 | $3,535 |
| **4** | 0.51 | 2,654 | 113 | 299,064 | 82,799 | 2.27 | 0.63 | 0.13 | 0.03 | 17,024 | $17,024 | $4,713 |
| **5** | 0.46 | 2,907 | 110 | 319,764 | 103,498 | 2.43 | 0.79 | 0.13 | 0.04 | 18,202 | $18,202 | $5,891 |
| **6** | 0.42 | 3,173 | 107 | 340,463 | 124,198 | 2.59 | 0.94 | 0.14 | 0.05 | 19,380 | $19,380 | $7,070 |
| **Total:** | | 17,042 | | 1,948,550 | 434,693 | 14.82 | 3.306 | 0.82 | 0.18 | 110,917 | $110,917 | $24,744 |

| | N0x | PM10 | Fuel Savings |
|---|---|---|---|
| **Expected target, 100 pumps:** | **331 tons** | **18 tons** | **$2,474,406** |

(1) N0x reductions for Tier 1 Diesel Engines at 6.9 gms/bhp-hr; 1 ton = 907,200 grams
(2) PM10 reductions for Tier 1 Diesel Engines at 0.38 gms/bhp-hr; 1 ton = 907,200 grams
(3) Diesel usage is at 0.37 lbs/hr-bhp; 6.5 lbs per gallon of fuel

An estimate by Cal EPA Air Resources Control Board for the year 2000 indicated a total of 7,253 diesel pumping units, with 3,473 stationary units of which about half (1,599 engines) were 175 hp (2). The diesel engine size in the above model is about 175hp with a 70% load rating. The CAL EPA document indicates a useful life of about 16 years for the diesel pumping unit, suggesting an annual repair rate of about 217 units per year due to wear. With effective marketing and public awareness, it is projected that 100-300 repairs per year would be submitted for incentive grants. Table 4 projects the annual N0x reductions and costs for 100 repairs.

**Table 4: Projected Savings and Costs for 100 Diesel Pump Repairs Per Year**

| Year | Number of Repairs | 1st Yr N0x Emission Savings Tons | 2nd Yr N0x Emission Savings Tons | 3rd Year N0x Emission Savings Tons | 4th Year N0x Emission Savings Tons | 5th Year N0x Emission Savings Tons | 6th Year N0x Emission Savings Tons | N0x Annual Savings Tons | Annual Incentive Rebate $ |
|---|---|---|---|---|---|---|---|---|---|
| **1** | 100 | 94.46 | na | na | na | na | na | 94 | **$348,200** |
| **2** | 100 | 78.72 | 94.46 | na | na | na | na | 173 | **$348,200** |
| **3** | 100 | 62.98 | 78.72 | 94.46 | na | na | na | 236 | **$348,200** |
| **4** | 100 | 47.23 | 62.98 | 78.72 | 94.46 | na | na | 283 | **$348,200** |
| **5** | 100 | 31.49 | 47.23 | 62.98 | 78.72 | 94.46 | na | 315 | **$348,200** |
| **6** | 100 | 15.74 | 31.49 | 47.23 | 62.98 | 78.72 | 94.46 | 331 | **$348,200** |
| **7** | 100 | 94.46 | 15.74 | 31.49 | 47.23 | 62.98 | 78.72 | 331 | **$348,200** |
| **8** | 100 | 78.72 | 94.46 | 15.74 | 31.49 | 47.23 | 62.98 | 331 | **$348,200** |
| **9** | 100 | 62.98 | 78.72 | 94.46 | 15.74 | 31.49 | 47.23 | 331 | **$348,200** |

References:

(1) Data from the Agricultural Peak Load Reduction Program, funded by the California Energy Commission and administered statewide by the Center for Irrigation Technology, California State University, Fresno. Also includes data from the Agricultural Pumping Efficiency Program, funded by the California Public Utilities Commission and administered statewide by the Center for Irrigation Technology.

(2) CalEPA Air Resources Board, “Implementing the Diesel Risk Reduction Plan: Stationary Diesel Irrigation Pump Emissions Inventory”, 2000.

(3) Air Resources Board Emissions Forecast, 1988-1995, 121 hp and larger Tier 1off-road diesel engine produces 6.9 gm/bhp-hr NOx.

**Appendix B – Pro-forma Budgets for a Mid-Level and Full-Scale Diesel Pumping Efficiency Program. Note that these are annual budgets and both are envisioned as multi-year efforts**.

## MID-LEVEL DIESEL PUMPING EFFICIENCY PROGRAM

### Anticipated Program Deliverables

1. 400 pump tests per year

2. 50 pump repairs per year resulting in

- 165 tons NOx reduction
- 9 tons PM10 reduction
- 1,237,200 gallons of diesel saved

3. 2 educational seminars per year – these impacts are unknown. However, the evaluation, verification, and measurement study performed for an existing pumping efficiency program indicates that those attending APEP educational seminars found it a valuable experience ("Draft Report for Evaluation of the Agricultural Pumping Efficiency Program – CPUC Project 230-02", Equipose Consulting, Inc., April 2004). If partnered correctly (with pump repair companies, engine distributors, water conservation groups, etc.) they can also be a valuable marketing tool.

- Unknown impact on water management
- Unknown impact on diesel engine maintenance
- Unknown impact on pump selection/maintenance

### Pro-Forma Budget

| | Quantity | Cost | Program Total |
|---|---|---|---|
| ADMINISTRATION AND OVERHEAD | | | |
| Salaries | | | $10,000 |
| Benefits | | | $12,000 |
| Overhead (acct., insurance, legal, rent, travel, etc.) | | | $100,000 |
| **TOTAL ADMINISTRATION AND OVERHEAD (29%)** | | | **$122,000** |
| | | | |
| **MARKETING AND OUTREACH (4%)** | | | **$18,000** |
| | | | |
| FIELD IMPLEMENTATION | | | |
| Pump Test Subsidy | 400 | $250 | $100,000 |
| Pump Retrofit/Repair Incentive Rebate | 50 | $3,000 | $150,000 |
| Education | | | $12,000 |
| Rebate and Pump Test Review | | | $20,000 |
| **TOTAL FIELD IMPLEMENTATION (67%)** | | | **$282,000** |
| | | | |
| **TOTAL MID-LEVEL PROGRAM COST/YEAR** | | | **$422,000** |
| | | | |
| **Cost per ton of NOx reduction (165 tons), Incentives** | | | **$1,515** |
| **Cost per ton of NOx reduction (165 tons), Total Program** | | | **$2,558** |

## FULL-SCALE DIESEL PUMPING EFFICIENCY PROGRAM

### Anticipated Program Deliverables

1. 800 pump tests per year

2. 100 pump repairs per year resulting in
   - 331 tons NOx reduction
   - 18 tons PM10 reduction
   - 2,474,400 gallons of diesel saved

3. 4 educational seminars per year

### Pro-Forma Budget

| | Quantity | Cost | Program Total |
|---|---|---|---|
| ADMINISTRATION AND OVERHEAD | | | |
| Salaries | | | $16,500 |
| Benefits | | | $23,000 |
| Overhead (acct., insurance, legal, rent, travel, etc.) | | | $160,000 |
| **TOTAL ADMINISTRATION AND OVERHEAD (25%)** | | | **$199,500** |
| **MARKETING AND OUTREACH (5%)** | | | **$40,000** |
| FIELD IMPLEMENTATION | | | |
| Pump Test Subsidy | 800 | $250 | $200,000 |
| Pump Retrofit/Repair Incentive Rebate | 100 | $3,000 | $300,000 |
| Education | | | $15,000 |
| Rebate and Pump Test Review | | | $33,500 |
| **TOTAL FIELD IMPLEMENTATION (70%)** | | | **$548,500** |
| **TOTAL FULL-SCALE PROGRAM COST/YEAR** | | | **$788,000** |
| **Cost per ton of NOx reduction (331 tons), Incentives** | | | **$1,511** |
| **Cost per ton of NOx reduction (331 tons), Total Program** | | | **$2,381** |