CascadeEnergy®

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Review and Update Industrial/Agricultural Incentive Table Measures

Utah

Prepared for

PacifiCorp

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1 EXECUTIVE SUMMARY

In June of 2013 PacifiCorp requested a review and update of Industrial/Agricultural Incentive Table Measures for the state of Utah. The goal of the review and update is to increase energy savings results and participation while maintaining or improving cost-effectiveness. Periodic review of existing measures is needed in order to align measure definitions and eligibility criteria with any changes that may have occurred in codes, standards, common practice, costs, emerging alternative technologies, and the results of program evaluations. In addition, the measure review and update provides an opportunity to investigate and propose new measures in markets not currently addressed. In this report, Cascade Energy Inc. examines and updates the three existing categories of Industrial/Agricultural measures – Irrigation, Farm and Dairy, and Compressed Air – and proposes five additional measures. Each of the proposed new measures uses a calculator-based streamlined implementation approach to simply program administration, reduce cost, and increase uptake.

The listed measures here are designed with trade allies in mind – contractors, installers, and suppliers who are in position either to sell and install baseline, standard-practice equipment or the more efficient alternatives embodied in the energy efficiency measures. Trade allies are well-placed to generate efficiency project leads if they clearly understand and believe in the value of efficiency for them and their customers. Through outreach efforts and relationship development, the wattsmart Trade Ally Coordinators reach out to installers and suppliers, seeking first to develop awareness, then interest and enthusiasm for participation in wattsmart Business. The listed measures provide opportunities for trade allies to effectively initiate projects, then hand them off to their Trade Ally Coordinator for follow up.

Table 1.1 on the next page presents estimated energy and demand savings together with costs and incentives for each measure group. These estimates are based on Cascade's assessment of the local Utah market conditions for each measure. Conditions that affect likely participant uptake are well known for most of the existing measures via experience in the market and relationships with current trade allies. There is more uncertainty around the estimates for new measures, because experience with these markets is more limited.

Each measure category is briefly discussed in the Executive Summary below, followed by more detail in the report section for each measure category. Analysis files are referenced in each section, as are calculator tools for each measure where appropriate.

Repositioning the program as the simpler, more streamlined wattsmart Business offering, together with continued repeat exposure and new measure options is anticipated to improve participation rates.

Table 1.1. Estimated incremental Savings and Costs, Utah

	Incremental Annual Energy Savings, kWh/yr	Incremental Peak Demand Savings, kW	Incremental Incentives $/yr	Incremental Program Administrator Costs $/yr	Total Incremental Utility Costs $/yr	Incremental Customer Costs $/yr
Irrigation						
Year 1	230,000	173.7	$13,002	$20,700	$33,702	$60,082
Year 2	230,000	178.1	$12,988	$20,700	$33,688	$59,935
Year 3	230,000	173.4	$13,004	$20,700	$33,704	$59,933
Compressed Air						
Year 1	340,000	1.7	$51,000	$30,600	$81,600	$122,740
Year 2	340,000	1.5	$51,000	$30,600	$81,600	$122,740
Year 3	340,000	1.3	$51,000	$30,600	$81,600	$122,740
Farm & Dairy						
Year 1	0	0.0	$0	$0	$0	$0
Year 2	0	0.0	$0	$0	$0	$0
Year 3	0	0.0	$0	$0	$0	$0
Oil & Gas Pump Off Controller						
Year 1	143,847	0.00	$21,577	$12,946	$34,523	$50,177
Year 2	143,847	0.00	$21,577	$12,946	$34,523	$50,177
Year 3	143,847	0.00	$21,577	$12,946	$34,523	$50,177
Adaptive Refrigeration Control						
Year 1	214,000	35	$29,100	$19,260	$48,360	$58,800
Year 2	332,000	62.5	$45,600	$29,880	$75,480	$99,600
Year 3	396,000	62.5	$54,000	$35,640	$89,640	$111,600
Fast Acting Door						
Year 1	232,000	0.0	$34,800	$20,880	$55,680	$145,000
Year 2	296,000	0.0	$44,400	$26,640	$71,040	$185,000
Year 3	360,000	0.0	$54,000	$32,400	$86,400	$225,000
End Use Compressed Air Reduction						
Year 1	25,000	12.6	$3,750	$2,250	$6,000	$6,200
Year 2	37,500	18.9	$5,625	$3,375	$9,000	$9,300
Year 3	50,000	25.2	$7,500	$4,500	$12,000	$12,400
Wastewater Mixing - Grid Bee						
Year 1	140,000	0.0	$21,000	$12,600	$33,600	$40,000
Year 2	140,000	0.0	$21,000	$12,600	$33,600	$40,000
Year 3	140,000	0.0	$21,000	$12,600	$33,600	$40,000
TOTALS						
Year 1	1,324,847	223.0	$174,229	$119,236	$293,465	$482,998
Year 2	1,519,347	261.0	$202,190	$136,741	$338,931	$566,752
Year 3	1,659,847	262.4	$222,081	$149,386	$371,467	$621,849

ADDITIONAL UTILITY COSTS	Utility admin	Marketing	Evaluation
Year 1			
Year 2			
Year 3			
	$ 0	$ 0	$ 0

Table 1 gives the estimated annual kWh savings and kW demand reduction for each of the first three years of operation of the updated program. Total incentives are given in the third column. Estimated cost for contractor administration of the Trade Ally Coordinator portion of the program is shown in column four. (Listed measures may also be included in Custom Projects administered by PacifiCorp program managers. This may result in additional savings and costs not included in the Table 1 figures.) Column five, total utility cost, is the sum of columns three and four. The last column is the total estimated project cost seen by participants, which generally comprises total project cost for retrofit projects and eligible incremental cost for new construction projects.

Estimates of additional utility costs for program administration, marketing, and evaluation are shown at the bottom of the table.

Irrigation

In April 2013 the Regional Technical Forum revised its unit energy savings and cost values for irrigation measures in light of leakage values and overirrigation estimates provided in a 2013 study by Dr. Howard Neibling of the University of Idaho. In this study, field measurements of leakage were made on wheel lines, hand lines, and pivots in Southern Idaho, and the extent of overwatering due to lack of uniformity caused by component wear was estimated. These revised leakage values have been used to update the energy and demand savings estimates for Utah, adjusting for local conditions such as pumping lift, annual operating hours, and pump discharge pressure. The result is an increase in unit energy savings for gaskets, drains, levelers, and pipe repair and a slight decrease in savings for nozzles, impact sprinklers, and goosenecks/droptubes.. In addition the low pressure sprinkler measure for pivots and linear moves was combined with the pressure regulator measure so that these are offered only as a combination package (together with the nozzle on the sprinkler). This is because regulators are present on a large fraction of pivots and linears, producers almost always replace regulators at the same time they replace sprinklers (a recommended practice), and one cannot tell which component – sprinkler or regulator – is the cause of a uniformity problem.

Compressed Air

Recommended measures remain unchanged, but the recommended method of determining energy savings is revised. For example, annual savings for a cycling refrigerated dryer is currently estimated by multiplying the unit energy savings value 0.00242 kWh/hr/unit by annual hours of operation and by rated cfm of the dryer. This has introduced unnecessary complication into the administrative and tracking processes. As a revision, we propose to apply an average annual pressurized hours figure of 5,302 to this unit energy savings to simplify the units. For the cycling dryer this converts the unit energy savings to 12.83 kWh/unit (where the unit is cfm). This 5,302 hours average is a figure that three sources converge upon – PacifiCorp project data, Energy Trust project data, and the U.S. Department of Energy.

For the cycling dryer measure, if the dryer is purchased along with a VFD air compressor, we propose to let the Northwest Regional Compressed Air Tool perform the savings calculation rather than relying on the unit energy savings value, since most of the information about the savings estimate is already present in the calculator and it is a simple matter of checking a box to invoke the dryer savings calculation. The dryer incentive would be paid at the custom rate along with the compressor incentive, subject to the usual cost and payback caps.

Farm and Dairy

Farm and Dairy measures are retained as-is with two exceptions: Change the incentive rate for milk precooler from $0.12/kWh plus $50/kW to the revised value of $0.15/kWh, and restructure the heat reclaim measure to use a calculator in place of the current value of $220/condensing unit kW.

The savings from avoided electric water heating through the use of heat recovered from the refrigeration system is directly related to the amount of refrigeration needed per day, which is closely related to milk production per day. The other important factor is whether well water precooling is in place to take load off the refrigeration system. If precooling is employed, the potential for heat recovery is reduced (though still substantial). A straightforward calculator may be used to estimate electric water heat energy savings from heat reclaim on the basis of daily milk production and milk temperature after precooling. A draft calculator accompanies this report.

The agricultural engine block heater timer measure is applicable to residential customer vehicles in addition to agricultural or business customer vehicles. In the future there may be an opportunity for joint marketing with the residential efficiency programs to promote this measure. This would allow for point of purchase promotion for both eligible sectors. Cascade recommends that the residential program analyzes offering a comparable incentive for this equipment through an analogous post purchase application process next time program changes are evaluated.

Oil and Gas

Rod Pumps, also known as sucker rod pumps, are used on oil wells and gas wells to bring groundwater and other fluid to the surface. These present an efficiency opportunity because many rod pumps operate more than they need to in order to manage the fluid level in the well. Timers are used to mitigate this, but a rod pump controller, or pump off controller, will do a better job optimizing pump operation, which reduces energy use and helps well productivity. In recent years over five hundred pump off controllers have been installed in Rocky Mountain Power territory in Utah and Wyoming with assistance from Energy FinAnswer. Savings per well varies from about 3,500 kWh to over 16,000 kWh because of differences in baseline operating practice and fluid level. Savings for any single well can be difficult to predict, but the average savings per controller over the 509 well sample set is 9,707 kWh/yr.

We recommend a unit energy savings approach for this measure based upon this data: 9,707 kWh/yr, no demand savings, with a $1,500 fixed incentive, subject to the project cost cap and one year payback cap. Only retrofit projects are eligible; new construction should be considered standard practice. Participation is difficult to gauge because vendors differ on their assessment of the fraction of the market that already has controllers, which varies by state. It is estimated that several dozen to one or two hundred controllers per year would apply for incentives.

Potato Storage Fan VFDs

The potato storage fan VFD measure is significant in Idaho, Washington, and to a lesser extent, in California. Utah potato production and storage is so small in comparison that this measure is expected to produce no opportunities. Although the measure is not applicable in Utah, a brief description is included here for reference, since, with few exceptions, alignment of incentive offerings is maintained among the states.

Adaptive Refrigeration Controls

Adaptive refrigeration controls are relatively new on the market, having begun to get traction only in the past two years. These controllers replace traditional refrigeration controls, managing evaporator fans, defrost, and in some cases electric expansion valves based on sensed inputs provided to a microcontroller, resulting in average savings of about 20% of refrigeration energy use. The controllers' relationship to conventional pressure-based controls is rather like a comparison of a modern cellphone to a rotary dial telephone. Despite this, the freon refrigeration market has traditionally been slow to change. Adoption is expected to be sporadic, and so immediate savings projections for this measure are modest.

Savings per project varies widely, depending on the size and temperature of the cooler or freezer, climate, and baseline equipment condition. We recommend a calculator-based approach to estimate savings for each project, using the $0.15/kWh custom incentive rate and the custom 70% and 1 year payback caps.

Fast Acting Doors

For large refrigerated spaces, a fast acting door in place of a manually operated hard door or an automatic door with long cycle time is a good energy efficiency measure with broad applicability. Savings vary between approximately 5,000 and 50,000 kWh per year depending on cooler or freezer temperature, hours of operation, activity level, and climate. Higher-end doors are to be somewhat costly, however, with paybacks ranging from 5 to 10 years or more. Because of this, and because the annual project count is relatively low (one to several dozen), a calculator-based approach to estimating savings for each site is recommended.

Compressed Air End Use Reduction

Reduction of ineffective and wasteful compressed air use has long been recognized as an excellent efficiency opportunity, but the practical aspect of quantifying the savings and administering an incentive has been a challenge. The proposal here is to deploy a field engineer to opportunistically evaluate specific compressed air reduction occasions when the engineer is already on site for another purpose. The engineer would look for and evaluate opportunities by estimating the flow reduction (in cubic feet per minute) together with applicable annual hours, then use the Northwest Regional Compressed Air Tool (NW RCAT) to calculate energy savings with information about the site-specific compressor system. Examples of end use reduction instances include replacement of an air operated diaphragm pump with an electric pump, adding an engineered nozzle to a blowoff pipe, or installing an isolation valve to prevent leakage in portions of a compressed air system during non-production hours. This is not generally a measure oriented toward trade ally lead generation – estimating flow reduction in detail is not an activity most trade allies are accustomed to. Rather, leads may be identified by consultants or by especially interested trade allies with the requisite skill during the course of site visits for other purposes, then lateralled to Trade Ally Coordinators for follow through.

A compressed air end use reduction worksheet or calculator may be used together with the NW RCAT to estimate savings, and incentives can be paid at the custom rate of $0.15/kWh up to the 70% cost cap and one-year payback cap. The size of prospective opportunities varies widely, from a few hundred kWh to as much as 100,000 kWh depending on the type of reduction and the type of trim compressor in the system.

Wastewater

Three wastewater measures were considered for inclusion as listed measures – low power mixers, real-time aeration controls, and screw press sludge dewatering. Of these, only the low power mixer measure was retained. The other two can offer excellent energy saving project opportunities, but due to the size of investment and implementation complexity, these are better treated as custom projects. All three are detailed in the Wastewater section below.

The low power mixer is a floating, extended-range circulator that replaces more energy intensive methods of mixing wastewater in lagoons. One unit can typically supplant 30 to 40 hp of conventional aeration power, making it a significant saver. Over 1,600 have been installed throughout the country. The investment is manageable as well - $20,000 to $40,000 per unit. Certain types of treatment plants over a certain minimal size, both municipal and industrial, are suitable candidates.

A study of Utah municipal wastewater facilities has identified at least five candidate sites served by Rocky Mountain Power. Certain industrial sites may also be good candidates. Economics are favorable, but the potential rate of adoption is unknown. We have estimated one project at 140,000 kWh per project each year.

2 IRRIGATION

2.1 MEASURE DESCRIPTION

Irrigation measures recommended here are divided into two categories – those generally applicable for wheel lines and hand lines and those designed for center pivot and linear moves. The last measure in the list, irrigation pump VFD, is independent of system type and applicable to both. Several changes to the FinAnswer Express offerings currently in place are suggested, following the conclusions of the Regional Technical Forum (RTF) of April 2013, where changes to leakage and estimated flow reduction values were made based on recent research and information from the experience of the irrigation subcommittee members.

Wheel Line and Hand Line Measures

1. Flow control nozzle – replace worn with new
2. Nozzle – replace worn with new
3. Impact sprinkler – rebuild or replace leaking or malfunctioning sprinkler with new or rebuilt
4. Rotating sprinkler – replace leaking or malfunction impact or rotating
5. Gasket – replace leaking with new
6. Drain – replace leaking with new
7. Pipe repair – cut and press or weld repair of leaking wheel line, hand line, or portable main line
8. Thunderbird wheel line hub – replace leaking with new
9. Leveler – rebuild or replace leaking or malfunctioning with new
10. Wheel line feed hose – rebuild or replace leaking with new

Measures for Center Pivots and Linear Moves

1. Low pressure sprinkler, including nozzle – conversion from impact or replacing worn
2. Pressure regulator
3. Gooseneck – nearly always conversion from impact; replacing existing is rare but possible
4. Drop tube – conversion from impact or replacing leaking
5. Center pivot base boot gasket – replacing leaking

Measure applicable to both

1. Irrigation pump VFD – add VFD to irrigation pump, currently existing or new pump installation.

The order in which these measures are presented is incidental, following the RTF tables as a matter of convenience, not indicative of savings potential, priority, or market uptake. Fixed-in-place (solid set) sprinkler systems are not included in the eligible categories above because the incentives were designed around annual operating hours for equipment that moves over the irrigated area, incurring much more runtime in a season than fixed-in-place equipment. The pump VFD measure is the one exception – this measure is eligible independent of the type of water distribution system the pump serves. Both mobile and fixed-in-place systems are eligible.

2.2 HOW THE MEASURE REDUCES ENERGY USE

Irrigation measures reduce pumping energy in multiple ways. Most measures reduce leakage by replacing leaking components with new ones. This reduces flow from the pump, reducing pumping energy.

Several measures, such as nozzles or conversion from impact sprinklers to low pressure sprinklers, improve the uniformity of water distribution, which improves crop uniformity. This results in less pumping energy because operator decisions about when and how long to irrigate are often driven by the appearance of the crop. With non-uniform distribution, the grower's assessment of the least-irrigated portion of the field will tend to drive the decision to irrigate even though the majority of the field may not need it yet. Over the course of the season, this results in significant excess pump runtime – commonly in the range of 10 to 20%.

Measures for pivots and linears that involve drop tubes bringing the sprinklers closer to the crop save energy by reducing evaporation – approximately 1% for each foot closer to the crop canopy.

Pump VFDs save energy by controlling pressure and flow with pump speed rather than taking pump speed as a given and using external devices – throttling and bypass – to manage pressure or flow.

2.3 APPLICABLE CODES AND STANDARDS

Energy codes are not applicable to irrigation pumping and distribution equipment. New pump motor efficiency is regulated at the federal level by the provisions of the Energy Independence and Security Act relating to premium efficiency motors.

2.4 RELATED MEASURES OFFERED BY OTHER PROGRAMS

Prescriptive irrigation incentives are common in the Northwest. Public utilities in the Bonneville Power Administration (BPA) system offer UES measures defined in the Agriculture section of the BPA Implementation Manual, which is updated in April and October of each year. Unit Energy Savings, unit cost, and measure life are generally taken from the tables established by the RTF. Energy Trust of Oregon offers incentives, the amounts of which generally follow the BPA pattern. Idaho Power offers irrigation incentives as well, and is an active participant in the RTF irrigation subcommittee. See references for copies of incentive application forms from Energy Trust and Idaho Power.

2.5 INFORMATION FROM MARKET ACTORS – SUPPLIERS, DISTRIBUTORS, CONTRACTORS

Suppliers and distributors of irrigation components in the Northwest are, for the most part, well aware of the existence of utility incentive programs. Those that serve customers in multiple utility territories, however, have a tendency to conflate the details of the different program offerings. As of this writing, irrigation incentives have been offered in Utah for one irrigation season. Awareness of the wattsmart program is spreading as more suppliers and producers hear about incentives for VFDs, sprinklers, and gaskets from other farmers and producers who have participated.

2.6 RECOMMENDED METHOD OF DETERMINING SAVINGS AND INCENTIVE

The savings estimation method for irrigation measures begins with RTF data and assumptions, then applies information about local conditions to estimate unit energy savings specific to each state. First, flow reduction is determined for each measure in gallons per minute (gpm). Flow reduction derives from the elimination of leaks or reduction in excess irrigating hours relating to a lack of uniformity in water distribution. Decisions about when and how long to irrigate are often driven by crop appearance in those areas receiving the least water, resulting in significant overwatering over much of the land area.

Flow reduction is then related to a reduction in pumping power, using values for average pressure, lift, and pumping plant efficiency for each state. Reduced power together with average operating hours for each state leads to the estimate of energy savings for each measure.

Flow Reduction

Flow reduction values for each measure come from the University of Idaho study by Dr. Howard Neibling, P.E. of March 2013, which sought to measure representative values of leakage from various irrigation components and to estimate the extent of overwatering associated with non-uniform irrigation as a consequence of worn nozzles, sprinklers, and regulators. These gallon-per-minute pumping reduction values informed the RTF update of April 2013, which assigned prescriptive irrigation measures to the "Small Savers" category.

Two adaptations have been made which cause the gpm reduction values here to differ from RTF average flow reduction values for four particular measures. For nozzles and flow control nozzles, the average nozzle diameter in the PacifiCorp FinAnswer Express project database is larger than that seen in the University of Idaho Study. Secondly, as a practical matter, a "realization rate" factor has been applied to the average RTF leak reduction values for gaskets and drains to adjust for an estimated 25% of pre-emptive installations where the baseline gasket or drain is replaced even though it is not yet leaking significantly. This tends to be the practice among larger growers doing pre-emptive batch replacements, as larger retailers sometimes do with lighting. These adjustments are further described below.

Energy Savings from Flow Reduction

Reduction in flow leads to energy savings because less pumping work and or shorter pumping hours are required to get the same irrigating effect. (As an additional benefit, improved uniformity of water distribution is likely to improve crop yield.) For each state, pumping lift, average discharge pressure, and average irrigating hours are used along with an average pumping plant efficiency to calculate unit energy and demand savings. The RTF baseline factor of 0.75 is used throughout to account for installations that do not effectively contribute to programmatic energy savings because they may have taken place in the absence of the program.

Irrigation measures are grouped into two categories – those applicable to wheel lines and hand lines, and those that apply to center pivots and linear moves. Pump VFDs are the exception. They are applicable across both categories. Each measure is addressed in detail below. Eligibility criteria are listed. Measure lives are taken from the RTF documents in every case. Incentive levels are designed to offset a material portion of the measure cost or provide a material reduction in simple payback. These considerations must be tempered in some cases by the of the lifetime savings available.

2.7 RECOMMENDED DELIVERY MECHANISM

The post-purchase prescriptive approach with Unit Energy Savings and incentive is recommended for all measures except the pump VFD. For the pump VFD, we recommend the post-purchase application with incentive and savings determined by the Irrigation Pump VFD calculator. Savings, project costs, and incentive amounts are subject to approval by PacifiCorp.

In order to collect information to further inform assumptions about UES calculation inputs as well as user attitudes, additional information fields on the application may be added: system operating pressure, pumping lift, fraction of gaskets, drains, sprinklers etc. that replace active leakers, gpm, crop type, etc.

2.8 BASELINE DEFINITION AND ELIGIBILITY CRITERIA

Defined for each measure in the tables and discussion below.

2.9 MEASURE COST, SAVINGS, MEASURE LIFE, CUSTOMER ECONOMICS

Defined for each measure in the tables and discussion below.

The analysis deriving energy and demand savings appears in the accompanying file *PacifiCorp Irrigation Measure Analysis 11 Oct 2013.xlsx*. Outputs are in the first tab at the left, supported by input derivation, assumptions, and source data tabs to the right. Reference cost information is in the rightmost tab. The second tab, gpm leakage estimates, compares values by measure from RTF 2012, the revised RTF 2013 values, Rumsey 2008, and Fazio 2005. Cost comparison data is from RTF 2012, RTF 2013, the FinAnswer Express project database 2011-13, and Energy Trust 2010-13.

For all measures except pump VFD, a state-specific set of inputs used to derive energy savings from flow or the operating hours reduction described above. For Utah, these inputs are as follows:

Annual hours of operation: Average annual pumping hours is taken as 1,766. This is calculated from 2012 kWh and kW demand data from Utah irrigation accounts. This figure is close to the USDA Farm and Ranch Survey figure for Utah of 1,852 hours.

Proportion of surface water to ground water: In Utah, irrigation water comes approximately half from surface water and half from groundwater. The U.S. Geological Survey indicates that, statewide, 48% of irrigation water withdrawals are from surface water and 52% is from wells. This proportion impacts overall average pumping lift.[1]

[1] http://pubs.usgs.gov/circ/2004/circ1268/htdocs/table07.html

Average pumping lift: For groundwater coming from wells, the average lift is taken from the Farm and Ranch Survey at 99 ft. Average lift for surface water from Farm and Ranch Survey is 15 feet. The weighted average of these two values gives an overall average lift of 55 feet.

Average pump discharge pressure: 57.5 psi, which is the average value of pressures taken from past pump VFD projects in the FinAnswer Express project database.

The table of unit energy savings, incentives, and costs is given on the next two pages.

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	Irrigation measure	Replace	With	Limitations	Customer incentive	incremental cost	Energy savings (kWh/yr/unit)	Demand savings (kW/unit)
Wheel Line / Hand Line Measures	New flow control nozzle for impact sprinkler replacing existing nozzle or worn flow control nozzle of same design flow or less	Worn nozzle	New flow control nozzle	1. Nozzle to be replaced may be fixed orifice or flow control type. 2. New flow control nozzle shall have a flow rating equal to or less than the flow rating of the existing nozzle at 40 psi. 3. All nozzles on the wheel line or hand line shall be replaced. 4. Fixed-in-place (solid set) systems not eligible. 5. Incentive limited to two nozzles per irrigated acre.	$2.75 each	$6.92	24.8	0.019
	New nozzle replacing worn nozzle of same design flow or less on existing sprinkler	Worn nozzle	New nozzle of same design flow or less	1. Flow rate shall not be increased. 2. All nozzles on the wheel line or hand line shall be replaced. 3. Fixed-in-place (solid set) systems not eligible. 4. Incentive limited to two nozzles per irrigated acre.	$0.50 each	$2.34	24.8	0.019
	New or rebuilt impact sprinkler replacing worn or leaking impact sprinkler	Leaking or malfunctioning impact sprinkler	New or rebuilt impact sprinkler	1. New nozzle shall be included in new or rebuilt sprinkler. 2. Rebuilt sprinkler shall meet or exceed manufacturer's specifications. 3. Fixed-in-place (solid set) systems not eligible. 4. Incentive limited to two sprinklers per irrigated acre.	$2.25 each	$15.18	32.0	0.024
	New rotating sprinkler replacing worn or leaking impact or rotating sprinkler	Leaking or malfunctioning impact or rotating sprinkler	Rotating sprinkler	1. Fixed-in-place (solid set) systems not eligible. 2. Incentive limited to two sprinklers per irrigated acre.	$2.50 each	$16.36	32.0	0.024
	New gasket replacing leaking gasket, including mainline valve or section gasket, seal, or riser cap (dome disc)	Leaking gasket	New gasket, including mainline valve or section gasket, seal, or riser cap (dome disc)	1. New gasket must replace leaking gasket. 2. Fixed-in-place (solid set) systems not eligible. 3. Incentive limited to two gaskets per irrigated acre.	$2.00 each	$3.94	143.4	0.108
	New drain replacing leaking drain	Leaking drain	New drain, including drains on pivots and linears	1. New drain must replace leaking drain. 2. Fixed-in-place (solid set) systems not eligible. 3. Incentive limited to two drains per irrigated acre.	$3.00 each	$6.00	148.7	0.112
	Cut and press or weld repair of leaking wheel line, hand line, or portable main line	Leak in wheel line, hand line, or portable main line	Cut and pipe press or weld repair	Invoice must show number of leaks repaired.	$10.00/repair	$17.60	95.2	0.072
	New Thunderbird wheel line hub replacing leaking wheel line hub	Leaking Thunderbird wheel line hub	New Thunderbird wheel line hub	New hub must replace leaking hub.	$10.00 each	$50.00	82.3	0.062
	New or rebuilt wheel line leveler replacing leaking or malfunctioning leveler	Replace leaking or malfunctioning leveler	New or rebuilt leveler	1. Applies to leaking or malfunctioning levelers only. 2. For rebuilds, invoice must show number of rebuild kits purchased and installed.	$3.00 each	$7.51	47.4	0.036
	New or rebuilt wheel line feed hose replacing leaking wheel line feed hose	Leaking wheel line feed hose	New or rebuilt wheel line feed hose	1. Applies to leaking wheel line feed hose only. 2. For rebuilds, invoice must show number of rebuild kits purchased and installed.	$12.00 each	$141.38	192.4	0.045

Pivot/Linear Measures	Pressure regulator	Worn pressure regulator or, in conversion from higher pressure system, no pressure regulator	New pressure regulator of same design pressure or less (if applicable)	1. If replacing existing regulator, new regulator is of same design pressure or less.	$3.00	$7.62	52.2	0.039
	Low pressure sprinkler (e.g. rotating, wobbling, multi-trajectory spray) replacing impact sprinkler	Impact sprinkler	New low pressure sprinkler (on-board nozzle is considered part of sprinkler, not a separate item with additional incentive)	1. New sprinkler is of same design flow or less. 2. Nozzle is part of the package, not a separate measure with additional incentive.	$3.00	$16.36	53.7	0.041
	Low pressure sprinkler (e.g. rotating, wobbling, multi-trajectory spray) replacing worn low pressure sprinkler	Worn low pressure sprinkler (e.g. rotating, wobbling, multi-trajectory spray)	New low pressure sprinkler (on-board nozzle is considered part of sprinkler, not a separate item with additional incentive)	1. New sprinkler is of same design flow or less. 2. Nozzle is part of the package, not a separate measure with additional incentive.	$1.50	$16.36	20.2	0.015
	Gooseneck as part of conversion to low pressure system		New gooseneck as part of conversion to low pressure system	Gooseneck shall be used to convert existing center pivot with sprinkler equipment mounted on top of the pivot to low pressure sprinklers with regulators on new drop tubes	$0.50 per outlet	$4.21	8.1	0.006
	Drop tube (3 ft minimum length)	Leaking drop tube	New drop tube (3 ft minimum length) OR add new drop tube as part of conversion to low pressure system	Drop tube or hose extension shall extend below the pivot tower brace or shall be a minimum of 3 feet in length, whichever is greater	$2.00 per drop tube	$8.43	8.1	0.006
	New center pivot base boot gasket replacing leaking base boot gasket	Leaking center pivot base boot gasket	New center pivot base boot gasket	1. Gasket shall replace leaking gasket at the pivot point of the center pivot 2. No more than one gasket shall be claimed per pivot	$125 each	$250.00	1,539.2	1.162
	New tower gasket replacing leaking tower gasket	Leaking tower gasket	New tower gasket	1. New gasket shall replace leaking tower gasket	$4.00 each	$53.70	38.5	0.029
All System Types	Irrigation pump VFD		Add Variable Frequency Drive to existing or new irrigation pump	1. Pumps serving any type of irrigation water transport or distribution system are eligible - wheel lines, hand lines, pivots, linears, fixed-in-place (solid set) 2. Both retrofit and new construction projects are eligible.	$0.15/kWh of annual savings			

Notes for Irrigation Table

1. Except for the pump VFD measure, incentives listed here are available only for retrofit projects where new equipment replaces existing equipment (i.e. new construction is not eligible).
2. Except for the pump VFD measure, equipment installed in fixed-in-place (solid set) systems is not eligible for incentives. Incentive is limited to two units per irrigated acre.
3. Incentives are capped at 70 percent of Energy Efficiency Project Costs, and incentives will not be available to reduce the Energy Efficiency Project simple payback below one year. Energy savings and Energy Efficiency Project Costs are subject to Rocky Mountain Power approval.

MEASURES FOR WHEEL LINE AND HAND LINE SYSTEMS

Measure:	**Flow Control Nozzle**
Description:	Replace worn nozzle with new flow control type nozzle for impact sprinkler
Label for application document:	New flow control nozzle replacing existing brass nozzle or worn flow control nozzle of same flow rate or less
Eligibility/intended application:	• Nozzle to be replaced may be fixed orifice or flow control type. • New flow control nozzle shall have a flow rating equal to or less than the flow rating of the existing sprinkler nozzle at 40 psi. • All nozzles on the wheel line or hand line shall be replaced. • Fixed-in-place (solid set) systems not eligible. • Incentive limited to two nozzles per irrigated acre.
Savings mechanism:	Improved uniformity leading to reduction in operating hours
Baseline condition:	Existing nozzle with excess flow 0.653 gpm
Technical life:	4 years
Unit Energy Savings:	24.8 kWh per nozzle
Demand Savings:	0.019 kW per nozzle
Unit cost:	$6.92 per nozzle
Incentive:	$2.75 per nozzle
% of installed cost:	Incentive is 39.7% of installed cost

Discussion

Average flow reduction for both the Flow Control Nozzle and the Nozzle measures is taken as 12.1% of standard nozzle flow at the state-specific weighted average pressure for wheel lines and hand lines, using average pressure values at the sprinkler measured by Neibling (2013) and the Farm and Ranch Irrigation Survey (2008) to estimate relative share of wheel lines and hand lines.

The absolute value of the gpm flow reduction for PacifiCorp is different from that of the Idaho study because the average nozzle size for PacifiCorp, based on the FinAnswer Express project database for 2011-2013, is 11/64" while the average nozzle diameter in the Idaho study was 9/64". This leads to an average flow per wheel line nozzle of 5.7 gpm and an average flow per hand line nozzle of 5.0 gpm. The weighted average nozzle flow came to 5.4 gpm. 12.1% of flow from this average nozzle size leads to 0.653 gpm average excess flow, compared to 0.472 average excess flow in the Southern Idaho study. This is the average for the entire nozzle population, not just those that are worn or severely worn.

Measure:	Nozzle
Description:	Replace worn nozzle with new nozzle
Label for application document:	New nozzle replacing existing worn nozzle of same flow rate or less
Eligibility/intended application:	• Flow rate shall not be increased. • All nozzles on the wheel line or hand line shall be replaced. • Fixed-in-place (solid set) systems not eligible. • Incentive limited to two nozzles per irrigated acre.
Savings mechanism:	Improved uniformity leading to reduction in operating hours
Baseline condition:	Existing nozzle with excess flow 0.653 gpm
Technical life:	4 years
Unit Energy Savings:	24.8 kWh per nozzle
Demand Savings:	0.019 kW per nozzle
Unit cost:	$2.34 per nozzle
Incentive:	$0.50 per nozzle
% of installed cost:	Incentive is 21.4% of installed cost

Discussion

Comments for the flow control nozzle measure above apply to the nozzle measure as well.

In the FinAnswer Express project database, nozzle purchases have come in batches. Of 33 purchases, all but one were batches greater than 30 quantity.

Data on nozzle sales by size from Ernst Irrigation, St. Paul, OR, corroborates the programmatic average nozzle size of 11/64". Over 17,100 nozzles sold in the past two years, the weighted average nozzle diameter was 10.86 sixty-fourths. See the tab *nozzle size FinAnswer Express* in the Excel analysis file.

Measure:	**Impact Sprinkler**
Description:	Rebuild or replace leaking or malfunctioning impact sprinkler with new or rebuilt impact sprinkler
Label for application document:	New or rebuilt impact sprinkler replacing leaking or malfunctioning impact sprinkler
Eligibility/intended application:	• New nozzle shall be included in new or rebuilt sprinkler. • Rebuilt sprinklers shall meet or exceed manufacturer's specifications. • Fixed-in-place (solid set) systems not eligible. • Incentive limited to two sprinklers per irrigated acre.
Savings mechanism:	Leak reduction and improved uniformity if not rotating correctly
Baseline condition:	Existing sprinkler leaking 0.415 gpm
Technical life:	5 years
Unit Energy Savings:	32.0 kWh per sprinkler
Demand Savings:	0.024 kW per sprinkler
Unit cost:	$15.18 per sprinkler
Incentive:	$2.25 per sprinkler
% of installed cost:	Incentive is 14.8% of installed cost

Discussion

Leakage reduction for this measure is taken directly from RTF 2013.

There are two differences here from the specific language in the RTF 2013 document relating to constraints. The word "brass" that appears in the RTF document does not appear here. This is because, on occasion, a few farmers purchase the newer plastic sprinklers due to worries about brass theft. It is unclear at this time whether these will hold up as well as brass. Vendors have expressed the impression that in recent years more and more of the brass sprinklers are coming from imported sources, and quality has been dropping, which they believe, it likely to lead to more leaks sooner.

Also, the RTF phrase requiring that sprinkler rebuild be performed by an "established repair shop that can provide a legitimate invoice" has been omitted. Such a constraint can lead to implementation difficulties when a family farm does its own work, but their application must be rejected due to a technicality that does not affect the savings outcome.

Measure:	Rotating Sprinkler
Description:	Rotating sprinkler replacing leaking or malfunctioning impact or rotating sprinkler
Label for application document:	Rotating sprinkler replacing leaking or malfunctioning impact or rotating sprinkler
Eligibility/intended application:	• Fixed-in-place (solid set) systems not eligible. • Incentive limited to two sprinklers per irrigated acre.
Savings mechanism:	Leak reduction and improved uniformity
Baseline condition:	Existing sprinkler leaking 0.415 gpm
Technical life:	5 years
Unit Energy Savings:	32.0 kWh per sprinkler
Demand Savings:	0.024 kW per sprinkler
Unit cost:	$16.36 per sprinkler
Incentive:	$2.50 per sprinkler
% of installed cost:	Incentive is 15.3% of installed cost

Discussion

This measure is not present in the RTF 2013 lineup. It is a viable option, though, and more of it may be seen in the near future because it is an alternative to brass and may be seen as more desirable than plastic impact sprinklers. Manufacturers claim a uniformity advantage as well. Leakage and savings are assumed to be the same as those of the impact sprinkler measure.

Measure:	Gasket
Description:	Replace leaking gasket with new gasket
Label for application document:	New gasket replacing leaking gasket
Eligibility/intended application:	• New gasket must replace leaking gasket. • Fixed-in-place (solid set) systems not eligible. • Incentive limited to two gaskets per irrigated acre.
Savings mechanism:	Leak reduction
Baseline condition:	Existing gasket leaking an average of 1.864 gpm (after 0.75 derating factor, assuming 25% of gaskets are replaced pre-emptively before they develop significant leaks)
Technical life:	5 years
Unit Energy Savings:	143.4 kWh per gasket
Demand Savings:	0.108 kW per gasket
Unit cost:	$3.94 per gasket
Incentive:	$2.00 per gasket
% of installed cost:	Incentive is 50.8% of installed cost

Discussion

There is a substantial difference between the RTF 2012 leakage value for gaskets (0.350 gpm) and the 2013 value resulting from the Neibling study (2.485 gpm). RTF builds the UES value around the assumption that each gasket receiving an incentive will replace a gasket that leaks this amount. However, it is difficult in practice to verify this assumption. Vendor discussions lead to the impression that the smaller growers may only change out actively leaking gaskets, but larger farms will sometimes do group replacements (as is so often recommended, but not necessarily implemented, in the lighting world), resulting in a fraction of replacements that were not in fact leaking. We have built a factor of 0.75 into the gpm leakage determination to account for this, assuming that 25% of gaskets replaced did not actually significantly leak. Hence the gpm value of 1.864 gpm rather than the RTF 2013 value of 2.485 gpm.

Measure:	**Drain**
Description:	Replace leaking drain with new drain
Label for application document:	New drain replacing leaking drain
Eligibility/intended application:	• New drain must replace leaking drain. • Fixed-in-place (solid set) systems not eligible. • Incentive limited to two drains per irrigated acre.
Savings mechanism:	Leak reduction
Baseline condition:	Existing drain leaking an average of 1.932 gpm (after 0.75 derating factor, assuming 25% of drains are replaced pre-emptively before they develop significant leaks)
Technical life:	5 years
Unit Energy Savings:	148.7 kWh per drain
Demand Savings:	0.112 kW per drain
Unit cost:	$6.00 per drain
Incentive:	$3.00 per drain
% of installed cost:	Incentive is 50.0% of installed cost

Discussion

The discussion above pertaining to gaskets applies here to drains as well. A 0.75 realization rate factor has been applied to the RTF 2013 leakage value of 2.576 gpm, giving a recommended PacifiCorp leakage value of 1.932 gpm.

Occasionally, customers will apply for incentives for drains on pivots, not wheel lines. We propose to accommodate this by allowing pivot drains as part of the wheel line drain measure using the same unit energy savings, rather than creating an entirely separate measure.

Measure:	Pipe Repair
Description:	Cut and pipe press or weld repair of leaking wheel line, hand line, or portable main line
Label for application document:	Cut and pipe press or weld repair of leaking wheel line, hand line, or portable main line
Eligibility/intended application:	Invoice must show number of leaks repaired.
Savings mechanism:	Leak reduction
Baseline condition:	Existing pipe leaking 1.24 gpm
Technical life:	8 years
Unit Energy Savings:	95.2 kWh per leak repaired
Demand Savings:	0.072 kW per leak repaired
Unit cost:	$17.60 per leak repaired
Incentive:	$10.00 per leak repaired
% of installed cost:	Incentive is 56.8% of installed cost

Discussion

The leakage value for pipe repair increased from 0.700 gpm (RTF 2012) to 1.236 gpm (RTF 2013). PacifiCorp 2012 had been 1.000 gpm.

The words “or weld” have been added to the measure description to accommodate those occasions when weld repairs are done. As with impact sprinkler rebuilds, the RTF phrase, “Repair must be performed by a repair shop that can provide a legitimate invoice showing the number of pipes repaired” has been omitted so that the occasional farm that has a pipe press and does its own repairs will not have to be rejected.

Measure:	**Thunderbird Wheel Line Hub**
Description:	Replace leaking Thunderbird wheel line hub with new hub
Label for application document:	New Thunderbird wheel line hub replacing leaking wheel line hub
Eligibility/intended application:	New hub must replace leaking hub.
Savings mechanism:	Leak reduction
Baseline condition:	Existing hub leaking 1.070 gpm
Technical life:	10 years
Unit Energy Savings:	82.3 kWh per hub
Demand Savings:	0.062 kW per hub
Unit cost:	$50.00 per hub
Incentive:	$10.00 per hub
% of installed cost:	Incentive is 20.0% of installed cost

Discussion

To date, no applications for this measure have been received in the FinAnswer Express program.

Measure:	**Wheel line Leveler**
Description:	Wheel line leveler or leveler rebuild kit
Label for application document:	Rebuild or replace leaking or malfunctioning leveler with new or rebuilt leveler
Eligibility/intended application:	• Applies to leaking or malfunctioning levelers only. • For rebuilds, invoice must show number of rebuild kits purchased and installed.
Savings mechanism:	Leak reduction
Baseline condition:	Existing leveler leaking 0.616 gpm
Technical life:	5 years
Unit Energy Savings:	47.4 kWh per leveler rebuilt or replaced
Demand Savings:	0.036 kW per leveler rebuilt or replaced
Unit cost:	$7.51 per leveler rebuilt or replaced
Incentive:	$3.00 per leveler rebuilt or replaced
% of installed cost:	Incentive is 39.9% of installed cost

Discussion

The savings on this measure took a big jump between 2012 and 2013 RTF figures. The reason is the 2012 figure had been very small at 0.030 gpm. The 2013 figure is more on par with the other types of leaks at 0.616 gpm.

The costs on this measure have been seen to come in two groupings. Installed cost of the rebuild kit option is $3.25. Cost of a new leveler is about $13. Idaho Power calls this out as a leveler kit, not a new leveler. Average cost figures contain a mix of both. Here the two variants of the measure have been treated as an average, assuming that the 100% cost cap will limit incentives for rebuilt levelers. Another possible way to deal with the issue would be to divide the measure into two measures, a rebuild and a new leveler.

Measure:	**Wheel line feed hose**
Description:	Wheel line feed hose
Label for application document:	New or rebuilt wheel line feed hose replacing leaking wheel line feed hose
Eligibility/intended application:	• Applies to leaking wheel line feed hose only. • For rebuilds, invoice must show number of rebuild kits purchased and installed.
Savings mechanism:	Leak reduction
Baseline condition:	Existing wheel line feed hose leaking 2.500 gpm
Technical life:	5 years
Unit Energy Savings:	192.4 kWh per wheel line feed hose
Demand Savings:	0.045 kW per wheel line feed hose
Unit cost:	$141.38 per wheel line feed hose
Incentive:	$12.00 per wheel line feed hose
% of installed cost:	Incentive is 8.5% of installed cost

Discussion

The wheel line feed hose measure does not appear in the RTF analysis. It is currently offered by PacifiCorp. We propose to keep it at the 2012 values because a few applications for the measure do come in and one sees leaking hoses in the field regularly.

MEASURES FOR CENTER PIVOTS AND LINEAR MOVES

Measure:	**Pressure Regulator**
Description:	New pressure regulator
Label for application document:	New pressure regulator replacing worn regulator of same design pressure or less or, in conversion from higher pressure system, no pressure regulator
Eligibility/intended application:	If replacing existing regulator, new regulator is of same or lower design pressure
Savings mechanism:	Improved uniformity leading to reduction in operating hours; reduction in excess flow caused by higher than planned pressure at the nozzle
Baseline condition:	Existing pivot or linear operating 19.65% excess hours due to poor uniformity with savings attribution allocated between new regulator (where applicable) and new sprinkler
Technical life:	5 years
Unit Energy Savings:	52.2 kWh per regulator
Demand Savings:	0.039 kW per regulator
Unit cost:	$7.62 per regulator
Incentive:	$3.00 per regulator
% of installed cost:	Incentive is 39.4% of installed cost

Discussion

This measure can be invoked either as a conversion from impact or as replacement of worn equipment on an existing pivot or linear.

Measure:	**Low Pressure Sprinkler Replacing Impact Sprinkler**
Description:	New low pressure sprinkler (including nozzle)
Label for application document:	New low pressure sprinkler (including nozzle) replacing impact
Eligibility/intended application:	• New sprinkler is of low pressure type (e.g. rotating, wobbling, multi-trajectory spray, etc.) • Nozzle is part of the package, not a separate measure with additional incentive • New sprinkler is of same design flow or less
Savings mechanism:	Improved uniformity leading to reduction in operating hours; reduction in excess flow due to higher application efficiency
Baseline condition:	Existing pivot or linear operating 19.65% excess hours due to poor uniformity with savings attribution allocated between new regulator (where applicable) and new sprinkler
Technical life:	5 years
Unit Energy Savings:	53.7 kWh per sprinkler
Demand Savings:	0.041 kW per sprinkler
Unit cost:	$16.36 per sprinkler
Incentive:	$3.00 per sprinkler
% of installed cost:	Incentive is 18.3% of installed cost

Discussion

Low pressure sprinklers may replace either higher pressure sprinklers (measure presented above) or worn low pressure sprinklers (measure presented below). The equipment is the same in either case, but the baseline usage, and thus the savings, is higher in the first case than the second.

Measure:	**Low Pressure Sprinkler Replacing Worn Low Pressure Sprinkler**
Description:	New low pressure sprinkler (including nozzle)
Label for application document:	New low pressure sprinkler (including nozzle) replacing low pressure sprinkler
Eligibility/intended application:	• New sprinkler is of low pressure type (e.g. rotating, wobbling, multi-trajectory spray, etc.) • Nozzle is part of the package, not a separate measure with additional incentive • New sprinkler is of same design flow or less
Savings mechanism:	Improved uniformity leading to reduction in operating hours; reduction in excess flow due to higher application efficiency
Baseline condition:	Existing pivot or linear operating 19.65% excess hours due to poor uniformity with savings attribution allocated between new regulator (where applicable) and new sprinkler
Technical life:	5 years
Unit Energy Savings:	20.2 kWh per sprinkler
Demand Savings:	0.015 kW per sprinkler
Unit cost:	$16.36 per sprinkler
Incentive:	$1.50 per sprinkler
% of installed cost:	Incentive is 9.2% of installed cost

Measure:	**Gooseneck**
Description:	Gooseneck
Label for application document:	Gooseneck as part of conversion from impact
Eligibility/intended application:	Gooseneck shall be used to convert existing center pivot with sprinkler equipment mounted on top of the pivot to low pressure sprinklers with regulators on new drop tubes
Savings mechanism:	Reduced evaporation, improved uniformity
Baseline condition:	Evaporation loss 0.105 gpm
Technical life:	15 years
Unit Energy Savings:	8.1 kWh per gooseneck
Demand Savings:	0.006 kW per gooseneck
Unit cost:	$4.21 per gooseneck
Incentive:	$0.50 per gooseneck
% of installed cost:	Incentive is 11.9% of installed cost

Measure:	Drop Tube
Description:	Drop tube (3 ft minimum)
Label for application document:	Drop tube replacing leaking drop tube, or new drop tube as part of conversion from impact (3 ft minimum)
Eligibility/intended application:	Drop tube or hose extension shall extend below the pivot tower brace or shall be a minimum of 3 feet in length, whichever is greater
Savings mechanism:	Reduced evaporation, improved uniformity, leak reduction
Baseline condition:	Evaporation loss 0.105 gpm
Technical life:	10 years
Unit Energy Savings:	8.1 kWh per drop tube
Demand Savings:	0.006 kW per drop tube
Unit cost:	$8.43 per drop tube
Incentive:	$2.00 per drop tube
% of installed cost:	Incentive is 23.7% of installed cost

Discussion

In PacifiCorp 2012, the gooseneck and drop tube measures had been combined into a single measure that required both. RTF 2013 addresses them separately, which provides an opportunity for growers to make use of the measure to replace leaking drop tubes, rather than using it solely for conversion from impacts. This recommendation follows the RTF 2013 pattern, and weights the incentive more toward the drop tube than the impact.

Measure:	**Center Pivot Base Boot Gasket**
Description:	Center pivot base boot gasket
Label for application document:	Center pivot base boot gasket replacing leaking base boot gasket
Eligibility/intended application:	• Gasket shall replace leaking gasket at the pivot point of the center pivot • No more than one gasket shall be claimed per pivot
Savings mechanism:	Leak reduction
Baseline condition:	Existing gasket leaking 20.0 gpm
Technical life:	8 years
Unit Energy Savings:	1,539.2 kWh per gasket replaced
Demand Savings:	1.162 kW per gasket replaced
Unit cost:	$250.00 per gasket replaced
Incentive:	$125.00 per gasket replaced
% of installed cost:	Incentive is 50.0% of installed cost

Discussion

The leakage gpm for this measure is unchanged between RTF 2012 and 2013, but the RTF value is double that of the Rumsey 2008 estimate. This recommendation follows the RTF value. No applications for this measure have been received in FinAnswer Express in the last two years.

Measure:	Tower Gasket
Description:	Tower gasket for center pivot or linear move
Label for application document:	Tower gasket for center pivot or linear move replacing leaking tower gasket
Eligibility/intended application:	New gasket shall replace leaking tower gasket
Savings mechanism:	Leak reduction
Baseline condition:	Existing gasket leaking 0.5 gpm
Technical life:	8 years
Unit Energy Savings:	38.5 kWh per gasket replaced
Demand Savings:	0.029 kW per gasket replaced
Unit cost:	$53.70 per gasket replaced
Incentive:	$4.00 per gasket replaced
% of installed cost:	Incentive is 7.4% of installed cost

Discussion

This is a new measure in RTF 2013 stemming from the Neibling study. The recommendation here follows RTF 2013.

Measure:	**Irrigation Pump VFD**
Description:	Irrigation Pump VFD
Label for application document:	VFD added to existing or new irrigation pump
Eligibility/intended application:	• Pumps in systems that transport or distribute irrigation water are eligible • Energy savings figures are subject to approval by PacifiCorp
Savings mechanism:	Reduction in discharge pressure and/or reduction in flow
Baseline condition:	Pump operating without VFD using throttling, bypass, or simply riding the pump curve with no pressure or flow control method
Technical life:	15 years
Unit Energy Savings:	n/a Savings determined using Irrigation Pump VFD calculator
Demand Savings:	n/a Demand savings are assumed to be negligible
Unit cost:	n/a
Incentive:	$0.15/kWh of annual energy savings
% of installed cost:	Varies

Discussion

The Irrigation Pump VFD calculator (Excel file accompanies this report) is used to estimate savings for pump VFDs on a site-specific basis, taking into account pumping lift, operating hours, and a load profile in terms of flow and pressure bins. The prescriptive application for irrigation measures is used to administer the incentive as a post-purchase application. However, in nearly all instances program staff have completed the analysis and discussed it with the grower prior to committing to the VFD project. A VFD is usually regarded as a large purchase, and the savings and incentive information is an important factor in the purchasing decision.

New construction applications have been added to the scope of eligibility for this measure. Previously, the measure had been categorized as retrofit only along with the other irrigation measures.

2.10 NON-ENERGY BENEFITS

Improved uniformity correlates with higher yield per acre on average and can result in lower fertilizer cost through reduced leaching.

The ramping start/stop control inherent with VFDs reduces water hammer and saves labor when managing wheel lines and hand lines. Some installations may extend motor life by mitigating overloading of the motor.

2.11 MARKET POTENTIAL AND ESTIMATED PARTICIPATION

Irrigation incentives have only been offered in Utah for a single irrigation season to date. Awareness among vendors is beginning to broaden for the prescriptive measures as well as the pump VFD measure as initial participants spread the work to fellow producers. Trade allies provide their customers with information and incentive applications at the point of purchase. The program is currently engaged in a third round of outreach to trade allies to further acquaint them with the opportunities afforded by participation and to reinforce the relationship.

3 COMPRESSED AIR

3.1 COMPRESSED AIR OVERVIEW

PacifiCorp began offering post-purchase incentives and simplified analysis for small compressor systems 75 hp and below in January of 2010. This suite of measures will be reviewed using four years of project data that provides greater insight into costs, hours of operation, and market uptake of the offered measures. The measures under review are:

Table 1: Compressed Air Measures Currently Offered by PacifiCorp

Existing PacifiCorp Compressed Air Measures
Low Pressure Drop Filters
Receiver Capacity Addition
Refrigerated Cycling Dryers
VFD Controlled Compressor
Zero Loss Condensate Drains
Outside Air Intake

3.2 APPLICABLE CODES AND STANDARDS

Compressors and components of compressed air systems are not subject to energy performance requirements in either State or Federal codes. However, while the U.S. Department of Energy (DOE) does not have an established energy conservation standard for compressors, the DOE has proposed to determine that commercial and industrial compressors meet the criteria for covered equipment under Part A-1 of Title III of the Energy Policy and Conservation Act (EPCA). DOE proposes that "classifying equipment… as covered equipment is necessary to carry out the purpose of Part A-1 of EPCA, which is to improve the efficiency of electric motors, pumps, and certain other industrial equipment to conserve the energy resources of the nation." Although this discussion is just beginning, and no specific standards have been laid out as of yet, it appears that the DOE is proposing to create some level of efficiency standards around compressor technologies. DOE welcomed comments from interested parties on the proposed determination for compressors. As anticipated, they received favorable responses from non-profit organizations and cautionary responses from compressor manufacturers.

The DOE proposal has been supported by letters of comment from Northwest Energy Efficiency Alliance (NEEA), The National Rural Electric Cooperative Association (NRECA), and the Edison Electric Institute (EEI). NEEA's letter urged the DOE to consider commercial and industrial compressors as covered equipment and that they believe substantial energy savings can be achieved as compressor sales shift to smaller compressors under 15 hp. They add that "the price point of these smaller compressors tends to negate independent testing of performance through ISO 1217 that would allow confirmation of performance and energy use. The performance and energy use of the smaller compressors tends to be self-reported by manufacturers and is not as accurate as independent testing." The NRECA and EEI letters requested that compressors driven by other fuels besides electricity be included in the covered equipment.

Frank Meuller, President of Kaeser Compressors, urged the DOE to proceed with caution. He pointed out that wrongly sized VFD compressors can degrade system efficiency. He also added that the compressor is just one element of a system in which efficiency losses can be found throughout. A. Brian Freeman, Director – Air Products, Americas Region for Ingersoll Rand also wrote to the DOE requesting clarification of equipment definitions and cautioned against what he termed 'inflated' numbers by the DOE regarding compressor sales. He also spoke to Ingersoll Rand's high efficiency standards and their voluntary participation with CAGI.

The major compressed air industry organization, the Compressed Air and Gas Institute (CAGI), has developed a voluntary performance certification program for compressor technologies. Current sections are Air Drying and Filtration, Blower, Centrifugal Compressor, Pneumatic Tool, Rotary Positive Compressor and the Reciprocating Compressor Section. CAGI certifies manufacturer's stated air flow capacities and efficiencies and allows manufacturers to post the CAGI Program Verification Seal on the equipment. CAGI randomly tests two units per participant per year to verify that the submitted ratings accurately represent the equipment listed on their website.

3.3 INFORMATION FROM MARKET ACTORS – SUPPLIERS, DISTRIBUTORS, CONTRACTORS

Compressed air vendors have been successful employing utility incentives on the west side of the PacifiCorp system for VFD compressor upgrades. Some vendors with a major presence on the west side of the PacifiCorp system have opened up locations in Rocky Mountain Power (RMP) territory to expand on that success. Although they have yet to experience major traction in these areas, they believe that RMP territory has numerous opportunities for increased sales of efficient equipment and the only barrier to that success is having more time to establish meaningful relationships with customers. Vendors are sometimes wary of lengthy custom analysis processes, feeling that it interferes with their sales cycles. They express enthusiasm at post-purchase incentives provided by utilities for smaller compressor systems.

Some of the prescriptive compressed air measures are perceived as cost-prohibitive for customers to implement on a one-off basis and therefore, market uptake has been limited. However, with more time, and as vendors become more familiar with the program and offerings, post-purchase incentives should become more common on some of the smaller compressed air measures. Additionally, many of these measures will come as more VFD compressor projects are implemented. Rolling the cost of these smaller measures in with a large capital investment of a new VFD compressor increases the likelihood of implementation.

3.4 COMPRESSED AIR MEASURE DESCRIPTIONS

3.4.1 Low Pressure Drop Filter

Coalescing filters are designed to remove solids and aerosols from compressed air systems. Aerosols coalesce into liquid that falls to the bottom of the filter body and is removed through a drain to a condensate system. Low pressure drop filters save energy by reducing pressure drop, enabling a lower pressure setpoint at the compressor discharge to deliver the same pressure to the system. Energy savings are estimated to be 1% for every 2 psi reduction in pressure.

3.4.2 Receiver Capacity Addition

For load/unload compressors, adding receiver capacity saves energy by minimizing the part load efficiency penalty associated with load and unload cycling. A load/unload compressor runs continuously, loading and unloading to deliver air in response to changes in plant pressure. Frequent unloading occurs if there is insufficient compressed air storage to provide a buffer, allowing the compressor to remain unloaded while the system uses the stored air. Since the unloading process results in venting of compressed air as well as standby losses while the compressor continues to spin, but delivers no air, additional receiver capacity improves efficiency by minimizing these losses.

3.4.3 Cycling Refrigerated Dryer

The purpose of a compressed air dryer is to remove moisture from a compressed air system. There are two types of refrigerated dryers: non-cycling and cycling. The standard baseline is the non-cycling air dryer. Common in the industry, non-cycling dryers operate the refrigeration compressor continuously, using a hot gas bypass valve to redirect refrigerant around the expansion device and back to the compressor at less than full load conditions. Energy consumption of a non-cycling dryer is nearly the same at part load as it is under full load conditions. A cycling dryer utilizes a thermal storage medium, either liquid or a solid, which is used to store cooling capacity whenever the inlet conditions to the dryer are less than the full load conditions. The excess refrigeration capacity that is not needed to cool the compressed air is used to cool the storage medium. Once the mass has been chilled to a pre-determined temperature, a thermal switch turns the refrigeration compressor off. The air is now dried solely by the thermal medium. When this material warms up once again, the thermal switch activates and restarts the refrigeration compressor. The result is reduced compressor runtime in approximate proportion to the moisture load on the system.

3.4.4 VFD Controlled Compressor

VFD machines save energy by varying the motor speed and compressed air output to match the compressed air demand, greatly reducing or eliminating unloaded operation. Because motor speed can be varied, there is no longer a need to use pressure switches to load and unload the compressor at pressures that are 10 or 20 psi apart. The VFD maintains constant pressure within one or two psi.

3.4.5 Zero Loss Condensate Drains

Zero loss drains allow for the release of condensate without the loss of compressed air which saves air compressor energy. The drain's valve only opens when signaled by the condensate level control. The baseline scenario for drains is the typical timer drain that opens on a time signal independent of need and remains open longer than needed to discharge condensate, resulting in the loss of compressed air when employed.

3.4.6 Outside Air Intake

Outside air intake entails installing ductwork at the compressor to bring outside air to the compressor rather than having the compressor take in warm compressor room air. When inlet air to a compressor is cooler, it is also denser. As a result, mass flow is enhanced, and it takes less runtime to deliver the same air to the system.

3.4.7 Related Measures Offered by Other Programs

Low Pressure Drop Filters

Utility	Incentive
Salt River Project Power & Water (Arizona)	$0.80/scfm
PacifiCorp (Idaho)	$0.80/scfm

Receiver Capacity Addition

Utility	Incentive
Salt River Project Power & Water (Arizona)	$1.50/gal above 2 gal/scfm
PacifiCorp (Idaho)	$1.50/gal above 2 gal/scfm

Cycling Refrigerated Dryers

Utility	Incentive
Salt River Project Power & Water (Arizona)	$2.00/scfm
PacifiCorp (Idaho)	$1.50/scfm

VFD Controlled Compressor

VFD controlled compressors are typically offered on a custom or simplified analysis basis. There are a few prescriptive incentives offered for VFD controlled compressors:

Utility	Incentive
Xcel Energy (Colorado)	$4,000 (10 – 24 hp) $4,500 (25 – 49 hp)
Salt River Project Power & Water (Arizona)	$90/hp

Zero Loss Condensate Drain

Utility	Incentive
Xcel Energy (Colorado)	$200/drain
Salt River Project Power & Water (Arizona)	$90/drain
PacifiCorp (Idaho)	$90/drain

Outside Air Intake

No prescriptive measures for outside air intake were found other than that for PacifiCorp which offers $6.00/hp.

3.5 RECOMMENDED METHOD OF DETERMINING SAVINGS AND INCENTIVE

3.5.1 Determining Savings

FinAnswer Express has been using unit energy savings values that involve multiplying not only by a size rating for a product (for example, cfm for a cycling dryer), but also by the hours of operation. For example the unit energy savings for a cycling dryer is in the units:

kWh/cfm/annual hours of operation

While this is an accurate method for each individual project, it complicates the administrative and tracking processes. We recommend that the current mechanism using unit energy savings in terms of kWh per cfm per hour of operation be replaced with a simpler unit energy savings in kWh per cfm. This will avoid the necessity to collect annual operating hours for each of the smaller measures (including even zero loss drains), which must then be tracked in the database and passed through in the invoicing process in order to confirm the saving amount. Instead, an average value of 5,260 annual operating hours may be used to convert the former 0.00242 kWh per scfm per hour to a new unit energy savings of 12.73 kWh/scfm, for example. This average figure of 5,260 hours is the weighted average (by compressor horsepower) of the pressurized runtime figures collected from the 15 VFD compressor projects in the FinAnswer Express progam over the past two years. It is conservative relative to the comparable value from Energy Trust of Oregon's Small Industrial program – 5,934 hours per year (average weighted by compressor horsepower for 340 projects over five years) – and aligns well with the U.S. Department of Energy figure of 5,538 annual hours of operation for compressed air systems.

3.5.2 Determining Incentives

It is recommended to increase incentives on most of the prescriptive measures for compressed air for three reasons:

1. Using data from PacifiCorp and Energy Trust of Oregon projects, it was found that many of the incremental costs that informed incentives had been slightly low relative to the current market.
2. The tables in the previous section demonstrate that PacifiCorp incentives have room to increase in order to align better with other utility incentives
3. Market uptake has been limited for many of these measures, and therefore raising the incentive may assist market uptake

3.6 RECOMMENDED DELIVERY MECHANISM

Continue to offer the suite of compressed air measures on a post-purchase prescriptive incentive basis with unit energy savings for all measures except VFD compressors and, in some cases, cycling refrigerated dryers as follows. Use the simplified analysis method for VFD compressors, employing the NW Regional Compressed air Tool. It is recommended that refrigerated cycling dryers purchased in combination with the VFD compressor measure use the post-purchase administrative method, but instead of using the UES value, calculate site-specific savings with the NWRCAT, since the inputs for the savings calculation have already been collected for the compressor measure. In these cases the incentive for the dryer would be paid at the custom rate and cap like the compressor measure.

3.7 BASELINE, ELIGIBILITY CRITERIA, SAVINGS, MEASURE COST

The table of unit energy savings, incentives, and costs is give below on next page.

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Compressed Air Incentives

Equipment category	Replace	With	Limitations	Customer incentive	Gross incremental cost (NC) ($/unit)	Gross incremental cost (retro) ($/unit)	Energy savings (kWh/unit/yr)	Demand savings (kW/unit)
Zero loss condensate drain	Timer drain	Zero loss condensate drain (see note 4)	Drain is designed to function without release of compressed air into the atmosphere. Any size system is eligible - there is no restriction on compressor size.	$100 each	$110.00	$445.00	786.37	0.03100
Cycling refrigerated dryer	Non-cycling refrigerated dryer	Cycling refrigerated dryer	1. Rated dryer capacity must be ≤ 500 scfm. 2. Dryer must operate exclusively in cycling mode and cannot be equipped with the ability to select between cycling and non-cycling mode. 3. Refrigeration compressor must cycle off during periods of reduced demand.	$2.00/scfm	$2.73	-	12.73	0.00024
VFD controlled compressor	Fixed speed compressor	< 75 hp VFD controlled oil-injected screw compressor operating in system with total compressor capacity ≤75 hp, not counting backup compressor capacity.	1. Total compressor capacity in upgraded system is ≤75 hp, not counting backup compressor capacity. 2. Compressor must adjust speed as primary means of capacity control.	$0.15/kWh annual energy savings[3]	Incentive and savings are calculated using the Northwest Regional Compressed Air Tool. Cost is actual cost from invoice.			
Receiver capacity addition	Limited or no receiver capacity (≤ 2 gallons per scfm of trim compressor capacity)	Total receiver capacity after addition must be > 2 gallons per scfm of trim compressor capacity.	1. Compressor capacity ≤75 hp, not counting backup compressor(s). 2. Trim compressor must use load/unload control, not inlet modulation or on/off. 3. Systems with VFD compressor or variable displacement compressor are not eligible.	$3.00/gal above 2 gal/scfm	$4.87	$7.85	13.10	0.00062
Low pressure drop filter	Standard coalescing filter	Low pressure drop filter where: 1. Pressure loss at rated flow is ≤ 1psi when new and ≤ 3psi at element change. 2. Particulate filtration is 100% at ≥ 3.0 microns and 99.98% at 0.1 to 3.0 microns with ≤ 5 ppm liquid carryover. 3. Filter is of deep-bed "mist eliminator" style, with element life ≥ 5 years. 4. Rated capacity of filter is ≤ 500 scfm.	1. Compressor must be ≥ 25 hp and ≤75 hp. 2. Compressor discharge pressure setpoint must be reduced by 2 psi or more after installation of low pressure drop filter.	$2.00/scfm	$3.62	$6.97	6.79	0.00032
Outside air intake	Compressor drawing intake air from compressor room	< 75 hp compressor with permanent ductwork between compressor air intake and outdoors.	Ductwork must meet manufacturer's specifications which may include: (a) ≤ 0.25" W.C. pressure loss at rated flow, and (b) allow use of compressor room air during extremely cold outside air conditions.	$6.00/hp	$37.50	$37.50	48.97	0.00233

Notes for Compressed Air table

1. Equipment that meets or exceeds the efficiency requirements above may qualify for incentive.
2. Except for the zero loss condensate drain measure, eligibility for incentives is limited to compressed air systems with total compressor capacity of 75 hp or less, not including backup compressor capacity that does not normally run.
3. Incentives for VFD compressors are calculated based on compressor size and other system parameters at $0.15/kWh of annual energy savings, with the usual project level caps (70% of project cost and one year payback). Energy savings figures are subject to approval by Rocky Mountain Power.
4. Zero loss condensate drains purchased as an integral part of another measure are eligible for the incentive shown above.

scfm - standard cubic feet per minute at standard conditions (14.5 psia, 68 degrees F, 0% relative humidity)

3.7.1 Zero Loss Condensate Drain

Measure:	Zero Loss Condensate Drain
Description:	Installation of zero loss condensate drain
Savings Mechanism:	Prevents loss of compressed air
Baseline:	Timer drain
Technical Life:	10 years
Unit Energy Savings:	786.37 kWh/drain[1]
Demand Savings:	0.03100 kW/drain
Unit Cost (retrofit):[2]	$445
Unit Cost (NC):	$110
Incentive:	$100/drain
% of Installed Cost (Retro):	22.5%
% of installed Cost (NC):	90.9%

Footnotes:

1. Based on 0.1495 kWh/unit multiplied by average operating hours of 5,260.
2. Based on average project cost for 26 projects in PacifiCorp and Energy Trust of Oregon territory combined with vendor estimate of 2 hours at $92.50/hr for retrofit. No labor was added for New Construction.

Changes from previous:

Incentive has been increased from $90/drain to $100/drain.

New construction incremental cost has increased from $65 to $110.

Retrofit incremental cost has increased from $379 to $445.

Energy savings has changed from $0.14950 kWh/hr/yr/unit to 786.37 kWh/unit/yr.

Any size system is eligible. There is no restriction on compressor size.

3.7.2 Cycling Refrigerated Dryer

Measure:	Cycling Refrigerated Dryer
Description:	Installation of a cycling refrigerated dryer
Savings Mechanism:	Reduced dryer compressor runtime
Baseline:	Non-cycling refrigerated dryer
Technical Life:	10 years
Unit Energy Savings:	12.73 kWh/scfm[1]
Demand Savings:	0.00024 kW/scfm
Unit Cost (NC)	$2.73/cfm[2]
Incentive:	$2.00/cfm[3]
% of Installed Cost (NC):	73.3%

Footnotes:

1. Based on 0.00242 kWh/scfm/operating hour per year multiplied by average operating hours of 5,260.
2. An average of incremental costs was taken from 8 projects in PacifiCorp and Energy Trust of Oregon territory. Incremental cost was in good agreement with the previous Market Characterization analysis.
3. Cascade Energy recommends increasing the incentive to $2.00/scfm to help increase market uptake.

Changes from previous:

Incentive has been increased from $1.50/scfm to $2.00/scfm.

Energy savings has changed from 0.00242 kWh/scfm/hr/yr to 12.73 kWh/scfm/yr.

Some states call out that the compressor system must be 75 hp or less. This callout has been eliminated. The ≤500 cfm rated capacity constraint is sufficient.

When a cycling dryer is purchased in conjunction with a new VFD compressor, it is proposed to let the Northwest Regional Compressed Air Tool calculate savings rather than use the unit energy savings here.

3.7.3 VFD Air Compressor

Measure:	VFD Air Compressor
Description:	Installation of a oil flooded VFD rotary screw compressor
Savings Mechanism:	Improved efficiency at part load operation
Baseline:	Fixed speed rotary screw compressor
Technical Life:	15 years
Average Cost (Retrofit)	$622/hp + $2,500 labor[1]
Average (NC)	$186/hp[1]
Average hp (Retrofit):[1]	46
Average hp (NC):[1]	66
Incentive rate:	$0.15/kWh up to 70% of project cost, 1 yr PB

Footnotes:

1. Based on average hp, energy savings, project cost, and operating hours of 35 projects in PacifiCorp and Energy Trust of Oregon territory.

Changes from previous:

Changed phrasing of baseline from "Compressor 75 hp or smaller" to "Fixed speed compressor." On rare occasion, one encounters a situation where downsizing the compressor is the appropriate course. It is sometimes possible to downsize from 100 hp to 50 or 75 hp. (This has not occurred in FinAnswer Express in the past three years, but it has occurred infrequently in other programs.)

Changed upgrade description from "≤75 hp VFD controlled oil-injected screw compressor operating in single compressor system (i.e. not discharging into common header with any other compressor)" to "≤75 hp VFD controlled oil-injected screw compressor operating in system with total compressor capacity ≤75 hp, not counting backup compressor capacity." This makes eligible the rare occasion when a 50 hp VFD compressor operates together with a 25 hp fixed speed base compressor, or when a 50 hp VFD compressor meets the entire plant load 95% of the time, but a small second compressor is operated a few hours a week to run the sandblaster.

Removed limitation "Compressor must not use inlet modulation when demand is below minimum allowed VFD speed." These instances are infrequent, and the effect on savings is more than offset on average by the new machines with permanent magnet motors that automatically shut off entirely during periods of very low load.

3.7.4 Receiver Capacity Addition

Measure:	Receiver Capacity Addition
Description:	Total receiver capacity after addition must be > 2 gallons per scfm of trim compressor capacity.
Savings Mechanism:	Reduced loss during load/unload compressor cycling
Baseline:	Limited or no receiver capacity (≤ 2 gallons per scfm of compressor capacity)
Technical Life:	10 years
Unit Energy Savings:	13.10 kWh/gal[1]
Demand Savings:	0.00062 kW/gal
Unit Cost (Retrofit):	$7.85/gal[2]
Unit Cost (NC)	$4.87/gal
Incentive:	$3.00 per gal above the first 2 gal/cfm[3]
% of Installed Cost (Retrofit):	38.2%
% of Installed Cost (NC):	61.6%

Footnotes:

1. Based on 0.00249 kWh/gal/hour of operation per year multiplied by average operating hours 5,260.
2. Unit cost for retrofits was increased from $6.83 to $7.85 based on 6 projects in Energy Trust of Oregon territory. No receiver capacity addition projects have occurred in PacifiCorp territory.
3. Recommending increasing the incentive to $3.00/gal to help increase market uptake.

Changes from previous:

Added the word “trim” to receiver capacity callout for both baseline and upgrade.

Rephrased eligibility limitations.

Increased incentive from $2.00/gal above 2 gal/scfm of trim compressor capacity to $3.00/gal above 2 gal/scfm of trim compressor capacity.

Retrofit incremental cost increased from $6.93/gal to $7.85/gal.

Energy savings changed from 0.00249 kWh/gal/hr/yr to 13.10 kWh/gal/yr.

3.7.5 Low Pressure Drop Filter

Measure:	Low Pressure Drop Filter
Description:	Replace standard coalescing filter with low pressure drop filter
Savings Mechanism:	Pressure reduction
Baseline:	Standard coalescing filter
Technical Life:	10 years
Unit Energy Savings:	6.79 kWh/scfm[1]
Demand Savings:	0.00032 kW/scfm
Unit Cost (Retrofit):	$6.97/scfm[2]
Unit Cost (NC)	$3.62/scfm
Incentive:	$2.00/scfm[3]
% of Installed Cost (Retrofit):	28.7%
% of Installed Cost (NC):	55.2%

Footnotes:

1. Based on 0.00129 kWh/scfm/hr of operation per year multiplied by average operating hours of 5,260.
2. Unit costs for retrofits and new construction unchanged.
3. Recommending increasing the incentive to $2.00/scfm to help increase market uptake.

Changes from previous:

Incentive increased from $0.80/scfm to $2.00/scfm of rated filter capacity.

Energy savings changed from 0.00129 kWh/scfm/hr/yr to 6.79 kWh/scfm/yr.

3.7.6 Outside Air Intake

Measure:	Outside Air Intake
Description:	Installing ductwork between compressor air intake and outdoors.
Savings Mechanism:	Higher density intake air leads to reduced compressor runtime.
Baseline:	Compressor drawing intake air from the compressor room
Technical Life:	10 years
Unit Energy Savings[1]:	48.97 kWh/yr/hp
Demand Savings:	0.00233 kW/hp
Unit Cost (retrofit & NC):	$37.50
Incentive:	$6.00/hp
% of Installed Cost (Retro & NC):	16.0%

Footnotes:

1. Based on 0.00931 kWh/hp/hr of operation per year multiplied by average operating hours of 5,260.

Changes from previous:

Energy savings changed from 0.00911 kWh/hp/hr/yr to 48.97 kWh/hp/yr.

3.8 NON-ENERGY BENEFITS

VFD compressors operate with significantly less noise than fixed speed compressors, which many owners find very attractive. They also maintain system pressure at a nearly constant level, unlike baseline compressors, for which pressure oscillates up and down over a typical 10 to 20 psi band.

3.9 REFERENCES

– Work Paper SCE13PR007 – Southern California Edison Company: "Cycling Air Dryers for Compressed Air Systems" Page 3: To estimate savings, pre and post equipment conditions were established. This was done by reviewing existing literature on compressor market. In a study performed by the DOE [B], the annual operating hours for customers with compressors was calculated to be approximately 5,538 hours. This average annual operating hours of operation has been used throughout the workpaper for estimating energy savings.
– http://www.airbestpractices.com/technology/air-compressors/applying-variable-speed-compressors-multiple-applications-application-suc
– http://www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/newmarket5.pdf
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– http://energytrust.org/industrial-and-ag/incentives/industry/compressed-air-systems/CompressedAirSystems/

4 FARM & DAIRY

4.1 DAIRY OVERVIEW

Dairies have been moderately active program participants in Utah. The state ranks 22nd in milk production at 1.76 billion lbs in 2009. (For comparison, Idaho is the 4th ranking state, with 12.15 billion lbs, almost seven times Utah production.) Measures available for farms and dairies are given below in Table 2. It is recommended to retain the existing measure set unchanged, except for restructuring the heat reclaim measure to use a simplified calculator similar to the approach used for milk precoolers, paying the incentive at the custom rate with the usual caps.

Table 2: Dairy Measures Currently Offered by PacifiCorp

Existing PacifiCorp Dairy Measures
Automatic Milker Takeoffs
Agricultural Engine Block Heater Timers
Circulating Fan
Heat Reclaimer
High-Efficiency Livestock Waterer
High-Efficiency Ventilation System
Milk Pre-Cooler
Programmable Ventilation Controller
VFD for dairy vacuum pump

4.2 APPLICABLE CODES AND STANDARDS

None of the measures offered by PacifiCorp are subject to state or federal energy codes.

4.3 INFORMATION FROM MARKET ACTORS – SUPPLIERS, DISTRIBUTORS, CONTRACTORS

Dairy trade allies in Utah and Southern Idaho have been developing relationships with the program over the course of the past year. Vendors working with agricultural customers tend to like the simplified analysis and prescriptive measure offerings. One vendor stated that "the automatic milker takeoff program is the perfect fit. It's easy, fair, consistent, and makes selling the equipment easier. It also offers value to the customer."

One vendor was enthusiastic about replacing chiller equipment in dairies, but was hesitant about the custom project process due to the perceived length and complexity of the process. This invites the possibility of a chiller calculator for dairy, which would be a relative of the milk precooler tool.

4.4 MARKET POTENTIAL AND ESTIMATED PARTICIPATION

No change to the majority of these measures is recommended for the PacifiCorp offerings. Simplified analysis is still the preferred method for milk pre-coolers, and although a calculator was considered for vacuum pump VFDs, it was determined that the prescriptive approach has been adequate and there is no reason to disrupt this. We do propose one change: replace the unit energy savings incentive for the heat reclaim measure with a calculator-based approach.

Engine Block Heater Timers could potentially be a measure that could have cross-over appeal to the residential sector. Michigan Energy offers a 100% rebate up to $35 for engine block heater timers. This delivery mechanism may provide an outreach mechanism that could help generate awareness of Rocky Mountain Power Incentives in Utah markets.

Partial market saturation has been observed with some of the dairy measures – most dairies at this time are equipped with vacuum pump VFDs and automatic milker takeoffs. There remain a few, mostly smaller, dairies that do not yet have this equipment.

4.5 RELATED MEASURES OFFERED BY OTHER PROGRAMS

Other utility programs offer Farm and Dairy incentives as follows:

4.5.1 Automatic Milker Takeoffs

Utility	Incentive
Alliant Energy	$5.00/cow milked
PacifiCorp	$235 each

4.5.2 Agricultural Engine Block Heater Timers

Utility	Incentive
Michigan Energy	$35.00 up to 100% of first block heater timer
Nova Scotia Efficiency	$40/timer
ComEd	$20/timer
Holy Cross Energy	50% of cost up to $10/timer
PacifiCorp	$20/timer

4.5.3 Circulating Fan

Utility	Incentive
Alliant Energy	$25 - $75 / fan
Focus on Energy Wisconsin	$2.00 per blade inch
ComEd	$25 - $100/fan
PacifiCorp	$25 - $75 / fan

4.5.4 Heat Reclaimers (electric water heating)

Utility	Incentive
Alliant Energy	$5.00/cow milked
TIP Rural Electric Coop	$4.00/Cow Milked
Efficiency Vermont	$1,500/unit
Focus on Energy Wisconsin	$500/unit
PacifiCorp	$220/condensing unit kW

4.5.5 High Efficiency Livestock Waterer

Utility	Incentive
ComEd	$110/unit
Focus on Energy Wisconsin	$50/unit
Alliant Energy	$40/unit
PacifiCorp	$165/unit

4.5.6 High Efficiency Ventilation Systems

Utility	Incentive
ComEd	$25 - $100/fan
PacifiCorp	$45 - $150/fan

4.5.7 Milk Precoolers

Utility	Incentive
Efficiency Vermont	$2,000/unit
Focus on Energy Wisconsin	$750/unit
Alliant Energy	$3.40/cow milked
TIP Rural Electric	$3.00/cow milked
PacifiCorp	Calculator Tool

4.5.8 Programmable Ventilation Controller

No prescriptive measures for programmable ventilation controllers were found other than that for PacifiCorp which offers $20/fan controlled.

4.5.9 VFD for Dairy Vacuum Pumps

Utility	Incentive
Efficiency Vermont	$1,500/VFD
Focus on Energy Wisconsin	$750/unit
Alliant Energy	$5.00/cow milked
PacifiCorp	$165/hp

4.6 RECOMMENDED CHANGES TO THE CURRENT MEASURES

Farm and Dairy measures are retained as-is with four exceptions:

- Revise unit cost for vacuum pump VFDs from $340/hp to $415/hp based on cost data collected from 2012-13 FinAnswer Express projects.
- Revise unit cost for automatic milker takeoffs from $610/milking unit to $1,400/milking unit based on cost data collected from 2012-13 FinAnswer Express projects.
- Change the incentive rate for milk precoolers from $0.12/kWh plus $50/kW to the revised value of $0.15/kWh with the standard project level caps (percent of project cost and one-year payback).
- Restructure the heat reclaim measure to use a calculator in place of the current value of $220/condensing unit kW.

Heat Recovery

The current basis for the heat reclaim incentive, $220 per condensing unit kW, is ambiguous and can be improved. To arrive at a kW value, one must convert compressor nominal horsepower to kW units, then add the estimated kW from the condenser fan(s). Actual operating kW is likely to be approximately 80% of nominal full load kW, and will vary with outdoor temperature. Instead, a calculator is proposed to estimate water heating energy savings using daily milk production, taking into account whether well water precooling is in place. See example below.

The amount of heat that the milk refrigeration system rejects is directly related to the quantity of milk cooled per day. Therefore the reduction in electric water heating energy is a direct function of lbs/day milk production. Starting milk temperature will typically be between 95 and 98°F if there is no milk precooler and in the 50 to 58°F range if there is a precooler. The $0.15/kWh custom rate is then applied to the resulting savings, with the usual 70% cost cap and one year payback cap. Naturally, the dairy must use electricity as the water heating source in order to be eligible. Measure life is 15 years.

DAIRY HEAT RECOVERY CALCULATOR

Project Cost Inputs

Estimated Equipment Cost	$	2,500
Estimated Freight	$	500
Estimated Installation Cost	$	1,000
Estimated Tax, if applicable	$	42
Total Project Cost	$	4,042

Electric Cost/Incentive Inputs

Energy Cost ($/kWh)	$	0.0580
Incentive Rate ($/kWh)	$	0.15
Incentive Cost Cap (%)		70%

Milk Harvest Inputs

Pounds of milk harvested per day	7,000
Starting milk temperature (°F)	95
Milk storage temperature (°F)	38

Heat Recovery Calculations

Temperature difference (°F)	57
Specific heat of milk, Cp (Btu/lb°F)	0.94
Heat removed from milk (Btu/day)	375,060
Heat recovery efficiency	60%
Heat delivered to water (Btu/day)	225,036
Electric heating avoided (kWh/day)	66.0
Electric heating avoided (kWh/year)	24,073

Economic Summary

Project Cost Before Incentive ($)	$	4,042
Incentive ($)	$	2,646
Percent of project cost paid by incentive		65%
Project Cost After Incentive ($)	$	1,396
Annual Energy Cost Avoided ($)	$	1,396
Payback Period After Incentive (years)		1.00

Engine Block Heater Timer: Engine block heater timers show an excellent savings-to-incentive ratio together with the potential to reach a large number of customers. To date, however, they have not gained much traction, likely because of lack of awareness. One solution to this is to approach retailers with a promotional campaign to raise awareness and generate volume with the measure. However, there is an administrative issue to be addressed first – it is likely that many purchasers would not be Rocky Mountain Power customers on an electric rate that is eligible for wattsmart incentives; most purchasers would likely be residential accounts.

Accordingly, Cascade recommends that this measure be retained even though agriculture sector uptake in the near future may be limited, and that the residential Home Energy Savings program consider offering a comparable incentive for block heater timers through an analogous post purchase application process next time program changes are evaluated. Promotional efforts could then encourage participation in both sectors without provoking issues around eligibility.

4.7 RECOMMENDED DELIVERY MECHANISM

Continue to offer the farm/dairy measures as post-purchase prescriptive incentives.

4.8 ELIGIBILITY CRITERIA, UNIT ENERGY SAVINGS, INCENTIVE

Eligibility requirements, recommended incentive, gross incremental cost, energy savings, and demand savings for each measure are given in the table below.

UTAH November 2013

Farm & Dairy Equipment Incentives

Equipment type	Equipment category	Minimum efficiency requirements	Customer incentive	Gross incremental cost/unit	Energy savings (kWh/yr/unit)	Demand savings (kW/unit)
Variable frequency drive for dairy vacuum pump (retrofit only)	--	VFD must vary motor speed based on target vacuum level. Incentive available for retrofit only (i.e. new construction and replacement of existing VFD not eligible)	$165/hp	$415/hp	2,505	0.370
Automatic milker takeoffs (retrofit only)	--	1. Equipment must be able to sense milk flow and remove milker when flow reaches a pre-set level. 2. Must have VFD in place on vacuum pump. 3. Replacement of existing automatic takeoffs is not eligible for this listed incentive, but may qualify for a custom incentive.	$235 each	$1,400 per milking unit	992	0.407
Milk precooler[2]	--	The equipment must cool milk with well water before it reaches the bulk cooling tank.	$0.15/kWh annual energy savings	Incentive and savings are calculated using the milk precooler calculator tool. Cost is actual cost from invoice.		
Heat recovery[2]	--	Heat recovery unit must use heat rejected from milk cooling refrigeration system to heat water. Customer must use electricity for water heating.	$0.15/kWh annual energy savings	Incentive and savings are calculated using the heat recovery calculator tool. Cost is actual cost from invoice.		
Agricultural engine block heater timer	--	Timer must be a UL-listed device and rated for a minimum of 15 amps continuous duty.	$10 each	$20/timer	512	0.000
High-efficiency livestock waterer	--	1. Must have $\geq$ 2 inches of insulation surrounding the inside of the waterer and an electric heating element. 2. Waterers with a heating element > 250 watts must have an adjustable thermostat. 3. Non-electric heated waterers do not qualify.	$165 each	$450/each	1,209	0.100
Programmable ventilation controller	--	Controller must control ventilation fans based on temperature or other applicable factors such as humidity, odor concentration, etc.	$20/fan controlled	$115/controller	1,020	0.139
High-efficiency circulating fan[3]	12-23" Diameter	Fans must achieve an efficiency level of 11 cfm/watt.	$25/fan	$55/fan	419	0.057
	24-35" Diameter	Fans must achieve an efficiency level of 18 cfm/watt.	$35/fan	$82/fan	486	0.066
	36-47" Diameter	Fans must achieve an efficiency level of 18 cfm/watt.	$50/fan	$100/fan	557	0.076
	≥48" Diameter	Fans must achieve an efficiency level of 25 cfm/watt.	$75/fan	$120/fan	1,460	0.200
High-efficiency ventilation fan[3]	12-23" Diameter	Fans must achieve an efficiency level of 11 cfm/watt.	$45/fan	$120/fan	419	0.057
	24-35" Diameter	Fans must achieve an efficiency level of 13 cfm/watt.	$75/fan	$180/fan	750	0.103
	36-47" Diameter	Fans must achieve an efficiency level of 17 cfm/watt.	$125/fan	$215/fan	1,500	0.205
	≥48" Diameter	Fans must achieve an efficiency level of 19.5 cfm/watt.	$150/fan	$290/fan	3,000	0.411

Notes for Farm & Dairy table

1. Equipment that meets or exceeds the efficiency requirements listed for the equipment category in the above table may qualify for the listed incentive.
2. Fan performance must by rated by an independent testing body in accordance with the appropriate ANSI/AMCA standards.
3. Except where noted all equipment listed in the table will be eligible for incentives in both new construction and retrofit projects.
4. Incentives are capped at 70 percent of Energy Efficiency Project Costs, and incentives will not be available to reduce the Energy Efficiency Project simple payback below one year. Energy savings and Energy Efficiency Project Costs are subject to Pacific Power approval.

4.9 NON-ENERGY BENEFITS

Many of the measures offered by PacifiCorp help keep cows comfortable in hot weather, which improves milk production. Automatic milker takeoffs prevent over milking of the cows which can lead to productivity and disease issues.

4.10 REFERENCES

- http://usda01.library.cornell.edu/usda/nass/MilkProd/2010s/2013/MilkProd-02-20-2013.pdf
- http://www.progressivedairy.com/downloads/2011/general/2011_pd_r_nw_stats_lowres.pdf
- http://www.wyomingbusinessreport.com/article.asp?id=85905
- http://users.humboldt.edu/adamc/project_clarkmcvay.html
- http://www.michigan-energy.org/heatertimer
- http://www.focusonenergy.com/sites/default/files/FE32-0313%20Services%20and%20Incentives%20Commercial_Single%20Page%20Final.pdf
- http://www.efficiencyvermont.com/for_my_business/ways-to-save-and-rebates/agriculture/rebates.aspx
- http://www.alliantenergy.com/SaveEnergyAndMoney/Rebates/FarmIA/029868
- https://www.comed.com/business-savings/commercial-industrial/Pages/farms.aspx

5 OIL & GAS

5.1 MEASURE DESCRIPTION

Sucker rod pumps are typically used by gas and oil companies in the process of extracting natural gas and oil from the ground. They draw water from oil and gas wells. The depth of the well varies but typical installations are in the range of 1,000 ft to 5,000 ft. For gas wells, in the well bore, water is pumped up the center pipe and gas flows up the casing around the pipe. For oil wells, water and oil are pumped up the center pipe and any natural gas flows up the casing around the pipe. These pumps are typically equipped with simple timer controls that operators adjust periodically to start and stop the pumps. If the well liquid level is allowed to get too high, gas production decreases. If the fluid level gets too low, pump efficiency decreases as gas is also pulled into the pump chamber. Since gas and oil production is the primary operating objective, the timers are almost always set too high, causing the pumps to operate more than they need to. In addition, when the pump cavity is partially filled with gas, on the down stroke the pump plunger can ram into the liquid in the pump cavity causing a hammer effect on the pump. This hammer effect increases wear and tear and thus maintenance costs on the pump.

This measure replaces these timer controllers with pump-off controllers (POC). POCs utilize load sensors on the pump to determine when it starts to draw in gas. It then shuts the pump down and allows the liquid level in the well to rise to the point that the pump should start up again. This maintains production rates for the well pump and allows it to operate less, reducing the pump's energy use.

Year round operation is typical for sucker rod pumps. However operating hours are highly dependent on the location of the well pump and the amount of gas and oil produced from the well.

POCs are available on the market from such vendors as Lufkin, Weatherford, SPOC Automation, and Global Oil Flow. There are simple controllers and more advanced versions that use a variable frequency drive (VFD) to reduce the speed of the pump. Some have regenerative VFDs that generate electricity on the down stroke of the pump.

5.2 HOW THE MEASURE REDUCES ENERGY USE

Energy savings are achieved by reducing the operating time of the sucker rod pumps using the controllers. The POCs only operate the pump as needed to keep the liquid level down in the well.

5.3 APPLICABLE CODES AND STANDARDS

There are no known national or state code requirements for sucker rod pump POCs.

5.4 RELATED MEASURES OFFERED BY OTHER PROGRAMS

PG&E has in the past used a calculation tool for POCs to estimate the energy savings and incentive levels for companies that plan on installing them. The inputs for this tool are as follows:

- Number of Wells

- Well identification Number
- Motor Horsepower (hp)
- Average Daily Liquid Production (barrels per day, or BPD)
- Annual Hours (hr/yr)
- Pump Diameter (inches)
- Stroke Length (inches)
- Strokes per Minute (spm)

The output files summarize the measure inputs for each well and the energy consumption and savings estimates. The incentive is calculated based on the energy savings and an applicable incentive rate. Estimated savings from this tool are based on a simplified empirical model. The results may not accurately reflect the performance of an individual well; rather they are intended to represent an average performance. This tool also provides an estimate of demand savings, which is based on an empirical study conducted in 1994.

Xcel Energy began providing rebates for oil well POCs in 2011 for their New Mexico customers. The rebate is offered for systems less than 100 hp; larger pump motors take the custom incentive route. The application requests information about the well pump that Xcel Energy then uses to calculate the energy savings. The prescriptive incentive is calculated based on the lesser of either 60% of project cost or $3,000. Energy savings are calculated based on the formula below, which was developed based on a Society of Petroleum Engineers paper entitled “Electrical Savings in Oil Production” by J.E. Johnson.[1]

$$kWh_{Savings} = \frac{(HP \times LF \times 0.746)}{(Eff_{Motor} \times Eff_{SurfMech})} \times \left(TC \times 8760 - \left(\frac{Run_{Const} + Run_{Coeff} \times Eff_{VolPump} \times TC \times 100}{100}\right) \times 8760\right)$$

Where:

- HP: motor horsepower (provided by the customer on the incentive application).
- LF: Load factor of the motor (this value is estimated by Xcel Energy).
- TC: The baseline time clock assumption, the percentage of time the pump would have been running before installing the POC (this value is assumed by Xcel Energy).
- Eff_{Motor}: Efficiency of the motor (this value is estimated by Xcel Energy).
- $Eff_{SurfMech}$: The mechanical surface efficiency (this value is estimated by Xcel Energy).
- Run_{Const}: The run constant from a linear correlation equation from the “Electrical Savings in Oil Production” paper. This value is 8.366.

[1] J.E. Johnson, Electrical Savings in Oil Production, SPE Production Engineering, 1988.

- Run_{Coeff}: The run coefficient/slope from a linear correlation equation from the "Electrical Savings in Oil Production" paper. This value is 0.956.

Peak demand savings is also estimated. However, it is unclear how peak demand savings are determined. Given that the controller is simply causing the pump to operate less often, the operating power when running would remain similar before and after the controller is installed, indicating no peak demand savings for an individual unit. If many controllers are deployed in a field, the diversity of runtimes between well pumps would statistically result in demand savings.

According to Xcel Energy, 2012 was their first full year of offering a standard rebate. They provided approximately 349 rebates in 2012. An independent audit of the energy savings was conducted, and due to the results, Xcel has reduced the incentive to $2,000 per POC.

Both utility calculations appear to be using a general correlation in their calculations of the energy savings, which most likely is a reasonable average estimate of the energy savings of POCs. However it does not necessarily provide an accurate estimate of the energy savings per individual POC installation.

Xcel Energy does not provide a prescriptive incentive for gas well POCs. The California utility incentive calculator is for any type of sucker rod pumping application in the oil and gas field.

Xcel Energy does not provide an incentive for new construction wells being installed after March of 2011, regarding controllers as standard practice for new construction. If a customer wants to install a POC with a VFD, this is routed through their custom incentive program.

5.5 INFORMATION FROM MARKET ACTORS – SUPPLIERS, DISTRIBUTORS, CONTRACTORS

Weatherford, Lufkin, and SPOC Automation were contacted about their POC products. A Lufkin sales representative, a Lufkin technical support representative, and the SPOC Automation president were interviewed for the purposes of this report.

The Lufkin sales representative was stationed out of Colorado. He covers North and South Dakota, Wyoming, Utah, Texas, Colorado, and New Mexico. The sales representative indicated that the majority of the controllers currently installed on existing sucker rod pumps are a type of advanced POC and not a timer controller. From his experience, he estimated that only 10% of the pumps that are out there are using timer style controls. The majority of new sucker pumps that are installed are equipped with POCs. However it does depend on the operator and the well and how it will be controlled. Typically, if an oil well pump has water injection, then the energy savings will be less.

Lufkin offers a one year warranty on their controllers, but they indicate the controllers last considerably longer than this. They have POCs that are 20 to 30 years old still in service. They don't have an official calculation for the amount of energy savings achieved for installing POCs, but they estimate it is 15% of the baseline energy use on average. If you add a VFD to the controller, the savings increase an additional 8 to 10%. If a regenerative VFD is installed, then electrical generation could also be achieved.

They typically only offer regenerative VFDs on applications with 100 hp or more of connected motor load. Otherwise it is typically not cost effective.

The cost for a normal Lufkin Well Manager POC is approximately $4,000 installed. If a VFD is also added, it can increase the cost by an additional $15,000 to $25,000 depending on the size of the pump motor.

The president of SPOC Automation was also interviewed. Their POC is a firmware upgrade on a VFD that they offer. The VFD uses the pump motor as the sensor for when to shut off. He indicated that he thought the majority of new pumps being installed included some type of POC, possibly 60% to 70%, however he indicated there are quite a few smaller “mom and pop” pump installations that prefer not to spend the extra money up front on a POC. He did indicate that it depends also on which state the pump is being installed in. If it is going into North Dakota, South Dakota, Texas, or California, almost all of these pumps have POCs on them. However if you look at Oklahoma and Wyoming, he indicated that only about 50% of the pumps will be equipped with controllers.

Since their product is an upgrade to a VFD, the life expectancy is strictly based on the life of the VFD. He bases the life of the VFD at 8 to 10 years, possibly up to 15 years on some applications. The cost for a SPOC controller is $1,500 in addition to the cost of the VFD. They typically see electrical savings in the 20% to 40% range.

5.6 RECOMMENDED METHOD OF DETERMINING SAVINGS AND INCENTIVE

Cascade Energy has analyzed eleven Energy FinAnswer projects involving POCs in PacifiCorp service territory. Three of the projects involved oil well POCs with a total of 26 well pumps. The remaining eight projects involved gas well POCs with a total of 483 well pumps. The following table provides a summary of the costs for the well pumps for each project and the energy savings for each well pump. Two of the projects had abnormally low implementation costs per controller. These have been excluded in the totals below. Average inspected savings per controller is 9,707 kWh/yr.

From an Xcel Energy case study done in 2011, each oil well POC was estimated to save approximately 23,882 kWh/yr per well. This is considerably higher than what has been estimated in the FinAnswer program at PacifiCorp. After a 2012 evaluation of the Xcel POC measure, the incentive was reduced to 2/3 of the 2011 value, presumably because the savings was less than anticipated. Similarly, a 2010 evaluation of the pump off controller measure in the PG&E Fabrication, Process, and Manufacturing Contract Group showed a realization rate of 46% for savings that had been based on the California empirical calculator. Applying this realization rate to the Xcel 2011 savings figure would give an estimated savings per controller of 10,986 kWh.

Table 3: Cascade Energy FinAnswer Express Oil & Gas Projects

CAS #	Description	Type (Oil/Gas)	State	Total Project Cost ($)	Total Estimated Savings (kWh/yr)	Total Inspected Savings (kWh/yr)	Controller Qty	Savings per Controller (kWh/Cont.)	Cost per Controller ($/Cont.)
3030-1	Project A Pump Off Controllers (POCs), Phase 2	Oil	WY	$32,227		74,896	9	8,322	$3,581
2740	Project B Pump Off Controllers (POCs)	Oil	WY	$49,945		52,843	15	3,523	$3,330
3533-02	Project C Pump Off Controllers (POCs)	Oil	WY	$7,750	21,412		2	10,706	$3,875
	Project D Pump-Off Controllers- Phase 1	Gas	UT	$264,522		1,362,556	100	13,626	$2,645
1376-1	Project E Pump-Off Controllers- Phase 2	Gas	UT	$89,091		931,039	100	9,310	$891
1588	Project F Pump-Off Controllers- Phase 3	Gas	UT	$99,366		307,860	30	10,262	$3,312
2701	Project G Pump-Off Controllers- Phase 4	Gas	UT	$82,481		135,890	25	5,436	$3,299
3071	Project H Pump-Off Controllers- Phase 5	Gas	UT	$682,918		1,065,704	208	5,124	$3,283
1593	Project I Pump-Off Controllers	Gas	UT	$425,683		1,604,347	99	16,206	$4,300
2297-4	Project J Pump-Off Controllers Ph 2	Gas	UT	$78,575		336,560	21	16,027	$3,742
1273	Project K Energy	Gas	UT	$23,016		438,228	50	8,765	$460
	Totals All Wells*			$1,723,467		4,940,656	509	9,707	$3,386
	Totals Oil Wells			$89,922		127,739	26	4,913	$3,459
	Totals Gas Wells*			$1,633,545		4,812,917	483	9,965	$3,382

Cascade recommends a prescriptive incentive based on the study work done thus far by PacifiCorp on pump off controller projects. The recommended incentive is $1,500 per controller, and the unit energy savings would be the average value for the 509 POCs to date, 9,707 kWh/yr. The standard project cost cap and one-year payback cap would apply. This prescriptive approach is preferred because the savings value is inferred from past project work in the local areas of interest, avoiding the issue of over-estimation characteristic of the two previous calculator-based implementations discussed here.

It is proposed that the incentive not be offered for new wells. POCs may be regarded as standard practice for new construction. POCs with VFDs and POCs on wells larger than 100 hp would not be eligible for this listed incentive; they would take the custom project route.

5.7 RECOMMENDED DELIVERY MECHANISM

It is proposed that the incentive be advertised to all oil and gas companies in PacifiCorp territory through a flyer and by email. It should also be provided to vendors of POCs to inform them of the rebate. Vendors could also be contacted directly by phone or email to explain the specifics of the incentive rebate and how it will be determined and to provide them with PacifiCorp's service territory, so they can assess which customers might be good candidates. This will provide them with information they can provide to their customers when they are considering a POC.

5.8 BASELINE DEFINITION AND ELIGIBILITY CRITERIA

The baseline is an existing sucker rod pump on an oil or gas well with either no shut-off control or simple timer control. The measure definition would be to install a POC that uses load sensors to control the operation of the pump.

5.9 MEASURE COST, SAVINGS, MEASURE LIFE, CUSTOMER ECONOMICS

From the previous PacifiCorp POC projects, controller costs average $3,386 installed. It is reasonable to estimate that the cost for a POC is in the range of $3,000 to $4,000.

Average energy savings from the previous PacifiCorp POC projects are estimated at 9,707 kWh/yr.

According to a vendor, they have controllers operating that are 20 to 30 years old. It is expected that these controllers would have a measure life in the range of 15 years.

If an incentive of $1,500 were provided, using an energy charge of $0.05/kWh, the overall average simple payback after the rebate for installing a POC would be 3.9 years. It should be noted that there are non-energy benefits associated with installing a POC, which are an important consideration for the installation of POCs.

5.10 NON-ENERGY BENEFITS

The following are typical non-energy benefits associated with installing POCs:

- Reduced man hours for adjusting timer controls and checking on status of timer controller.
- Reduced pump hammer, which should improve pump life and reduce maintenance costs.
- Improved production

5.11 MARKET POTENTIAL AND ESTIMATED PARTICIPATION

There are approximately 9,700 oil and gas wells in Utah. Most of these are in RMP territory, a fraction of those are sucker rod pumps, and it is likely that half or more already have pump off controllers. The size of the market isn't quite clear – vendor impressions vary. Xcel was able to do several hundred units in other states with a $3,000 incentive. At $1,500, we project 21 units in each of the next three years. It is possible that this estimate is low, and two to five times this many units may come in.

http://www.calmac.org/publications/PG&E_Fab_06-08_Eval_Final_Report.pdf

6 POTATO STORAGE FAN VFDS

6.1 MEASURE DESCRIPTION

A new listed measure is proposed for PacifiCorp's Washington and California service areas – potato storage fan VFDs. This measure is not applicable in Utah because of the minimal industry presence in the state, but a brief description is included here for reference.

Many potato and onion storage facilities operate fans constantly throughout the storage season to manage temperature and humidity. This measure involves the installation of variable frequency drives (VFDs) with controls to manage fan speed. Throughout much of the storage season, the full fan output is not actually required by the product and fan speed can be reduced, saving energy.

A typical storage season runs from September through May. Though the average season length is approximately eight months, data indicates this can vary from five months to year round. The cooling system size and complexity of a storage facility is highly dependent upon its climate and storage season length. Some storage facilities have only ventilation, whereby fans draw fresh air through the product. Other facilities have evaporative coolers that draw outside air through a wetted medium. This humidifies and reduces supply air temperature, providing cooling without mechanical refrigeration. Finally, some facilities have a mechanical refrigeration system (compressor, condenser, and evaporator) which provide the highest cooling capacities. These are typically found in the warmest climates and allow for the longest storage lengths. Most these refrigerated systems use unitary air-cooled condensing units. The refrigeration typically operates only during the warmest part of the storage season, approximately June through August.

Fan VFDs can be installed on any of the three systems described above (ventilation fans, evaporative cooling fan, or evaporator fans).

Storage facilities have stringent temperature and humidity requirements, which necessitate some form of fan control strategy. Some facilities utilize manual control, by which the fans and inlet louvers are manually adjusted on a daily basis. Others have a control system that continually monitor product and ambient conditions, and vary the fans and louvers automatically. Numerous brands of controllers are available on the market from such vendors as AGRI-Control Tech, Agri-Stor Co. Inc., Industrial Ventilation Inc. (IVI), JMC Ventilation Refrigeration, LLC, and Suberizer, Inc. All of these vendors are capable of fan VFD retrofits for either potato or onion storage facilities.

6.2 HOW THE MEASURE REDUCES ENERGY USE

Primary energy savings comes from reduced fan speed. The relationship between fan speed and fan power draw is theoretically defined by the fan affinity laws which describe how percent fan power is proportional to the cube of percent fan speed. In actual practice, power measurements from fans operating at various speeds indicate this fan affinity law power exponent is approximately 2.7, and VFD efficiency averages 97%. Using this relationship, reducing fan speed to 50% results in fan power draw reducing to 15.9% of full speed power draw.

The level of fan speed reduction varies based on product type, ventilation requirements, and ambient conditions . In general, speed can be reduced to 50% during the cooler storage months (November to March). Speed reduction in the shoulder seasons and summer can also be achieved to a lesser degree.

6.3 MARKET POTENTIAL AND ESTIMATED PARTICIPATION

In 2002, approximately 220 potato storage facilities existed in the Pacific Northwest (Idaho, Montana, Oregon and Washington). These facilities used an estimated 193,000 MWh/yr and had a cumulative savings potential of 39,000 MWh/yr. The majority are concentrated in southern Idaho, eastern Oregon, and Washington.[1] The market for potato storage specifically in Rocky Mountain Power territory in Utah, however, is minimal. Because of this we recommend that a listed measure for potato storage fan VFDs not be established for Utah. Any project activity could be accommodated with standard offer incentives using the calculator.

[1] Ekman, A., Degens, P., Morton, R., Scott, S., Focus on Cold Storage Evaporator Fan VFDs is a Market Transformation Success

7 ADAPTIVE REFRIGERATION CONTROLS

7.1 MEASURE DESCRIPTION

Two brands of controllers that optimize operation of unitary refrigeration equipment have entered the market in the past three years: the KE2 Therm Evaporator Efficiency controller and the Cool Expert MIC QKL e3 controller. These are distinct from previous offerings in two ways. First, they do not focus on a single aspect of the refrigerated as past refrigeration measures have. Second, they do not merely skip defrost cycles and cycle evaporator fans when the compressor is off; rather they use sensors to pick up on conditions as they change throughout the day and the season and they adapt fan and defrost operation accordingly. For this reason we have termed them "Adaptive Refrigeration Controllers."

Both of these controllers take over the role of the thermostat, the defrost time clock, and the defrost temperature termination switch for walk-in coolers and freezers. Applicable system sizes range from the 60 sq ft coolers in fast food restaurants to distribution centers reaching tens of thousands of square feet. Freon-based unitary systems are the primary market, but the controllers have been applied in ammonia systems as well.

The controller is mounted either inside or outside the refrigerated space. Temperature sensors are located in the evaporator coil itself and in the circulating airstream as it is about to enter the evaporator. KE2 Therm offers an optional pressure sensor as well, which is used if one wishes to monitor superheat or control it directly with the optional electric expansion valve add-on.

The controllers function by cycling evaporator fans off when refrigerant is not flowing to the evaporator or by slowing the fans when two-speed electronically commutated motors (ECMs) or VFDs are in place. However, this is not simple fan cycling. Fans run a portion of the time when the compressor is off in order to circulate air and sublimate frost, recovering some of the cooling that had been tied up in frost. They also control defrost initiation, defrosting only when sufficient frost has accumulated to reduce the coil's heat transfer capacity by 10%, based on the rate of change of the sensed temperature difference between the coil and return air. Electric defrost is pulsed, giving the heat an opportunity to migrate through tubing and fins, creating fewer local hot spots that vaporize moisture – the cause of condensation and icing. In many installations, defrost frequency drops from three per day to one per day or even one every two days. Controllers automatically adapt to changes in season, product loading, and operating schedule.

Both KE2 Therm and Cool Expert are positioned as retrofit control solutions. In addition, several Original Equipment Manufacturers have incorporated the KE2 Therm controller into their new product offerings as a premium upgrade option.

The KE2 Therm controller offers two additional energy-related options – a sensor package for measuring superheat directly, and a built-in electronic expansion valve (EEV) control board. The superheat sensor package includes a pressure transducer and a temperature sensor which are installed at the point where refrigerant leaves the evaporator. The degree of superheat can then be read directly on the controller's display, which provides the information needed by the technician to manually set the superheat at the (mechanical) thermostatic expansion valve (TXV). This in itself can save significant energy because superheat levels are often higher than they need to be, because they were conservatively set years ago and haven't received much attention since.

The EEV control board provides an opportunity to replace the TXV with an EEV. This add-on to the controller project saves additional energy by automatically managing superheat to a user-defined set point, optimizing the usage of the evaporator surface area as above. With an EEV, there is no need to maintain the customary 100 psi minimum pressure differential across the expansion valve in order to make sure it feeds correctly. The EEV is driven by a servomotor, not by fluid pressure. This provides an opportunity to reduce the high side pressure by running the condenser fans more during cooler outdoor ambient conditions, which reduces compressor power and increases compressor capacity, saving a great deal of energy. (If a holdback valve is present, it may need to be adjusted, disabled, or removed.)

7.2 HOW THE MEASURE REDUCES ENERGY USE

Primary energy savings comes from reduced evaporator fan runtime and reduced defrost runtime. These reductions lead to less equipment heat load in the refrigerated space, reducing load on the entire system, so compressor runtime drops as well. Further savings accrue from resetting the superheat at the TXV, installing the optional EEV to automatically manage superheat, and making changes to the controls on the high side of the system (condenser fan and holdback valve controls) to operate at reduced high side pressure when outdoor conditions permit.

7.3 APPLICABLE CODES AND STANDARDS

The Energy Independence and Security Act of 2007 (EISA), effective January 1, 2009, contains several provisions relating to walk-in efficiency, but none that relate directly to the refrigeration controls. There is a provision on evaporator fan motors that affects efficiency calculations – walk-ins 3,000 sq ft and smaller must use either electronically commutated motors or three-phase motors for evaporator fans under one horsepower and less than 460 volts. (This eliminates the traditional permanent split capacitor and shaded pole options.) Condenser fan motors under one horsepower must use either electronically commutated motors, permanent split capacitor motors, or three-phase motors. This requirement saves fan motor energy, which reduces savings from adaptive refrigeration controls in new construction installations. The calculator will capture this effect.

7.4 RELATED MEASURES OFFERED BY OTHER PROGRAMS

Utility DSM programs known to have offered custom incentives for adaptive refrigeration controllers include Seattle City Light, Avista, PacifiCorp's Energy FinAnswer, the BPA Energy Smart Industrial program, and Energy Trust of Oregon. No prescriptive incentives have yet been identified. However, managers at National Energy Conservers, the distributor for Cool Expert in North America, are currently working with PG&E and the Southern California utilities in an effort to establish a prescriptive incentive.

There are several other product offerings focusing on walk-in cooler and freezer equipment. These differ from adaptive controllers in that they typically focus on the evaporator fan motor, cycling or two-speed control of evaporator fans, or defrost. They do not take over and integrate control of the entire system.

- Electronically commutated motors (ECMs) – single-phase motors under one horsepower with permanent magnet rotors that can be single-speed, two speed, or continuously variable speed. More efficient than the shaded pole or permanent split capacitor motors they replace.
- Frigitek – evaporator fan controller for either traditional motors or ECMs. Does not control defrost. Does have a three-phase model.
- NRM Cooltrol – controls evaporator fans and door heaters for walk-ins. Does not control electric defrost.
- FanMiser – one of the original evaporator fan controllers on the market. Operates fans in two-speed mode by reducing voltage to the motors.
- Fan Ally by Supermarket Energy Technologies – two speed evaporator fan controller for ECMs.
- SDK Smart Defrost Controller – reduces defrost operation by omitting unnecessary defrost cycles.

7.5 INFORMATION FROM MARKET ACTORS – SUPPLIERS, DISTRIBUTORS, CONTRACTORS

The two brands of adaptive refrigeration controllers approach the market in distinctly different ways. The primary sales channel for KE2 Therm is the traditional refrigeration wholesale supply houses where contractors go to purchase systems, parts, and supplies. Examples include Thermal Supply in the Northwest and G.A. Larson in Utah. The new construction primary channel is via partnerships with OEMs such as Century Refrigeration, where the OEM integrates the KE2 Therm controller into a system and sells the system under a specific brand identity. KE2 Therm builds contractor awareness through the trade press, trade shows, and sales visits to wholesalers. They drive traffic to their website where full information on benefits, technical details, and theory of operation are offered. Contractors or buyers initiate most sales.

The primary sales channel for Cool Expert, in contrast, is a direct selling approach to management at large fast food and refrigerated warehouse chains. The product is represented by National Energy Conservers out of Lake Oswego, OR, with sales reps located in Oregon and on the east coast. Most sales are generated by the sales reps, who then work with the buying firm to select and train contractors.

Cascade Energy staff has met with both controller companies numerous times. Both companies are eager to work with utility programs to help communicate the value of a controller retrofit to refrigeration users and contractors. Despite the benefits and incentives, however, refrigeration controllers are not yet an easy sell. Refrigeration equipment is, for the most part, “out of sight, out of mind” as far as the user is concerned. Contractors are often hesitant to try anything unfamiliar that might upset the system and result in downtime and lost product. Nonetheless, the benefits of these controllers, especially in terms of monitoring and remote diagnosis, are compelling. As market awareness spreads so that people begin to know other people who have installed them, contractor interest in pushing the product will grow.

7.6 RECOMMENDED METHOD OF DETERMINING SAVINGS AND INCENTIVE

Energy savings per controller ranges from approximately 3,000 kWh for small walk-in coolers to 30,000 kWh for large freezer units. Projects size varies from one or two controllers in a fast food outlet to 30 or 40 for a distribution center with many evaporators. The primary variables affecting savings are compressor hp, local climate, target space temperature, and defrost type and setup. Other factors include activity level in the space and whether or not the refrigeration equipment is oversized, undersized, or just right for the load conditions.

Because of all these factors, a calculator that estimates savings based on the conditions at each specific site is recommended. The calculator file, *Adaptive Refrigeration Control Calculator ARC ESE v2.0.xlsm*, accompanies this report. A user and technical reference document, *ARC ESE Explanation of Inputs 06 2013.docx*, also accompanies this report. Typically the calculator would be operated by program staff using information provided by the contractor and/or the customer. Some trade allies, once they have experience with multiple project installations, may wish to operate the calculator themselves. In these instances program staff would support this interest and assist the trade ally in developing understanding of the calculator.

The wattsmart custom incentive rate of $0.15/kWh with the 70% project cost cap and the one year payback cap is recommended.

7.7 RECOMMENDED DELIVERY MECHANISM

The post-purchase application with incentive and savings determined by the Adaptive Refrigeration Calculator is recommended. Savings, project costs, and incentive amounts are subject to approval by PacifiCorp. In practice, the analysis will nearly always be completed and discussed with the customer prior to implementation of the measure because of the role that the savings information plays in the customer decision.

7.8 BASELINE DEFINITION AND ELIGIBILITY CRITERIA

Retrofit projects are expected to make up the majority of installations. New construction projects are also eligible. There is no difference in the calculation between new construction and retrofit. The baseline in a retrofit situation is the existing equipment. New construction baselines are affected by the EISA national standard for walk-in equipment, requiring electronically commutated motors for refrigerated spaces 3,000 sq ft and under. Condenser fan baseline efficiency may also be affected under certain circumstances. There are no standards or codes specifically affecting baseline head pressure or which type of expansion valve to use in either new construction or retrofit. Baseline head pressure will be in the 180 to 220 psi range, depending on refrigerant, and the baseline expansion valve will be the mechanical thermostatic type. An electric expansion valve installed at the same time as an adaptive controller will save significant additional energy. The calculator will address such cases.

7.9 MEASURE COST, SAVINGS, MEASURE LIFE, CUSTOMER ECONOMICS

Equipment cost for adaptive controllers ranges from $800 to approximately $3,000 per controller, depending on brand and options. Installation cost varies. Simple situations within reach of a ladder would require three to five hours at approximately $85/hr. More difficult spaces – freezers with product in the way and evaporators mounted high in the space – require more time. Installation can double the cost of the controller. As a result installed cost will vary in the range from about $1,200 to $6,000 per controller.

Energy savings varies from approximately 3,000 to 30,000 per controller. Customer payback after incentive typically ranges from 0.8 year to 7 years.

The controller is designed to last the life of the refrigeration equipment, which for new equipment is in the 15 year range. Retrofits would be the same 15 years for the controller, though the remaining life of the baseline equipment is unknown. Users do not tend to engage in much early replacement of refrigeration equipment, however, which tends to point toward long equipment life in practice.

7.10 NON-ENERGY BENEFITS

Adaptive controllers bring several benefits to both user and service technician.

1. Receive alarms by text or email when something is wrong.
2. Look at the system remotely to diagnose issues before rolling the service truck at 1 a.m.
3. Monitor space temperature and defrost events over time.
4. Maintain more stable temperature with fewer and less severe temperature excursions during defrost cycles.
5. Drastically reduce problems with icing and dripping.
6. Gain back some refrigeration capacity currently lost to inefficiency.

With the KE2, monitoring and communication features are accessed by connecting the controller to a router with CAT5 Ethernet cable. No further software is needed. Each controller has a MAC address, so all you need is the browser on your laptop or smartphone to access the unit. The Cool Expert controller uses LonWorks, so an add-on communication module is needed.

7.11 REFERENCES

– www.ke2therm.com
– http://www.neconservers.com/neconservers.com/refrigeration_controls.htm
– NRM Cooltrol case studies by sector
– http://www.nrminc.com/national_resource_management_case_studies_cooltrol_cooler_control_systems.html
– Fan Ally
– http://www.supermarketenergytech.com/product-category/refrigeration-controls/
– Fan Miser
– http://geminc.us/web/index.php?option=com_content&task=view&id=39&Itemid=73

8 FAST ACTING DOORS

8.1 MEASURE DESCRIPTION

This measure involves the installation of a fast acting door (also known as a high speed door) on the entrance to a refrigerated space to reduce net infiltration load on the refrigeration system. Typically these doors replace existing strip curtains or a manually operated door which separates a cooler from a freezer or a refrigerated space from an unconditioned room or the outside (ambient). Fast acting doors rapidly open and close and can be triggered by sensors, pull chords, and/or timers to ensure doors remain closed as much of the time as possible. This reduces infiltration, thereby saving refrigeration energy.

8.2 HOW THE MEASURE REDUCES ENERGY USE

Fast acting doors reduce the infiltration of warmer air into refrigerated spaces which reduces the load on the refrigeration equipment (compressors, condensers, and evaporators), saving energy. Existing freezer doors can have large electric resistance heaters for defrost. Replacing these with doors that instead have defrost blowers can save additional energy.

Savings is a function of operating hours, traffic level, baseline door type, baseline heater type if any, and temperature differential between inside and outside the affected space.

8.3 APPLICABLE CODES AND STANDARDS

California

California Energy code, Title 24, applies to this measure. Title 24, Section 120.6 dictates "Passageways between freezers and higher-temperature spaces, and passageways between coolers and non-refrigerated spaces, shall have an infiltration barrier consisting of strip curtains, an automatically-closing door, or an air curtain designed by the manufacturer for use in the passageway and temperature for which it is applied." Openings less than 16 ft^2 and dock doorways for trailers are exempt. This applies to the current 2008 and proposed 2012 Title 24 code, the latter of which will becomes effective January 1, 2014. This is interpreted to mean that the baseline would be strip curtains, because it is much lower cost than automatically closing doors or air curtains. The code applies to new construction projects. [2]

Idaho

Idaho has adopted the 2009 International Energy Conservation Code (IECC) as the state energy code. A review of the code indicates there are no implications for this measure.[3], [4]

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[2] http://www.energy.ca.gov/title24/
[3] http://adminrules.idaho.gov/legislative_books/2011/pending/11H_BUSINESS.pdf

Utah

Utah has adopted the 2009 International Energy Conservation Code (IECC) as the state energy code. A review of the code indicates there are no implications for this measure.[5], [6]

Washington

Washington has adopted the 2012 International Energy Conservation Code (IECC) with amendments, known as the Washington State Energy Code (WSEC). Section C402.6 of the WSEC states:

> *Refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with all of the following:*
>
> *a. Shall be equipped with automatic door closers that firmly close walk-in doors that have been closed to within 1 inch of full closure.*
>
> *Exception: Doors wider than 3 feet 9 inches or taller than 7 feet.*
>
> *b. Doorways shall have strip doors (curtains), spring-hinged doors, or other method of minimizing infiltration when doors are open.*

This is interpreted to mean doors less than 3'-9" wide and shorter than 7' high must have automatic door closers, and all other doors must have a minimum of strip curtains. This size limitation carries limited implications for the fast acting door measure, because most doors being considered for incentives are significantly larger than this. The code applies to new construction projects. [7]

Wyoming

Wyoming does not have a statewide energy code. However, the eight most populated cities and counties have energy codes that meet IECC 2006 or equivalent, and two counties are moving toward IECC 2012 in the future. Assuming IECC 2012 is the most stringent code that will apply in Wyoming, this code was reviewed and there are no implications for this measure. [8], [9]

8.4 RELATED MEASURES OFFERED BY OTHER PROGRAMS

Utility DSM programs known to have offered custom incentives for this measure include the BPA Energy Smart Industrial program, Energy Trust of Oregon, Idaho Power, and PacifiCorp's Energy FinAnswer.

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[4] 2009 International Energy Conservation Code, International Code Council, Inc., June 2010

[5] http://www.energycodes.gov/adoption/states/utah

[6] 2009 International Energy Conservation Code, International Code Council, Inc., Jan 2009

[7] http://apps.leg.wa.gov/wac/default.aspx?dispo=true&cite=51

[8] http://www.energycodes.gov/adoption/states/wyoming

[9] 2012 International Energy Conservation Code and Commentary, International Code Council, Inc., May 2011

In 2011, Avista offered prescriptive rebates in Washington and Idaho for Retrofit (not new construction) projects for freezers and coolers at $80 and $30 per square foot. Additionally the requirements were as follows:

> "Fast-acting door incentives are not available for new doors with heated air curtains. Bi-fold doors must open or close within 1.5 seconds and have a minimum R-value of 4 and rapid roll doors must open or close within 4 seconds to qualify for incentives."

Xcel Energy in Colorado offers custom rebates up to $400/kW saved, which typically results in incentives from $1 to $50 per square foot of door opening.[10], [11]

[10] http://www.avistautilities.com/savings/rebates/Documents/2011_Avista_Comm_RefrigeWHIncent_Form-final.pdf

[11] http://www.xcelenergy.com/staticfiles/xe/Marketing/CO-MN-Recommisioning-High-Speed-Door.pdf

8.5 INFORMATION FROM MARKET ACTORS – SUPPLIERS, DISTRIBUTORS, CONTRACTORS

The following table is a brief summary of recent collaboration between Cascade and fast-acting door suppliers.

Table 4: Table Fast Acting Door Supplier Information

Vendor	Door Brand	Salesmen	Summary
Arbon	Rite Hite	Zach Anhorn Grant Halone	Arbon is major sales/dist of Rite Hite equipment. Arbon did 6 projects with us over '11-'12. Zach is new, he likes the program, is detailed oriented and continues to bring in leads.
Northwest Handling Systems	RyTech	Jason Simpson Tyler Hull Rick Brown	NWHS is #1 competitor with Arbon as the distributor of similar products under the RyTech brand. 6 projects over '11-'12. Continuing to bring in qualified leads which have moved forward nicely
DACO	ASI Doors	Mike Callahan Shad Huber	Small distributor for ASI Doors. New vendor participation in '13
Cold Chain	Cold Chain	Robert Spence	Small door vendor since Cold Chain started making their own doors recently. Robert Spence is sole salesman on West Coast. New vendor
LaCosta Doors	RyTech	Howard Cagan	New vendor operating from California
ASI Doors	ASI Doors	Josh Hearn	Josh is the local rep for door supplier ASI Doors. New vendor
Mike Bruce Construction	Goff	TBD	New vendor selected by customer
Industrial Equipment Solutions Inc.	Rytec	Dave Barrett	Vendor in Naches, WA
McCormick Equipment Company, Inc.	Rite Hite		McCormick is based in OH, serving project in UT

The prospect for future high speed door projects seems strong. Cascade encountered 22 projects within the last six months in Energy Trust of Oregon territory alone by stepping up personal outreach efforts. Doors are primarily sold to facilities with large refrigerated spaces, including refrigerated warehouses and food production facilities.

8.6 RECOMMENDED METHOD OF DETERMINING SAVINGS AND INCENTIVE

Historically, fast acting door projects in PacifiCorp have taken the Energy FinAnswer custom analysis route. Typically data logging is not part of the pre-project analysis. However, key data is collected, including:

- Door dimensions, operating hours per day, and cycles per day
- Door effectiveness (an indication of infiltration level when the door is closed)
- Anticipated high speed door cycles per day
- Anticipated high speed door cycle time (time to open, allow traffic to pass through, then close)
- Space temperature on both sides of the door, including TMY3 ambient temperature if applicable
- Relative humidity of the refrigerated space
- Refrigeration equipment information (compressor, condenser, and evaporator type)
- Wind speed on exposed doors (TMY3 data)
- Door orientation with respect to prevailing wind direction

An energy model is created with the above information and infiltration equations from the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Refrigeration Handbook. This model is used to estimate energy pre and post energy use prior to project implementation. Post installation data logging often occurs to validate energy savings as part of project commissioning.

Cascade has created a simplified tool to estimate energy savings for the vast majority of high speed door projects that PacifiCorp has historically seen. This tool incorporates the key inputs listed above and is derived from the same calculation methodology used in custom analysis. A copy of this tool, the "*Cascade Energy – Fast-Acting Door Tool v2.3.2.xls"* has been submitted as an attachment to this report. Details of the tool are described in the next section

Cascade Tool Details:

The tool includes all of the inputs listed above with the following key exceptions:

- Instead of 8,760 hours of weather data, the tool utilizes simplified bin weather data (Dry Bulb and Relative Humidity). Currently the tool is equipped with weather data from 41 cities that represent climate conditions in the majority of the PacifiCorp territory, and weather data for further sites may be added if needed.
- Refrigeration equipment efficiency is based on averages of manufacturers' ratings and generic part load curve fits.

Key inputs that most drastically affect energy savings are run hours, temperature differential between spaces, and expected door cycles per day.

Cascade recommends using the wattsmart Business custom incentive rate and caps.

8.7 RECOMMENDED DELIVERY MECHANISM

Cascade recommends an approach that engages with vendors to identify and bring energy savings projects to the PacifiCorp program.

8.8 BASELINE DEFINITION AND ELIGIBILITY CRITERIA

For new construction projects, state energy code dictates the baseline as a minimum of strip curtains in California and Washington. There is no code-established baseline for retrofit situations in all states or for new construction in Idaho, Utah, and Wyoming. Cascade recommends the baseline to be the existing door for retrofits. For new construction, it is recommended that strip curtains be taken as the baseline for all projects, but that exceptions are allowed if the customer can make a case for their need for no strip curtains.

For retrofits, any existing door, including an automatic door that is slow to operate, would be eligible.

8.9 MEASURE COST, SAVINGS, MEASURE LIFE, CUSTOMER ECONOMICS

<u>Costs</u>

High speed doors range in price from $10,000 to $30,000 (installed) with an average of about $20,000. Lower cost doors are generally roll-up doors with thin material. Doors increase in cost with the addition of features, such as:

- Break-away design (resistance to fork lift damage)
- Increased insulation
- Increased open and close speed
- Close delay timers
- Photo eyes
- Slider style (not roll-up)
- Defrost blowers

<u>Savings</u>

Typical cooler door upgrades can save between 5,000 and 40,000 kWh/yr while freezer doors can save between 25,000 and 100,000 kWh/yr per door. Overall averages fall in the 30,000 to 40,000 kWh/yr per door range.

<u>Measure Life</u>

Recommend 15 year life.

<u>Economics</u>

Fast acting door projects can have simple paybacks ranging from five to ten years or more. For projects eligible for incentives, these have historically capped on the energy savings limit ($/kWh). Often non-energy benefits play a factor in the customer's decision to move forward with the project.

8.10 NON-ENERGY BENEFITS

Non-energy benefits include:

- Reduced maintenance on existing doors. Specifically this can include replacing failed strip curtains, rebuilding slider doors, and repairing doors impacted by fork lifts. Sometimes new doors have break-away features, allowing them to disconnect upon impact. These can easily be reconnected and require no repair work.
- Reduction in icing issues associated with leaky doors in freezers

8.11 MARKET POTENTIAL AND ESTIMATED PARTICIPATION

In 2002, there were approximately 236 controlled atmosphere and 245 cold storage facilities in the Pacific Northwest (Idaho, Montana, Oregon, and Washington), with at least nine high speed door vendors serving the west coast.[12] In addition, there are numerous smaller commercial opportunities. Vendor focus and persistence has been seen to be a key ingredient in high speed door sales. We estimate that vendor-driven door sales will begin at a modest pace, with approximately eight projects per year anticipated in the first year, with growth thereafter.

[12] Ekman, A., Degens, P., Morton, R., Scott, S., Focus on Cold Storage Evaporator Fan VFDs is a Market Transformation Success

9 COMPRESSED AIR END USE REDUCTION

9.1 MEASURE DESCRIPTION

In the past, compressed air efficiency efforts have been focused primarily on the supply side of the system – the compressors, dryers, and filtration equipment. The demand side – end use equipment and distribution piping – is commonly recognized as a source of savings, but the extent of practical implementation of specific measures has been limited to date. This measure consists of a collection of methods by which compressed air use may be reduced on the demand side of the system. The process entails estimating cfm reduction, then calculation and claiming savings on the basis of that cfm reduction. Common opportunities include engineered air nozzles in place of plain nozzles (or no nozzle at all), isolation valves, sensor-operated solenoid valves, and replacement of equipment that consumes air with equipment that does not, such as electrical cabinet coolers or air-operated diaphragm pumps.

9.2 RELATED MEASURES OFFERED BY OTHER PROGRAMS

Utility DSM programs known to have offered custom incentives for compressed air reduction measures include the BPA Energy Smart Industrial program, Energy Trust of Oregon, and Energy FinAnswer. Energy Trust is currently investigating a Small Industrial compressed air leak repair offering.

Table 5: Similar Incentive Programs

Programs offering similar incentives	Measure	Incentive
Xcel Energy	Zero Loss Drains	$200/Zero Loss Drain Installed
District of Columbia Sustainable Energy Unit	Zero Loss Drains	$150/Zero Loss Drain Installed
Efficiency Vermont	Zero Loss Drains	$100/Zero Loss Drain Installed
Energy Trust of Oregon	Zero Loss Drains	$60/Zero Loss Drain Installed
Southern Minnesota Municpal Power Agency	Leak Repair	$4/Compressor hp, to complete a leak sweep and repair 50% of leaks
RPU; Rochester, MN; largest municipal utility in MN	Leak Repair	$4/Compressor hp, to complete a leak sweep and repair 50% of leaks
Wells Public Utilities	Leak Repair	$4/Compressor hp, to complete a leak sweep and repair 50% of leaks
District of Columbia Sustainable Energy Unit	Efficient Air Nozzles	$20/Air Entraining Nozzle Installed
Efficiency Vermont	Efficient Air Nozzles	$5/Air Entraining Nozzle Installed (Under 14 scfm)

9.3 INFORMATION FROM MARKET ACTORS – SUPPLIERS, DISTRIBUTORS, CONTRACTORS

The following is a brief summary of recent collaboration between Cascade and vendors that support and supply equipment and services for reducing consumption of compressed air.

<u>Sonic Air Systems</u>

Mike Landsperger

Regional Sales for the Western United States

714-989-5923

Mike says that using a blower to replace compressed air where practical will result in an equivalent power reduction of 75%. Usually these measures have a great return on investment.

__Exair – Air Nozzles and Intelligent Compressed Air Products__

Dave Woerner

Application Engineer

513-671-3322

Exair's Nozzles are well accepted in the industry. These nozzles, safety air guns, air knives, etc. are easy to replace existing "inefficient" equivalents. Often OSHA requires safety nozzles, so having an incentive to install efficient safe nozzles would be a relevant upgrade.

9.4 RECOMMENDED METHOD OF DETERMINING SAVINGS AND INCENTIVE

Reductions in compressed air end use produce very good energy savings in some situations, but only marginal savings in others. The main drivers of savings are run hours and the type of part load control used by the trim compressor. VFD, start/stop, and load/unload compressors all use significantly less energy as load is reduced. Energy use for Inlet modulating compressors, however, varies only slightly with change in loading.

A simplified tool for estimating end use reduction in compressed air use accompanies this report, the Excel file, *"Compressed Air Demand Reduction Calculator.xls."* It can be used to estimate energy savings for the vast majority of compressed air reduction measures typically seen in an industrial facility. The tool uses the calculated flow reduction and estimated power penalty for new equipment. Savings are based on power vs. flow relationships for the trim compressor specified at the facility. This tool may either be used to calculate savings directly, or the cfm reduction can be transferred into the *NW Regional Compressed Air Tool v2.7.xls* calculator to estimate savings. Details of the tool Compressed Air Reduction Calculator are described below.

__Cascade Tool Details:__

The tool includes the following:

- Determine existing flow requirement and annual operating hours.
- Determine new flow requirements if any and annual operating hours.
- Input compressor type to determine power and energy savings associated with the flow reduction.
- Determine the power of new electric equipment and operating hours.

9.5 RECOMMENDED DELIVERY MECHANISM

Opportunities for compressed air end use reduction may be identified by trade ally staff, customer maintenance or operating staff, or engineers scoping a facility in the course of a Custom Project engagement. Specific interventions may be identified, but because they are often small (relative to a new 250 hp compressor, for example) they tend to receive little attention. A calculator-based method of determining savings is proposed in order to streamline the administration of incentive funding to help these projects get the attention they need to get off the ground. A program staff engineer would estimate savings on a site-specific basis. The incentive is based on the custom incentive rate and caps. Leads are generated opportunistically during site visits for other purposes or projects. This is less of a broad market offering for all comers than it is a way to practically address savings opportunities uncovered during the course of other projects.

9.6 BASELINE DEFINITION AND ELIGIBILITY CRITERIA

The baseline is the existing compressed air demands and compressors operating as observed. OSHA has some requirements regarding compressed air systems. These do not affect the baseline system definition or eligibility of the project types identified. The OSHA requirements can be found at the website below.

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9823

9.7 MEASURE COST, SAVINGS, MEASURE LIFE, CUSTOMER ECONOMICS

Costs

Compressed air demand reduction measures range widely in price from $30 to $25,000. Low cost measures such as air nozzle replacement can be inexpensive ($30), while higher cost measures such as identification and repair of leaks could be as high as $25,000 or more.

Savings

Typical energy savings could be in the range between 530 and 600,000 kWh/yr. Larger engagements may be more appropriately addressed through another program offering such as Energy Management.

Measure Life

Recommend 15 year life for capital measures where a compressed air use is removed or replaced. Incentive rate would be the usual $0.15/kWh.

Economics

Compressed air demand reduction projects can have simple paybacks ranging from several months to several years. For projects eligible for incentives, these have historically capped on project cost as energy savings are often relatively large.

Below is a summary of some sample projects and economics.

Table 6: Sample Compressed Air Demand Reduction Projects and Economics

Existing	Meas. Life, yrs	Baseline Flow, cfm	Annual Op. hrs	Annual kWh/year	Measure	Total EEM kWh/yr	Savings, kWh/yr	Cost Savings/ year	Installed Cost	Pre-Incentive Payback, Years	Incentive	Cost after incentive	Post-Incentive Payback, Years
Small AOD Pump	15	19	4000	10,857	Install Small Electric Pump	1,657	9,200	$ 460	$802	1.74	$ 561	$241	0.5
Large AOD Pump	15	155	4000	88,571	Install Large Electric Pump	16,571	72,000	$ 3,600	$2,593	0.72	$ 1,815	$778	0.2
Air Receiver Timed Drain	15	5	8760	6,257	Install Zero Loss Drain	0	6,257	$ 313	$326	1.04	$ 228	$98	0.3
Air Leaks Small Facility	3	25	6000	21,429	Repair Air Leaks	10,714	10,714	$ 536	$625	1.17	$ 438	$188	0.4
Air Leaks Large Facility	3	1000	8760	1,251,429	Repair Air Leaks	625,714	625,714	$ 31,286	$25,000	0.80	$ 17,500	$7,500	0.2
Un-Used Small Equipment	15	5	6000	4,286	Install Isolation valve (50% of time)	2,143	2,143	$ 107	$304	2.84	$ 213	$91	0.9
Un-Used Section of Large Mill	15	250	8760	312,857	Install Isolation valve (50% of time)	156,429	156,429	$ 7,821	$3,781	0.48	$ 2,647	$1,134	0.1
1/4" nylon tube constant blowing on camera (cleaning)	15	12	8760	15,017	Reduce Operation time to 5 seconds out of 60 seconds	1,251	13,766	$ 688	$434	0.63	$ 304	$130	0.2
1/2" NPT pipe blow off	15	150	8760	187,714	Operate only when product is present (no product 2' out of 10' on a conveyor)	150,171	37,543	$ 1,877	$434	0.23	$ 304	$130	0.1
1/4" tube blow gun	15	12	1000	1,714	Install high efficiency nozzle	1,186	529	$ 26	$29	1.10	$ 20	$9	0.3

9.8 NON-ENERGY BENEFITS

Non-energy benefits include:

- Reduced operation time and maintenance on the air compressors.
- Reduced noise in the facility.
- Increased safety with OSHA approved equipment.
- Increased back-up compressor capacity.
- Energy savings and the associated decreased cost results in more overall profitability for each facility.

9.9 MARKET POTENTIAL AND ESTIMATED PARTICIPATION

According to the US Department of Energy (DOE), approximately 30% of all compressed air system energy consumption feeds leaks, with additional air feeding inappropriate end uses. In 2007, DOE estimated that 57% of all facilities had made little to no effort to reduce compressed air leaks or usage.

Participation and uptake are difficult to estimate for a measure set like this. Much depends on the initiative of trade allies, end user staff, and engineers doing scopings. However, once a lead is identified, Trade Ally Coordinator staff can follow through to focus attention on the opportunity, outline the path forward, and follow up on each of the steps needed in practice to turn these opportunities into completed projects.

9.10 REFERENCES

– http://www.uesystems.com/new/wp-content/uploads/2012/08/energy-guide.pdf

10 WASTEWATER

10.1 LOW-POWER MIXERS

10.1.1 Measure Description

This measure involves the installation of floating, extended-range circulators in water/wastewater treatment facilities in order to effect mixing mechanically rather than relying on the aeration system to provide mixing. Treatment of wastewater involves two distinct needs: 1) a source of dissolved oxygen and 2) mixing or circulation to ensure contact between oxygen and bacteria as well as to keep solids in suspension. Dissolved oxygen is typically provided by an aeration system that uses electrically powered blowers. The mixing function is typically provided either by the aeration system, which is good at supplying oxygen but very inefficient at mixing, or high power floating mixers or circulators at the surface. The low-power mixer measure is essentially a low-speed, high-volume mixer analogous in its function and its energy savings to a high volume low speed fan (though the geometry of the circulation pattern is different). The mixer draws water from a user-specified depth below the surface of the pond, and distributes this higher density water in a near-laminar long distance horizontal flow projection that efficiently circulates water within the treatment pond or cell by taking advantage of the difference in density between stratified layers of water. By varying the intake depth, units can be used in different types of treatment cells, including complete-mix, partial mix, and facultative ponds and basins. The mixing effect is improved with dramatically less energy input.

Ponds using surface aerators are designed to meet two distinct requirements: oxygen transfer (pounds O_2 per hour) and mixing intensity (horsepower per million gallons). In the vast majority of cases, mixing intensity is the limiting factor that drives the design, resulting in a system that adds more oxygen than necessary for full treatment. Once the biological oxygen demand is met, the excess oxygen simply elevates the residual dissolved oxygen (DO) levels within the pond, adding no value. Floating aerators, the typical baseline alternative, have a relatively small zone of influence in which much of the water sprayed out in the donut shape at the surface cycles back toward the center of a vertical, toroidal circulation patterns with a radius of roughly 1x or 2x pond depth. Because of the relatively small zone of influence, many such mixers are needed to reach the entire volume of the pond or lagoon, driving up energy requirements.

The low-power mixers reduce energy use by reducing the average amount of aerator horsepower in operation. First, in cases of large partial-mix and facultative ponds, improved circulation brings more wastewater into contact with the air-water interface at the surface of the pond thereby improving overall oxygen transfer within the cell by taking advantage of natural oxygenation. Second, the circulators provide mixing velocity that helps prevent solids from settling out while also moving water into and out of the existing aerators' zone of influence. This helps decouple mixing energy from aeration energy and allows the aerators to be controlled by oxygen demand rather than mixing intensity. This allows a reduction in the number of existing aerators that must operate at one time to maintain treatment.

Upgrades may also include the addition of an on-line dissolved oxygen (DO) probe that can achieve additional savings by cycling existing aeration systems to maintain a set point DO level. Alternately the existing aerators can be cycled on and off with timers based on daily or weekly DO checks with portable probes. The low-power mixers typically operate continuously.

Primary applications are anticipated to be in wastewater treatment plants (WWTPs) with partial and total mix lagoons and activated sludge basins.[1] Additionally, units “have been successfully implemented in potable water tanks and reservoirs… and it also has been used to improve water quality in freshwater lakes, reservoirs and estuarine environments.”[2]

10.1.2 How the Measure Reduces Energy Use

Energy savings is achieved by reducing the runtime of the existing aeration system. Low-power mixers, drawing only 100 to 150 watts per unit (depending upon model size), can run all of the time without substantially increasing facility power use. Typically one low-power mixer can offset 30 to 40 horsepower of existing aeration and mixing power.

10.1.3 Applicable Codes and Standards

California

A review of California Energy code, Title 24, indicates there are no implications for this measure.[3]

Idaho

Idaho has adopted the 2009 International Energy Conservation Code (IECC) as the state energy code. A review of the code indicates there are no implications for this measure.[4],[5]

Utah

Utah has adopted the 2009 International Energy Conservation Code (IECC) as the state energy code. A review of the code indicates there are no implications for this measure.[6],[7]

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[1] *Solar-Powered Circulator Technology Energy Assessment Project*, Application Assessment Report No. 0810, Quantum Energy Services & Technologies, Inc., Pacific Gas & Electric, 2008. http://www.etcc-ca.com/images/stories/solarbee_etcs_report_final.pdf

[2] Randolph, E.F., Advice Letter 2640-E, SCE and PG&E Request to Provide Stand-Alone Solar-Powered Water Circulators as a Measure in the 2010-2012 Energy Efficiency Portfolio, State of California Public Utilities Commission, April 3, 2012. https://www.sce.com/NR/sc3/tm2/pdf/2640-E.pdf

[3] http://www.energy.ca.gov/title24/

[4] http://adminrules.idaho.gov/legislative_books/2011/pending/11H_BUSINESS.pdf

[5] 2009 International Energy Conservation Code, International Code Council, Inc., June 2010

[6] http://www.energycodes.gov/adoption/states/utah

Washington

A review of Washington State Energy Code (WSEC) indicates there are no implications for this measure.[8]

Wyoming

Wyoming does not have a statewide energy code. However, the eight most populated cities and counties have energy codes that meet IECC 2006 or equivalent, and two counties are moving toward IECC 2012 in the future. Assuming IECC 2012 is the most stringent code that will apply in Wyoming, this code was reviewed and there are no implications for this measure.[9], [10]

10.1.4 Related Measures Offered by Other Programs

Utility DSM programs known to have offered custom incentives for this measure include the BPA Energy Smart Industrial program, Energy Trust of Oregon, Idaho Power, Illinois Clean Pilot Program, PacifiCorp Energy FinAnswer, PG&E, PSE and SCE (Southern Cal Edison). [11],[12] PacifiCorp is currently working on a project with the City of Selah.

In 2008, PG&E's Emerging Technologies Program studied the energy efficiency potential of the SolarBee brand of low-power mixer. The studied included the results of eight successfully implemented projects in PG&E territory, with an average site savings of 770,000 kWh/yr and payback of 3.77 years.[13] Based on the results of this and other studies by SCE, the State of California Public Utilities Commission is currently reviewing the implementation of these mixers as a standard measure in PG&E's and SCE's Energy Efficiency (EE) portfolio of offerings.[14] The measure was previously offered in the 2006-2008 EE portfolio, and is up for permanent renewal.

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[7] 2009 International Energy Conservation Code, International Code Council, Inc., Jan 2009

[8] http://apps.leg.wa.gov/wac/default.aspx?dispo=true&cite=51

[9] http://www.energycodes.gov/adoption/states/wyoming

[10] 2012 International Energy Conservation Code and Commentary, International Code Council, Inc., May 2011

[11] https://www.sce.com/NR/sc3/tm2/pdf/2640-E.pdf

[12] http://www.illinoiscleanenergy.org/waste-water/

[13] Solar-Powered Circulator Technology Energy Assessment Project, Application Assessment Report No. 0810, Quantum Energy Services & Technologies, Inc., Pacific Gas & Electric, 2008. http://www.etcc-ca.com/images/stories/solarbee_etcs_report_final.pdf

[14] Randolph, E.F., Advice Letter 2640-E, SCE and PG&E Request to Provide Stand-Alone Solar-Powered Water Circulators as a Measure in the 2010-2012 Energy Efficiency Portfolio, State of California Public Utilities Commission, April 3, 2012. https://www.sce.com/NR/sc3/tm2/pdf/2640-E.pdf

10.1.5 Information from Market Actors – Suppliers, Distributors, Contractors

The dominant product in the low-power mixer market is the GridBee, by Medora Corporation. Typical users include municipal and industrial WWTPs. There were about 1,600 installations in the U.S. and Canada as of 2008[15] and the vendor indicates about 200 projects are installed per year. Cascade has worked with Medora on a few GridBee projects, performing energy analysis to fulfill incentive requirements for DSM programs.

10.1.6 Recommended Method of Determining Savings and Incentive

A simplified tool-based approach is recommended for this measure because the analysis method is simple and repeatable, but energy savings depends upon equipment sizing and operating practice at each individual site. Inputs to the savings calculation include:

- Total baseline and upgrade aeration motor horsepower
- Baseline and upgrade aeration operating hours
- Number of low-power mixers to be installed
- Winter and summer operating periods

Motor power measurements on existing aerators can be used if available. Otherwise motor power is calculated based on motor efficiency (standard or premium) and motor loading. Motor load on floating aerators depends on the depth of impeller and blade design. Once an aerator is set up, motor loading remains constant (unless it is damaged or bearings fail, etc.) regardless of plant flow and load. Data from previous projects indicates motor loading varies from 77% to 105% and averages 94%. The tool suggests a value of 90%. Energy savings is calculated by subtracting upgrade aerator energy from baseline aerator energy, and adding in the small amount of low-power mixer energy. Information on aerator runtime is available by checking timer controls, the facility's SCADA system, or operator logs.

Cascade recommends utilizing the wattsmart custom incentive levels and caps for this measure.

10.1.7 Recommended Delivery Mechanism

Cascade recommends an approach that engages with vendors to identify energy savings projects across multiple states and bring them to the PacifiCorp program. The potential for a simplified, tool-based approach is evident. These projects are readily repeatable and the industry is concentrated, so there are few suppliers in the market. Relationships with these suppliers may be readily cultivated.

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[15] Solar-Powered Circulator Technology Energy Assessment Project, Application Assessment Report No. 0810, Quantum Energy Services & Technologies, Inc., Pacific Gas & Electric, 2008. http://www.etcc-ca.com/images/stories/solarbee_etcs_report_final.pdf

10.1.8 Baseline Definition and Eligibility Criteria

For new construction, the baseline is the traditionally designed aeration system using surface aerators that provide both oxygen-transfer and mixing to the pond. In some cases, new construction may include shore-based blowers and submerged aeration diffusers designed to provide both mixing and oxygen transfer. For retrofit projects, the baseline is the existing aeration system.

A variant on the low-power mixer energized solely by the grid is the solar powered mixer, which is equipped with solar panels to make use of solar energy when available. Units of the same size are nearly identical to non-solar-powered models, with the same fractional horsepower motor on a 120 volt, 15 amp circuit. The only difference is that solar-equipped model is equipped with a frame, panels, and batteries, allowing it to operating without a power source. In most wastewater applications, the solar units are also equipped with shore power cables so they are not weather dependent. They do not put power back into the grid. Cascade recommends allowing the solar powered models to be an eligible upgrade, with the following stipulations:

- The upgrade case will include the unit's energy consumption in the savings calculation, the same as an equivalently sized non-solar model. The effect on savings is small; since even the non-solar powered mixers use so much less energy than the baseline case, the solar panel feature itself adds only a small amount to energy savings.
- No solar power generation will be accounted for.
- The additional cost for solar option, estimated at $20,000 per unit, will not be considered an eligible project cost.

These stipulations are in line with the recent Energy FinAnswer project in Washington. This increases the customer's purchasing options while still allowing incentives to be offered and savings to be claimed.

10.1.9 Measure Cost, Savings, Measure Life, Customer Economics

Costs

Low-power mixers range in cost from $25,000 to $50,000 (installed) with an average of about $40,000 depending upon the size of the selected unit. As previously mentioned, the solar option typically increases total cost by $20,000 for the same size unit. That portion of the cost associated with the solar upgrade is not considered an eligible project cost.

Savings

Project savings vary from to 50,000 kWh/yr to 1.7 million kWh/yr, depending upon how many mixers are installed. Average savings appear to be slightly above 100,000 kWh/yr per unit, based on data collected from seven case studies from California, Maine, Nevada, and New Hampshire, and energy analysis reports from the two previously mentioned reports in Washington and Oregon. Note that some of these projects included the solar option, which increased project costs. These projects installed anywhere from three to 20 units, with an average of seven units per site.

Previously completed projects for PG&E and BPA have claimed demand savings. However, this does not appear universal for all projects. Cascade suggests that demand savings be evaluated and claimed on a project-specific basis.

Measure Life

Cascade recommends a 15-year measure life. SCE and PG&E have indicated that these "units have a 25-year life, with a need to replace the battery every 5 to 15 years," if the solar option is employed.[16]

Economics

Collected data indicates the measure can have a simple payback before incentives between 1.6 and 8 years with an average of 4.2 years. The study conducted by PG&E's Emerging Technologies Program found eight projects with an average payback of 3.77 years.[17]

10.1.10 Non-Energy Benefits

Non-energy benefits vary on a case by case basis, but can include:

- Reduced odor events
- Better solids digestion and decreased sludge build-up, extending time between pond dredging
- Improved mixing, prevented short-circuiting, reduced stratification and improved oxygen profiles
- Reduced run-time on existing aerators extends lifespan in calendar years and extends time between rebuild/replace
- Better performing cells can extend treatment plant life and avoid or delay upgrades

10.1.11 Market Potential and Estimated Participation

Wastewater treatment and population data was collected for municipalities in the State of Utah. Based on rough estimates of the required aeration power per person, it is estimated that at least five WWTP's in Rocky Mountain Power territory would have good potential for low-powered mixer projects, with an average site savings of approximately 140,000 kWh/yr . The potential rate of adoption is unknown. Wastewater treatments facilities often have long budget cycles, which tends to slow implementation. We have estimated one project per year at 140,000 kWh/yr per project.

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[16] Randolph, E.F., Advice Letter 2640-E, SCE and PG&E Request to Provide Stand-Alone Solar-Powered Water Circulators as a Measure in the 2010-2012 Energy Efficiency Portfolio, State of California Public Utilities Commission, April 3, 2012. https://www.sce.com/NR/sc3/tm2/pdf/2640-E.pdf

[17] *Solar-Powered Circulator Technology Energy Assessment Project*, Application Assessment Report No. 0810, Quantum Energy Services & Technologies, Inc., Pacific Gas & Electric, 2008.

10.2 REAL-TIME AERATION CONTROL

10.2.1 Measure Description

This measure involves installing sensors to optimize aeration control in wastewater treatment applications.

In most wastewater plants, the aeration system is the single largest consumer of electricity. Most modern facilities utilizing blowers and diffused air delivery systems include controls to modulate air flow. When aeration control is optimized, aerator runtime can be decreased, saving energy. Traditionally, the control is based on dissolved oxygen (DO) sensors located in the aeration basin. They can be used in conjunction with VFDs, control valves, or both to provide just enough air to meet the biological demand. This is generally set by maintaining a set point residual DO level, typically 2.0 ppm. The 2.0 ppm is excess – that is, it is residual at the surface AFTER the bugs have taken their share. Sophisticated plants with tight controls and confident operators run at lower set points. Plants with more lax control or in areas where they can be hit with spike loads run at higher DO levels to provide a buffer before running into oxygen depletion.

DO levels are a proxy, however, for what is happening inside the tank. Maintaining a positive residual DO means only that aerobic conditions have been met, and that more oxygen is present than is needed. This insures that a viable environment exists for the aerobic biology, which is critical, but in no way means that the system is operating at best efficiency.

Multiple real-time sensors are now available, besides DO, including ammonia, nitrite, nitrate, suspended solids, and oxygen-reduction potential (ORP) meters. By using a combination of sensor inputs, the amount of air added to the basin can be minimized. For example, plants that discharge to the ocean (or some large rivers) do not have nitrogen limits. Certain organisms in wastewater convert ammonia to nitrite and then to nitrate in a process called nitrification. This is an additional oxygen demand that can be as large as the oxygen demand from consuming the carbonaceous organic load. Because nitrification is an oxygen consumer, it will suppress the basin DO once initiated. A traditional control system would call for more air once nitrification starts as DO drops. Using nitrite and ammonia sensors, the control system can turn down (or turn off) the aeration system if nitrification is occurring. This stops the nitrification process.

Other plants must remove nitrogen completely from the wastewater. They are intentionally operated to go into nitrification, then denitrify (where nitrates are used for an oxygen source, freeing the nitrogen that is then released to the atmosphere.) In these plants, monitoring the ammonia:nitrite:nitrate ratios in real time allows the aeration system to provide the correct amount of air (or no air) so that the denitrification process can be optimized. This further reduces aeration demand because denitrification "gives back" a little less than half of the oxygen consumed for the nitrification process.

A further development is real-time BOD sensors. BOD is a measure of the organic load in wastewater. It is the primary pollutant that WWTPs are meant to remove. The BOD test requires five days of incubation, so a plant that tests every day is still only reacting to what was in the water five days previous. Again, DO sensors provide a proxy to control aeration, but actual BOD levels in the basin provide a real-time indicator of how much oxygen is required.

This measure is optimal for WWTPs that are aerated with submerged diffusers. Over-aeration, even with tight DO control, is common due to most facilities having a diurnal load profile, with a peak in the morning and evening and a long period overnight of very low loading. With the implementation of this measure, aeration systems are controlled based on the actual plant load, what's happening within the aeration basin, and the status of the desired or required biological activity. Energy is saved by providing only enough oxygen to insure the work is done.

At this time, Cascade recommends keeping the current custom energy analysis process for this measure in lieu of utilizing a simplified tool approach. The primary reasons include:

- Complex energy analysis – Many variables affect the energy savings that can be achieved with this measure, and it makes most sense to perform a study to account for these variables.
    - Aeration blower power is not well known without performance curve data.
    - The load profile is a large determining factor in potential energy reduction. The DO profile is highly variable from one site to the next, and data is not always available from the WWTP control system.
    - The plant's age and current flow conditions compared to ultimate design flow conditions determine to some extent how much extra aeration capacity is in use.
    - Plants that receive input from industrial facilities, especially food processors, can see seasonal swings in flow.
    - Public works construction and engineering complexities. These types of measures generally require integration with a plant's SCADA system, as well as new hardware and expensive instrumentation. Typically this involves work with a design engineering firm on a public works construction project. These are not "turn-key" projects as of yet; currently only one manufacturer is offering a "package" of programming and instrumentation for retrofit applications, and that has only been available since Fall, 2012.
- Combined measure complexity – Often additional measures, such as blower VFD retrofits, most-open-valve control strategies, and optimized sludge recycle rates pair well with this measure, but are hard to incorporate into a simplified tool.

10.2.2 Measure Cost, Savings, Measure Life, Customer Economics

Control upgrades appear to range from $30,000 to $300,000 depending on plant size and complexity, which is fairly low cost for the WWTP industry. Because aeration equipment size can vary from 10 to over 1,000 horsepower, savings is highly variable but can be substantial. Projects typically have low paybacks and DSM programs will tend to cap incentives based on project cost (not kWh/yr limits).

When moving from tight DO control to real-time process control, vendor white papers and published studies indicate savings from 7 to 20% in the aeration system. The savings can be greater than 50% when moving from minimal or no DO control.

Measure life is recommended at 15 years.

10.2.3 Non-Energy Benefits

Non-energy benefits can include:

- Improved process control and better effluent quality
- Reduced runtime and reduced differential pressure across blowers, improving bearing life
- Opportunity for further optimization by studying sensor trend data, e.g. lowering “buffer” levels during low flow periods; anticipatory moves based on predicted biochemistry, etc.
- Higher waste sludge concentration (less water pumping) through tighter control of filaments and prevention of bulking (floating) sludge in clarifiers.

10.3 SCREW PRESS SLUDGE DEWATERING

10.3.1 Measure Description

The screw press is an efficient alternative to the typical centrifugal sludge dewatering method in a wastewater treatment plant (WWTP). Screw presses require much less power, often between one-fifth and one-tenth that of an equivalently-sized centrifuge. Upgrades yield substantial energy savings.

Sludge is the settled mass of raw organic solids (primary sludge) and or active biological mass (secondary sludge – called waste activated sludge) that is collected in the bottom of the WWTP clarifiers. Its volume is reduced through digestion, typically, but ultimately it must be physically removed from the facility. To reduce the overall tonnage, sludge is dewatered to typically 25%-35% solids prior to hauling.

Sludge dewatering is often a batch process, for example, operated during day shift when the majority of plant staff are present. Some systems require near continuous operation, while others run a small fraction of the time. Polymers are mixed with the sludge to aid in extracting water.

At this time, Cascade recommends staying with the current custom project process for this measure. Primary reasons include:

- Anticipated project completion rate is low.
- Project costs are high – a driving factor in the low potential project completion rate.
- Energy analysis requires significant data logging both pre- and post-project because the motor loads vary substantially, but not necessarily linearly, with product loading.
- Baseline motor power is unknown. This has a large effect on energy saving estimates, and would be difficult to estimate with a simplified tool without power measurements.

10.3.2 Measure Cost, Savings, Measure Life, Customer Economics

<u>Costs</u>

Screw Presses can range in price from $60,000 to $500,000 for the equipment. This is due to the large variation in available sizes, which range from 8” to 50” diameter. Installation costs are typically double the equipment costs. The average screw press costs about $200,000 with an additional $400,000 in installation for a total of $600,000, as outlined by one vendor.

<u>Savings</u>

Investigation of this measure indicates energy analysis data is not readily available. Based on a few case studies and assumptions, energy savings for the measure appear to range from 50,000 kWh/yr to 500,000 kWh/yr. Energy savings seems to be highly variable. First, baseline centrifuges can be as large as 150 hp with an upgrade screw press as small as 0.5 hp. Second, run hours can vary from as little as 4 hours a month to nearly continuous operation. [1]

Measure Life

Cascade recommends a 15 year measure life.

10.3.3 Non-Energy Benefits

Non-energy benefits vary on a case by case basis and can often outweigh costs associated with energy savings. Non-energy benefits include:

- Reduced labor and Maintenance costs
- Reduced composting costs [2]

10.3.4 Market Potential and Estimated Participation

Based on the leading manufacturer estimates that only six to seven screw presses sell annually in the region, and with only a quarter of these saving energy, market potential (project completion rate) seems low.

The equivalent of a unit energy savings table for these new measure groups is given on the next page.

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[1] Giguere, V.N., P.E., Sewer sludge dewatering improvements save energy, simplify operation http://www.seacoastonline.com/articles/20130221-BIZ-302210379

[2] Mahoney, D., Morin, M., Vermette, R., "The First Huber Q800 Inclined Screw Press Installation in the East Help the City of Dover Optimize Solids Handling and Reduce Costs." Presentation at Northeast Residuals and Biosolids Conference, November 2011,http://www.nebiosolids.org/uploads/pdf/NE-Conference-2011/Mahoney-InclPress-10Nov11.pdf

UTAH November 2013

Equipment category	Replace	With	Limitations	Customer incentive	Gross incremental cost (New Const) ($/unit)	Gross incremental cost (Retrofit) ($/unit)	Energy savings (kWh/unit/yr)	Demand savings (kW/unit)
Oil and gas Pump off controller (Rod pump controller)	Timer control or no control	Pump off controller	1. Retrofit installations only. New construction not eligible. 2. Pump motors greater than 100 hp and pumps with VFDs are not eligible for this prescriptive incentive, but may be eligible for Custom Project incentives.	$1,500 per controller	n/a	$3,386.00	9,707	0.00
Adaptive refrigeration control	Conventional controls (defrost timeclock, space thermostat, evaporator fan control, if any, thermal expansion valve in some cases)	Adaptive refrigeration controller and, in some cases, electric expansion valve		$0.15/kWh annual energy savings	Incentive and savings are calculated using adaptive refrigeration control calculator. Cost is actual cost from invoice. 70% project cost cap and one year payback cap apply.			
Fast acting door	Manually operated door, automatic door with long cycle time, strip curtain, or entryway with no door in refrigerated/conditioned space	Fast acting door		$0.15/kWh annual energy savings	Incentive and savings are calculated using adaptive refrigeration control calculator. Cost is actual cost from invoice. 70% cost cap and one year payback cap apply.			
Compressed air end use reduction	Inappropriate or inefficient compressed air end uses	Functionally equivalent alternatives, leak reduction, or isolation valves		$0.15/kWh annual energy savings	Incentive and savings are calculated using adaptive refrigeration control calculator. Cost is actual cost from invoice. 70% project cost cap and one year payback cap apply.			
Wastewater - Low Power Mixer	Excess aeration capacity	Extended range circulator		$0.15/kWh annual energy savings	Incentive and savings are calculated using adaptive refrigeration control calculator. Cost is actual cost from invoice. 70% project cost cap and one year payback cap apply.			

Notes
Incentives are capped at 70 percent of Energy Efficiency Project costs, and incentives will not be available to reduce the Energy Efficiency Project simple payback below one year. Energy savings and Energy Efficiency Project costs are subject to Rocky Mountain Power approval.