

Irrigation Load Control Credit Rider Dispatch Pilot

Bill Marek, Rocky Mountain Power

Steve Hodges, M2M Communications

Andrew Dunlap, Utah State University, Ph.D. Candidate, Dept of Information Systems

Abstract

As regulated entities, electric utilities are required to build infrastructure and generation to meet the annual peak. For nearly all electric utilities the biggest contributor to peak is summer heat. Increasingly, electric utilities have turned to Demand-Side solutions in lieu of expensive infrastructure / generation build-out. The reason Demand-Side solutions are attractive are twofold. First, expensive assets are not sitting idle for all but 40 hours per year. Second, Demand-Side is a far more environmentally friendly solution. Since 2003 Rocky Mountain Power has offered a 'Scheduled Forward' Irrigation Load Control Program to its 2,500 customers (4,700 agricultural pump sites) in southeast Idaho (service territory \cong 10,000 sq miles). Since inception the Idaho Irrigation Load Control Program has grown to roughly 100MW (25% of the 400MW customer base). In 2007 a large-scale Dispatchable pilot was approved by the Idaho Public Utilities Commission and made available to growers. The 2007 pilot complemented the on-going 'Schedule Forward' initiative. Nationwide there is a growing appetite for utility-sponsored irrigation load control. This article describes what growers and/or those in a position to advise growers need to know before leaping into utility sponsored irrigation load control programs.

The Rocky Mountain Power system

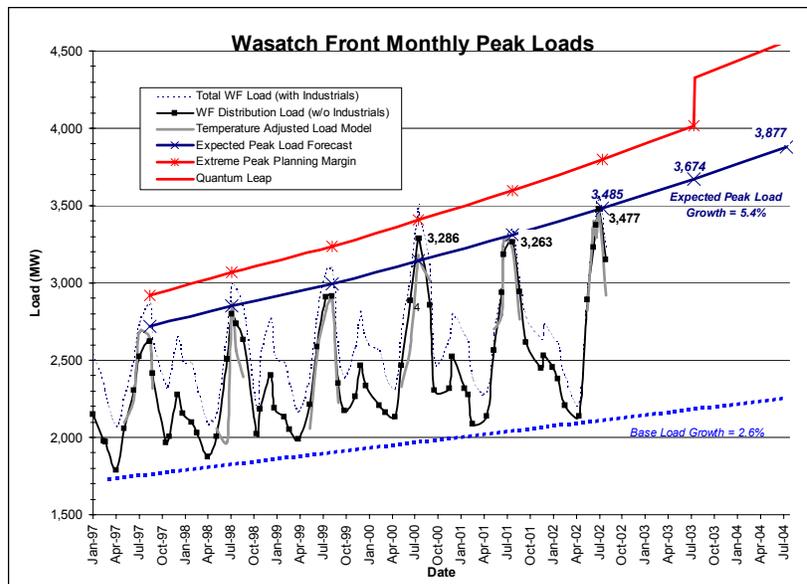
PacifiCorp is a regulated electric utility serving \cong 1.6 million customers. The Company does business under the *Rocky Mountain Power* brand in the states of Utah, Wyoming and Idaho. The 'western' part of the PacifiCorp system serves Oregon, Washington and California and does business under the *Pacific Power* brand. The Utah / Idaho portion of the system has been and continues to experience significant load growth. Infrastructure assets are 'stressed' and all efforts are being directed to do more with less. Environmental entities level pressures that make it difficult to add infrastructure. Recently environmental organizations have taken legal action to prohibit the expansion of existing resources. It is with this background that the Idaho Irrigation Load Control Program was born.

The peak problem

There is a desire on hot summer afternoons (usually between 4:00p and 6:00p) for nearly everyone to want to use devices driven by electric power. This desire for power within the space of a narrow two to three hour window creates a 'peak' (think top of the bell-shaped curve). Illustration One provides actual Wasatch Front (Salt Lake City and surrounding cities) load profile data from 1997 through 2002. The illustration depicts a typical electric utility peak.

Keep in mind that ‘needle peaks’ such as that shown in Illustration One means that a significant portion of system resources (transformers, substations, poles, peak generation plants, conductor, switching gear and so on) must be sized, in place and operationally ready to meet just roughly 40 hours per year (that’s one-half of one percent). The costs for those idle assets are huge. Like it or not (and most don’t like it) those costs are deemed ‘prudent’ by regulatory bodies and are passed along to consumers in the form of rate increases. To the extent that growers can, as a group, mobilize and participate in well designed irrigation load control programs, they can reduce the amount that irrigation contributes to peak. By so doing environmental and economic savings could be realized.

Illustration One
Wasatch Front 1997–2002 Load Profiles



Until recently utilities have simply added more ‘supply stuff’ to meet the peak. Today the emphasis of electric utilities is increasingly directed to meet the peak via Demand-Side solutions which drives the need for irrigation load control.

But before you or someone you know jumps headlong into a utility sponsored program there are a few things that deserve a second look. The recommendations below arise from having designed, implemented and operated an irrigation load control initiative for the past five years.

Do participation credits off-set the risks?

Growers cannot and should not be easily dissuaded by the lure of participation credits. Instead, the value proposition itself should be the primary reason for participation and the

deal workable within the grower's parameters of reasonable agri-business operations. In 2003 when Rocky Mountain Power first brought the load control initiative forward there was a single participation option—2 x 6-hour dispatches a week. Growers were required to participate for the full irrigation season (14 weeks or 168 hours). The offering was attractive for growers raising field crops (wheat, barley, grain, and alfalfa). Water sensitive row crops such as potatoes and corn were noticeably absent from participation.

Preparatory for the 2004 growing season the Irrigation Management Team introduced a 2 x 3-hour dispatch option and a 4 x 3-hour dispatch option in hopes of gaining additional participation. Both options were miserable failures. We later learned that 3-hour blocks failed to carry sufficient participation credit to outweigh the labor and fuel cost of having to manually re-start the pump. Subsequently the Irrigation Team has implemented a 1 x 6-hour option which seems to have found favor with some growers producing field crops but still almost no row crop sites found their way into program participation.

Only with the introduction of the 'Dispatchable' option in 2007 did we find high water-use crop participation. By tariff the Dispatchable offer was constrained by the following parameters:

- Available Dispatch Hours: 2:00 PM to 8:00 PM MDT
- Maximum Dispatch Hours: 65 hours per Irrigation Season
- Dispatch Duration: Not more than three and one-half hours per *Dispatch Event*
- *Dispatch Event* Frequency: limited to a single (1) *Dispatch Event* per day
- Dispatch Days: Monday through Friday (inclusive)
- Dispatch Day Exclusions: July 4 and July 24 and/or their respective designated weekday official holiday

Under the Dispatchable offer growers were able to receive the same participation credits for only one-third of the total hours. Moreover, and as part of the value proposition, growers also had the opportunity to 'opt-out' of any given *Dispatch Event* but would have their credits reduced by the amount Rocky Mountain Power would otherwise have to pay for power during the *Dispatch Event*. The 'opt-out' alternative proved pivotal in increasing program participation. The terms and conditions of the 'opt-out' provision provided financial protections to both Rocky Mountain Power and to growers. Under 'opt-out' circumstances, Rocky Mountain Power would otherwise be subject to market price vagaries. Growers, on the other hand were often faced with equipment or weather considerations which did not permit them to participate in a specific *Dispatch Event*. The opt-out provision mitigated the risks for both parties.

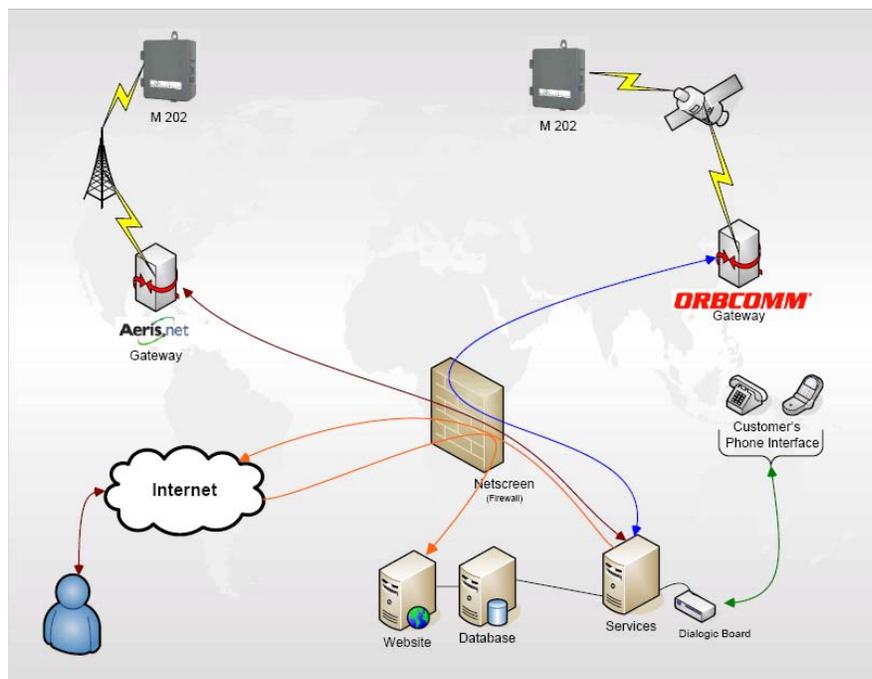
The Dispatchable option provided an acceptable value proposition. The option was bounded by utility considerations which were tolerable for the rewards growers were being asked to take. In short, the deal was both realistic and appropriate. And because Rocky Mountain Power had sufficient financial protections their interests were similarly protected. The bottom line is this: growers would be well advised to NOT engage in an irrigation load control program that fails to meet their core agri-business needs. If avoided capacity is valuable to

the utility they will come and listen to you. The utility will then find ways to cobble together an acceptable value proposition. It is not simply about the participation credit but rather how well the value proposition fits with the agri-business circumstances and whether or not the risk / reward metrics pencil out.

Is the enabling control technology familiar to agriculture?

Prior to 2006 off-the-shelf generic electronic programmable timers were used to control pump / pivot systems according to pre-arranged participation schedules. Beginning in 2006 Rocky Mountain Power tested 25 advanced 2-way communication control units. These units were engineered and produced by the developer / manufacturer of the *Valley Tracker* control system. The *Valley Tracker* and subsequently, the Rocky Mountain Power units provided remote 2-way interface to the pump / pivot site through the Internet or the public cellular network. Illustration Two (*M2M Communications System Interface Diagram*) provides a graphical presentation of the system interface and associated communication networks.

Illustration Two
M2M Communications System Interface Diagram



Although the Illustration depicts a satellite communication channel, we found that with nearly 450 installations the cell coverage was sufficiently robust and the satellite system was never implemented. However, during the 2007 pilot roll-out, field installation teams did have to install a half-dozen high gain omni-directional antenna to effectively 'reach' cell towers. The

cell system was surprising robust and a complete surprise to the entire Irrigation Load Control Team given that the southeast Idaho service territory is extraordinarily rural.

Field installations required a bit of a learning curve in developing the appropriate protocols systems and routines. Once units got installed in the field they didn't seem to work as nice or as neat as they did in the laboratory or even in simulated field conditions (this shouldn't surprise anyone who has every been involved in introducing a new technology). Fortunately, and with the exception of an occasional surface mount resistor that got damaged in the assembly process all changes / settings were:

- Accommodated in version-controlled Operating System (OS) releases and/or
- The retrofitting of external antenna that eliminated the rare signal attenuation issue.

Re-flashing units with new OS's while in the field could have proven to be very costly as irrigation sites were spread over vast distances...often requiring 45 minutes travel (one-way) to reach a single site had it not been for one extraordinary grower. This grower had a keen interest in the technology and stepped-forward offering their farm managers and their 51 participating sites as 'guinea pigs' for the entire pilot population.

Solving the technical issues with a single grower first allowed the Irrigation Management Team to solve the technical and operational challenges presented by the new technology without jeopardizing customer relations should complications arise. Focusing on a single grower at a time allowed installation teams to focus resources, resolve problems in a single geographic area, and communicate coherently with the grower before taking on another grower. Instead of installing all 448 participating sites in parallel with multiple installation teams. The project was rolled out one grower after another. The emphasis would be on getting the installation process, technology settings and database components correct with this single grower before moving on to parallel installations with subsequent growers.

A key point is that this particular grower had previously investigated the *Valley Tracker* remote control system. The system was not a stranger to the irrigation industry. It was an easy 'leap-of-faith' for growers to accept the Rocky Mountain Power control unit that would be affixed to their pump panels. Electronic timers while a relatively stable platform were woefully inadequate for the harsh agricultural environment. Timers simply did not work reliably. Timers were a case of an acceptable application not targeted to the correct application. Year-over-year timer failures (one year as much as 38%) meant that field technician teams were routinely deployed in the spring to perform maintenance on all units. The program would simply not continue to operate with the volume of customer complaints that was being generated.

The 2-way M2M unit, on the other hand, is designed exclusively for agricultural applications. Similar models have been offered by Valley Irrigation for years and maintenance has been practically nil. Moreover, the M2M technology offers a variety of functional capabilities that are recognized and valued by growers. Some but not all of those feature sets include:

- Controls and monitors pivot or linear irrigation systems by phone or Internet
- Receive phone-based notifications when changes or problems occur
- Report AC power outages, water usage, and run times
- Saves time and fuel
- Works with all brands and models of irrigation equipment (Valley, Zimmatics, Reinke, L&T, Lockwood, etc.)

Selling growers on using the technology was not difficult. In fact, when growers learned we would be installing this type of product interest in the pilot out-stripped resources.

Throughout the service territory there are a number of sites where a single large pump (say 800Hp) will serve multiple pivots. Over the years the irrigation team learned that an additional constraint to participation was being able to independently control the pivots and/or linears configured to a single pump. Working with M2M Communications, an innovative master / slave design was implemented. The 'master' communicates to the web site via a digital cellular modem. The 'master' also communicates to its associated 'slave' units through a radio frequency (RF) channel. This means that the grower has full 2-way interface / control with each separate piece of equipment on any given site. When the standard control panel is configured with auto re-start the grower can completely remotely-manage their irrigation operations.

The point is that the core M2M technology was conceived, designed, built and implemented for agricultural irrigation equipment. It was not and is not a 'bolt-on', kludged to interface with the pump panel. While we are not promoting a particular brand, what we are suggesting is that any self-respecting load control initiative should deploy equipment that is specifically designed to work with the specific load. Utilities and their potential end-use growers will be well advised to heed this council.

It has been our experience that while you can get a non-load specific control system to work reasonably well with the underlying equipment there will be enormous time and expense to ensure its operational integrity and often the economics or customer service issues simply make that decision more bothersome than beneficial. Equipment that fails the grower once is understandable. On-going inability to maintain tolerances is a guaranteed formula for failure. Growers, steer clear of equipment and systems inadequately designed for your agricultural applications.

On a side note, but still every bit as important, proprietary (utility built and maintained) communication systems for customer-centric programs are fraught with extended 'down time'. Here, as in elsewhere, we have unfortunately learned from our own mistakes. We strongly suggest that before you participate in a load control program that you make sure the communication channel take advantage of pervasive public communication networks. These networks and the folks that manage them do this for a living. They are professionals.

Proprietary systems are a sideline to the utility and should not be used when the risks, as they are in irrigation applications, are huge to the end-user.

Are operational components grower friendly?

With nearly 100 megawatts (MW) participating on the Irrigation Load Control program and 78 MW derived from the Dispatchable option there has been a fair amount of interest generated by Rocky Mountain Power executives. Recently a Rocky Mountain Power executive was wanting to get a better understanding of the value proposition. In an e-mail he asked whether growers appreciated (1) the benefits of the M2M control technology? (2) were only interested in the participation credits? or (3) some combination of the two? Part of my response to this executive is excerpted below:

The equipment we use and provide to the grower for their use does provide a convenience. In fact, Valley Irrigation sells the equipment based largely on fuel and labor savings. But it is not an 'over night' conversion. In talking with Valley they told me it takes 3-years before the grower gets comfortable (aka, trusts) the equipment to perform as expected. Over-time we anticipate Idaho growers to get there also. What we are talking about here is a technology transformation. Not unlike going from sailing ships to steam ships, horse-drawn carriages to horseless carriages, passenger trains to interstate travel and airplanes and so on.

Some growers are early adopters, others are more skeptical in their tolerance for change. We are attempting to introduce change with the idea that the change will benefit both the grower and the Company. This initiative was designed for the grower to gain benefit and for the Company to realize gain also. We have been and are in the business of 'shaping' customer behavior away from electric use during on-peak periods, no ifs, ands or buts! In short we are attempting to teach growers to help the Company. In so doing both parties benefit.

From Rocky Mountain Power's perspective there are two foundational program drivers. First and foremost, the irrigation initiative has had an eye to shaping behavior as to how power is used. Second, customer service reigns supreme. Irrigation Load Control is not a quick fix to peak problems. The Irrigation Team has taken the approach that a customer-centric design will have impacts surpassing the credits provided. Accordingly, program design has focused on providing an agri-business solution that has a load control component and not a load control program that may have some interest for irrigation management.

How does this translate? Customers are first consulted on their irrigation requirements. Next, the load control system is engineered to complement those needs. All Internet logins and phone system access are set-up and configured for the grower. The grower only has to learn how to access and navigate operational menus. To learn those systems, growers are provided detailed training to themselves and their farm managers. Laminated 'cheat sheets' are provided as reminders to growers as they master menus and systems operations. To accommodate the large population of Spanish speaking labors leave-behind materials are

provided in Spanish. Training is provided in a classroom setting at the grower's operation. That is followed by physically going to the grower's pivot site where participants are given the opportunity to issue various control commands to the pivot via their cell phone.

Initial training is followed by field installation teams providing regular 'circuit rider' interface to the grower. 7 x 24 help line service is made available by these same field installation teams. Growers and their farm managers are encouraged to call day or night regardless as to how 'trivial' their question or concern may be. The Irrigation Team determined that for the program to succeed it would be important that the grower not spend hours struggling with the website or phone system.

Upon first encounter we are only asking growers to become familiar with system operations. We assumed that in subsequent years growers would be better prepared to address advanced system components. Growers should expect utilities to provide help in the use of remote control equipment on irrigation pump sites. Assuming or trying to make the change overnight is a recipe for failure. We suggest that utilities plan on helping growers make the adjustment and keeping it simple. To the point: the solution needs to be easily understood and implemented over time.

The proprietary 2-way technology had a distinct advantage over the electronic timers. Control commands could be sent to the field installed units and the units could report various state conditions and settings. For the purposes of the Rocky Mountain Power sponsored Irrigation Load Control initiative, units could be dispatched on-demand. Participating customers' equipment would no longer be turned off from 2:00p–8:00p on summer weekdays. Instead *Dispatch Events* could be called only when it was necessary to help off-set peak load requirements. However, the 'random' dispatch schedule meant that a communication system, to inform the grower of *Dispatch Events*, had to be implemented. This communication system would send day-ahead notification to growers so they could make operational plans. In fact, growers were notified on a day-before (no later than 5:00p) and again on the morning-of (by 10:00a) the *Dispatch Event*. Without advance, predictable notifications, chaos would have dominated the random dispatch schedule.

Another advantage afforded by the 2-way technology is information timeliness. The amount of time that passes between the initial need to make a decision and having all the information necessary to make a decision is information timeliness. Our experience has shown that the 2-way technology facilitates information timeliness. Getting information to appropriate parties is critical to high customer service ratings. Consider this scenario.

A grower is experiencing some problem with irrigation equipment on which a load control device is installed. The natural thing to do is to suspect the load control device. The grower calls customer support. Within moments, customer service representatives can make an initial prognosis before the call is ended. The grower can be given an indication of what the problem is and the customer service representative can dispatch a technician to service as

needed. It is also possible with the 2-way units for the grower to logon to the website and diagnose the problem himself.

Compared to a timer control device, 2-way technology can significantly reduce customer service time-to-resolution. Also, the incident of unnecessary trouble calls or false trouble calls can be reduced to near zero. For the growers, this means less time on the phone, definitive troubleshooting, and less trips to irrigation sites.

Why would a grower elect to participate in the Load Control Program? First and foremost, of course, are the participation credits. In 2003 the credits totaled \$6.48/kW-yr. By 2007 and as a result of the overwhelming customer support and the impact to peak load reductions credits had risen to \$11.19/kW-yr. By participating in the Load Control initiative growers had effectively transformed a portion of their pump costs into revenue producing assets.

Second, growers could now remotely communicate with their pivots and linears, receive notification of unanticipated changes in pump status and issue commands to their irrigation equipment. The benefit of the change-in-status notification option was vividly brought to light by one grower who reported that soon after installation his phone rang at 1:00a. On the phone was a robotic-like voice message telling him that a certain pump had turned off. At first he thought there must be some computer error. His curiosity got the better of him. So he got dressed and went out to check. Sure enough lightening has interrupted the power supply and the pump which was previously running had now turned off. Prior to the installation of the 2-way technology a grower would not discover the pump had turned off until the next day when checking his units. He would have likely lost eight hours of valuable irrigation.

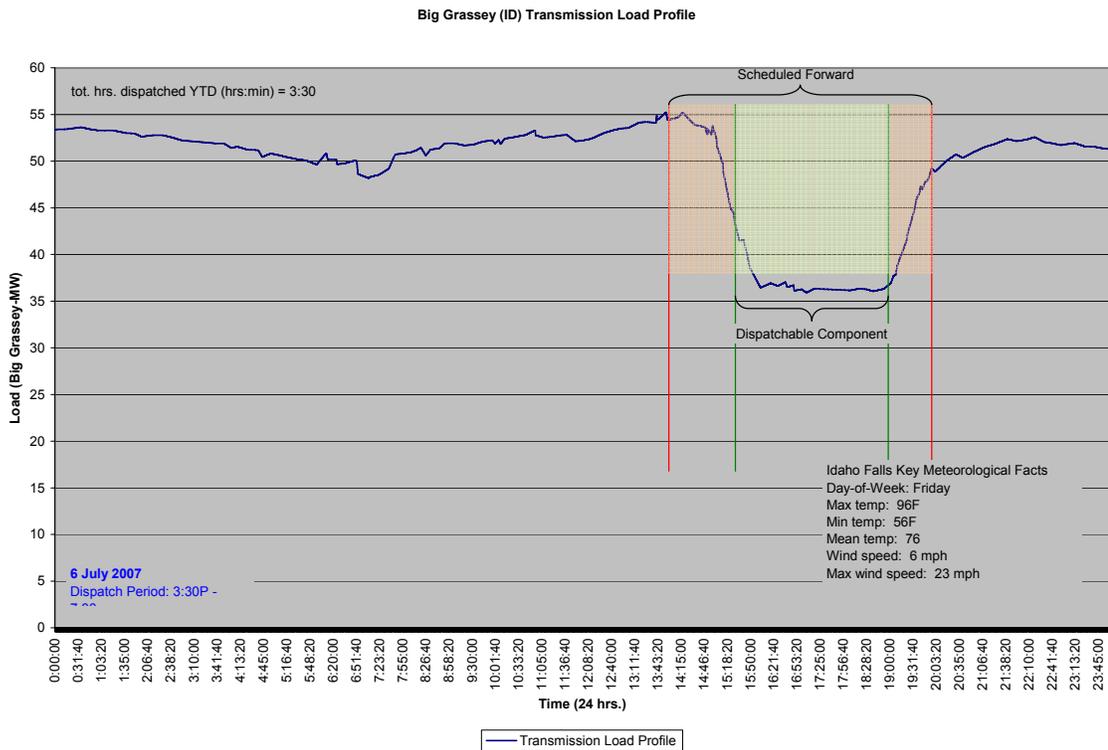
So what has been the results?

17 customers (448 sites) participated in the full-scale Dispatchable initiative using the proprietary (cellular / RF) M2M 2-way control technology. In 2007, 78 MW were aggregated under the Dispatchable pilot. Based on standard utility tests that compare total program benefits (avoided peak demand) against total program costs (equipment, labor, administration, customer service support, database and so on) the program calculated to be extraordinarily 'cost-effective'.

Throughout the control period, Rocky Mountain Power SCADA data were collected and used in preparing impact analyses. Log data from Circuit Breaker #67 which was known to have a significant number of Program participants was mined for this analysis. A significant portion of the participants in this area where Circuit Breaker #67 resides participated in the Dispatchable program. Due to the impact of the Dispatchable initiative the results of the Scheduled Forward component is difficult to observe. Nevertheless, SCADA values were taken and logged at 20-second intervals for periods when dispatches were executed. Virtually all of the 13 'Dispatch Events' had identical profiles.

Illustration One depicts Circuit Breaker #67 grid impacts as a function of both Scheduled Forward and Dispatchable options. What is noteworthy is (1) the magnitude of the load shifting effect as depicted in the difference between control and non-control hours and (2) the impact of 'load shaping' as a function of the combined impacts of the Scheduled Forward and Dispatchable program components. This shaping capability is important as it provides Rocky Mountain Power with more options and greater control over the grid in systematically meeting load requirements during summer peak periods.

Illustration One
Big Grassey Transmission Load Profile July 8, 2007)



Concluding thoughts and recommendations: some parting thoughts

Utility irrigation load control programs can and do deliver measured impacts to electric grids which can measurably assist in improving reliability, reducing operating costs, provide important environmental benefits and, in some cases, delay build-out of expensive infrastructure / generation resources. Before utilities offer or growers decide to participate in such an effort there are a handful of considerations you will want to keep 'top-of-mind'.

First, what utilities need to know / do...

- Utility sponsored irrigation load control programs can deliver SCADA-measured peak reductions.

- An option for grower 'opt-out' is pivotal in managing the risk to both growers and the utility offering the program. Without protections for both parties it will be difficult, if not impossible, for DSM to gain internal support for the initiative and for the grower to see his way clear to participate.
- Growers will participate with cash crop acreage if the 'opt-out' option and credits are appropriate for the risk.
- Putting customer service at the top-of-the-list of key operational considerations is pivotal to grower / farm manager training.

Second, what growers need to know / do...

- The advanced 2-way control system provides value-added convenience to optimize field operations and deliver labor, fuel, and equipment O&M cost savings.
- Make sure your farm manager(s) is/are comfortable with the use and operation of the equipment in managing regular irrigation turns. Require reluctant farm managers to jump in with both feet in learning how to manage irrigation systems by the 2-way equipment. Likewise require that farm managers learn how to appropriately navigate phone and secure Internet menus to accommodate '*Dispatch Events*'.
- Be willing to invest in computer as well as remote Internet mobile connectivity technology. The above mentioned 'guinea pig' grower has eagerly taken to the installation of lap top computers in the pick-ups of each of his farm managers.

If you fail to see evidence of (1) an appropriate value proposition, (2) control equipment that can work seamlessly with irrigation systems and (3) systems, processes and procedures that make operations easy and efficient; work cooperatively with the utility promoting the initiative to translate these parameters into realities. The utility is new at the Demand Side game also. Chances are the utility will listen to your concerns, ideas, suggestions, opinions and recommendations and, where possible, incorporate them into the program design. After all, they have a vested interest in the success of their irrigation load control initiative as much as you do.