# Integration of Retail Demand Response with Midwest ISO Wholesale Markets

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**ABSTRACT**

The Organization of Midwest ISO States (OMS) launched the Midwest Demand Resource Initiative (MWDRI) in 2007 to identify barriers to deploying demand response (DR) resources in the Midwest Independent System Operator (MISO) region and develop policies to overcome them. The MWDRI stakeholders decided that a useful initial activity would be to develop more detailed information on existing retail DR programs and dynamic pricing tariffs, program rules, and utility operating practices. This additional detail could then be used to assess any "seams issues" affecting coordination and integration of retail DR resources with MISO's wholesale markets.

With the active assistance of state regulators and utilities we conducted a detailed survey of existing DR programs and their features. Utilities were asked to provide information on advance notice requirements to customers, operational triggers used to call events (e.g. system emergencies, market conditions, local emergencies), use of these DR resources to meet planning reserves requirements, DR resource availability (e.g. seasonal, annual), participant incentive structures, and monitoring and verification (M&V) protocols. In this paper, we describe the results of this survey and discuss policy implications for integrating legacy retail DR programs into organized wholesale markets. Based on responses from 37 MISO members and 4 non-members that provided information on 122 DR programs, there is over 4,400 MW of retail DR resource available in the MISO footprint. More than three-quarters of available DR is from interruptible tariffs offered to large commercial and industrial customers. The retail DR resource may be well-suited for addressing system emergencies by MISO system operators, as almost 2,000 MW can be dispatched on less than 30 minutes notice. These legacy DR programs are increasingly used by utilities for economic in addition to reliability purposes, with over two-thirds (68%) of these programs callable based on market conditions.

## Introduction

The unusually hot summer of 2006 broke peak electricity demand records in most parts of the country, including the Midwest. The success of system operators in "keeping the lights on" despite record peak demands was partially due to the extensive use of demand response (DR) resources across the nation (Hopper et al., 2007). The Midwest Independent System Operator requested LSEs to dispatch their retail DR programs for providing emergency operating reserves during separate incidents in August 2006 and February 2007. On August 1-2 MISO system operators declared Energy Emergency Alert (EEA) Level 2 conditions and requested Load Serving Entities (LSEs) to interrupt non-firm load. A 3,000 MW drop in peak demand on August 1 and 2,000 MW drop in peak demand on August 2 were sufficient to avoid triggering scarcity pricing and were instrumental in minimizing the possibility of outages. However, MISO did not have an emergency demand response program to dispatch DR resources to maintain system reliability and load reductions undertaken by LSEs and their customers were not explicitly compensated by MISO.[1]

Use of retail DR resources in MISO's reliability operations and system planning activities requires coordination between the wholesale and retail sides of the electricity system.[2] When MISO called emergency events in August 2006, not much was known on a region-wide basis about how much retail DR could be expected to respond and under what conditions.

In October 2006 the Organization of MISO States (OMS) established the Midwest Demand Response Initiative (MWDRI) to support MISO's efforts to further integrate demand response into all aspects of regional transmission planning and operations and wholesale market design. The efforts of MWDRI are focused on retail DR programs and tariffs and are intended to complement the ongoing efforts of MISO's Demand Response Working Group (DRWG) and other MISO working groups (e.g. Resource Adequacy Working Group) that impact the future role of DR resources in the Midwest.

This paper describes a survey effort undertaken at the request of MWDRI to collect the detailed information on retail DR programs needed to characterize the aggregate retail DR resource in the MISO foot-print and identify issues that affect use of legacy DR programs in regional wholesale market and system operations. The survey effort addressed the following questions: existing resource contribution of DR resources in MISO, key program design features and operational characteristics of existing retail DR programs and tariffs, extent of DR resource participation in MISO energy markets, role of DR resources in meeting resource adequacy requirements, and potential barriers to more participation of DR resources in wholesale energy markets and in future.

## Organization of Wholesale and Retail Electricity Markets in Midwest

Established in 2001, MISO is responsible for the reliable operation of nearly 94,000 miles of interconnected high voltage power lines serving more than 100,000 MW of demand throughout the Midwest. MISO also has the responsibility for ensuring that the Midwestern bulk power infrastructure expands to meet the growing regional demand for power. In 2005 MISO became the first multi-state RTO without a history of tightly-pooled power sharing arrangements to implement organized wholesale energy markets (day-ahead and real time) with centralized economic dispatch and locational marginal pricing. MISO does not operate a capacity market, although capacity is traded by market participants in bilateral transactions.

OMS was formed in 2003 as a membership organization of the states and Canadian provinces within which MISO provides electric transmission, wholesale market operation, transmission system planning coordination, and other services. OMS coordinates electricity transmission and wholesale market policy and planning oversight among the states within the MISO footprint, including making recommendations to MISO, FERC, and other government entities, and intervening in proceedings before the FERC.

MISO and its stakeholders, including the OMS, have grappled with complex institutional and transition issues in establishing their organized wholesale market: (1) the need to

[1] LSEs may or may not have compensated their customers for reducing load depending on each program and tariff design.

[2] The Federal Energy Regulatory Commission (FERC) regulates MISO's operation of wholesale energy markets, maintenance of system reliability, and system planning activities. Public utility commissions (PUCs) in 14 states regulate utilities and other load-serving entities that administer retail DR programs and tariffs in the MISO footprint.

accommodate the reliability rules of three different regional reliability entities (MRO, RFC, and SERC); (2) 16 retail jurisdictions with varying combinations of vertically integrated structures and retail choice; and (3) developing a single transmission tariff that could accommodate regional variations in marginal losses.

## Current Status of Demand Response in Midwest

Currently, DR resources in the regional Midwest energy market are only dispatched by LSEs that administer DR programs and tariffs. DR resources can participate only in MISO day-ahead (and not in real-time) energy markets and must meet the same requirements as a supply-side resource. Alternatively, LSEs can act as price-takers in both the day-ahead and real-time energy markets (MISO refers to this as "price-sensitive demand bids"). DR resources can also qualify for capacity credits in the LSE's resource adequacy requirements if they meet existing rules.[3] In future, DR resources may be able to participate in the Ancillary Services market (FERC, 2008), get explicit compensation for load reductions during emergencies, and get included in the integrated resource planning process of MISO.

On December 31, 2007 MISO filed a proposed Emergency Demand Response (EDR) Schedule 30 (MISO, 2007) with FERC, which provides payments from MISO to Market Participants (MP) that curtail loads during emergency events (i.e., EEA2 and EEA3).[4] Only authorized MPs are allowed to participate in Schedule 30. In order to be compensated under MISO's proposed emergency DR program, EDR Participants will be required to submit an EDR offer to MISO at least 30 days before the "month". The offer will remain in effect for at least a month. Each offer must include: (1) minimum and maximum amounts of demand reduction; (2) minimum and maximum number of continuous hours demand reduction; (3) any shutdown costs associated with the demand reduction; (4) number of hours of advanced notice required to reduce demand and whether such reductions are limited to certain hours during the day; and (5) an actual dollar per MWh offer (subject to a $3,500/MWh cap). During an EEA2 or EEA3 event, MISO will issue instructions that contain details regarding when reductions will begin and the amount and necessary duration of the demand reduction. Compensation is based on the higher of the real-time LMP or the EDR Offer price and only for the amount of demand reduction included in MISO's instructions. In case of non-compliance, a penalty is charged.

## Research Approach

The LBNL-RAP team undertook a broad survey of the retail DR programs administered by MISO member utilities as well as other utilities operating in OMS member states. We

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[3] MISO's resource adequacy rules (referred to as Module E) are currently under review and are being modified. The Module E requirements are meant to compliment and coincide with the reliability mechanisms of the states and the regional reliability organizations within MISO region. According to the proposed rules, DR resources can be included in meeting the resource adequacy requirements as capacity resources or load modifying resources.

[4] EEA2 signifies that the balancing authority, reserve sharing group, or LSE is no longer able to provide its customers' expected energy requirements, and is designated an Energy Deficient Entity (EDE). The EDE foresees or has implemented procedures (e.g. public appeals to reduce demand, voltage reduction, and interruption of non-firm end use loads in accordance with applicable contracts, demand-side management, and utility load conservation measures) up to, but excluding, interruption of firm load commitments. If the energy balance is not achieved after EEA2 procedures are implemented, then the MISO Reliability Coordinator issues an EEA3 and resorts to Load Shedding to restore the energy balance.

developed the survey template with input from OMS members. State commissions transmitted the survey to utilities in their states. Some PUCs sent the survey to all utilities while other PUCs sent the survey only to those utilities that are MISO members. In some states, surveys were not sent to rural cooperatives and municipal utilities because PUCs either did not have jurisdiction or utility staff contacts. Consequently, the survey population included all investor-owned utilities that are MISO members and a limited sample of public-owned utilities and MISO non-members in OMS member states.

LBNL staff compiled the survey data, conducted follow-up interviews and consistency checks to ensure accuracy of the survey responses, supplemented survey data with information from other sources, and analyzed the data.

## Retail DR Resources in the Midwest

We asked utilities to provide information on their demand response programs (e.g., interruptible/curtailable tariffs, direct load control, emergency DR programs, or "economic" or demand bidding programs where events are triggered by high prices), dynamic pricing (defined to include Real Time Pricing (RTP) and Critical Peak Pricing (CPP) tariffs, and voluntary DR programs (i.e., a program where customers voluntarily participate and make a "best efforts" attempt to curtail load during a system emergency but are not compensated for load reductions).

In this study, we focus on demand response programs that involve some type of compensation to customers; our analysis does not include results reported by utilities for dynamic pricing. Our DR program categories are consistent with surveys of retail DR programs previously conducted by the Energy Information Administration (EIA), the FERC, and others. Interruptible tariffs provide a rate discount or bill credit to the customer for curtailing or shedding load upon request. Typically, interruptible tariffs are offered to larger industrial and commercial customers and often involve penalties if the customer fails to curtail load when requested to do so. Direct Load Control (DLC) involves an end-user (typically, residential and small commercial) that agrees to allow their utility or a curtailment service provider to control an appliance or device within certain pre-set limits of frequency and duration. Participants in DLC program typically receive compensation in the form of bill credits and/or payments based on performance during events. Customers enrolled in an Economic DR program have to offer bids to curtail load based on market prices. These programs are mainly offered to large customers; however, some utilities also allow aggregation of small customer loads.

### Survey Response

Thirty-five utilities responded to the survey with information on 122 DR programs and tariffs. Of these, four utilities (accounting for 13 DR programs and tariffs) are not members of MISO but operate in states that belong to OMS. Our analysis includes all 122 programs.

We define the size of the existing DR resource as the potential peak load reduction that the utility expects from the DR program or tariff, which is the definition used by FERC and EIA in their reports that summarize existing DR resources. The utilities reported retail DR resources totaling 4,406 MW, of which 757 MW are from MISO non-members (~17%).

For comparison, similar surveys of MISO members conducted by FERC and the ISO/RTO Council (IRC) report 4,099 MW and 8,645 MW respectively of existing DR resources (FERC, 2007, and ISO/RTO Council, 2007). Response to the survey was quite good as MISO member utilities reported results on ~3,650 MW of DR resources, compared to the ~4,100 MW reported in the latest FERC DR report (FERC 2007). However, the ISO/RTO Council estimates of DR resources are much higher and include "behind-the-meter generation," which utilities appear not to have reported in our survey or the FERC DR report.

The distribution of DR resources by state is shown in Figure 1. States with the most DR resources include Minnesota (1,168 MW), Indiana (702 MW), and Michigan (630 MW). Note that OMS member states such as Illinois and Pennsylvania have large DR resources, although some utilities in these states were not sent or did not respond to the survey because they were not MISO members (e.g. Commonwealth Edison is member of PJM).

**Figure 1. Distribution of Existing DR Resources by State**

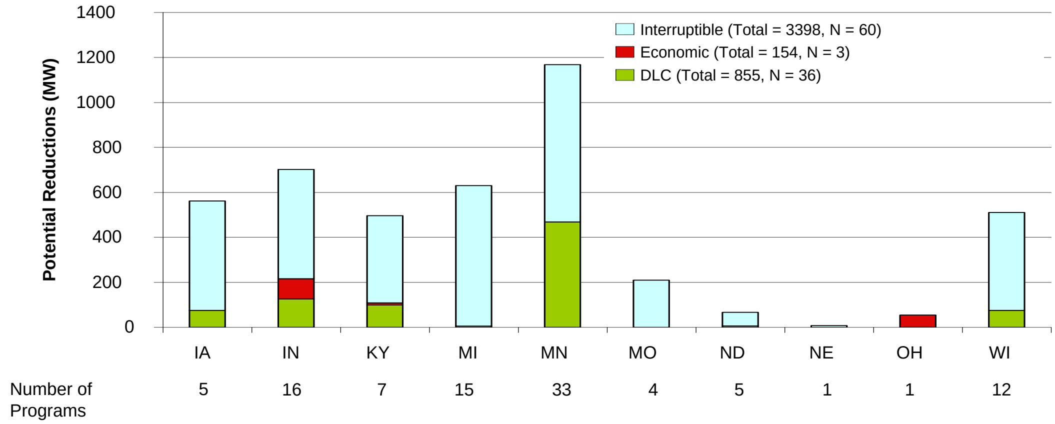
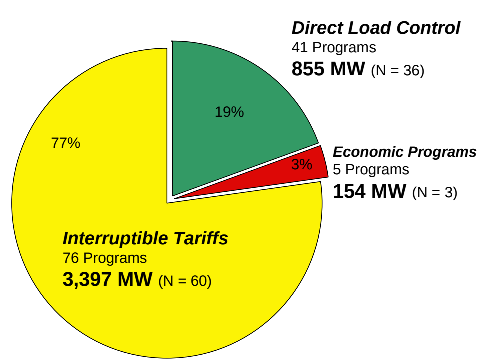



Figure 2 shows how survey respondents characterized their retail demand response program offerings. Interruptible tariffs account for ~77% of the DR resource, while DLC programs account for ~19%, and economic programs account for ~3% of existing DR resources. Interruptible tariffs and DLC programs are offered in almost all OMS member states, however, economic programs were offered by LSEs only in IN and OH.

**Figure 2. Distribution of DR Resources by Program Type**



## DR Resource Characteristics

The survey requested detailed information about a range of DR program and tariff characteristics, including operational triggers, frequency of events, advance notice provided, program duration, participation requirements (e.g. size thresholds, market segments, etc.), communications arrangements, monitoring and verification protocols, and others. In this section we discuss these DR resource characteristics and their implications to DR resource participation in MISO markets and programs.

### Operational Triggers

A key question that the survey addressed was the initiation trigger for mobilizing DR programs and tariffs. The most common purposes for which utilities trigger DR programs are to maintain system reliability, reduce cost of procuring power, maintain system demand below contracted levels, and address local reliability or congestion problems (see column headings in Table 1). Survey respondents were allowed to indicate more than one operational trigger for each DR program and tariff. Approximately 83% of the programs (accounting for ~94% of enrolled load reductions) have more than one operational trigger.

As expected, most DR programs (~81% of programs and ~87% of potential peak load reductions) are triggered for system emergencies. Surprisingly, ~68% of all DR programs (~70% of enrolled load reductions) are triggered for economic reasons. Contrary to traditional understanding of DLC and Interruptible programs being dispatched, primarily, for reliability purposes, this survey makes it clear that utilities are dispatching these programs in response to other market conditions (e.g. high prices, lower overall system costs). Some survey respondents noted that regulators have given them additional flexibility in recent years to decide how DR resources are deployed and the number of times they can be deployed. LSEs also reported an increase in DR events triggered by economic conditions since MISO markets began operating.

**Table 1. Operational Triggers for DR Programs and Tariffs**

| Program Type | System Emergency | High Prices | Maintain demand below contracted levels | Local/utility reliability/ congestion |
|---|---|---|---|---|
| DLC | 28 | 25 | 21 | 16 |
| Economic | 1 | 5 | 0 | 1 |
| Interruptible | 66 | 49 | 35 | 42 |
| TOTAL | 95 | 79 | 56 | 59 |

Survey respondents indicated that 79 DR programs can be triggered for economic reasons (i.e. high prices); however, only 13 DR programs (9 interruptible and 3 DLC accounting for ~580 MW) actually offer DR resources in similar manner as generation resources in MISO's day-ahead energy market (see Table 1). It appears that many LSE are acting as "price-takers" instead of having to commit to reduce a specific amount of load if their bid is accepted.

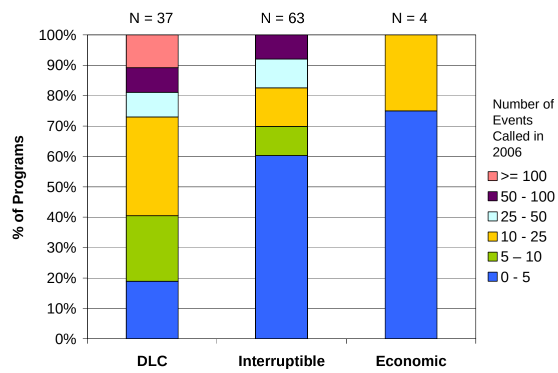
This wide-spread use of DR resources for economic reasons suggests that program operators are capable of valuing the resource purely in economic terms as opposed to using it as a last resort for ensuring system reliability. For participation in either MISO's energy markets or the proposed EDR schedule (and possibly future ancillary services market), program administrators will need to develop an offer price for their DR resources. Past experience in monetizing the value of DR resource should make it easier for program administrators to develop offer prices.

### Frequency of DR Events

We also asked utilities to provide information on the minimum and maximum number of DR events that can be called in a year and the number of actual events called by utilities. ~36% of programs do not have any limits on the number of events that can be called each year

Figure 3 shows the distribution of the frequency of actual DR events called in 2006. More than 60% of DLC programs and 30% of interruptible tariffs were called on 10 or more occasions. In terms of potential load reductions, we observe the same distribution. Follow-up discussions with some utilities suggest that the large number of DR events is a consequence of using economic criteria as operational triggers. Utilities also indicated that there were not many customer complaints despite the high frequency of DR events.

**Figure 3. Distribution of 2006 DR Event Frequency**




The lack of annual limits on maximum number of events called or maximum hours of load reductions coupled with the fact that LSEs do not report significant customer satisfaction issues suggests that many LSEs may have the flexibility to continue calling and relying on DR resources in the future even for programs that are called fairly frequently.

### Advance Notice

As shown in Table 2, 83% of programs and 89% of potential load reductions require less than 2 hours advance notice. Nearly all DLC programs provide either no advance notice or it is less than 30 minutes; this is not surprising because equipment (e.g. air-conditioning unit, water heater) is cycled directly by the utility. Surprisingly, ~36% of interruptible tariffs provide either no notice or less than 30 minutes advance notice. Customers on interruptible tariffs reduce load after receiving notice from the utility. Hence, it is expected that longer advance notice would help customers in implementing their load curtailment strategies and lead to better performance. The majority of economic programs are “day-ahead” programs, bidding load curtailments into the day-ahead energy market.

**Table 2. Advance Notice Requirements for DR Resources**

| Program Type | Potential Enrolled Load Reductions (MW) | | | | |
|---|---|---|---|---|---|
| | Less than 30 minutes | 30 minutes – 2 hrs | 2 - 4 hrs | 4 - 12 hrs | Day-ahead |
| DLC | 740 | 10 | 0 | 0 | 0 |
| Economic | 0 | 0 | 0 | 0 | 154 |
| Interruptible/Curtailable | 1,221 | 1,927 | 202 | 7 | 31 |
| TOTAL | 1,961 | 1,937 | 202 | 7 | 185 |

The proposed MISO EDR Schedule 30 requires market participants to specify in their offers the advance notice. However, it is not clear how MISO will "stack" the DR resource offers for dispatch under the EDR schedule. The schedule notes that dispatch instructions will be sent to accepted offers in the event of EEA2 and EEA3 alerts, but does not specify exactly when the alerts are initiated and dispatch instructions sent to the DR resources.

## DR Resource Availability

As noted previously, MISO called on DR resources in both summer (danger of demand exceeding supply) and winter (equipment failure) in the last two years to provide operating reserves. Consequently, having access to most DR resources throughout the year is extremely valuable for MISO system operators. It is clear that certain types of DR resources are simply not going to be available during certain months - for example, DLC programs targeted to air-conditioning units are less likely to be available in winter and those targeted to water-heaters are less likely to be available in summer.

More than 96% of the DR programs and tariffs are available during summer months when there is a higher probability of calling DR events (see Table 3). Surprisingly, more than two-thirds of all DR programs and tariffs, at least on paper, can be operated year-round (~50% of DLC programs, and ~75% of interruptible tariffs). However, it is likely that some DR programs never get called during off-peak months (e.g. DLC air conditioning cycling programs). Consequently, the potential load reductions available during non-peak months (e.g. winter season in lower Midwest region) could be much lower than reported.

**Table 3. Seasonal Availability of DR Resources**

| Program Type | Summer only | Summer & Winter | Winter only | Year-round | TOTAL |
|---|---|---|---|---|---|
| | # of Programs | | | | |
| DLC | 16 | 3 | 2 | 20 | 41 |
| Economic | | | | 5 | 5 |
| Interruptible | 15 | 2 | 2 | 57 | 76 |
| TOTAL | 31 | 5 | 4 | 82 | 122 |

The proposed MISO EDR Schedule 30 requires market participants to specify their offers one month in advance and to provide one months notice if the offer is to be changed. The offer must describe the restrictions on the availability of the DR resource (i.e. minimum and maximum hours, times during the day, days during month when the load reduction is available). Hence, DR program administrators will have to develop resource availability estimates by month in order to develop appropriate offers for participation in the MISO EDR program.

## Participation Requirements

Some DR programs establish eligibility criteria for enrollment or target specific groups of customers. For example, DLC programs are targeted to residential and small commercial customers while interruptible tariffs are targeted to large industrial and commercial (including government, institutions, healthcare, and others) customers. Survey respondents also indicated that other types of eligibility criteria were also employed in lieu of or in addition to market segment targeting.

The most commonly cited criteria were minimum size of load reduction offered by customer, minimum level of customer peak demand, presence of specific types of equipment or appliances (e.g. air conditioners) and access to onsite generation (see Table 4). The category "other" referred to contracts negotiated between an individual customer and the utility. Approximately 25% of DR programs explicitly indicated that they had no specified eligibility criteria. About 48% of DR programs allow participating customers to meet their program commitments using onsite generators in lieu of load reductions.

**Table 4. Distribution of DR Resources According to Customer Eligibility Criteria for Enrolling in DR Programs and Tariffs**

| Program Type | Certain End-uses Required | Min. Size of Load Reduction | Minimum Customer Peak Demand | Other |
|---|---|---|---|---|
| DLC | 191 | | | 301 |
| Economic | | 154 | | |
| Interruptible | 8 | 841 | 1,008 | 247 |
| Total | 199 | 995 | 1,008 | 548 |

Specifying minimum size thresholds for load curtailments or customer size requirements in the form of minimum customer peak demand are equally likely to be used as eligibility criteria by utilities in terms of potential load reduction. These eligibility criteria serve as proxies for market segment targeting since commercial and industrial customers are most likely to be able to offer large load reductions and/or have high peak demands. However, framing the eligibility criterion in terms of load reduction or peak demand can also allow a load aggregator to enroll smaller (i.e. not necessarily commercial or industrial) customers in these programs. The proposed MISO EDR Schedule 30 does not include any eligibility criteria; hence, potentially all existing DR resources may be able to participate.

## Monitoring and Verification

Participation in MISO EDR schedule or in MISO wholesale energy markets requires the ability of the LSE to accurately monitor (or measure) and verify the actual load reduction. The survey response shows that only 54% of the DR programs have been evaluated in the last 2-3 years. Therefore not all LSEs have recent estimates of actual load reductions during DR events compared to potential load reduction based on enrollment information. A robust monitoring and verification (M&V) protocol is necessary to develop accurate estimates of actual load reductions.

Only ~50% of the DR programs provided details about the monitoring and verification (M&V) protocols used in their DR programs and tariffs. ~80% of the 29 interruptible tariffs used interval meter data for M&V. Customer baselines for measurement of actual load reduction were defined as part the M&V protocol.

In case of DLC programs, ~77% of the 26 programs used substation level SCADA data to measure aggregate load impacts during DR events. This technique does not measure or estimate actual load reduction for each participating customer. Consequently, participation in a program such MISO's EDR where compensation depends on actual and verifiable load reduction may be problematic.

Approximately 19% of the DLC programs used statistical techniques to improve the accuracy of their load reduction estimates. This methodology consists of extrapolating the measured actual load reductions for a sample of participants to the population of participants in a DLC program using various statistical methods and data analysis techniques. These methods are currently being utilized or considered by ISO-NE, NYISO, and PJM for their mass-market customers.

The overall survey response suggests that M&V protocols may vary substantially across the MISO foot-print. Although, MISO does not include a specific M&V protocol in its proposed EDR schedule, MISO proposes to review and approve the M&V protocol proposed by the enrolled market participant. In the short-term this case-by-case approach may expedite the roll-out of the program, however, in the long-term MISO must develop a consistent M&V protocol that is used by all market participants similar to other ISOs and RTOs that use standardized M&V protocols to estimate load curtailments in their DR programs.

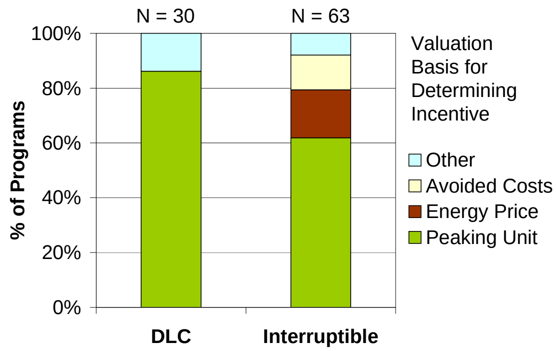
## DR Program Incentives

We also requested information on DR program incentive design, the type and size of incentives provided, and valuation basis to determine incentive levels. The incentive designs varied substantially across survey respondents and included bill discounts (i.e. $/month, $/season, $/year), capacity payment (i.e. $/kW offered per month or season or year), performance payment ($/kWh), and in some cases combinations of capacity and performance payments. The most commonly offered incentive is the capacity payment with or without a performance payment. In contrast, MISO EDR schedule 30 offers only a performance payment for load curtailed as its incentive. Hence, in case of many DR programs and tariffs, LSEs and state regulators may need to address the issue of aligning the compensation received by LSEs from MISO for load reduction with the actual incentive paid to the end-use customer.

Approximately ~30% of the 122 DR programs and tariffs indicated that they have some type of penalty provision if customers do not curtail load during a DR event. Utilities use a variety of approaches to ensure that enrolled customers actually curtail during events: 25 programs include a monetary penalty for non-performance; four programs include mandatory "buy-through" provisions (i.e. customer is forced to pay the real-time market price for load not reduced), and seven programs include provisions that remove enrolled customers from future participation in the program (and loss of incentives) for failure to perform. Survey respondents explicitly told us that there were no adverse consequences for non-performance in case of 27 DR programs. The penalty described in MISO EDR schedule is of the form $/MWh.

The most commonly used valuation basis for determining the size of incentives is the cost of a peaking unit (e.g., a natural gas-fired combustion turbine). As shown in Figure 4, more than 80% of DLC programs and more than 60% of interruptible tariffs use this valuation basis. About 17% of interruptible tariffs report using wholesale energy prices and ~12% used avoided costs (i.e. these include avoided transmission and distribution costs in addition to generation costs) to set incentive levels.

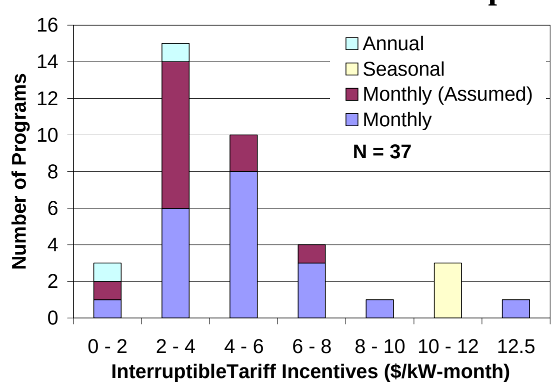
**Figure 4. Valuation Basis for DR Program and Tariff Incentives**




Many retail DR programs were approved prior to the formation of MISO and were justified primarily on reliability grounds. However, although "emergency" DR programs and tariffs are increasingly being utilized for economic reasons, this reality is not fully reflected in cost-effectiveness screening practices used by some MISO states. Anecdotal information also suggests that many LSEs provide "price-sensitive demand bids" in MISO day-ahead energy markets and use high prices from energy markets to trigger their DR programs. Going forward, state regulators may want to direct utilities to consider and assess the full range of DR program use in MISO markets in cost-effectiveness screening and in setting appropriate incentive levels.

In Figures 5 and 6, we present the size of the capacity payment incentive provided for interruptible tariffs and DLC programs, respectively. We converted survey responses to a comparable metric -- $/kW-month - in order to compare incentives across programs. The average incentive was $5/kW-month for interruptible tariffs, although there is significant variation across utilities (e.g. incentives ranged from $1 to 12/kW month).

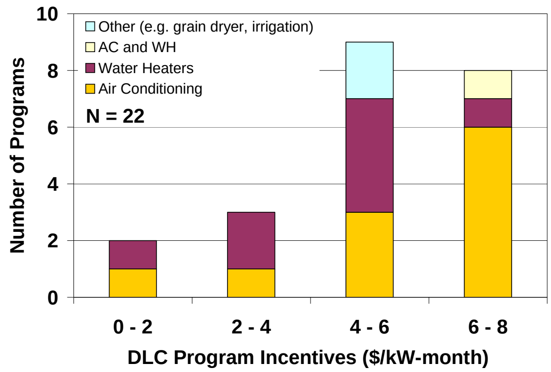
**Figure 5. Distribution of Incentives Offered to Interruptible Tariff Customers**




In Figure 6, we segment the DLC program incentives in terms of the end-use appliance targeted by the program (i.e., air conditioners, and water heaters). The average size of the incentive provided to customers is $6/kW-month for the 22 DLC programs that provided this information. The variation in incentive levels across DLC programs is less than that observed among interruptible tariffs. For example, ~77% of the programs provide incentives between $4/kW-month to $8/kW-month. Incentives offered to customers in water heating DLC programs are relatively lower than those offered to customers in air-conditioning (A/C) programs. About

55% of A/C DLC programs provide incentives greater than $6/kW-month while ~88% of water-heater DLC programs provide incentives less than $6/kW-month.

**Figure 6. Distribution of Incentives Offered to DLC Program Customers**




## Findings and Conclusions

This paper provides the first detailed assessment of legacy DR resources in the MISO foot-print. The size of the DR resource included in this survey is 4,406 MW of which ~84% is available in the MISO service territory through 122 DR programs and tariffs. Interruptible tariffs account for ~77% of the DR resource, while DLC programs account for ~19%. Almost 90% of the DR resources included in this survey are provided by investor-owned utilities.

Approximately 87% of the DR resource utilizes an operational trigger linked to system emergency conditions, although most programs allow for multiple triggers. Surprisingly, 70% of the DR resource can also deployed by LSEs for economic reasons. The frequency of use of DR programs and tariffs for economic reasons has increased since MISO markets began operating. Approximately 60% of DLC programs and 30% of interruptible tariffs called ten or more DR events in 2006. Despite the high frequency of DR events, customer complaints remained low. The use of economic criteria to trigger DR events and the flexibility to trigger a large number of events suggests that DR resources can help improve MISO wholesale markets.

Approximately, 90% of the DR resources are available with less than 2 hours advance notice and over 1,900 MW are available with less than 30 minutes notice. Almost all of the DR resources are available in summer and 67% of the programs throughout the year. However, the fact that a program operates throughout the year does not mean all potential load reductions from the program are available in each month. System planners will have to develop estimates of DR resource availability by season (or month) instead of using the existing estimates.

M&V protocols vary across MISO foot-print. In the case of most DLC programs, M&V protocols are simply not robust enough to allow participation in MISO's EDR schedule. MISO is in the process of developing M&V protocols that are consistent across its service territory. Almost half of the DR programs and tariffs have not been evaluated in recent times. Hence, data on performance during DR events is not available. System operators and planners will need to develop more accurate estimates of the load reduction capability and actual performance.

Most legacy DR programs offered a reservation payment ($/kW) for participation; incentive payment levels were about $5/kW-month for interruptible tariffs and $6/kW-month for DLC programs. Most utilities indicated that the avoided cost of a peaking unit was used as the valuation basis in cost-effectiveness screening and in setting incentive levels. Few programs offered incentive payments that were explicitly linked to the actual load reduction during an event and at least 27 DR programs do not have penalties for non-performance.

If MISO's proposed revisions to its emergency procedures are approved by FERC, it is unclear to what extent utilities will actually enroll their customers in this new MISO DR program. LSEs and participating customers would receive additional incentive payments during emergency events (up to $3,500/MWh), but LSEs will incur additional transaction costs, and LSEs and participating customers will face penalties for non-performance. For example, an LSE will have to specify the minimum and maximum amounts of curtailed load, number of hours of advance notice required and whether such reductions are limited to certain hours, periodically bid and update offer prices for curtailed load, accurately estimate load curtailments or be subject to penalties, and develop and negotiate an acceptable M&V protocol with MISO.

Participation and enrollment of legacy DR resources in the MISO emergency DR protocols may ultimately hinge on whether it is made a requirement for LSEs that want to take resource adequacy credit for their DR resources as part of the MISO reliability planning process. At a minimum, utilities and state regulators may have to rethink and possibly revise some tariff provisions of legacy DR programs that relate to customer's obligations and incentives for curtailing load during system emergencies, penalties for non-performance, periodic testing of existing DR assets, and more consistent M&V protocols.

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