TAD Project Update Content Development
Transactive Incentive Signals

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EXECUTIVE SUMMARY
Name of the Project Transactive Incentive Signals to Manage Electricity Consumption (TIME): A System for Transactive Load Management [EPC-15-045]
Issue driving the need for the Project Demand response (DR) has substantial potential to act as either a demand-side or a supply-side resource. However, existing programs and rates do not provide a participation incentive structure that accurately reflects system conditions or system costs, which is a suboptimal situation that results in higher ratepayer costs, low DR participation and an inability for system operators to regularly utilize demand-side resources. As the state moves toward more distributed generation and intermittent renewable energy generation, integration of those generation resources will further increase costs in the absence of significantly expanded DR resources responding to actual system needs in real time. Access to the system- and market-based economics to leverage load flexibility from consumers would provide a unique value proposition in support of efficient grid operations—i.e., it would enable Transactive Load Management (TLM).
Research Overview This research reviews California's pathways for a clean energy system with emphasis on the scope of the solicitation and TLM signals for electricity markets and demand response (DR) programs. The report focuses on the framework for the TLM system, and the TLM pricing and signal design structure to lead California toward the planned clean energy system. The research methodology includes: 1. review of the existing California electricity market, regulatory structures, and electric grid; 2. review of the Group 1 and Group 2 project proposals that use the TLM signals; 3. literature review on existing supply-side and demand-side DR programs and advanced pilots that leverage DR as a grid resource. In close coordination with the advisory committee members, the study proposes a TLM framework and design that incorporates early-stage research and a TLM reference model that is leveraged through a collaborative approach and in field tests of technology applications.

Key Research Questions

How does a universal pricing signal facilitate DR to retail and/or wholesale markets – can a single incentive signal be used for both?

Additional questions addressed by the research relative to the TLM signal include the following:

- What should the signal design be?
- What elements should the signal be made up of, and in what proportion?
- How do variations in the signal's composition affect consumer behavior?
- How can the design and operation of TLM signals and systems integrate supply- and demand-side markets in California?

Description of the technology(s) and the potential it holds for solving the issue

A software system that calculates and communicates real time, Transactive Load Management (TLM) signals in the form of proxy prices that reflect actual grid conditions. This system would allow utilities to calculate a pricing structure based on real time system needs that could then be used to effectively incentivize customers to participate in demand response during times of peak demand. Correctly calculated TLM signals would be transported via proven and available protocols and networks, ensuing customers receive compensation based on actual time of use rates, rewarding them for managing their energy use when needed most.

If successful, TLM signals would be integrated into programs and rate structures to ensure incentives accurately reflect system conditions and costs, resulting in stabilized ratepayer costs, higher DR participation and a path for systems operators to utilize demand-side resources as the state moves toward more distributed generation and intermittent renewable energy generation.

Timeline for the Project

5/18/2016 to 6/28/2019

PROJECT DETAILS

Overview of the Project – what is it and who is leading it?

EPRI is leading the development and implementation of an innovative software system that calculates and communicates Transactive Load Management (TLM) signals, expressed in the form of proxy prices reflective of current and future grid conditions. This project will use proven and available protocols and networks to transport these signals, and test the efficacy of the TLM signals through demand response Group 1 and 2 projects, awarded under GFO-15-311, Advancing Solutions that allow Customers to Manage Their Energy Demand.

Group 1 and 2 projects are led by multiple partners, with Group 1 efforts focused on supply side resources and Group 2 efforts focused on demand side resources.

If successful, EPRI's TLM signals software systems will facilitate communication on both sides of the meter.

Goals for the project – what do we hope to learn/develop/solve?

This project hopes to demonstrate the potential for a variety of different loads and customer types to respond automatically to a real-time proxy pricing signal. If successful, this system could advance the potential of DR being a supply side or a demand side resource for utilities and customers in California.

Approach – what methodology is being used?

EPRI is following a traditional approach of design, implement and operationally deploy transactive load management (TML) signals (proxy prices) to facilitate demand response by CA utilities and utility customers.

1. Design:
   - Perform literature review of dynamic TLM signal experience
   - Survey experts and review related projects for unpublished experiences
   - Determine initial definitions for TLM signaling framework and design
2. Implement
   - Interface to required data sources and calculate TLM signals
   - Send reference TLM signals via standard communication infrastructure
   - Integrate and test TLM signals with Group 1 and 2 projects
3. Operate
   - Provide operational TLM signals to Group 1 and 2 projects
   - Use Group 1 and 2 feedback to refine and improve TLM signals

***What is Transactive in an electricity context?*
1. Buying and selling of electricity (inherently 2-way)
2. Actions based on economic principles
3. Information exchange: operators, providers, and prosumers (systems)

Example: Price-based Demand Response

Project Participants – who is involved in the development and testing of this solution? What are they looking to accomplish?

Group 1 Projects (Supply Side:)

- **BMW**: EV smart change management/optimization based on cost and carbon savings
- **Center for Sustainable Energy (CSE):** Demonstrate the resource model for CAISO Proxy DR (PDR)
- **OhmConnect**: Generate load changes from large numbers of residential customers at specific times/ specific geographic areas.

Group 2 Projects (Demand Side:)

- **Alternative Energy Systems Consulting (AESC):** Demonstrate optimization of residential energy consumption based on day-ahead hourly pricing posted on the HEMS or aggregation
- **California Institute of Energy and Environment (CIEE):** use real or projected prices to initiate control sequences in small to large commercial building HVAC, lighting, and plug loads.
- **Electric Power Research Institute (EPRI):** Demonstrate aggregation of a wide variety of load types and products for residential and SMB customers
- **UCLA Luskin Center:** Study of how consumer response to incentives varies with weather, day of the week, and time of day
- **Universal Devices:** Demonstrate residential and commercial automated and self-managed energy use and storage.

Phases of the Project

Technical Tasks

- Task 1: General Project Tasks (Project Management and Planning)
- Task 2: TLM Signal Design: Literature Review, Interviews, and Technical Advisory Board
- Task 3: TLM Signal Definition, Requirements, and Use Cases

- Task 4: TLM Signal Open-Source Software Development and Integration
- Task 5: TLM Signal Groups 1 and 2 Project Integration and Testing
- Task 6: TLM Signal Operation & Refinement
- Task 7: Evaluation of Project Benefits
- Task 8: Technology/Knowledge Transfer Activities

Current Phase
Task 8: Technology/Knowledge Transfer Activities

MARKET POTENIAL

Target Audience – who is this solution being developed for?

Primary Audiences:
1. Electric utilities, System Operators, and Regulatory Agencies who are looking for ways to engage and incentivize residential and SMB customers in demand response programs designed to increase the use of demand-side resources as the state moves toward more distributed generation and intermittent renewable energy generation.
2. Residential and SMB energy consumers who will benefit from stabilized ratepayer costs, and increased grid reliability.

Secondary Audience:
Demand Response Technology and Service Providers

Potential Benefits – if the technology is adopted by the target market, what is the perceived long-term benefit?
- Flexibility - Demand Response as a supply side and demand side resource
- Consistency - real time pricing and incentive structure
- Customer Engagement - Higher participation in DR programs
- Rate stabilization – rates accurately reflect system demand
- Reliability – supports the state's growing distributed and renewable energy generation

Potential Market Challenges – what market actors or factors currently exist that may affect adoption?
Market challenges have not been identified at the time this document was created.

Delivery Channel – which key delivery channels have been engaged to date? What opportunities or challenges currently exist?
No delivery channels have been engaged. The transactive signal is simulated for the purpose of the project to prove the concept.

ADDITIONAL LEARNINGS AND OPPORTUNITIES RESULTING FROM THE PROJECT?

Have any unexpected or additional opportunities been identified during this project?

The interim findings show the critical need to integrate California's electricity markets in order to unlock customers' DR resources, and enable cost-efficient integration of variable renewable generation. The detailed project findings are as follows:

1. The 24-hourly day-ahead California wholesale electricity market prices constitute the consensus temporal base case for TLM Prices. There are outliers with intra-hour price notification and price duration signals.
2. The Pnode locational marginal prices (LMPs) published by the CAISO can be the lowest desired spatial disaggregation for wholesale electricity market prices. Likewise, the APnode prices for the IOU LAPs are the lowest spatial disaggregation for wholesale electricity market demand prices.
3. The distribution system variability (demand/supply) adjustment and electricity service providers and operations may be considered for customer-level TLM System and Prices that reflect integrated system and market conditions.
4. An integrated and inclusive approach to the CAISO (transmission and generation) domains and the electric utilities (distribution) domain is critical to determine “fair market” and integrated TLM Prices.
5. The determination of TLM Price must include data inputs for pre-market planning and real-□me analytics for both wholesale (supply-side), generation sources (for GHG) and retail (demand-side) markets. This ensures that advanced analytics are used to calculate Prices that consider real-□me system and market conditions.

Future Recommendations (outside the project scope)

- Analyze the impacts of distribution system cost adjustment on electric utility operations and planning and on existing electricity rate tariffs.
- Leverage synergies to design and develop methodologies to estimate transmission and distribution system TLM cost adjustments.
- Develop a roadmap and evaluate the impacts on utility business models and technology of adjusting the CAISO APnode prices to produce a distribution system price based on real system and market conditions.
- Develop an open-source TIME prototype software system and signaling tool using LMPs (wholesale) and LAP APnode (distribution) models.
- Evaluate the technology and cost-effectiveness of TIME for various scenarios for moving California toward a more transactive-enabled grid.

NEXT STEPS FOR THE PROJECT

How can results be applied?

The findings can be used by the industry and research organizations to develop new practices for widespread adoption of economics-driven transactive technologies and systems for an integrated, electric “grid of the future.” The solicitation project participants conducting field tests shall leverage the system and signals developed in this research to deploy advanced DR automation technologies to identify customer response strategies, end-use loads, system architecture, and value.

What activities are involved in the next stage?

For the purposes of applied research and development, the next one-year activity will focus on operationalizing and maintaining the TIME systems and TLM signals. Electric grid operators, service providers, regulators, and technology innovators can use these interim research findings to identify value in their regions and the grid- and customer-side benefits of using TLM system and signaling design constructs

Any additional comments:

This project is of great interest to EM&T and to CA.