

Intelligent Software Agents for Control and Scheduling of Distributed Generation

(CEC / PIER 500-98-040)

March 13, 2001

**Alternative Energy Systems
Consulting, Inc.**

Gerald Gibson
Donald Pratt

*Smart*DER Demonstration* Meeting Agenda

- ◆ *Introduction (10 - 15 min.)*
- ◆ *Domain Analysis/Market Research (15 min.)*
- ◆ *Smart*DER Agency Description (10 min.)*
- ◆ *Smart*DER Demonstration (45 min.)*
 - Single agency operation
 - Multiple agency operation
- ◆ *Open Issues (10 min.)*
- ◆ *Potential Follow-on Project Description (5 min.)*
- ◆ *Summary (5 min.)*
- ◆ *Questions / Answers (15 - 30 min.)*

Project Team

- ◆ **California Energy Commission (CEC)**

Jamie Patterson - Program Manager

Laurie A. ten Hope - PIER Program Lead

- ◆ **Alternative Energy Systems Consulting, Inc. (AESC)**

Gerald L. Gibson, Program Manager

Ronald K. Ishii

Donald Pratt

- ◆ **Reticular Systems Inc.**

Dan Ballard, President

CEC-PIER Project Objectives

The technical objectives of this project are to:

- Demonstrate how a prototype network of intelligent software agents can coordinate and schedule one or more distributed energy resources.
- Develop a demonstration package that will facilitate transfer of the project results into the private sector.

The economic performance objective of this project is to:

- Identify and initiate discussions with one or more potential partners who are willing and able to participate with commercialization of *Smart*DER* technology.

Intelligent Software Agents?

An *agent* acts on behalf of another....

An *Intelligent Agent*

- Executes autonomously
- Operates in real-time
- Communicates with other agents or users
- Able to exploit domain knowledge
- Exhibits goal-oriented behavior

Agency Advantages:

- Multi-agent Systems (a.k.a. Agency) allow distributed processing -- error/failure tolerant
- Individual agent complexity is kept low while agency intelligence is high
- Agent-based solutions are more open and extensible

Why Use Intelligent Software Agents?

DER scheduling problem is amenable to an agent-based solution because:

- It requires an open/extensible solution
- DER benefits are application & location specific requiring the use of local knowledge and decision-making
- Information comes from a variety of disparate locations
- A dynamic decision-making environment exists
- Aggregation of loads/supplies requires communication / collaboration between sites

Project Technical Tasks

1. Domain Analysis & Market Research

- Virtual Evaluation Group Formation
- Product Requirements

2. DER*S Agency Development & Testing

- Task Analysis
- Agent / Agency Definition
- Agent Development

3. EASE Development & Testing

- EASE Definition
- EASE Development

4. DER*S – EASE Integration/Testing

5. Documentation & Demo Development

Domain Analysis & Market Research

Virtual Evaluation Group:

Allied Signal/Honeywell

CAISO

Caterpillar

Encorp

Enflex

Lawrence Berkeley National
Laboratory

San Diego Gas & Electric

San Diego Regional
Energy Office

Southern California Edison

Mark Skowronski

David Hawkins

Eric Wong

Scott Castalaz

David Wollins

Chris Marnay

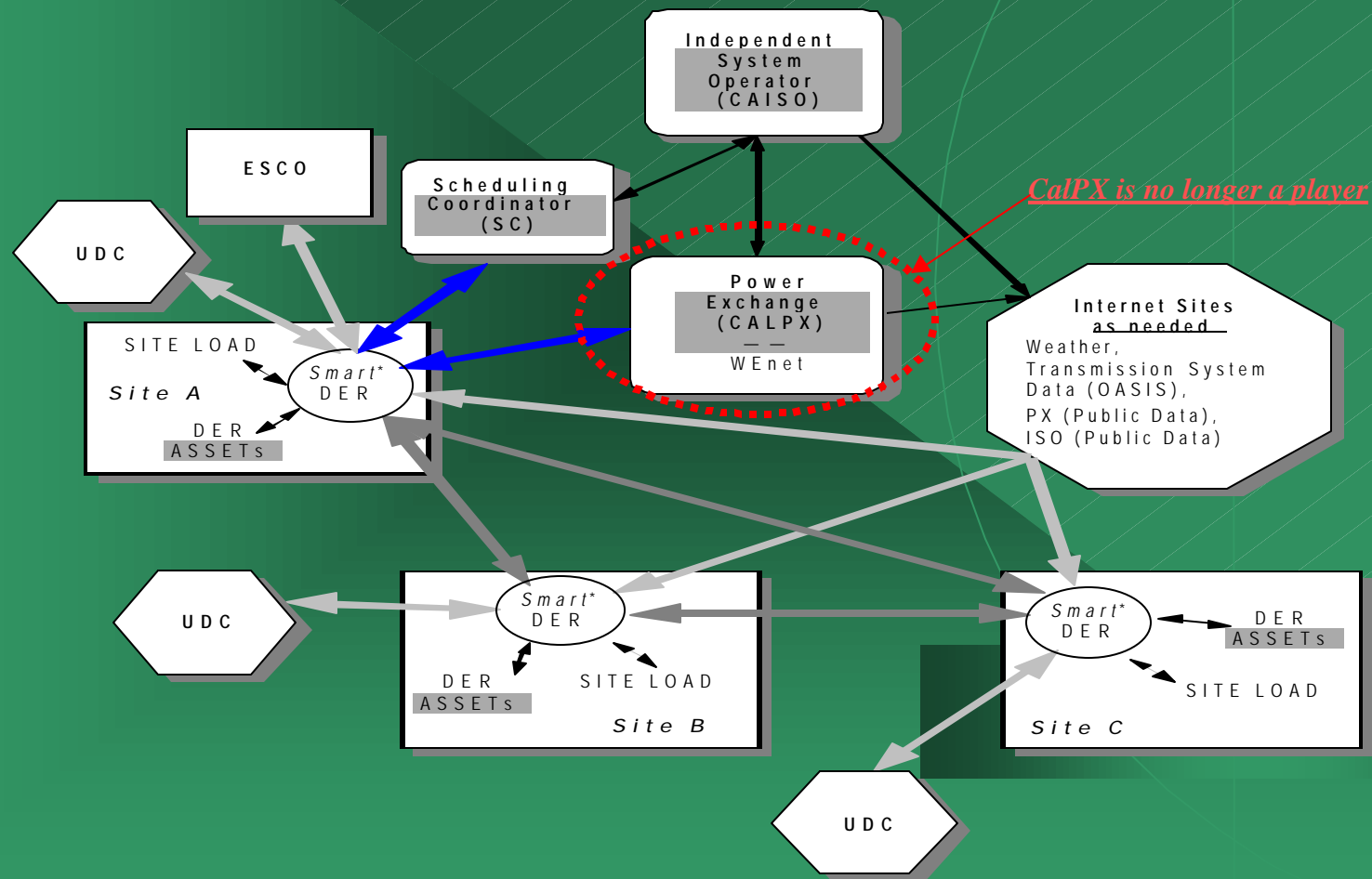
Victor Romero

Kurt Kammerer

Carlos Martinez

Smart*DER Operating Scenario

Multiple Site Aggregation / Market Participation

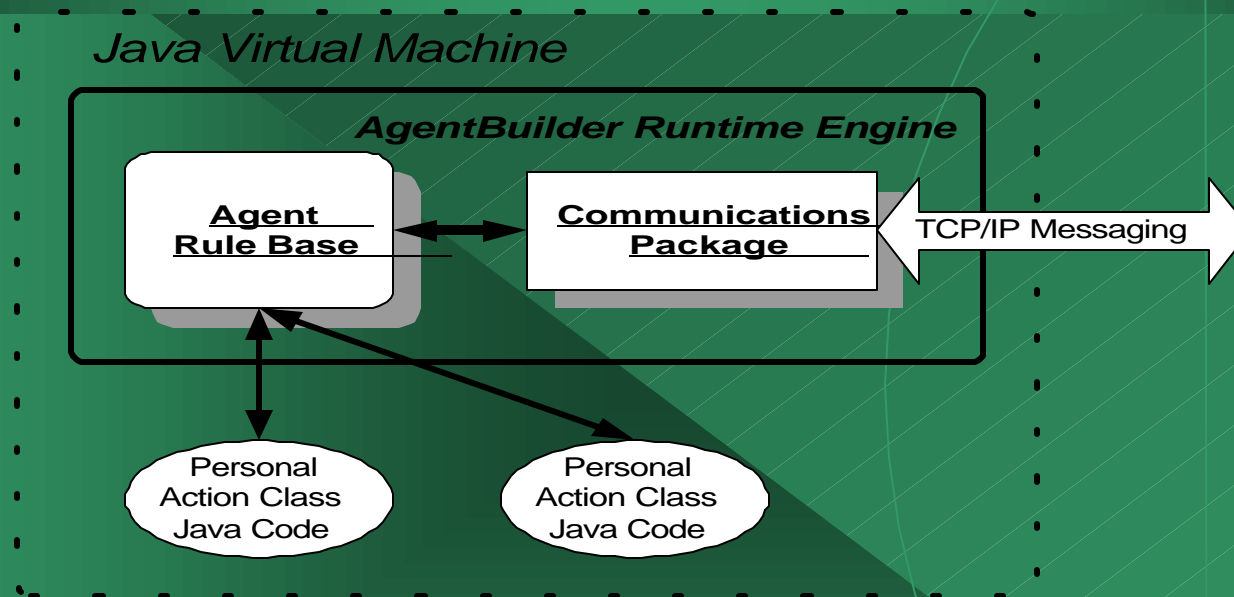


Smart*DER Product Requirements

A successful commercial product must ultimately:

- Monitor and Forecast DER Asset Performance / Output
- Monitor and Forecast Site Load (energy and demand) Requirements
- Monitor and Forecast Relevant Market Pricing
- Schedule DER Operation to Maximize Economic Benefit (local bill reduction plus dynamic market participation)
- Provide for User Input via a Graphical User Interface (GUI)
- Provide Data Storage & Retrieval
- Communicate as Needed with External Entities (i.e., Internet, DER controls, etc.)

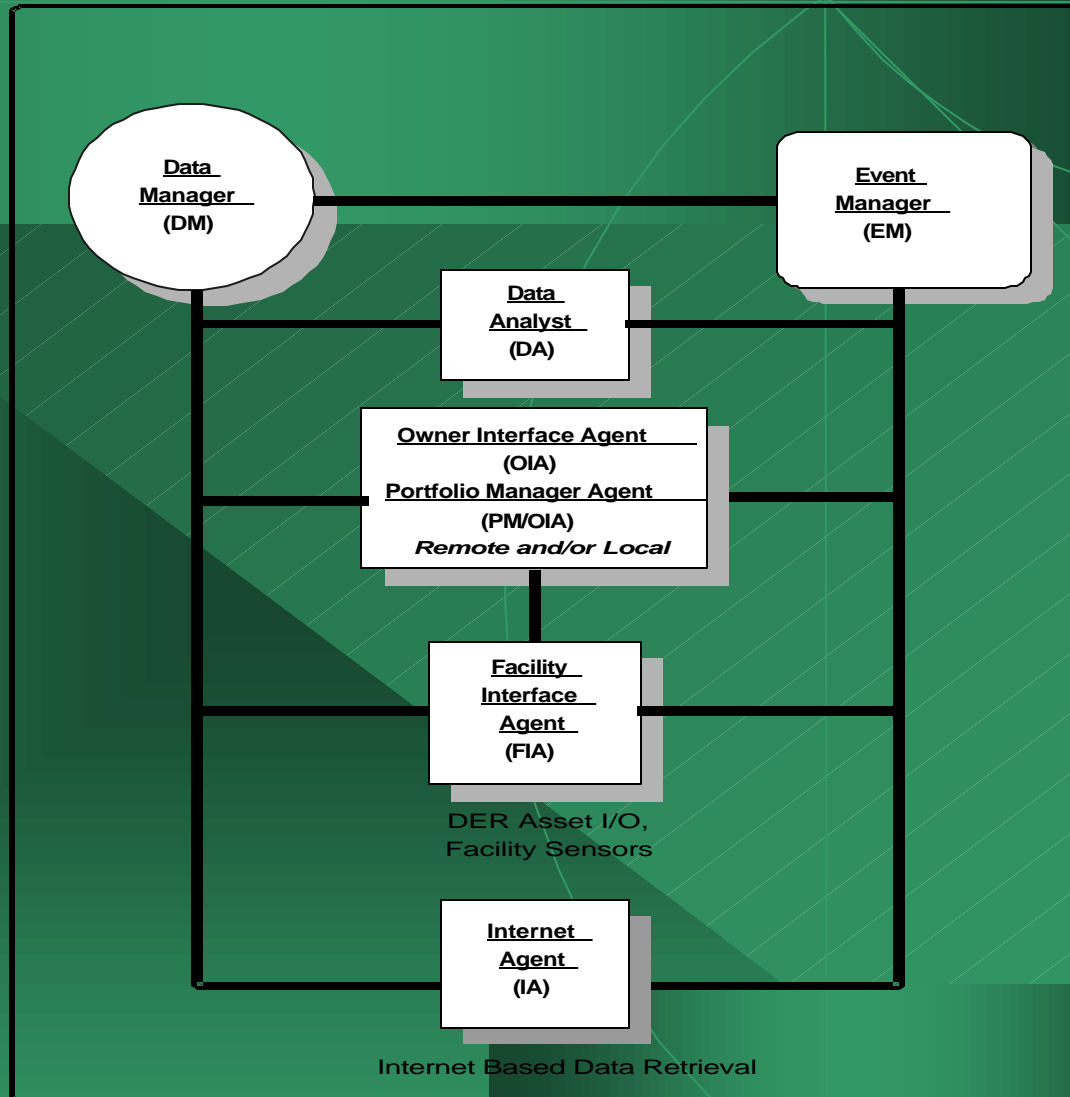
Smart*DER Agent



Agent Features:

- Agents operate within a JVM using the AgentBuilder® run-time engine
- AgentBuilder® provides for a robust development & operating environment
- Web based communications supported
- Java based code provides platform independence

Smart*DER Agency



*Smart**DER Demonstration Software

Demonstration Software Uses:

- Actual CAISO & CalPX price data for 1999 calendar year
- San Diego area weather data
- Generic commercial and industrial load profiles as provided by SDG&E
- Price and weather data supplied by a single website that emulates CAISO and CalPX data retrieval & auction interaction (hosted by Reticular Systems in San Diego)
- A single complete agency per PC (for demonstration purposes)
- Accelerated time base for quicker execution
- Microsoft Access DB, which limits it to the Windows OS

*Smart**DER Demonstration Software Cont'd

Demonstration Software DER Scheduling:

- Will provide for DER operation to:
 - ★ Reduce site utility bill
 - ★ Participate in the CalPX energy auction
 - ★ Participate in AS-NS & AS-RR markets
- Supports Day-Ahead auction participation
- Single day scheduling does not account for demand savings
- Probabilities of winning and subsequently providing AS capacity can be set. Demo is currently set so that AS bids are always accepted -- Probability of providing capacity in any given hour is set for 0.5.

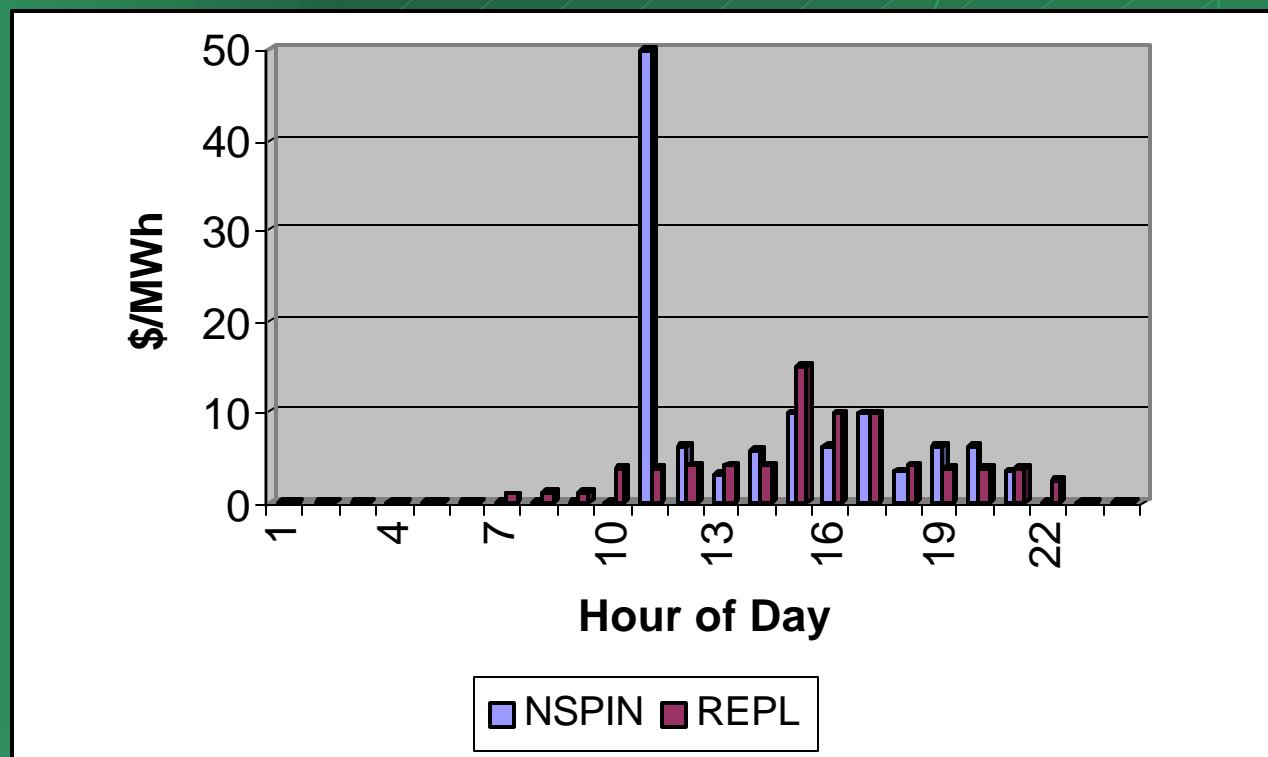
Smart*DER Demonstration Agenda

Today's Demonstration Will Show:

- Single site / agency operation
 - Inter-agent communications
 - DER schedule generation with and without market participation
 - Schedule execution
- Start-up of second site / agency
 - Automatic agency registration
 - Inter-agency communications
- Dual agency / portfolio operation
 - Portfolio schedule generation - market participation
 - Schedule execution

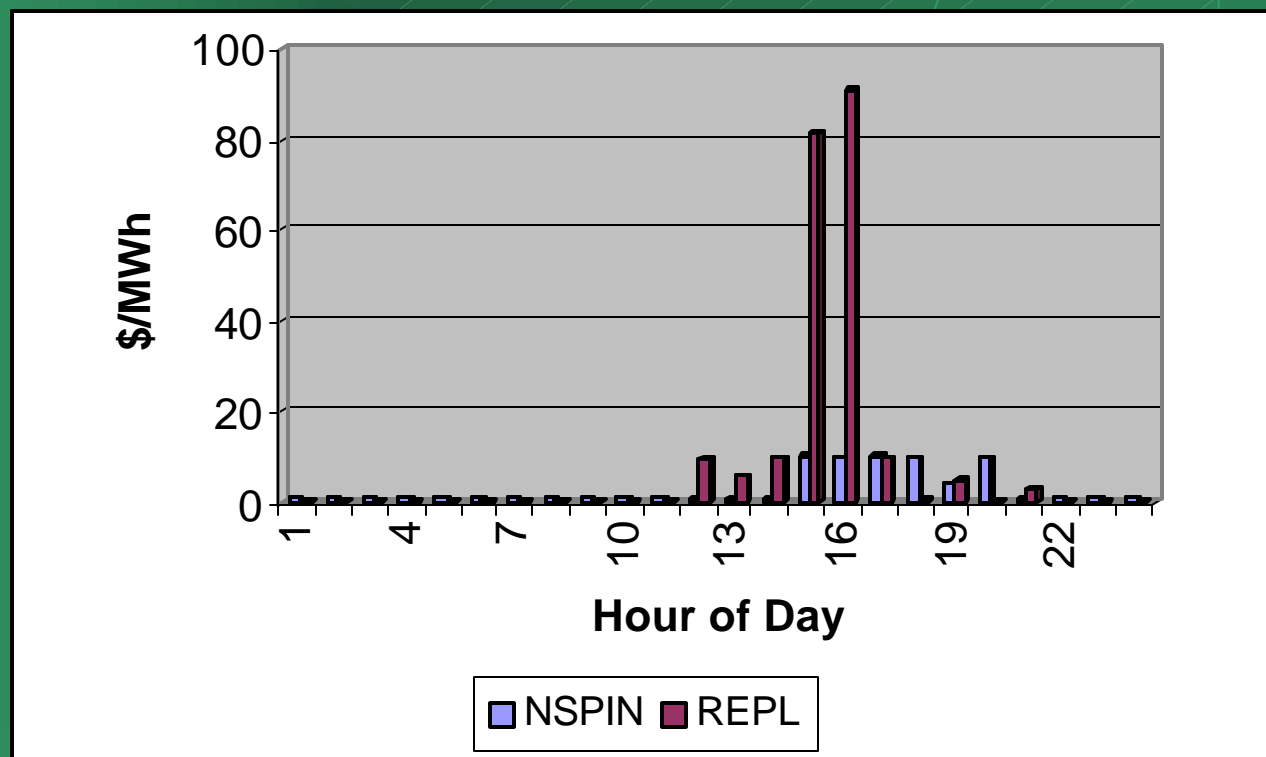
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Ancillary Services Pricing



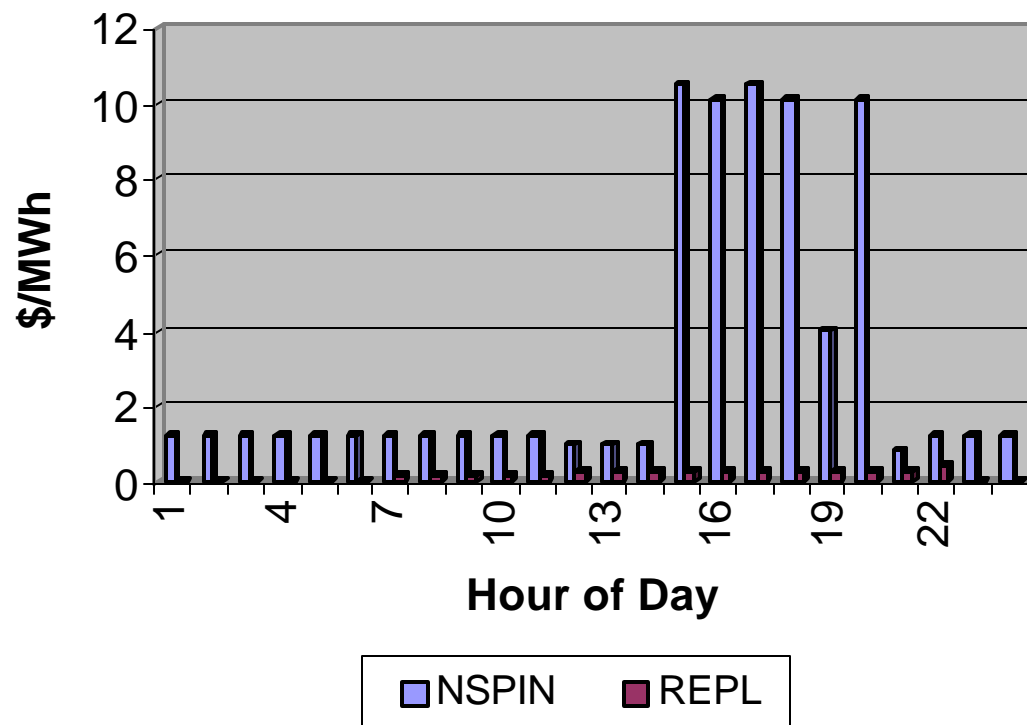
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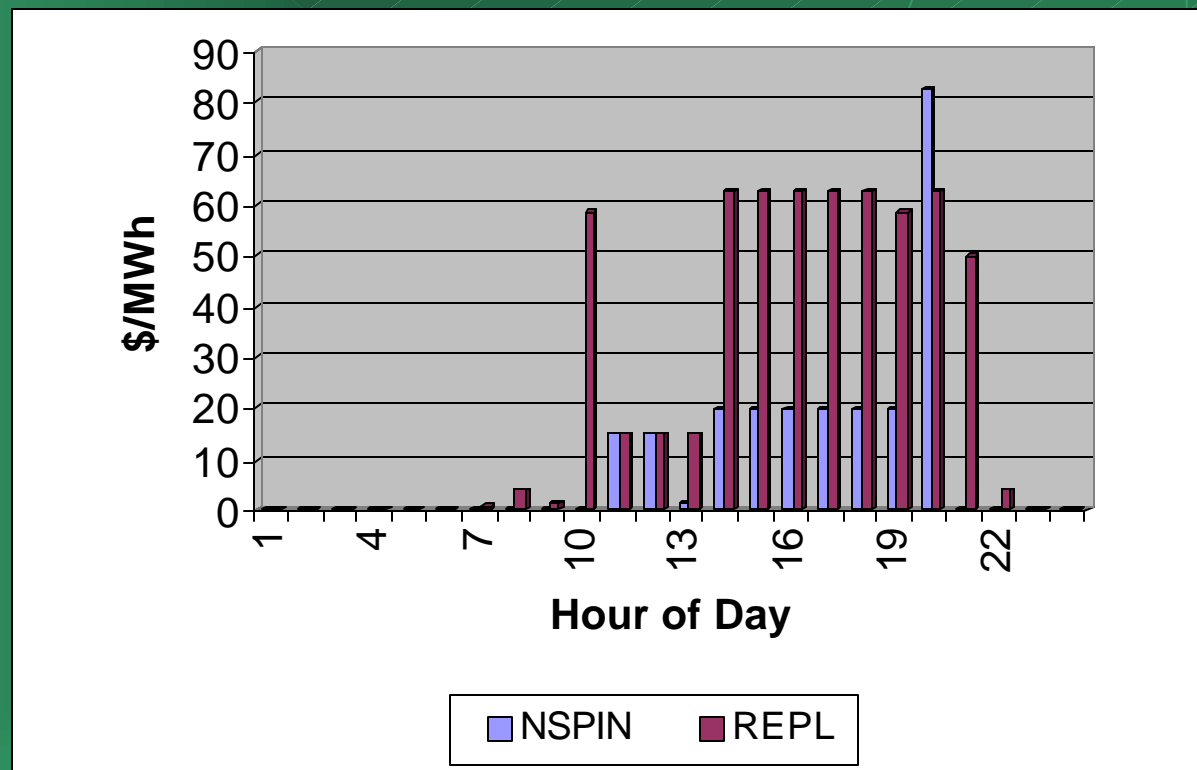
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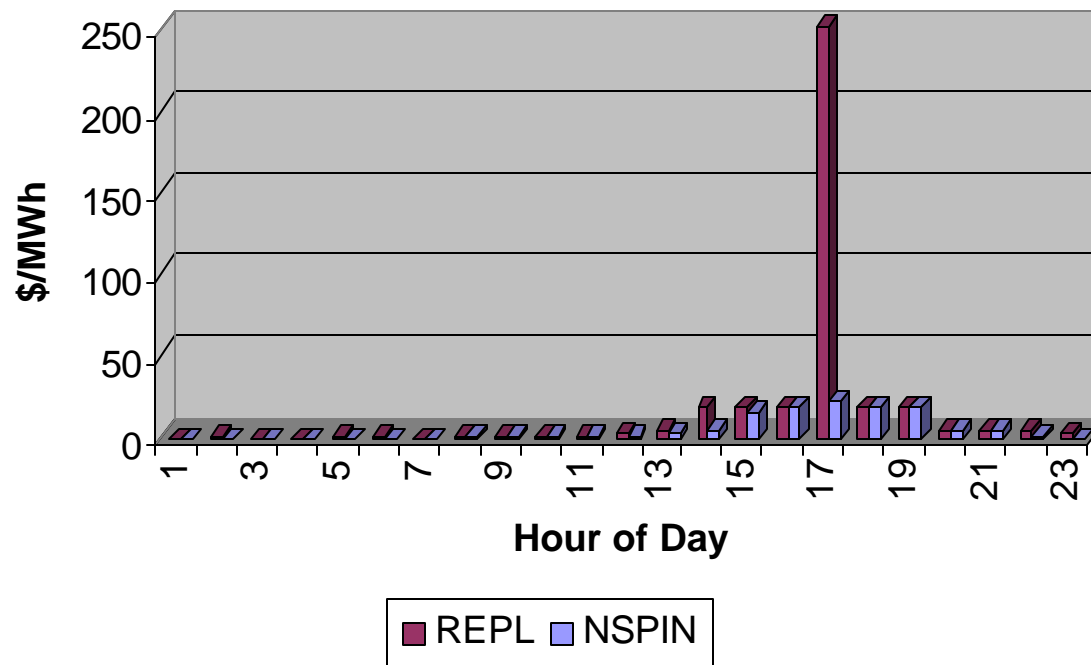
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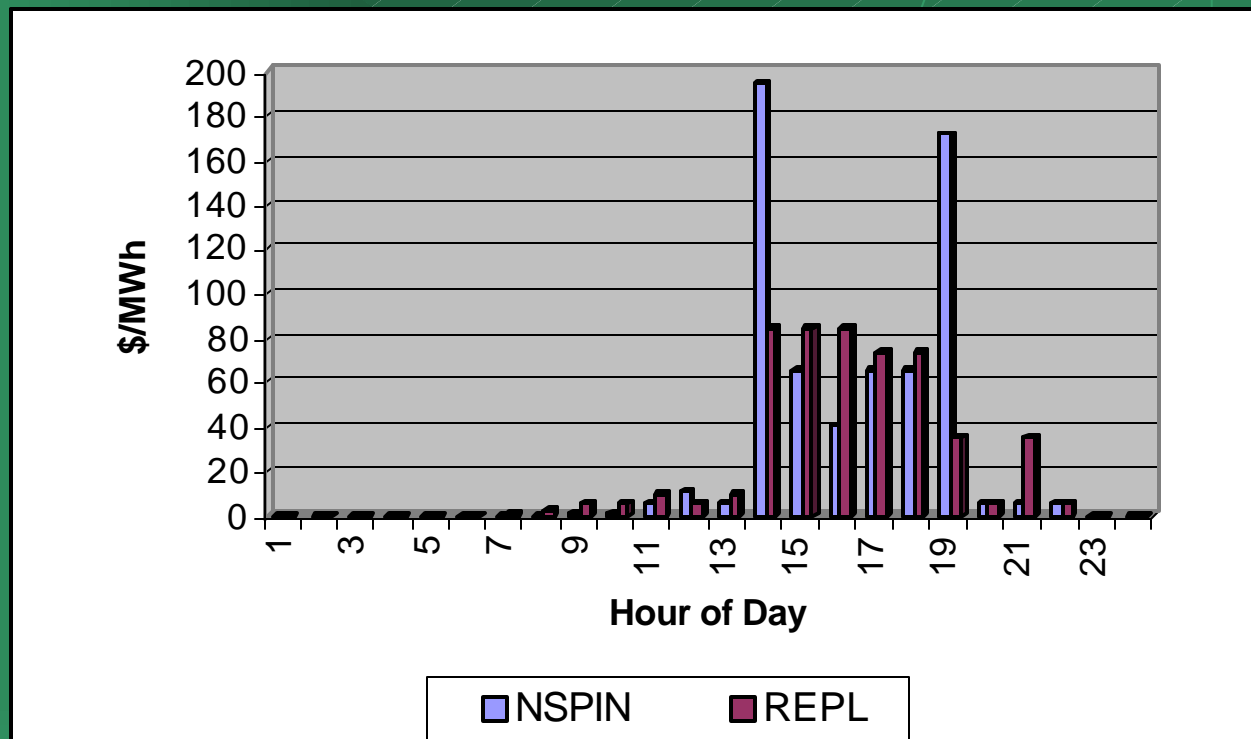
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Ancillary Services Pricing



Demonstration Day Pricing - 7/12/99

Ancillary Services Pricing



Open Issues

- ◆ Ever changing California marketplace -- Is current emphasis on DER a short-term phenomenon?
- ◆ Success or failure of current programs to promote DER use (CAISO, CEC...) -- *Smart**DER enhances ones ability to participate in these programs.
- ◆ Future role of CDWR and related programs -- What new programs and associated protocols/procedures will be instituted?
- ◆ Metering and interconnection issues -- legislation proposes to ease restrictions
- ◆ Environmental restrictions on DG operation -- complicates the decision process
- ◆ Regulatory policy regarding UDC ownership of DER -- Affects DER infrastructure

Potential Follow-on Project Description

The CEC has expressed an interest in a follow-on project that would:

- Update *Smart*DER* product requirements based on results of the current effort as well as changes that have occurred in the California energy marketplace.
- Enlist participation by one or more potential commercialization partners that will integrate *Smart*DER* into their technology for the field test.
- Refine *Smart*DER* technology to reflect changes in the product specification and to provide interfaces with field test participant's software/products.
- Complete a successful feasibility test assessment of *Smart*DER* technology scheduling distributed energy resource assets in the "real world" California marketplace.

Summary

- ◆ The results of this CEC PIER project show that intelligent agent technology (*Smart*DER*) could be successfully applied to scheduling of DER assets in California.
- ◆ The dynamic nature of the California marketplace combined with legislative and regulatory changes are opening up opportunities for increased DER involvement.
- ◆ *Smart*DER* agents utilize an open and extensible architecture that can be readily adapted to this changing marketplace.
- ◆ The next step is to test *Smart*DER* technology in a real-world environment and to advance efforts to integrate this technology with others already in the marketplace.

Questions / Answers

Demonstration Feedback

- ◆ Demonstration software will be made available in the near future on a limited basis.
- ◆ Please contact AESC regarding receipt of the demonstration software when it becomes available.
- ◆ AESC will be conducting this demonstration again during the week of March 19th in San Diego (date and time are TBD).
- ◆ AESC is very interested in your feedback regarding this demonstration, this technology and in the potential feasibility field test effort.

Please Contact:

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