Appendix I
Market Research Report

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CEC-PIER Project 500-98-040
Intelligent Software Agents for Control and Scheduling of Distributed Generation

Market Research Final Report

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Executive Summary

Alternative Energy Systems Consulting, Inc. (AESC) is currently under contract to the California Energy Commission (CEC) for development and demonstration of a Distributed Energy Resources (DER) scheduler that will operate in the California competitive energy marketplace. Specifically, the CEC-PIER project titled, "Intelligent Software Agents for Control & Scheduling of Distributed Generation", provides funding to demonstrate the viability of controlling and scheduling one or more distributed energy resources using intelligent software agents; where an intelligent agent is a software program that acts on behalf of the user and has the ability to exploit knowledge, tolerate errors, reason with symbols, learn and reason in real time, and communicate with other agents or entities. Multiple agents acting independently, in a cooperative fashion, are called an agency. For this project we will develop and test a prototype agency called the Distributed Energy Resource Scheduler (DER*S).

This report summarizes the market research effort associated with the subject project. The market research effort had four basic objectives, which were to:

- Establish a market participant evaluation group comprised of knowledgeable key individuals and companies.

- Solicit comments from the market participant group on key issues and questions that affect DER*S.

- Form a Virtual Evaluation Group of engaged market participants that will provide valuable feedback on project activities for the duration of the project.

- Identify potential DER*S commercialization partners.

Relative to these objectives our market research efforts were very successful in that we were able to achieve all of the stated objectives. During the market research effort, we assembled a diverse market participant group consisting of knowledgeable individuals that were well suited to providing the desired feedback. Ultimately, the group provided valuable comments that are reflected in changes that were made to the project's Preliminary Domain Analysis Report.

Overall, the market participant group found our description of the California electric market(s) to be both accurate and well written. Panel members understood the DER*S concept and confirmed the need for new scheduling and dispatch technologies. These technologies are necessary to facilitate widespread DER operation and grid integration. Panel comments will enable us to refine the DER*S and demonstration software designs to better accommodate the needs of the market.

The market participants agreed with our initial assessment of how DER*S could be integrated into the California marketplace but indicated that we were overly focused on the bulk power and ancillary services markets. We subsequently made changes that will provide for DER*S management of curtailable loads in response to either interruptible electric rates and/or the ancillary services markets. In addition, we now recognize the importance of DER*S operation at an individual site to directly offset facility utility costs without any need for involvement in either the bulk power or ancillary services markets.

Market participant comments compelled us to refine the DER*S market/operating scenarios that we identified in our Preliminary Domain Analysis Report. We were further able to identify DER*S near- and long-term operating scenarios, which will in turn allow us to focus the DER*S and demonstration software designs.

A Virtual Evaluation Group (VIREG) consisting of individuals that participated in our market participant group was formed. We had initially envisioned a relatively large base of market participants from which to choose VIREG participants. What we found was that market participants that had provided comments did so because they had both an interest and desire to participate throughout the project. For this reason, the VIREG is comprised of all ten (10) of the market participants that provided comments/feedback.

It would have been premature to negotiate with, or otherwise engage, a commercial partner given the early stage of our project. However, we were able to identify the commercial partner traits that will maximize the benefit to the DER*S development and commercialization efforts. These traits call for a commercial partner that has:

- ✓ An existing product or technology that enhances potential DER*S market penetration,
- ✓ An existing product distribution / support infrastructure, and
- ✓ Industry Name / Trademark Recognition

In addition, we were able to identify potential commercialization partners having some or all of these traits. Some of these potential partners have agreed to participate in the VIREG. Other partners will be more approachable as the DER*S product design solidifies. We will therefore continue our efforts to identify additional potential partners as the project progresses.

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1.0 Introduction

This market research effort is part of the first task in a California Energy Commission PIER research and development project titled, "Intelligent Software Agents for Control & Scheduling of Distributed Generation". The overall project objective is to demonstrate the viability of using intelligent software agents for scheduling/dispatch of one or more distributed energy resources (e.g., distributed generation, energy storage, cogeneration, etc.) in a competitive market. An intelligent agent is a software program that acts on behalf of the user and has the ability to exploit knowledge, tolerate errors, reason with symbols, learn and reason in real time, and communicate in an appropriate language. Multiple agents operating in conjunction, as an agency, can achieve goals/objectives that would not be otherwise achievable by a single agent. For this project we will develop and test a prototype agency called the Distributed Energy Resource Scheduler (DER*S) that will schedule operation of distributed energy resource (DER) equipment in a simulated competitive energy market.

There were four basic objectives of this market research effort:

- Establish a market participant evaluation group comprised of key individuals and companies that operate in, or have knowledge of, the competitive energy industry and/or distributed energy resources.

- Solicit feedback from the market participant group on key issues and questions that affect DER*S. This information would support our domain analysis efforts and ultimately help characterize the DER*S operating environment, or domain, for the most likely DER*S markets.

- Identify a smaller group of engaged market participants that will comprise a Virtual Evaluation Group (VIREG), which will continue to provide feedback on project activities during the course of the CEC PIER project.

- Identify potential DER*S commercialization partners

The remainder of this report is divided into five sections. Section 2, Market Participant Group describes the activities involved in identifying and forming the market participant group. Section 3, Market Participant Group Feedback, summarizes the feedback that was received and the its impact on DER*S. Section 4, Virtual Evaluation Group, discusses the purpose and formation of the Virtual Evaluation Group while Section 5, Potential Commercialization Partners provides an update on our activities to identify a commercialization partner for the DER*S technology. Section 6, Conclusions and Recommendations is self-explanatory.

2.0 Market Participant Group

A variety of sources were used to identify key market participants that operate in, or have knowledge of, the competitive energy industry and/or distributed energy resources. A number of individuals approached AESC directly after seeing the CEC PIER project description posted on the CEC website. In addition, AESC reviewed the following sources to establish the initial market participant group.

- ✓ California Public Utility Commission - Registered Energy Service Provider
- ✓ California Independent System Operator - Certified Scheduling Coordinators
- ✓ California Power Exchange - Participant Database
- ✓ NERC Western System Coordinating Council - Member Electric Utility Systems
- ✓ California Alliance for Distributed Energy Resources (CADER)
- ✓ California Large Energy Consumers Association
- ✓ California Retailers Association
- ✓ California Manufacturers Association
- ✓ Gas Research Institute
- ✓ Electric Power Research Institute

Using these data sources AESC developed an initial list of potential market participants containing information on 360 individuals and/or companies likely to manufacture, install, operate or otherwise interface with distributed energy resources. This list was further condensed to 111 individuals (see Appendix A) by removing multiple individuals from the same company and by removing companies that were not directly involved in the California marketplace. Because of the large size of the list we decided to target some participants for direct telephone contact and others for contact via a mailer. Of the 111 potential participants on the list, 70 received a mailer containing information on the project along with general information on AESC. A market participant group consisting of 10 individuals was ultimately identified in this manner.

Table 1 shows the breakdown of the market participant group members that have provided comments thus far. As the table shows, the market participant group contained a diversity of both academic and industry concerns as well as relevant regulatory agencies.

Table 1 – Market Participant Group Breakdown

Description	Company/ Agency
Utility Distribution Company (UDC)	2
UDC Affiliate (Non-regulated)	1
DER Manufacturer	3
DER Control Manufacturer	2
Regulatory Agency	1
National Lab	1
Total:	**10**

2.1 Soliciting Market Participant Feedback

AESC used three documents to first solicit participation and then subsequently obtain feedback from the market participant group. These documents and their use in obtaining market participant feedback are discussed in the following paragraphs.

***Participant Briefing Paper* –** This was the first document (along with a cover letter requesting participation) sent to each potential participant (see Appendix B). This white paper, provided basic project information as well as information on intelligent software agent technology. This document was sent either as part of the mailer or as a follow-up to a telephone contact and was used to solicit project participation.

***Preliminary Domain Analysis Report* –** This report contained a more in-depth discussion of the California energy industry and on the role of DER in this marketplace. Additional discussion on the DER*S concept and potential operating scenarios was also provided. This document was provided in hard-copy form to individuals that expressed an interest in participation and who had already received the project briefing paper.

***Participant Survey* –** This survey (see Appendix D) consisted of eight basic questions that were developed to focus participant feedback in areas of greatest concern to the project. Each participant that received the Preliminary Domain Analysis also received the Participant Survey. To minimize the effort necessary to complete the form, each participant was provided an electronic version that could be modified and returned via e-mail.

3.0 Market Participant Group Feedback

Market participant group feedback was obtained in a variety of ways. Some participants provided written feedback on the documents that they received while others responded verbally via telephone conversations. Group comments are discussed below beginning with general comments on the Preliminary Domain Analysis Report followed by a summary of responses to the Participant Survey and then a discussion of how market participant feedback affected DER*S.

3.1 General Comments - Preliminary Domain Analysis Report

The overall response of the market participant group, after reviewing the Preliminary Domain Analysis Report, was positive. The panel provided comments regarding the high quality of the report with respect to its description of the California electric markets, the state of deregulation, and how DER fits into current and future market scenarios. The panel also identified and proposed changes in the description of DER controls and technology, which we incorporated into the Domain Analysis Final Report. We have summarized the panel responses for each section of the Preliminary Domain Analysis Report below.

DER*S Description

A comment that was repeated from several panelists was the suggestion that DER*S should also interact with load management controls to reduce grid demand in response to various price signals. Some suggested that our draft description of the markets focused too much on higher voltage and statewide connections (ISO & PX) and too little on local price and integrated supply/load control. One panelist directed us to a recently proposed change in the California ISO ancillary market protocols called the Participating Load Agreement, which would permit bidding of curtailable loads into the ancillary services markets as either non-spinning reserve or replacement reserve.

Another insight provided by the panel was the difference in price signal time cycles among each of the market entities. For some *price signals*[1], such as calls for ancillary services and transactions involving the ISO imbalance energy market may be close to real-time while other price signals such as PX bid and pricing data are daily cycles.

One panelist, who had been separately developing DER market scenarios under a DOE contract, had identified five basic market scenarios (see Appendix E for the white paper/report on this topic). These market scenarios included: 1) an expanded role for back-up generators, 2) operation of local micro-grids containing one or more DER and/or energy storage assets, 3) interconnected local micro-grids, 4) direct integration of DER in the utility distribution grid to meet T&D needs, and 5) integration of local micro-grids with utility T&D grids. After comparing these five market scenarios relative to our three

[1] Where the term "price signal" describes both dispatch and pricing signals.

market scenarios[2] we concluded that there was no conflict and we were able to confirm this during discussions with the panelist that had developed the scenarios. The differences between the market segmentation methods were actually just a difference in perspective. Our domain analysis had focused on market scenarios as defined by participant interaction while their market scenarios were segmented by the configuration of the DER. We believe both market segmentations are compatible since we can identify our three market interaction scenarios in each of their five market configurations.

There was some expression by the panel that more detail was needed on DER*S functionality. Since we are using the Domain Analysis Report as a foundation to define the DER*S features and functions, we felt that the panel was a little ahead of our project plan at this point.

California's Competitive Market

While the market participants agreed that our general description of the California market(s) was accurate there were few specific comments. The few remarks that were received indicated an interest in a more detailed description including examples. We felt that an exhaustive description of California's current electric market, while highly informative, would provide little additional value to the project. Such a detailed report would not provide sufficient new information and the expenditure of project funds could not be justified.

One panelist suggested that we add price values to Figure 6 (Electric Price / Cost Contributors). While we had considered supplying this information when developing the chart, we elected against it in order to illustrate the general concept of electric cost accumulation. Describing the electric value chain, in more detail by including exact price values would cause undue debate about their accuracy and detract from the intended purpose of the figure.

DER Technology Description

Panelists indicated that our DER technology descriptions had excluded any discussion of load management technologies (e.g., curtailable loads, HVAC set-point modification, etc.), which could play a significant role in the deregulated market. Based on these comments we added curtailable load to the DER technology list shown in Table 2 (DER Technology Classifications). We further distinguished energy efficiency (improved utilization of energy), which is not dispatchable, from load management (shifting or reduction in load to improve load factors), which is dispatchable and therefore compatible with DER*S.

Another panelist suggested that we clarify the differences between DER control types and how DER*S would fit into DER control schemes. The suggestion was to separate real-time closed loop control from scheduling and load dispatch. In the Preliminary Domain Analysis Report we described local DER real-time controls as fundamental operating

[2] As described in the Preliminary Domain Analysis Report

requirements that would not be part of the DER*S functionality. However, the panel suggested that we clearly define these different DER control types in order to eliminate any possible confusion on this issue. While we believe these are largely semantic issues, we agree that clarification is beneficial and the following descriptions were therefore added to the Domain Analysis Final Report.

- *Local Real-Time Control*
  These controls are for local regulation and operation DER equipment. For example, we described these controls as systems that provide safety features, grid interconnection and fundamental unit operating requirements such as fuel control, speed regulation, etc. This type of control will not be considered as part of the DER*S technology function.

- *Unit Scheduling*
  In the report we refer to this function as unit commitment and is the strategic scheduling of DER operation to maximize value. This is considered an important part of DER*S functionality.

- *Load Dispatch*
  This control function sets the best DER load point (generator output or load reduction) to maximize its operating value. Note that the DER unit must be both "scheduled" and available for load dispatch to take place. We consider this control function another important DER*S function.

3.2 Summary of Survey Responses

In addition to the general comments we received from the panel, we also requested that the panel answer a set of specific questions. Our questions and the panel's answers are summarized below.

1. Did the Preliminary Domain Analysis Report that you received adequately summarize the current situation relative to DER integration/use in the California competitive marketplace?

Yes, the report accurately characterizes the market dynamics, status of deregulation, competition, barriers and regulated aspects of the energy industry in California.

2. The report (see section 2.1) offered three basic DER / DER*S operating scenarios (Single Site/Asset w/o market participation, Multiple Asset w/o market participation, Multiple Asset w/ market participation). Please rank each operating scenario with a value of 0 – 10 in terms its applicability in the near, intermediate and long term using the following table (where 0 is not at all applicable and 10 is very applicable). *(Range of responses shown)*

Operating Scenario	**Near-Term (0 – 2 yrs)**	**Intermediate-Term (2 - 5 yrs)**	**Long-Term (+5 yrs)**
1. Single Site (w/o market participation)	*8-10*	*10*	*10*
2. Multiple Asset (w/o market participation)	*5-6*	*7-8*	*10*
3. Multiple Asset (w/ market participation)	*0-4*	*6-7*	*8-10*

3. Is there another operating scenario that you would envision in the near-, intermediate- or long-term? If so, please describe it briefly.

In general no, but gradual or incremental steps within each of the three scenarios is likely.

4. Who do you see as the most likely DER / DER*S owner/operator in the near-, intermediate- and long-term? (UDC, ESP, Building Owner/Operator, Other (please explain). Please check the appropriate boxes in the table below.

Owner/Operator	**Near-Term (0 – 2 yrs)**	**Intermediate-Term (2 - 5 yrs)**	**Long-Term (+5 yrs)**
Utility Distribution Company (UDC)	*X*	*X*	*X*
Energy Service Provider / Energy Service Co.	*X*	*X*	*X*
Building Owner/Operator		*X*	*X*
Other, ( )			

Note: Some respondents indicated a stronger probability for UDC ownership and operation. However, the panel also commented that UDC ownership would depend on the current CPUC DG OIR.

5. What do you see as the top three (3) barriers (if any) to the integration of DER assets into the California competitive marketplace? *(All responses are summarized here)*

Full installed cost of DER including capital, O&M, installation, back-up charges and CTC's.

Unrealized benefits of ancillary services that are possible through unbundled distribution rates.

Interconnection barriers including time, cost, and lack of regulatory standards/rules.

UDC ownership questions, issues and opposition.

Lack of streamlining of permitting and antiquated air quality paradigm regarding emission offsets.

6. What do you see as the top three (3) barriers (if any) to the application of the DER*S concept to the problem of scheduling DER operation? *(All responses are summarized here)*

Simultaneous cooperation and recognition of the DER benefits and operating standards for all market participants (ISO, PX, SC's, etc.)

Development of software and communication protocols that enables DER to be scheduled by SC for aggregation purposes, enabling arbitrage into PX/ISO markets.

Bundled distribution rates, which hide price sensitivities to time and area.

Cost of DER scheduling must be in-line with market's perceived value at most basic level.

7. In the Preliminary Domain Analysis Report we described a variety of DER technologies (see Table 3 in Section 4) that are potential candidates for DER*S control. Please list below the top three candidate DER technologies with a brief explanation for your selection. Understanding that DER technology is

application specific please provide a brief description of the application that is the basis for your response.

- ✓ <u>*ICE Gensets*</u>
  Have largest market penetration and are improving with new technology innovations.

- ✓ <u>*Small Gas Turbines*</u>
  For peaking use. Are cost effective and proven.

- ✓ <u>*Micro-Turbines and Fuel Cells*</u>
  Future potential may be huge depending on performance improvements and cost reductions.

8. Please list below the three DER technologies that are the least likely candidates for DER*S control along with a brief explanation of your selection. Understanding that DER technology is application specific please provide a brief description of the application that is the basis for your response.

- ✓ <u>*Energy Storage*</u>
  More applicable to straight power quality applications. Economics need to improve considerably, probably by significant increases in on-peak power costs to be viable.

- ✓ <u>*Renewable fuel generators including PV, wind and hydro*</u>*.*
  These are fuel hostage technologies and would likely be at maximum capacity, fuel permitting.

- ✓ <u>*Dish Stirling and Hybrid Fuel Cells*</u>
  Cost and size factors improvements needed before they become commercially attractive.

3.3 Panel Feedback Impact on DER*S

The panel produced a number of insights into the operation of the energy markets that will affect the DER*S functional design. As a result of panel feedback we made a number of changes and clarifications in the Domain Analysis Report, which are reflected in the Domain Analysis Final Report. For clarity, the major impacts resulting from the comments are summarized as below.

Load Management Capability

For the California (or any other deregulated market) to become truly competitive there must be a balance between supply-side pricing and customer choice on the demand-side. In other words, to stimulate supply-side competition the customer must have the ability to alter their demand in response to the market. This requirement produces an interesting effect in that local load reduction can have an equivalent or higher value than electric supply under certain conditions. DER*S should therefore be capable of managing a variety of demand-side management technologies in response to market pricing or other operational signals. The commercial implementation of DER*S must have the ability to reduce local load through direct load interruption or indirectly through climate or process set-point adjustments (e.g., raise commercial building thermostats to reduce a/c electric consumption or slowing down a industrial process to reduce electric demand) as well as through operation of on-site generation. We will be addressing these capabilities specifically during the DER*S agency design.

Compatibility with Existing DER Asset Markets

The panel emphasized the need for DER*S to be compatible with the large installed base of DER generator assets that currently exists in California. DER*S needs to be able to function with these existing assets since they will probably constitute the early DER*S market. This will require compatibility with both current generator control technologies as well as the more antiquated communication protocols (i.e., analog and RS-232C) in use on older equipment.

It is apparent from both the domain analysis and participant comments that DER*S must be compatible with a variety of DER technologies and manufacturers. This could necessitate a substantial DER*S interface development effort that would depend on obtaining communications protocol information from various manufacturers. One means of minimizing this development effort would be to "team" with an organization that has already developed interfaces for a variety of equipment and manufacturers. Teaming with a partner having experience is this area would allow DER*S development to focus on the scheduling and dispatch functions.

Near-Term Versus Long-Term DER*S Market Applications

To achieve commercial success, the DER*S core technology must not only be scalable in terms of number of DER*S assets, but must also be compatible with new DER technologies and implementations. For example, panelists indicated that future DER markets may include micro-grids where end use customers meet their on-site needs using one or more generators and/or storage devices operating independent of the grid. These micro-grids could eventually be interconnected with utility transmission and distribution system in a cooperative operating environment. DER*S should therefore be compatible with these new potential markets and the complex interaction with local versus grid-wide operations as well as with multiple price/operating signals. The DER*S agency must function in a transparent way in these complex scenarios to ensure that maximum benefits are generated.

While micro-grid operation in cooperation with the local UDC was identified as a potential future operating scenario, the panel was in agreement that local operation of equipment at a single site to offset energy and demand costs represented the most immediate market (our Operating Scenario 1). Use of DER*S to coordinate operations at multiple sites for purposes of aggregating load (with or without direct involvement in the competitive markets) was identified as the next most likely operating scenario. Several barriers exist to UDC involvement in the DER market, the most significant of which being regulatory constraints (i.e., UDC limitations to own generation assets), the fear that the UDC could exercise unfair market power relative to DER assets in their control[3], and the fear that widespread DER deployment will result in stranded T&D assets[4]. While these barriers make UDC involvement unlikely in the near-term it is likely that the benefits of UDC participation (i.e., improved power delivery reliability, reduced capital

[3] A UDC could use T&D "concerns" to favor operation of one DER asset (their own) over another.
[4] Extensive use of distributed generation could conceivably result in underutilized T&D assets, thus the fear of stranded assets.

expenditures for T&D, utilization of time and area dependent power costs, etc.) will encourage UDC involvement at some point in the future. Therefore, the DER*S design should be able to accommodate eventual UDC involvement.

Based on panel feedback it is apparent that we should focus our development and demonstration efforts on operating scenarios involving a single site with one or more DER assets and on applications involving DER*S operation to aggregate load from multiple sites.

California ISO Needs / Requirements

Direct involvement of DER*S in the bulk power markets via the Power Exchange was not seen as a likely scenario while possible involvement in the ancillary services markets either directly via an SC or indirectly via an ESCO was deemed a more likely long-term operating scenario. Direct participation of DER*S in the ancillary services markets would require compliance with ISO protocols pertaining to minimum portfolio size, DER asset location and metering. The ISO has indicated that the requirements are:

- A minimum portfolio size of 1 MW would be needed,
- All of the portfolio assets would need to be located within a single ISO zone[5].
- Each individual asset in the portfolio would need to have its own ISO certified meter installed, and
- The ISO would need to have the ability to override DER asset operation in the event of an emergency. This would have to be accomplished either through direct communication with DER*S or via an SC (which would in turn need to communicate with DER*S).

[5] This would facilitate intra-zone load balancing

4.0 Virtual Evaluation Group (VIREG)

We originally envisioned the virtual evaluation group (VIREG) as a subset of the much larger market participant group. VIREG participants would be selected for continued participation in the DER*S project based on their:

- ✓ Knowledge or experience in DER related technology important to DER*S project success,
- ✓ Interest in DER*S project success that may include future involvement in any commercialization effort(s).
- ✓ Expressed desire to continue participation beyond the market research effort(s).

The virtual evaluation group represents a pool of knowledge that we can draw upon during the course of the project. Unlike the market participant group, participants in the virtual evaluation group will only be asked to participate in areas of the project related to their backgrounds and interests. Each participant will receive periodic updates on project progress but requests for information (opinions, etc.) will be tailored to each of the VIREG participants. In this way, the DER*S project can benefit from the experience of the VIREG and can continue to cultivate potential commercialization partners without overly burdening the VIREG participants. Communications with the VIREG participants will consist of e-mail, conference calls and conventional mail.

4.1 VIREG Participants

While we had envisioned a relatively large base of market participants from which to choose VIREG participants, the reality was that market participants that had expended the effort to provide feedback did so because they had both an interest and desire to participate throughout the project. For this reason, the VIREG is comprised of all ten (10) of the market participants that provided comments/feedback. Table 2 contains brief descriptions of the companies and individuals that have agreed to participate in the virtual evaluation group.

Table 2 – Virtual Evaluation Group Participants

Company Name	Individual Name	Company / Organization Description
Allied Signal Power Systems, Inc.	Mark Skowronski	A subsidiary of AlliedSignal Inc that manufactures and markets a 75 kW turbogenerator (see http://www.alliedsignal.com)
California Independent System Operator	David Hawkins	Regional transmission system operator for California (see http://www.caiso.com)
Caterpillar, Inc.	Eric Wong	Large multi-national corporation, that manufactures a variety of distributed generation equipment consisting of both conventional reciprocating and gas turbine based (Solar Turbines Subsidiary) equipment. (see http:/www2.cat.com)
ENCORP, Inc.	Scott Castelaz	*EN*CORP, Inc. developed and markets the *en*power™ control systems and Virtual Power Plant™ software product lines. *En*power simplifies the task of managing and controlling a large number and wide variety of distributed resources (conventional, renewable and storage). (http://www.encorp.com)
Enflex, Corp.	David Wollins	EnFlex Corporation developed and currently markets the EnFlex® product line. EnFlex is a low cost networked information management, monitoring, and control gateway that resides at a remote facility and connects to a variety of intelligent devices within that facility. EnFlex can transport information over TCP/IP networks, the Internet, and corporate Intranets. (see http://www.enflex.net)
Lawrence Berkeley National Laboratory (LBNL)	Christopher Marnay	National laboratory involved in DOE sponsored project on US infrastructure reliability (CERTS) (see http://www.lbl.gov)
M-C POWER Inc.	Robert Petkus	Developer/manufacturer of molten carbonate fuel cells (see http://www.mcpower.com)
San Diego Regional Energy Office (SDREO)	Kurt Kammerer	The SD Regional Energy Office implement the energy policies of the San Diego Association of Governments. SDREO serves as an information clearinghouse for energy information and promotes collaborative public-private energy programs in the areas including Energy Efficiency, Renewable Energy, Energy Research & Development and Clean Fuel Vehicles. (see http://www.sdenergy.org)
San Diego Gas & Electric Co.	Victor Romero	San Diego based utility distribution company (see http://www.sdge.com)
Southern California Edison Co.	Carlos Martinez	Rosemead / Los Angeles based utility distribution company (see http://www.sce.com)

5.0 Potential Commercialization Partners

The current DER*S CEC PIER project provides for demonstration of the DER*S concept in a simulated operating environment and for development of demonstration software that will expedite transfer of DER*S technology to the private sector. Commercialization of the DER*S technology will require further development and associated funding to demonstrate DER*S in a “real-world” application and to develop the necessary interfaces and supporting documentation. This “product development” effort would be expedited from a scheduling, funding and marketing standpoint if a commercialization partner can be identified during the course of the project. Ideally, a commercialization partner identified during the CEC PIER project would provide some or all of the needed funding and expertise to assist in commercializing DER*S technology after completion of the current project.

With the exception of the national laboratory, LBNL, the CAISO and the SDREO, any of the remaining seven VIREG participants shown previously in Table 2 are “potential” commercialization partners. Each participant has valuable expertise in the energy industry and has expressed an interest in continued project participation. In the case of the UDC participants it is not clear if a regulated UDC could participate directly as a commercialization partner but an unregulated affiliate would certainly not have the same potential regulatory constraints.

It would be premature at this point in the project to limit our discussion of potential commercialization partners to the VIREG participants. Since we are still in the very early stages of DER*S product design and development it is difficult to fully convey the full potential of the project/product to potential commercialization partners. As the project progresses and DER*S becomes more fully defined it will be much easier to spark the interest of additional potential commercialization partners.

It would be more appropriate at this point to identify the most desirable traits of a potential commercialization partner. In general, a commercialization partner must provide more than just financial support. The following traits characterize a commercialization partner that would both enhance and accelerate DER*S commercialization and acceptance:

Existing Product or Technology That Enhances Potential DER*S Market Penetration

One of the quickest methods for DER*S to gain acceptance in the marketplace is for it to be seen as a logical extension of an existing product or technology. As a “value added” enhancement, DER*S would be able to “leap-frog” into the commercial marketplace with far less resistance. In the Domain Analysis Report we discussed how DER*S functionality would be limited to the schedule and dispatch functions with intrinsic DER functions such as safety, grid interconnect, unit synchronization, etc. handled by a separate control system. Therefore, a commercial partner that already produced and marketed systems capable of providing this type of intrinsic DER while using DER*S to achieve advanced dispatch and scheduling would be a logical choice. Developing a relationship with this type of product would also eliminate the need to develop multiple interfaces for a variety of equipment since this would have already been completed by the commercialization partner for their product. In this way, a single interface to the commercialization partner's product would provide immediate compatibility with any equipment already accommodated by the partner's product.

Existing Product Distribution / Support Infrastructure

A commercialization partner with an established product distribution and support infrastructure would greatly accelerate DER*S market acceptance. With any new technology, there is an initial period of "wait and see" while demonstration projects are identified and product savings potential is verified. The process of identifying and signing-up potential demonstration sites requires knowledge of potential sites and the responsible personnel. This type of information is often readily available to product distribution and support personnel.

Industry Name / Trademark Recognition

Association with a commercial partner that has already achieved industry name or trademark recognition would also shorten the time required for DER*S to achieve product acceptance.

Based on this list of desirable traits, ENCORP and EnFlex both initially stand out as potential commercialization partners. Both companies market products that could be enhanced by DER*S and both have achieved a level of recognition in the industry. However, large OEM's such as Allied Signal[6] and Caterpillar, could by virtue of their large distributed generator market share, provide significant marketing opportunities and should not be ruled out.

[6] Allied Signal has recently merged with Honeywell. The combined company presents a significant opportunity for DER*S commercialization because of Allied Signal's distributed generator products and Honeywell's controls for energy management.

6.0 Conclusions

The original objectives of the market research effort were to: 1) establish a market participant evaluation group, 2) solicit feedback from the market participant group on key issues and questions that affect DER*S, 3) identify a select group of market participants and form a Virtual Evaluation Group (VIREG) to monitor and participate in the remainder of the project, and 4) identify potential DER*S commercialization partners. Relative to these objectives our market research efforts were very successful in that all of the stated objectives were achieved.

During the market research effort, we were able to form a diverse market participant group. We were overly optimistic regarding the number of market participants that would ultimately provide comments. Of the 111 potential market participants that we contacted via telephone or mail, we were able to obtain comments from 10 individuals. While the group was smaller than expected, the overall makeup of the group was both diverse and well suited to providing the feedback that we desired. Ultimately, the group provided valuable comments that resulted in changes to our Domain Analysis Report and will have a direct effect both the DER*S design and DER*S demonstration software. Market participant comments focused on:

- ✓ Our assessment of the California electric market(s),
- ✓ The compatibility/capabilities of DER*S with other DER technologies, and
- ✓ Projected DER*S market/operating scenarios

Overall, the market participant group found our description of the California electric market(s) to be both accurate and well written. Panel members understood the DER*S concept and confirmed the need for new scheduling and dispatch technologies to facilitate widespread DER operation and grid integration. Panel comments will enable us to refine the DER*S and demonstration software designs to better accommodate the needs of the market.

Based on the comments of the market participants, our initial assessment of how DER*S could be integrated into the California marketplace appeared to be pretty close to the mark. Their comments indicated that we were overly focused on the bulk power and ancillary services markets. We subsequently made changes that will provide for DER*S management of curtailable loads in response to either interruptible electric rates and/or the ancillary services markets. In addition, we now recognize the importance of DER*S operation at an individual site to directly offset facility utility costs without any need for involvement in either the bulk power or ancillary services markets.

In our Preliminary Domain Analysis Report we identified three basic DER*S operating scenarios. Market participant comments allowed us to refine these scenarios and to identify DER*S near- and long-term operating scenarios. In the near-term DER*S applications will likely focus on scheduling of DER operation at individual sites with little or no direct involvement in the electric markets. In the intermediate-term, DER*S operation could be extended to management of DER assets over multiple sites for purposes of load aggregation and load shaping. Multiple site operation could involve DER*S interaction with third parties such as ESCOs as well as involvement in the electric markets. Involvement in the bulk power markets, via the PX, was seen as unlikely given the relatively low price of bulk power. UDC involvement in both DER and DER*S operation is seen as a long-term development that is subject to the elimination of a number of market-based and regulatory barriers.

We were able to form the Virtual Evaluation Group (VIREG) from individuals that participated in our market participant group. We had initially envisioned a relatively large base of market participants from which to choose VIREG participants. What we found was that market participants that had provided comments did so because they had both an interest and desire to participate throughout the project. For this reason, the VIREG is comprised of all ten (10) of the market participants that provided comments/feedback.

Given the early stage of our project, it would have been premature to negotiate with, or otherwise engage, a commercial partner. However, we were able to identify the commercial partner traits that will maximize the benefit to the DER*S development and commercialization efforts. These traits call for a commercial partner that has:

- ✓ An existing product or technology that enhances potential DER*S market penetration,
- ✓ An existing product distribution / support infrastructure, and
- ✓ Industry Name / Trademark Recognition

In addition, we have identified potential partners having some or all of these traits. Some of these potential partners have agreed to participate in the VIREG. Other partners will be more approachable as the DER*S product design solidifies and we will therefore continue our efforts to identify additional potential partners as the project progresses.

Appendixes

Appendix A – Market Participant List

CEC - PIER Project
Market Participant List
(Status as of October 26, 1999)

Type	Name	Association	Position	Telephone Number	Fax Number	Email Address	Physical Address
DG Mfg	Mark Skowronski	Allied Signal Power Systems, Inc.				Mark.Skowronski@alliedsignal.com	2525 W. 190th Street Torrance, CA 90504-6099
ISO	Dave Hawkins	CAISO	Principal Engineer	(916) 351-4465	(916) 351-2310	dhawkins@caiso.com	151 Blue Ravine Road Folsom, CA 95630
DG Mfg	Eric Wong	Caterpillar	Product Consultant	(916) 498-3339	(916) 441-5449	erwong@worldnet.att.net	980 Ninth Street, Suite 2200 Sacramento, CA 95814
UDC	Carlos Martinez	Southern California Edison*	Manager	(626) 815-0512 (626) 815-0506	(626) 334-0793	jleeper@edisontec.com	6040 North Irwindale Avenue Irwindale, CA 91706
Ctrl Supplier	Scott Castalaz	Encorp	VP Marketing	(312) 945-3036		castelazsa@encorp.com	1512 South Prairie Ave, Suite F Chicago, IL 60605
Ctrl Supplier	David Wolins	EnFlex	VP Marketing	(510) 234-3244		dwolins@enflex.net	RICHMOND CA 94801
Researcher	Chris Marnay	Lawrence Berkeley National Laboratory	Staff Scientist	(510) 486 7028	(510) 486 7976	c_marnay@lbl.gov	90-4000 LBNL BERKELEY, CA 94720
DG Mfg	Robert Petkus	M-C Power Corp	Director Business Development				
Loc Gov	Kurt Kammerer	San Diego Regional Energy Office	Director	(619) 595-5630	(619) 595-5305	kkam@sandag.cog.ca.us	401 B Street, Suite 800 San Diego, CA 92101
UDC	Vic Romero	SDG&E		(619) 696-2000		VRomero@SDGE.com	8306 Century Park, CP52E San Diego, CA 92123-1593

Individuals listed below the line may still provide comments / feedback with participation in VIREG still a possibility.

Researcher	Dr. Jack Brouwer	UCI/NFCRC	Assitant Director	(949) 824-1999 x221	(949) 824-7423	jb@nfcrc.uci.edu	University of California, Irvine Irvine, California 92697-3550
Utility	Dimitra Fotinatos, et. al.	SCE		(818) 302-8250			

* - Formerly with Edison Technology Solutions

Appendix B – Project Briefing Paper

Briefing Paper for CEC/DER*S Project
Market Participant Candidates

1.0 Introduction

In September 1998, the California Energy Commission (CEC) awarded Alternative Energy Systems Consulting, Inc. (AESC) and it's principal subcontractor, Reticular Systems Inc. a contract for development and demonstration of an intelligent software agent based system for control and scheduling of distributed energy resources (e.g., distributed generation, energy storage, cogeneration, etc.) in a competitive energy market. This project, titled "Intelligent Software Agents for Control of Distributed Generation", was awarded under the second solicitation of the Public Interest Energy Research (PIER) Program (RFP 500-98-505).

Ultimately, an agent based controller/scheduler for distributed energy resources (DER) will only succeed in the marketplace if it meets the needs, experiences and standards of the industry. Therefore an important part of the proposed effort involves integration of industry requirements into the project/product requirements. To facilitate this effort, key players in the electric market will be identified, contacted and engaged with this project.

1.1 AESC Background

Alternative Energy Systems Consulting, Incorporated (AESC) is a closely held engineering and project development firm with offices in San Diego and Carlsbad, California. AESC was founded in 1994 to provide technical and management consulting support to utilities, large energy users and energy technology developers. AESC is focused on application of innovative technology in the rapidly changing energy markets. AESC's core personnel average 20 years of experience in the development and application of advanced computer processing systems and algorithms for power plant commitment/dispatch, diagnostics, large and small scale energy storage, energy theft detection, end-use control, and energy use optimization.

1.2 Project Description / Objectives

The proposed project is a research and development project involving the use of intelligent software agent technology in the energy industry. The proposed effort provides for development and demonstration of a Distributed Energy Resource Scheduler (DER*S) agency that assists the end-user in scheduling and controlling DER operations. Distributed Energy Resources are electrical generation or storage devices that, unlike large central generating plants, can be regionally located near loads and are often sited at customer facilities. Numerous studies[7] have shown that DER technology improves the reliability and cost effectiveness of electric distribution and transmission systems. These potential benefits combined with other competitive market forces will result in increased use of DER technology over traditional centralized generating stations relying on bulk transmission. This prototype agency of intelligent software agents will be suitable for use in scheduling/controlling one or more distributed energy resources.

[7] Specifically studies sponsored by Pacific Gas and Electric, the Electric Power Research Institute and others.

Briefing Paper for CEC/DER*S Project Market Participant Candidates

An intelligent software agent is a software based device that acts on behalf of the user and has the ability to exploit knowledge, tolerate errors, reason with symbols, learn and reason in real time, and communicate in an appropriate language.

This project will facilitate insertion of intelligent software agent technology into the energy industry with its associated benefits. One of these benefits is to facilitate the coordinated scheduling of multiple distributed energy resource assets. Another is to reduce the level of expertise and oversight needed to own and operate distributed energy resources, which will allow greater participation by owners of distributed energy resources in the competitive energy industry.

The technical objectives of this project are to:

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

2.0 Background Information

2.1 Intelligent Software Agents

Intelligent software agents are a software abstraction. Here we mean abstraction in the same sense that objects, methods, procedures and subroutines are software abstractions. However, past research by AESC, Reticular Systems Inc. (Reticular) and others have shown that intelligent agents are a very powerful abstraction that facilitates development and construction of complex distributed information systems.

Software agents have a number of capabilities including the ability to monitor their own execution environment, communicate with other agents or the user and maintain some representation of their own internal mental state. Software agents are characterized by their ability to operate autonomously. This means that after an agent starts executing, no further interventions are required from the user. An autonomous agent is able to complete its task on its own.

While software agents are widely used in a variety of applications they are only now being applied to problems in the electric power industry. An intelligent software agent can contain significant amounts of expertise and be used in applications that require planning or learning capabilities. Agents are particularly useful in applications involving communications. One popular use of agents is information seeking and cataloging activities on the Internet. Agents can be used in applications where they learn about an individual user and modify their own behavior to suit the information-seeking needs of the user. Agents are particularly useful in applications where multiple agents can communicate and cooperate with other agents for solving a given problem. These agents can be physically located on the same computer or distributed in a variety of locations.

2.2 DER*S Agency Description

The DER*S will schedule the operation of one or more DER sites. DER*S operation will be driven by the site load requirements, the operating characteristics of the DER (i.e., generation only, co-generation, thermal energy storage, etc.) and market pricing for energy and ancillary services. The DER*S agency will consist of multiple agents, each assigned a specific task related to overall DER*S operation. For instance, one agent could monitor DER operation and performance characteristics while another agent could obtain information from external sources (i.e., weather, electric rates, etc.) that would be used by yet another agent tasked with data analysis and schedule generation. The DER*S agency configuration will be established during the project where the number and capabilities of the various agents will be determined based on the outcome of the domain analysis, market research analysis and task analysis efforts.

It can be assumed that each individual agent within the DER*S agency will operate autonomously and communicate as needed with human operators and other agents to achieve their individual goals and objectives. The content and protocols used to achieve these communications will also be determined as part of the development effort. DER*S communications with other DER*S sites as well as with the PX and/or another SC (Schedule Coordinator) may be necessary and as with other DER*S capabilities, will be decided in the domain analysis and market research efforts.

3.0 Energy Market Participant Feedback

Obtaining market feedback is a crucial element of this development project. Therefore, one of the primary objectives of the project’s Domain Analysis and Market Research task is to identify and engage key players in the energy market. Realizing that that both interest level and time demand of potential participants will vary we will provide for participation at two levels. Additionally, we are acutely aware that the individuals that will be approached are already busy with their own pursuits. Therefore, we will make every attempt to minimize the level of effort for these individuals. Individual telephone conversations, conference calls and electronic mail will be used wherever possible to obtain the necessary feedback at the convenience of the participant.

As a potential market participants you have been provided with this DER*S Project Summary that includes; background information, project overview, technology descriptions, project objectives and initial topics for discussion. Feedback obtained in our initial discussions will be summarized in a Preliminary Domain Analysis Report along with the findings of AESC’s other domain analysis activities. After review by the CEC PIER Program Manager, this report will be provided to you for your review and comment. It is anticipated that additional domain analysis activities will flow from your comments. Any additional findings will be incorporated into a Market Research Report and into the Final Domain Analysis Report. This process will also clarify the market's perception of the requirements and immediate needs for DER*S. Ultimately, the feedback obtained from market participants such as yourself will help us to more effectively direct the development effort and to incorporate DER*S features and functions that directly address the needs of the energy marketplace.

3.1 Virtual Evaluation Group Description

Evaluators who may have a higher level of interest will be asked to monitor the project's on-going progress. These evaluators will be organized into a "virtual" evaluation group that will collaborate primarily through electronic e-mail and periodic teleconferences. Subject areas for discussion include:

- ✓ On-going Situation Evaluation
- ✓ Challenges and Goals
- ✓ Identification of Needs
- ✓ Definition of Economic Benefits
- ✓ EnerAgent™ based DER*S Design Requirements
- ✓ Hardware and Networking Requirements
- ✓ User Interface Design
- ✓ Transaction Performance Measures and Goals
- ✓ Market Opportunity & Risk Assessment
- ✓ Asset Evaluation, Commitment and Dispatch Methods
- ✓ External Information Source Identification

It is anticipated that the amount of time that these cooperative participants can spend on reviewing and commenting on DER*S aspects will be limited. Therefore, the first order of business for the virtual evaluation group will be to identify and prioritize the subject areas for review. This will also allow us to match the interests and backgrounds of individual participants with the various aspects of the project. Some individuals in the evaluation group will undoubtedly have an interest in specific aspects (i.e., communications protocols, market interaction, etc.) of the project with little interest in other aspects. Therefore, we will only ask participants to provide feedback on the project areas that are both relevant and of interest to them.

3.2 Potential Commercial Partner

Identifying potential commercial partners is another reason for engaging market participants in project activities at an early stage. If identified early on, the partner is expected to actively participate in the prototype development effort and to provide early input on the system design. Involvement at an early stage will facilitate product commercialization at the conclusion of this development effort.

4.0 Initial Topics of Discussion

The following issues / topics have been identified as potential topics for discussion.

4.1 What types and quantities of distributed energy resource equipment are and will be deployed?

While detailed market analysis and forecasting is beyond the scope of this project, we believe that a reasonably accurate assessment of existing and future DER applications can be made. Existing DER would include but would not be limited to; emergency/backup generators, cogeneration plants, renewable fuel generators, and on-site peak shaving generators. Future DER applications would include expansion for the existing applications plus; arbitrage generators, residential DER, electric energy storage, and UDC operated DER. Pending regulatory decisions may shape, to great extent, the emerging DER application market. For this project we are most interested in developing likely application scenarios and using them as models to determine benefits from implementation of the DER*S technology.

4.2 How does a distributed energy resource provide benefit to the end-user in both a regulated and competitive environment?

This question attempts to establish the baseline benefits for DER owners and customers ***without*** DER*S. Another way of asking this question would be: how will DER assets be controlled and what benefits are derived from this type of DER control? For example, backup generators are common equipment for many institutional, commercial and industrial customers. Their operation is typically controlled by loss of line, voltage or frequency abnormalities. We want to establish how these benefits, such as power supply reliability, are derived and limited by existing control.

4.3 Does the use of intelligent software agents provide additional opportunities for distributed energy resource savings?

We expect intelligent software agents to enable additional benefits beyond what conventional control of DER equipment can provide. Here we are asking the panel to validate the additional benefits by using intelligent software agents for DER coordination and scheduling. This will require thinking about these benefits in terms of the future electric market opportunities.

4.4 What other entities must a distributed energy resource communicate and/or interconnect with in order to operate effectively?

If DER*S is to increase benefit opportunity it probably will interact and communicate with other entities to derive these added benefits. For example, one of these entities may be the utility distribution company (UDC). DER*S may interact with UDC operations so that peak feeder loads may be controlled so that deferred utility capital investment may be realized. Other entities may include; the ISO, CalPX, other DER's and customer energy management controls.

4.5 What are the market factors that impact the viability of advanced control of DER?

We anticipate that the viability of DER*S will be limited by a number of market factors. One possible limitation is the speed of deployment of electric distribution automation. Without a robust automated distribution system, it will be difficult for the DER*S benefits from UDC operations to be realized. Other market factors such as low cost tolerances for DER control may also limit DER sophistication and functionality. We are interested, in asking these questions, in identifying all the significant market factors that limit the deployment and affect the design of the DER*S technology.

4.6 What is the current state-of-the-art in distributed energy resource control equipment?

Here we are interested in identifying available and future DER control equipment and their functional designs.

4.7 What are the technological barriers to successfully implementing distributed energy resource control with intelligent agent technology?

Here we are asking the panel to help us determine the technical obstacles that we must be aware of as the DER*S development project progresses. What are the difficulties interfacing with DER controls, communicating with utility distribution equipment, receiving electric price signals, etc?

Appendix C – Preliminary Domain Analysis Report

Appendix D – Market Participant Survey

CEC-PIER Project 500-98-040
Intelligent Software Agents for
Control and Scheduling of Distributed Generation

Market Participant Questions / Issues

1. Did the Preliminary Domain Analysis Report that you received adequately summarize the current situation relative to DER integration/use in the California competitive marketplace?

   If No, then please summarize the most significant deficiencies so that we may provide a more complete description in the Final Domain Analysis Report.

2. The report (see section 2.1) offered three basic DER / DER*S operating scenarios (Single Site/Asset w/o market participation, Multiple Asset w/o market participation, Multiple Asset w/ market participation). Please rank each operating scenario with a value of 0 – 10 in terms its applicability in the near, intermediate and long term using the following table (where 0 is not at all applicable and 10 is very applicable).

Operating Scenario	**Near-Term (0 – 2 yrs)**	**Intermediate-Term (2 - 5 yrs)**	**Long-Term (+5 yrs)**
1. Single Site (w/o market participation)			
2. Multiple Asset (w/o market participation)			
3. Multiple Asset (w/ market participation)			

3. Is there another operating scenario that you would envision in the near-, intermediate- or long-term? If so, please describe it briefly.

4. Who do you see as the most likely DER / DER*S owner/operator in the near-, intermediate- and long-term? (UDC, ESP, Building Owner/Operator, Other (please explain). Please check the appropriate boxes in the table below.

Owner/Operator	**Near-Term (0 – 2 yrs)**	**Intermediate-Term (2 - 5 yrs)**	**Long-Term (+5 yrs)**
Utility Distribution Company (UDC)			
Energy Service Provider / Energy Service Co.			
Building Owner/Operator			
Other, ( )			

5. What do you see as the top three (3) barriers (if any) to the integration of DER assets into the California competitive marketplace?

   I.

   II.

   III.

6. What do you see as the top three (3) barriers (if any) to the application of the DER*S concept to the problem of scheduling DER operation?

   I.

   II.

   III.

7. In the Preliminary Domain Analysis Report we described a variety of DER technologies (see Table 3 in Section 4) that are potential candidates for DER*S control. Please list below the top three candidate DER technologies with a brief explanation for your selection. Understanding that DER technology is application specific please provide a brief description of the application that is the basis for your response.

   I.

   II.

   III.

8. Please list below the three DER technologies that are the least likely candidates for DER*S control along with a brief explanation of your selection. Understanding that DER technology is application specific please provide a brief description of the application that is the basis for your response.

   I.

   II.

   III.

Appendix E – White Paper – Interconnection and Controls for Reliable, Large Scale Integration of Distributed Energy Resources[8]

[8] White paper by the Consortium for Electric Reliability Technology Solutions titled Interconnection and Controls for Reliable, Large Scale Integration of Distributed Energy Resources.