PIER DER Integration Research Program

Addendum: 2003 Update to the 2001 DER Research Assessment Report

CONSULTANT REPORT

Prepared For:

California Energy Commission
Public Interest Energy Research Program

Prepared By:

Navigant Consulting, Inc.

NAVIGANT CONSULTING

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Prepared By:
Navigant Consulting, Inc.
Stanley Blazewicz
Burlington, MA
Contract No. 500-02-019

Prepared For:

California Energy Commission

Mark Rawson
Project Manager

Laurie ten Hope
Program Team Lead
PIER Energy Systems Integration

Marwan Masri
Deputy Director
Technology Systems Division

Robert L. Therkelsen
Executive Director

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Executive Summary

It has been two years since the completion of the Distributed Energy Resources (DER) Research Assessment report. This addendum serves to provide an update to the research assessment report, to confirm the continued relevance of the findings of the original report, and identify new developments and trends that may have an impact on DER integration research going forward.

Over the past two years, private sector DER integration stakeholders have continued development of key elements of the DER industry value chain. However, due to the reduced demand and slow pace of adoption of DER, progress in some aspects of technology development has slowed.

With the private sector experiencing significant turmoil, the public and non-profit stakeholders are playing a greater role in DER research and development. Although some public sector and non-profit entities have been forced to reduce the scale and scope of their research and development activities in DER due to funding constraints, progress continues to be made.

Progress in the Interconnection area appears to be particularly significant given the advances in standards development. More moderate progress was observed in the Grid Effects area and little progress has been made against the vast majority of the research initiatives in the Market Integration area. There is widely held belief among industry stakeholders that the California Energy Commission's DER Integration Research Program has an important role to play in supporting the development and demonstration of critical technologies to advance industry development and assist policy making.

I. Introduction and Background

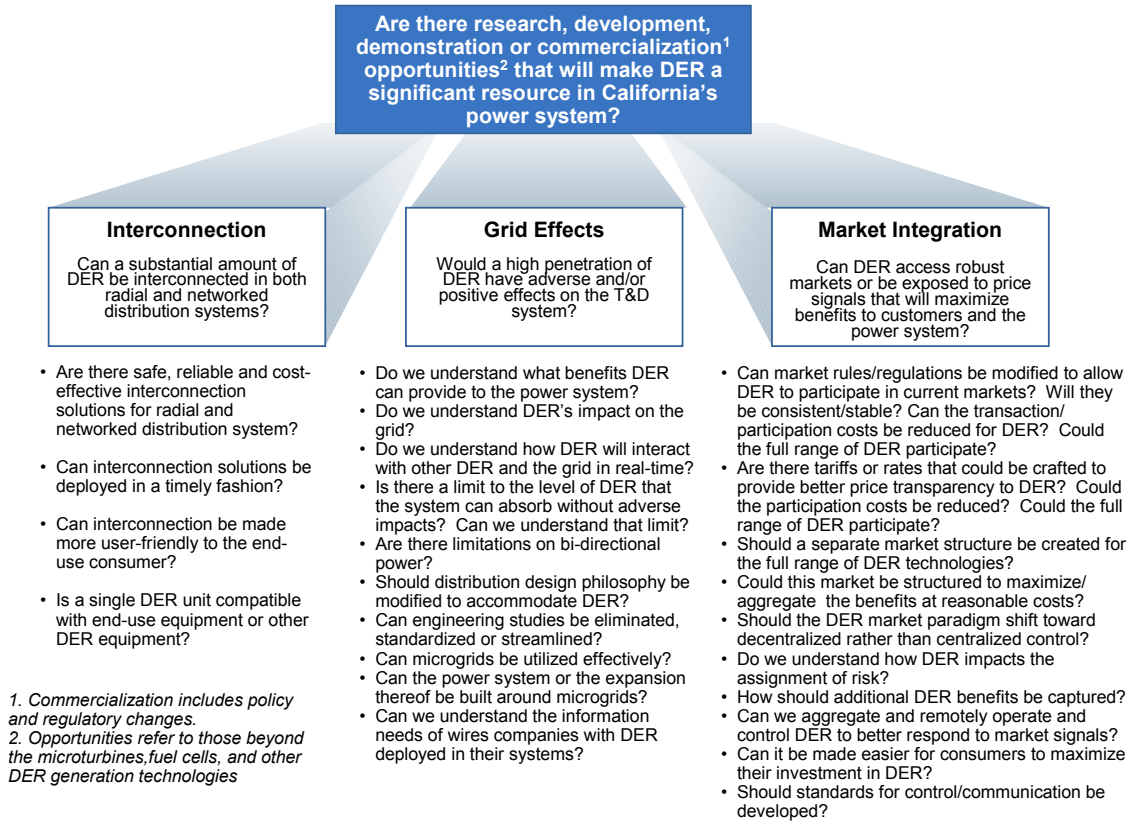
It has been two years since the completion of the Distributed Energy Resources (DER) Research Assessment report. This addendum serves to provide an update to the research assessment report, to confirm the continued relevance of the findings of the original report, and identify new developments and trends that may have an impact on DER integration research going forward.

In the DER Research Assessment prepared during the summer of 2001, issues confronting the development of DER and the research initiatives to address those issues were categorized into three focus areas

- Interconnection
- Grid Effects
- Market Integration

Please note that the term "strategy", as presented in the original report, has since been replaced by "research initiative". The figure below displays the high level questions the report was seeking to address along with issues identified for each focus area.

Figure A-1: Focus Area Questions and Issues



Each of project and research initiative was characterized by its stage of technology development and its competitive impact. All technology follows a natural progression through 4 stages of technology development: research, development, demonstration, and commercialization (Figure A-2). At any given time, a technology's stage of development is fixed regardless of the industry to which the technology is applied. Therefore, the technology development stage is intrinsic to the technology.

Figure A-2: Technology Development Stages

Research	Development	Demonstration			Commercialization	
		Initial System Prototypes	Refined Prototypes	Pre-Commercial Activity	Market Entry	Market Penetration
• General assessment of market needs • Assess general magnitude of economics • Concept and Bench testing • Basic research and sciences (e.g., materials science)	• Research on component technologies • Development of initial product offering • Pilot testing	• Integrate component technologies • Initial system prototype for debugging • Demonstrate basic functionality	• Ongoing development to reduce costs or for other needed improvements • "Technology" (systems) demonstrations • Some small-scale "commercial" demonstrations	• "Commercial" demonstration • Full size system in "commercial" operating environment • Communicate program results to early adopters/ selected niches • Standards creation • Testing and certification	• Initial commercial orders • Early movers or niche segments • Product reputation is initially established • Business concept implemented • Market support usually needed to address high cost production	• Follow-up orders based on need and product reputation • Broad(er) market penetration • Infrastructure developed • Full-scale manufacturing

Competitive impact describes how important a technology is to the way companies compete. As such, it always refers to a given product or industry. Competitive impact, therefore, is extrinsic and closely related to the industry in which the technology is applied. Competitive impact follows a pathway of four levels (Figure A-3), defined as follows:

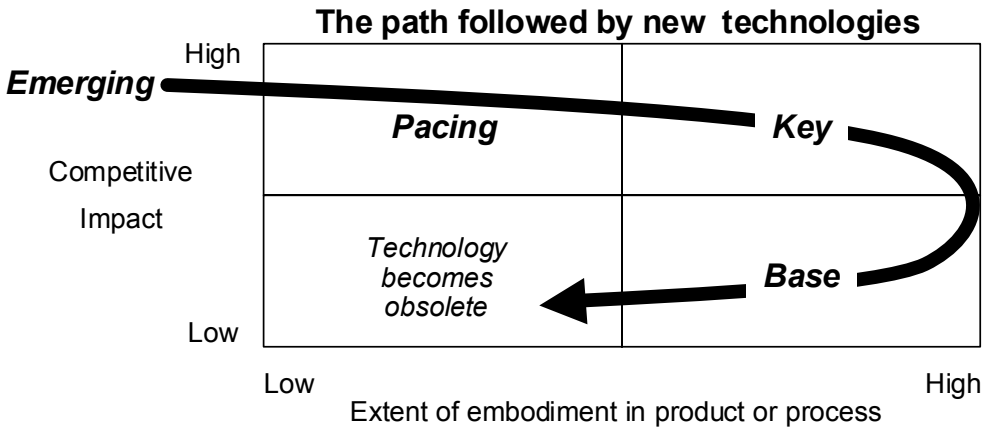
- Base: Although essential to the business, these technologies cannot provide significant competitive advantage

- Key: These technologies are critical for today's bases of competition

- Pacing: Although they are not fully embodied in current products, they may, if successfully applied, have a substantial impact on the basis of competition in the reasonably near future

- Emerging: These technologies may have an impact on competition in the future but this is far from certain

Figure A-3: Competitive Impact



In the following sections of the addendum, the findings of the update effort will be presented and possible implications for the California Energy Commission DER Integration Research Program will be explored. The appendix contains key data collected during the update process that may be of interest to the reader. The information presented in the addendum is based on current publicly available data and stakeholder perspectives provided through interviews. As the details of new projects in the process of being launched by public and private sector stakeholders are made public, the gap ratings for some research initiatives will certainly require reconsideration.

II. Findings

Interconnection

Significant strides have been made in the Interconnection area in the past two years with the progress in standards development and adoption. Assuming continued momentum in this area, many of the research gaps that were identified in the research assessment report are likely to be substantially addressed in the coming years. Indicative of the progress that has been made, three research initiatives that were previously considered to have significant gaps can now be rated has having moderate gaps:

- Type testing and certification of interconnection solutions
- Develop guidelines and best practices for interconnection
- Educate stakeholders on new requirements, contracts and processes

With steady progress being made in the adoption of IEEE 1547 and UL 1741, the level of activity in type testing and certification of interconnection solutions is increasing. There has also been a meaningful increase in the amount of activity revolving around guideline/best practice development and stakeholder education. As further clarity is achieved through widespread adoption of standards, activities in these three research initiatives will likely continue to increase.

Although some progress has been made, the level of activity pursuing the following research initiative previously rated as having a significant gap has not increased enough to warrant a rating adjustment:

- Understand impact of and adopt new interconnection requirement

However, given the progress being made in standards development, activity in this area will increase as new standards and requirements are adopted.

Increasing levels of research activity have been observed for following research initiatives, but no changes in the gap ratings are warranted at the present time as uncertainties remain regarding whether the increased activity is sufficient to close the gaps:

- Improve reliability and performance of interconnection components (e.g., power electronics)
- Integrate interconnection functions with other DER functions
- Turnkey solutions that integrate DER functions

No significant change in the level of activity pursuing the remaining research initiatives has been observed.

Figure A-4: Interconnection Research Initiative Gap Ratings

Research Initiatives

Standardization and Adoption of New Requirements and Processes

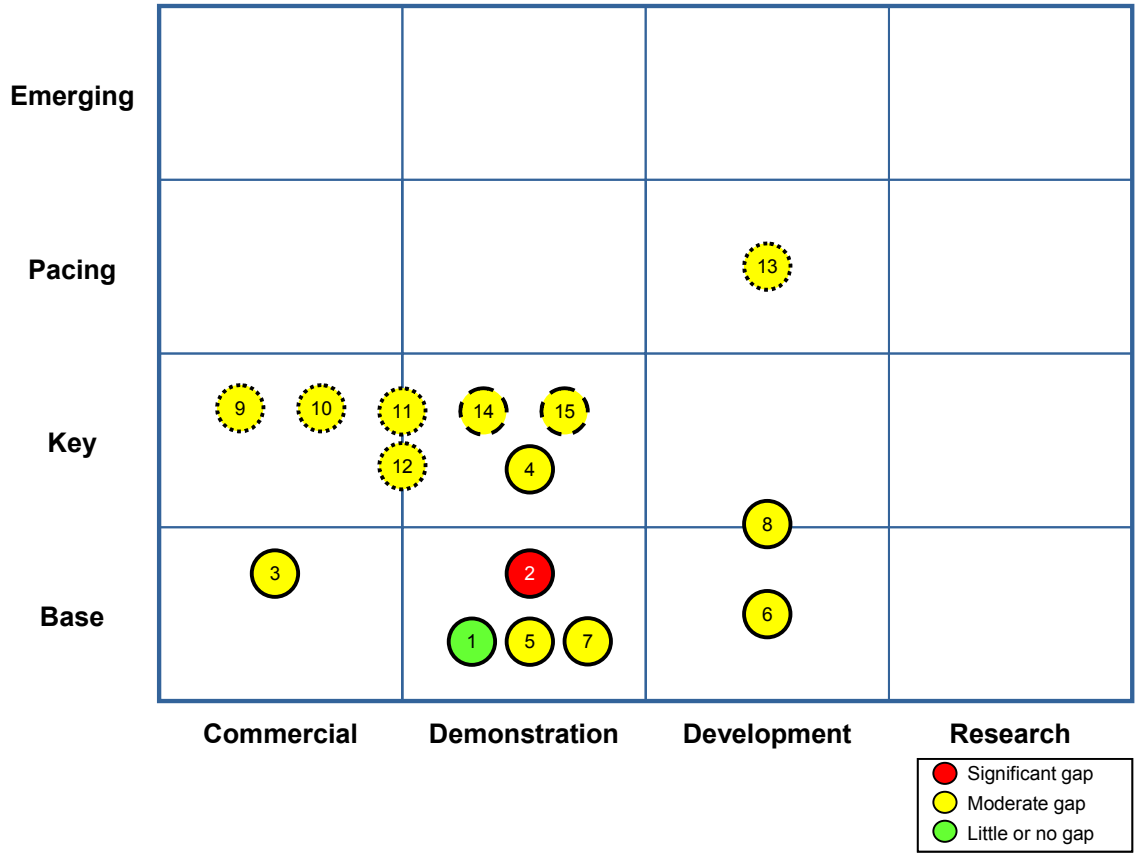
1. Standardize technical requirements, processes and contracts for interconnection (including networked systems and power export) that allow for innovative solutions
2. Understand impact of and adopt new interconnection requirement
3. Standardize designs around new requirements
4. Type testing and certification of interconnection solutions
5. Develop guidelines and best practices for interconnection
6. Modify standardized requirements and standardized designs based on modeling, testing and field experience
7. Educate stakeholders on new requirements, contracts and processes
8. Develop standardized products for small DER

Cost Reduction and Product Improvement

9. Reduce costs of interconnection components
10. Improve reliability and performance of interconnection components (e.g., power electronics)
11. Integrate interconnection functions with other DER functions
12. Turnkey solutions that integrate DER functions
13. Develop new technologies that would eliminate or reduce some requirements or costs of interconnection

Compatibility

14. Develop test protocols for compatibility and power quality testing of DER
15. Test and understand compatibility and power quality issues



Grid Effects

Some progress has been made in the modeling and testing as well as system impact studies aspects of Grid Effects research. However, a significant amount of new research activity is needed to address the Grid Effects research needs that still exist.

The rating for the following research initiative has been revised from significant gap to moderate gap given new research programs such as the Distributed Utility Integration Test (DUIT):

- Demonstrate and test varying levels of DER penetration in a distribution system

One Grid Effects research initiative continues to be rated as having significant gaps as little new activity has started to warrant a change in the gap rating:

- Demonstrate and test microgrids

However, with the removal of utility ownership restrictions in California under the latest round of the CPUC rulemaking, interest in demonstrating and testing utility-owned microgrids in the distribution system may very well increase among utilities.

The gap for research initiative "Perform analysis of the information and data needs of wires companies" has widened since the original research assessment as research activity that was expected to significantly help close the gap did not take place. Thus, this research initiative is now considered to have a moderate gap.

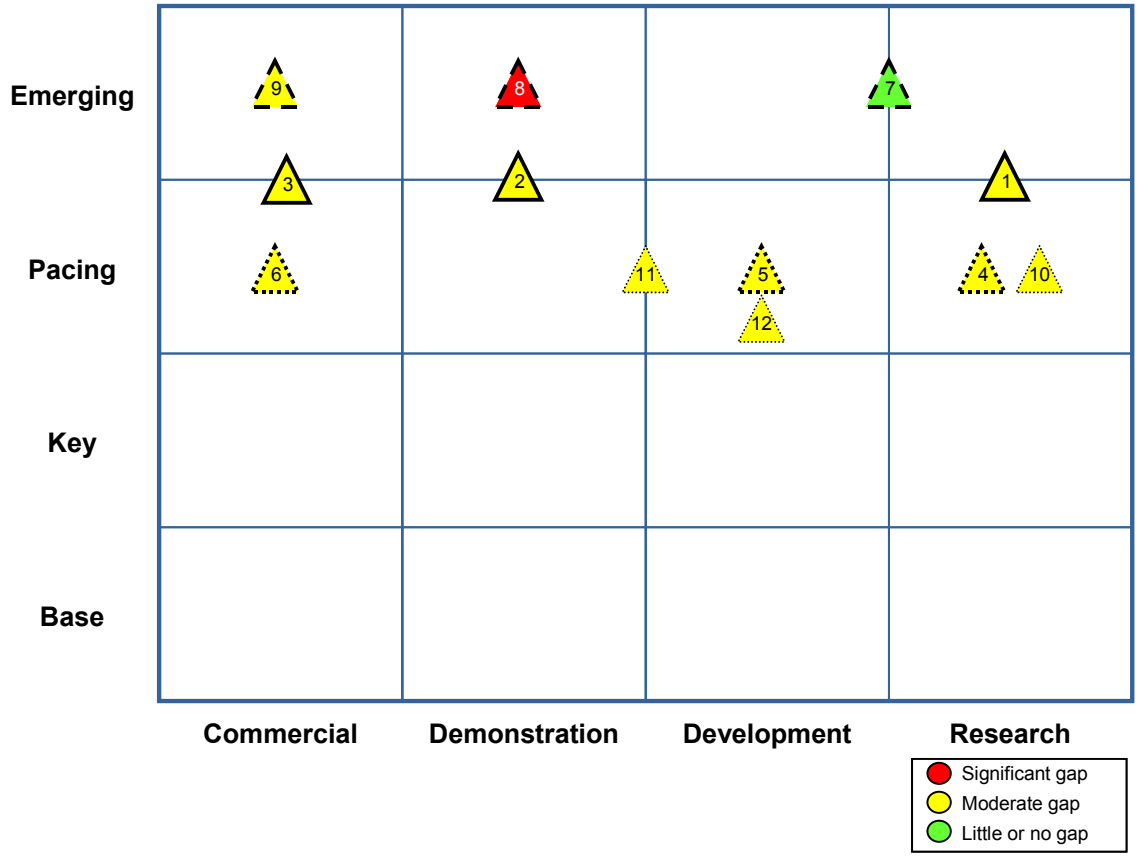
Increasing levels of research activity have been observed for following research initiatives, but no changes in the gap ratings are warranted at the present time as uncertainties remain regarding whether the increased activity is sufficient to close the gaps:

- Model and analyze the grid with varying levels of DER penetration
- Develop models to understand system impacts
- Develop software to facilitate impact studies

No significant change in the level of activity pursuing the remaining research initiatives has been observed.

Figure A-5: Grid Effects Research Initiative Gap Ratings

Research Initiatives
Modeling and Testing
1 Model and analyze the grid with varying levels of DER penetration
2 Demonstrate and test varying levels of DER penetration in a distribution system
3 Modify distribution system design approaches
System Impact Studies
4 Develop models to understand system impacts
5 Develop software to facilitate impact studies
6 Modify requirements for impact studies as appropriate
Microgrids
7 Model and analyze microgrids
8 Demonstrate and test microgrids
9 Develop design guidelines for microgrids
Wires Company Information Needs
10 Perform analysis of the information and data needs of wires companies
11 Develop and demonstrate systems for wires companies to monitor DER
12 Develop tools to evaluate DER solutions vs. traditional T&D investments



Market Integration

Uncertainties in the regulatory climate of the electricity industry combined with an insufficient base of grid-connected DER make it difficult for significant progress to be made in Market Integration at the present time. However, some conceptual work is continuing and improvements in the enabling technologies applicable to Market Integration continue to emerge.

The ratings for all but one of the Market Integration research initiatives previously rated as having significant gaps in the original research assessment persist. In addition, the gap for research initiative "Develop advanced storage to optimize DER in response to market price signals" has actually widened due to a pullback in the level of activity pursuing this research initiative. Thus, the research initiatives now rated as having significant gaps in research are:

- Assess current wholesale market rules for applicability to DER
- Modify market rules as appropriate to reduce the participation costs (fees, metering, process) for DER
- Reduce costs by creating critical mass through a demonstration program
- Assess requirements for tariffs or rates
- Develop market mechanisms to capture and monetize additional DER benefits (e.g., T&D, reliability, environmental, CHP, etc.)
- Develop standards / protocols for communications / control
- Develop advanced storage to optimize DER in response to market price signals

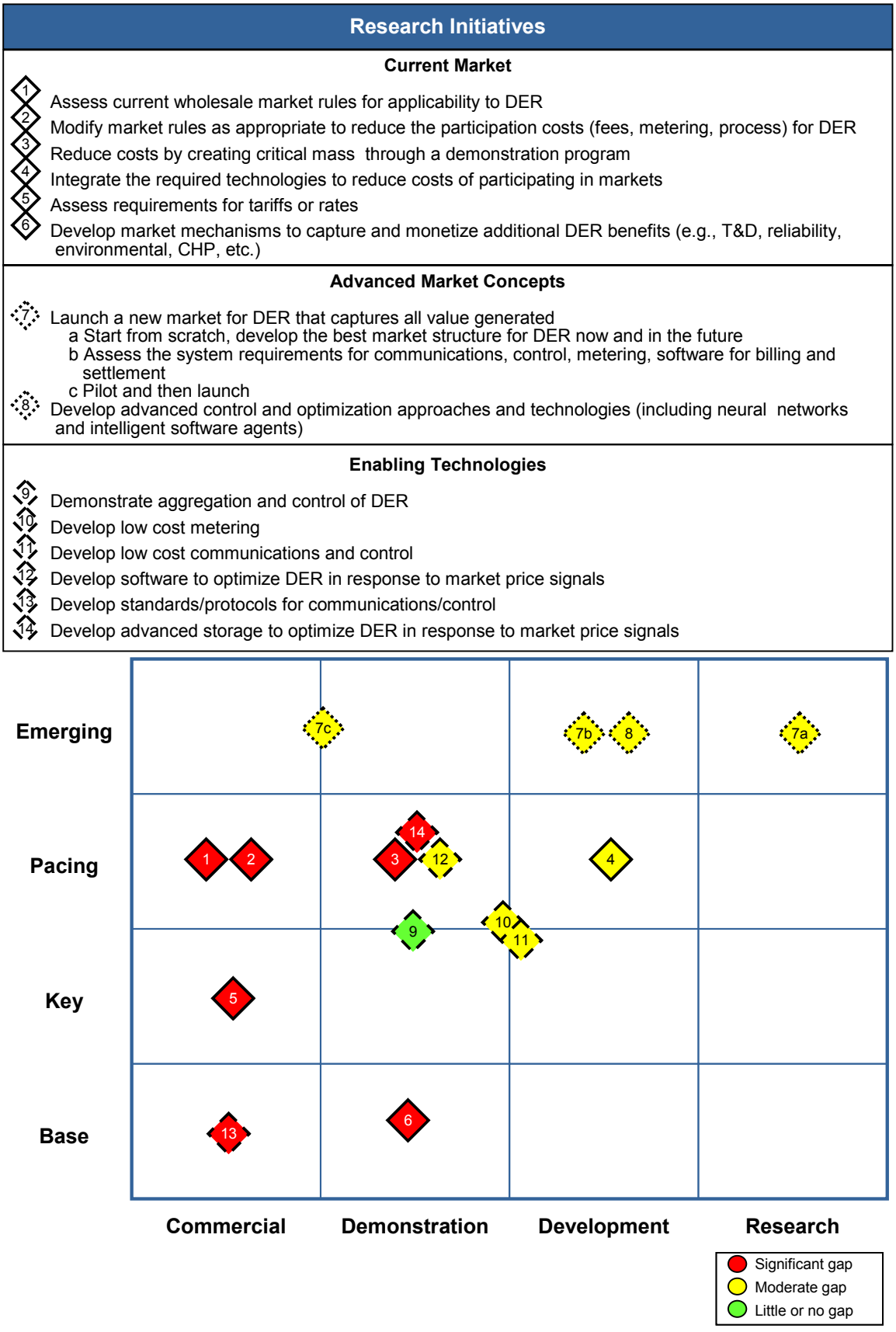
The rating for one research initiative "Launch a new market for DER that captures all value generated – start from scratch, develop the best market structure for DER now and in the future" was revised from significant gap to moderate gap not because of any significant increase in research activity. Rather, the change in rating is the result of a reevaluation of the initiative that deemed it premature for significant investment to take place in pursuit of this research initiative. More fundamental research in Markets needs to be completed such as those pursuing the "Develop market mechanisms to capture and monetize additional DER benefits (e.g., T&D, reliability, environmental, CHP, etc.)" before starting this research initiative.

Increasing levels of research activity have been observed for the following research initiatives, but no changes in the gap ratings are warranted at the present time as uncertainties remain regarding whether the increased activity is sufficient to close the gaps:

- Assess requirements for tariffs or rates
- Develop low cost metering
- Develop low cost communications and controls
- Develop software to optimize DER in response to market price signals
- Develop standards/protocols for communications/control

No significant change in the level of activity pursuing the remaining research initiatives has been observed.

Figure A-6: Mark Integration Research Initiative Gap Ratings



Research Initiatives With Significant Gaps

The following research initiatives previously rated as having significant gaps are now rated as having moderate research gaps (Figure A-4). Note that the change in rating for the Market Integration research initiative "Launch a new market for DER that captures all value generated – start from scratch, develop the best market structure for DER now and in the future" is the result of a reevaluation of the initiative that deemed it premature for significant investment to take place in pursuit of this research initiative.

Figure A-7: Moderate Gap Research Initiatives Previously Rated as Having a Significant Gap

Research Initiatives
Interconnection
4 Type testing and certification of interconnection solutions
5 Develop guidelines and best practices for interconnection
7 Educate stakeholders on new requirements, contracts and processes
Grid Effects
2 Demonstrate and test varying levels of DER penetration in a distribution systems
Market Integration
7 Launch a new market for DER that captures all value generated
a. Start from scratch, develop the best market structure for DER now and in the future

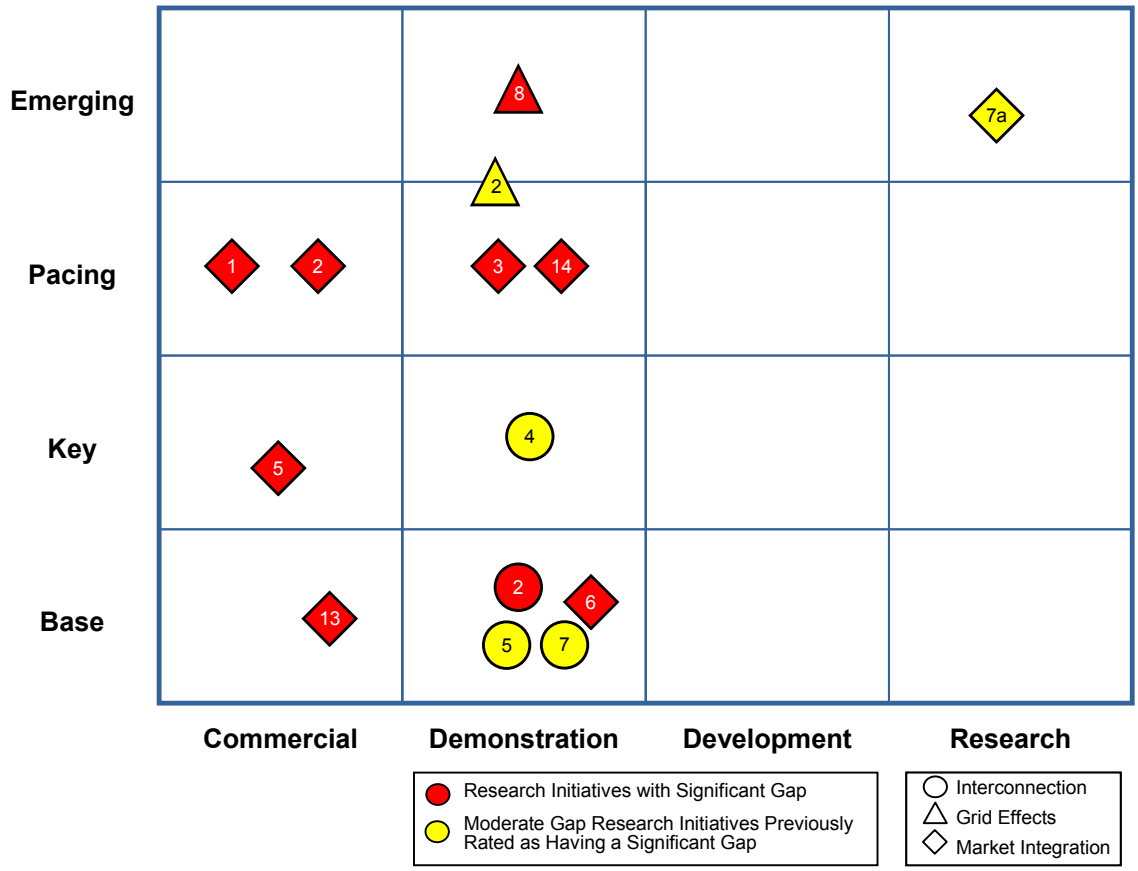
The gap for Market Integration research initiative "Develop advanced storage to optimize DER in response to market price signals" has actually widened due to a pullback in the level of activity pursuing this research initiative and is now rated as having a significant gap. Research initiatives currently rated as having significant gaps are presented below (Figure A-5).

Figure A-8: Research Initiatives with Significant Gaps

Research Initiatives
Interconnection
2 Understand impact of and adopt new interconnection requirement
Grid Effects
8 Demonstrate and test microgrids
Market Integration
1 Assess current wholesale market rules for applicability to DER
2 Modify market rules as appropriate to reduce the participation costs (fees, metering, process) for DER
3 Reduce costs by creating critical mass through a demonstration program
5 Assess requirements for tariffs or rates
6 Develop market mechanisms to capture and monetize additional DER benefits (e.g., T&D, reliability, environmental, CHP, etc.)
13 Develop standards/protocols for communications/control
14 Develop advanced storage to optimize DER in response to market price signals

The figure below (Figure A-6) graphically displays the research initiatives that have significant gaps along with moderate gap research initiatives that were previously rated as having significant gaps in the 2001 report.

Figure A-9: Research Initiatives With Significant Gaps and Those With Revised Gap Ratings



III. Implications for the CEC DER Integration Research Program

CEC has played a key role in narrowing the gaps in the Interconnection and Grid Effects areas. Continued investment in current and planned projects is required to narrow the gaps as indicated in this report.

The commercialization path for interconnected Distributed Energy Resources may be nearing a fork in the road. DER may still emerge from the current period of uncertainty being widely viewed as a key element of a market-based deregulated electrical system in the coming years. Conversely DER may be used as an attractive energy alternative in a re-regulated industry. Regardless of the path taken, gaps in Market Integration research initiatives may need to be closed to enable CEC to meets its vision of having DER be an integral part of CEC's energy system.

The results of interviews show that there are widely held expectations among DER integration stakeholders of continued significant CEC involvement in the development of technologies and research to support policy-making for DER market integration. There is also a desire to see the CEC support technology research that is currently not being actively supported by the private sector given their focus on short-term gains. However, this will be an ongoing challenge as the CEC must evaluate its level of participation given its mandate to conduct public interest research.

Appendix

Major Standards and Policy Developments in the Past Two Years

Approval of IEEE 1547
In June 2003, the IEEE Standards Board approved IEEE 1547 Standard for Interconnecting Distributed Resources With Electric Power Systems. This standard establishes the long-awaited technical foundation to allow the interconnection of all distributed generation (DG) technologies with the electric grid. It also ensures that major investments in distributed generation technology development by government and industry will result in real-world applications providing alternative sources of electric power to the electric utility operating infrastructure. The 1547 working groups continue to work on the remaining 1547 series of ancillary standards on testing (P1547.1), applications (P1547.2), and communications (P1547.3). Massachusetts was the first state to implement IEEE 1547.

FERC Proposed Rulemaking on DER Interconnection
To ensure generators' access to the transmission grid, beginning in the fall of 2001, the Federal Energy Regulatory Commission (FERC) has been working on a standard generator interconnection agreement and procedures that would be applicable to all public utilities that own, operate or control transmission facilities under the Federal Power Act. The proposed procedures provide for a degree of streamlining for "small generators," (defined as units or aggregations of 20MW and below), including waiver of deposits and a limitation of the scope of necessary engineering studies.

FERC Wholesale Market Design
In a white paper issued April 28, 2003, the FERC outlined a move away from standard market design and toward a new "wholesale power market platform" as a solution to a range of electricity market problems. The revised approach acknowledges regional differences and needs while allowing phased implementation. The previously proposed standard market design (SMD) solution drew criticism from some stakeholders. Major issues concerned jurisdiction, regional differences, protection of existing customers, and cost recovery. Comments are currently being reviewed.

California PUC 99-10-025 Rulemaking
On February 27, 2003, the California Public Utility Commission announced the completion of 99-10-025 Rulemaking, a 3 ½ year proceeding that investigated a variety of issues surrounding distributed generation. In the final decision of the rulemaking, Decision 03-02-068, the CPUC saw no reason to limit ownership of DER assets or adopt a tariff dedicated to DER. This decision paves the way for utility ownership of DER equipment to enhance their distribution systems. In addition, the Decision 03-02-068 allowed utilities to establish memorandum accounts to track distributed generation implementation costs that cannot be attributed to specific distributed generation projects and are not part of the utilities' existing budgets. In Decision 03-02-068, the CPUC chose not adopt a mass marketing information campaign, but rather a multi-pronged

education effort directed to those considering a DER installation. Rule 21 interconnection standards were previously adopted as part of this rulemaking effort.

Increased State Regulatory Activity in DER
Since the R&D Assessment Report was published in 2001, states such as Connecticut, Indiana, Michigan, Minnesota, Massachusetts, and Wisconsin have become further engaged in interconnection rulemaking and design of tariff applicable to DER. In May 2003, the New York Public Service Commission announced that it will begin investigating how electric utility rate structures provide financial disincentives against energy efficiency, renewable generation, and distributed generation.

Overview of Developments Among Private Sector DER Stakeholders

Over the past two years, private sector DER integration stakeholders have continued development of key elements of the DER industry value chain. However, due to the reduced demand and slow pace of adoption of DER, progress in some aspects of technology development and industry growth have been disappointing.

Compared to two years ago, fewer private dollars are being invested in DER technology in general and research in particular. Substantially less venture capital money is available to support private sector research and development. Developing marketable products and getting to profitability in the near term is becoming a major issue for smaller technology developers. The trend toward consolidation is clearly visible with Comverge's acquisition of Sixth Dimension and Itron's acquisition of Silicon Energy. Utility interest has also waned with DTE Energy Technologies being one of the last few utilities with an active interest in DER. Utility disinterest is due to financial pressures put on utilities in the last two years and a lack of sufficient progress on DER technologies and markets.

Interconnection Components
Advances in standards such as the adoption of IEEE 1547 is seen as a very positive development and there is some optimism that the resulting increase in demand for grid-connected DER will lead to a healthier interconnection components manufacturing sector. Some interconnection component manufacturers have refocused their products toward certain elements of the DER market that is experiencing relatively healthy growth such as wind and solar as opposed to fuel cells and microturbines, which have under-performed in the marketplace relative to expectations.

Interconnection Package
With the emergence of widely accepted standards such as IEEE 1547, interconnection package manufacturers now have clearer targets for their equipment specifications, as demonstrated by ASCO's Series 7000 Soft-Load transfer switch that passed the IEEE 1547 interconnection anti-islanding tests performed at NREL's DER Test Facility in late 2002.

Integrated DER Products/Interconnection/Control
Major equipment manufacturers continue to work to simplify the process of DER interconnection, but the continued lack of uniformity in standards adoption and

interconnection requirement regulations across the United States make more significant investment in true "plug-and-play" DER technology difficult to justify at the present time.

Communications/Control
Participants in this aspect of the industry have made progress in the functionality of their systems and improved their ease of use. There is a significant amount of existing technology that can be brought to bear on DER. But until many of the issues around the generation technology and the marketplace are addressed, application of these technologies to help DER reach their full potential is not likely to take place. Aside from research demonstrations and installations at some large commercial or industrial operations, adoption of advanced communications and controls technologies has been limited. The lack of a uniform communications standard or platform remains a major obstacle to the effective aggregation of DER.

Software
Given the continued lack of agreement on communication standards and the rate of development of the industry, opportunities for software developers have been limited. Incremental improvements have been made to allow for greater functionality, but widespread adoption will likely remain elusive until DER is more widely adopted.

Advanced Metering
Advanced metering products have made few inroads in the marketplace, as their application remains limited due to the infrequent installation of DER that is interconnected with the grid. The cost for non-utility owners of DG to install and operate the necessary equipment in such a way to make advanced metering necessary often remains prohibitively high.

Exchanges
Although the DER market has not yet matured sufficiently and obtained the market access required for real-time exchanges to have a significant economic impact on regional energy markets, new stakeholders have gotten involved in research to better understand the technical and economic requirements needed to make an DER energy exchange work. The California ISO DG Aggregation Program, the New York ISO, PJM, and the New England ISO have all engaged in research to better understand DER exchanges and laying the technical and infrastructure groundwork for improved DER integration with the energy marketplace. The New York ISO, PJM, and New England ISO now have programs in place to allow DER to participate in their power markets.

Overview of Activities by Public Sector and Non-Profit Stakeholders

Major Public Sector and Non-Profit Stakeholders
United States Department of Energy (DOE) – The DOE continues to play an important role in DER research through extensive funding of standards development, equipment testing, demonstration, and education activities. It is about to initiate a 3-year effort in interconnection technology development (inverter and non-inverter technologies), testing, as well as the impact of tariff rates. When project information

from this effort becomes available in the future, some of the research gap ratings may be revised to reflect the increased activity level.

California Energy Commission – Through the DER Integration Research Program, the CEC has increased its focus in DER integration with a $7 million budget in FY 2003-2004 to pursue research in Market Design and Integration Projects, Regional Grid Benefit Validation Demonstrations, Interconnection Equipment and Installation Cost Reduction, and Grid Effects/DG Penetration Testing.

New York State Energy Research and Development Authority (NYSERDA) – NYSERDA's DER research program is focused primarily in the demonstration and aggregation of DG-CHP systems in various industrial and commercial settings with the goal of obtaining economic and reliability improvements through these systems. NYSERDA also supports research and demonstration of new DER technologies such as PEM-based fuel cells.

EPRI – EPRI continues to focus on education and demonstration of DER technologies in service to its members. Research activities have been limited due to generally reduced member interest in cutting edge DER technologies. EPRI's non-profit affiliate focused on public-private initiatives, E2I, is focused on facilitating DER market integration by looking at the policies, market structure and incentives to make the business models viable.

GTI – GTI's Distributed Energy Group remains active in accelerating the development and deployment of efficient, low-emissions DER technology, as well as producing sustainable energy development resources for metropolitan communities.

NRECA CRN – The Cooperative Research Network (CRN) continues to fund demonstration projects for DER in rural settings. However, there is a shift underway where more resources are being focused on renewables and animal waste rather than new DER technologies such as microturbines and fuel cells given the lower than expected rate of improvement in performance and cost for the latter two technologies.

New Projects from Public Sector and Non-Profit Stakeholders

Figure AP-1: Comsys for Distributed Power

Project/Technology Development/Product	Issues	Research Initiatives	Expected Results
The project is a 6-month effort to demonstrate web-based communication and control protocols that apply across multiple types of distributed energy equipment, including fuel cells and internal combustion engine generation systems. This project leverages Connected Energy's existing COMSYS monitoring and control technology.	•Can we aggregate and remotely operate and control DER to better respond to market signals?	• Demonstrate aggregation and control of DER • Develop low cost communications and control • Integrate the required technologies to reduce the costs of participating in markets	This project will demonstrate enhanced integration of DER with the needs and operations of utilities, end users and the ISOs. It will also demonstrate application of various types of DER technology in a responsive and beneficial way to the system as a whole.

Funding/Source	Participants	Point of Contact
DOE, NYSERDA and other participants	Connected Energy, DOE, CA ISO, NYSERDA, LIPA, NYISO, Sandia National Lab, Southern California Edison	John Pohlhaus (Connected Energy) John.Pohlhaus@connectedenergy.com 585-697-3800

Project Area	Project Focus	Technology Characteristic	Project Type
Market Integration	IT, Communication/Control	Key/Pacing	Demonstration

Figure AP-2: SAIC – Distributed Generation Analysis Tool

Project/Technology Development/Product	Issues	Research Initiatives	Expected Results
The Distributed Generation Analysis Tool software calculates project screening information — in the form of a 20-year life cycle cost analysis and environmental impact assessment — and enables users to define projects that are most energy-efficient, environmentally friendly, and financially sound.	•Can it be made easier for consumers to maximize their investment in DER?	• Develop software to optimize DER in response to market price signals	A tool that provides state energy agencies, promoters of DG and combined heat and power projects, end users, and project financiers with a program to evaluate DG applications and predict successful projects.

Funding/Source	Participants	Point of Contact
DOE	NASEO, DOE, SAIC	Kate Burke (NASEO) Kb@naseo.org

Project Area	Project Focus	Technology Characteristic	Project Type
Market Integration	Modeling, Software	Pacing	Demonstration

Figure AP-3: The Florida Solar Energy Center – DG Installation Curriculum

Project/Technology Development/Product	Issues	Research Initiatives	Expected Results
The Florida Solar Energy Center is developing a curriculum on distributed energy systems. These courses are meant to train vocational workers to install and maintain distributed energy systems like photovoltaic systems, microturbines, and fuel cells. The courses, which will include training manuals, homework, hands-on exercises, and testing.	•Can interconnection solutions de deployed in a timely fashion? •Can interconnection be made more user-friendly to the end-use consumer?	• Educate stakeholders on new requirements, contracts and processes	Once developed, the curriculum can be used in community colleges nationwide and by other training organizations like the National Joint Apprentice and Training Committee, which develop courses for electricians.

Funding/Source	Participants	Point of Contact
DOE	Florida Solar Energy Center, distributed generation equipment manufacturers, national laboratories, and electrician apprenticeship programs	Kevin Lynn Ph: (321) 638-1440 E-mail: klynn@fsec.ucf.edu

Project Area	Project Focus	Technology Characteristic	Project Type
Interconnection	Education	Base	Demonstration

Figure AP-4: NRECA – DG Interconnection Tool Kit

Project/Technology Development/Product	Issues	Research Initiatives	Expected Results
The DG Interconnection Tool Kit contains seven documents that can be adapted by cooperatives to assist in the drafting of rules, policies, tariffs, and contract documents for interconnection. The documents include a business and contract guide for interconnection, consumer guidelines for generator installation and interconnection, a model interconnection application, model short-form and long interconnection contract, a DG rate manual, and technical application guide.	•Can interconnection solutions de deployed in a timely fashion? •Can interconnection be made more user-friendly to the end-use consumer?	• Standardize technical requirements, processes and contracts for interconnection that allow for innovative solutions • Develop guidelines and best practices for interconnection • Educate stakeholders on new requirements, contracts and processes	The kit's documents provide models and guidance that each cooperative can use and adapt to its own needs to create effective distributed generation interconnection policies and programs.

Funding/Source	Participants	Point of Contact
The National Rural Electric Cooperative Association, the Cooperative Research Network, the National Rural Utilities Cooperative Finance Corp. and Energy Co-Opportunity	The National Rural Electric Cooperative Association, the Cooperative Research Network, the National Rural Utilities Cooperative Finance Corp. and Energy Co-Opportunity	Patrick Lavigne (703) 907-5732

Project Area	Project Focus	Technology Characteristic	Project Type
Interconnection	Policy	Base	Demonstration

Figure AP-5: Forging a Consensus on Interconnection Requirements in California (FOCUS)

Project/Technology Development/Product	Issues	Research Initiatives	Expected Results
The FOCUS initiative is currently comprised of 4 projects: •Rule 21 Technical Support •Interconnection Guidebook •Interconnection Monitoring •IEEE 1547/Rule 21 Coordination	•Can interconnection be made more user-friendly to the end-use consumer? •Can interconnection solutions be deployed in a timely fashion? •Are there safe, reliable and cost-effective interconnection solutions for radial and networked distribution systems?	• Develop guidelines and best practices for interconnection • Standardize technical requirements, processes and contracts for interconnection that allow for innovative solutions	This initiative should provide greater clarity on interconnection requirements and policies for those interested in interconnected DER. The California interconnection requirements (Rule 21) will be aligned with IEEE 1547and model installations will be articulated.

Funding/Source	Participants	Point of Contact
CEC: $1.5 million	CEC, Reflective Energies, utilities, municipal utilities, manufacturers, DOE, CPUC	Edan Prabhu Reflective Energies (949) 380-4899

Project Area	Project Focus	Technology Characteristic	Project Type
Market Integration	Policy	Base	Demonstration

Figure AP-6: New Power Technologies – DER Locational Benefits Modeling Tools

Project/Technology Development/Product	Issues	Research Initiatives	Expected Results
This project will identify where DER projects can provide specific power delivery network performance improvements. It will quantify the value of these benefits to the power delivery network in engineering and economic terms. Barriers to DER with the greatest impact on the most beneficial projects will be identified and non-cost-shifting incentives for DER projects that enhance network performance will be suggested.	•Do we understand what benefits DER can provide the power system? •Can we quantify those benefits, capture them and monetize them through innovative tariffs, rates or other market mechanism?	• Develop market mechanisms to capture and monetize additional DER benefits • Develop models to understand system impacts • Model and analyze the grid with varying levels of DER penetration • Develop tools to evaluate DER solutions vs. traditional T&D investments	As a result of this project, an enhanced understanding of how DER can be used to improve the performance of the power delivery system will be developed. The knowledge obtained from this effort can be used to help aid the decision-making process for DER implementation where network performance benefits are sought.

Funding/Source	Participants	Point of Contact
CEC: $616k	CEC, New Power Technologies, Silicon Valley Power, Silicon Valley Manufacturers Group	Peter Evans New Power Technologies (650) 867-6789 PeterEvans@NewPowerTech.com

Project Area	Project Focus	Technology Characteristic	Project Type
Market Integration	Policy	Base	Demonstration

Figure AP-7: E2I Public-Private Initiative to Address DER Market Integration Issues

Project/Technology Development/Product	Issues	Research Initiatives	Expected Results
This project will take a closer look at ongoing initiatives that require or induce utilities to consider DER options, and encourage or procure those options where they can provide least-cost or best-fit solutions to system needs. This project will also create a framework or template for developing high-impact, collaborative DER pilot programs designed to allow real-world implementation of the incentive approaches developed	•Are there tariffs or rates that could be crafted to provide better retail price transparency to DER? Could the participation costs be reduced? Could the full range of DER participate? •Should a separate market structure (retail market or exchange)be created for the full range of DER technologies?	• Assess requirements for tariffs or rates • Develop market mechanisms to capture and monetize additional DER benefits • Launch a new market for DER that captures all value generated (a) Start from scratch, develop the best market structure for DER now and in the future	This project will improve understanding of the impact of tariffs and rates, identifying successful models that promote win/win scenarios. Parties interested in pilot programs to integrate DER into the electricity market will be able to better coordinate and get pilot programs up and running.

Funding/Source	Participants	Point of Contact
CEC: $250k NYSERDA, NYISO, and TVA: N/A	E2I, CEC, NYSERDA, NYISO, TVA	Ellen Petrill E2I ellen@e2i.org 650-855-8939

Project Area	Project Focus	Technology Characteristic	Project Type
Market Integration	Policy	Base/Key	Demonstration

Figure AP-8: GIS Development and Power Flow Simulations

Project/Technology Development/Product	Issues	Research Initiatives	Expected Results
Analyze existing spatial information related to energy use, environmental and demographic characteristics of sub-regions within the state. Create required data layers on available renewable energy resources. Identify areas (hot spots) where renewable DG systems can potentially help address electricity reliability, congestion and power quality problems using power flow simulations and GIS.	•Do we understand what benefits DER can provide to the power system?	• Model and analyze the grid with varying levels of DER penetration	Strategic locations for using renewable energy distributed generation systems will be identified to address electricity system problems through a combination of GIS tools and power flow models. A software program enabling remote access to the GIS information, run different and examine scenarios based on new data, and collect associated results.

Funding/Source	Participants	Point of Contact
CEC: $1.01 million $280k (CDF) and $730k (McNeil Technologies)	California Department of Forestry, McNeil Technologies, California Energy Commission	Prab Sethi (California Energy Commission) (916) 654-4509; psethi@energy.state.ca.us Dean Cromwell (California Department of Forestry) (916) 227-2667; dean_cromwell@fire.ca.gov Scott Haase (McNeil Technologies) (303) 273-0071; shaase@mcneiltech.com

Project Area	Project Focus	Technology Characteristic	Project Type
Grid Effects	Modeling	Pacing/Emerging	Research

Figure AP-9: Commonwealth Project 1.1-Program Planning and Analysis

Project/Technology Development/Product	Issues	Research Initiatives	Expected Results
Develop a matrix of cases to evaluate potential T&D impacts for a range of penetration level and mix of DR. The power flow study applying the GE Power Systems Load Flow (PSLF) program will be examine ways to help maintain or upgrade distribution service with DR installed. The analysis will be extended to the sub-transmission level, where appropriate.	•Do we understand what benefits DER can provide to the power system? •Do we understand DER's impact on the grid?	• Model and analyze the grid with varying levels of DER penetration	An assessment of potential for applying local renewable resources for meeting sub-regional electricity needs for two areas in California. A preliminary estimate of generation potential in these areas and in California as a whole along with estimates of economic and environmental benefits. A plan for developing specific biogas and PV generation facilities in one area being studied.

Funding/Source	Participants	Point of Contact
CEC: $302,910	California Energy Commission and Commonwealth Energy Corp.	Zhiqin Zhang (CEC) Phone: (916) 654-4063 Email: zzhang@energy.state.ca.us Max Carpenter Commonwealth Energy Corporation Phone: (714) 259-2517 Email: MCarpenter@electric.com

Project Area	Project Focus	Technology Characteristic	Project Type
Grid Effects	Modeling	Pacing/Emerging	Research

Figure AP-10: AESC-Distributed Intelligent Agents for Decision Making at Local DER Levels

Project/Technology Development/Product	Issues	Research Initiatives	Expected Results
During Phase I, this project will develop the high level requirements for a basic hierarchy of intelligent agents that communicate and collaborate to coordinate the operation of the electric grid system. Agents operating at the bottom-most level of the hierarchy (DER level agents) will be further specified and minimal agents will be developed and tested to demonstrate feasibility.	•Can we aggregate and remotely operate and control DER to better respond to market signals (e.g., energy capacity, ancillary services, and transmission and congestion)? •Should standards for communications/ control be developed?	• Develop advanced control and optimization approaches and technologies (including neural networks and intelligent software agents)	The effort will lay the groundwork for a hierarchy of intelligent power system agents that will enable DER to be more fully integrated into the U.S. power system. In addition, the feasibility of the approach will be demonstrated by developing and testing DER level agents that respond to DER level disturbances thus facilitating critically needed acceptance within the power industry.

Funding/Source	Participants	Point of Contact
DOE SBIR: $100,000 (Phase I) 1/3 of funds will go to Colorado State University	U.S. Department of Energy, Colorado State University, and AESC	Jerry Gibson AESC gibsonj@aesc-inc.com (858) 560-7182

Project Area	Project Focus	Technology Characteristic	Project Type
Market Integration	IT, Communication/Control	Pacing	Development

Figure AP-11: Infotility- Distributed Intelligent Agents for Decision Making at Local DER Levels

Project/Technology Development/Product	Issues	Research Initiatives	Expected Results
The goal of this project is to develop an adaptive, intelligent agent-based information system providing real-time, two-way communication and decision making between distributed DER system nodes. The agents will primarily be used to provide analysis and response to grid contingencies as well as provide coordination with power electronics and grid protection schemes to enhance grid reliability.	•Can we aggregate and remotely operate and control DER to better respond to market signals (e.g., energy capacity, ancillary services, and transmission and congestion)? •Do we understand how DER will interact with other DER and the grid in real-time?	• Develop advanced control and optimization approaches and technologies (including neural networks and intelligent software agents)	A software development plan will be developed in Phase I. Phase II activities will involve development of commercialized software that is tested in a real environment with actual DER devices connected to a major electrical system.

Funding/Source	Participants	Point of Contact
DOE SBIR: $100,000 (Phase I)	U.S. Department of Energy and Infotility	Dave Cohen Infotility Dave@infotility.com (925) 275-3185

Project Area	Project Focus	Technology Characteristic	Project Type
Market Integration	IT, Communication/Control	Pacing	Development

Quotes From Interviews Regarding Status of DER Industry Development

The following are quotes from interviews conducted with various stakeholders to gauge the status of the DER industry development.

"The price of gas and infrastructure has changed the environment for fossil fuel DER somewhat. Wind power has done quite well. Fuel cells have not yet generated a lot of products. Microturbines have done OK, but a few companies have pulled out in recent years. Some aggregation is taking place."
National Lab Researcher

"A lot of the market development we expected 2 years ago hasn't happened, except in solar and wind. Fuel cells are still emerging and microturbines are moving slowly. Energy storage advancement has really slowed down. People are dealing with the real interconnection and economic issues with PV.

Two years ago, we were making broad investments in the area where as we are now more focused on rate of return in determining where we invest."
Interconnection Component Manufacturer

"The reliability of new technologies is improving, although they're not quite there yet. We aren't moving fast enough to prepackaged and pre-engineered systems. Regulatory barriers will eventually wear away, but it is still a concern. Places experiencing pain such as NY and CA are saying 'cut the b.s.'"
Communication/Control Company

"Power flows into the utility grid are going to be less important than I thought. On-site generation that supplies the local structure, and no more, is going to be more important. Clean, quiet engines are going to be critical."
Research Coordinator

"Its taken about 2 years for the promise of DG to begin to be realized to where there is enough density to see that it can make an impact on the industry infrastructure. Everything is taking longer than people thought. Nothing would have happened without the rulemaking and incentives that have emerged. Exemption/capping of exit fees, Rule 21, etc."
Third-Party DER Owner/Operator

"Exit fees and standby charges are a problem for both new and existing DER owners. Having a more standardized platform for DER is needed in N. America. I don't know how long it will to take to get these issues resolved. There are too many regulatory barriers and the operating costs are too high for the end user."
Communication/Control Company

"I'm fairly disappointed in the way utilities have responded to DER. Since deregulation, utilities have essentially become Wal-Mart shelf space…buying cheap and selling to the highest bidder. As the regulations currently stand, there is very little incentive for utilities to take DER seriously.

Two-way grid infrastructure upgrades, whose costs can be passed to the ratepayer, need to take place before selling power back to the grid and net metering can happen. There needs to be shift in people's thinking for this business."
Public Sector Researcher

Quotes From Interviews Regarding Needs Going Forward

"We need to bring other states to look at DER as an option. People waiting for the technology to be more mature before considering integrating DER into the grid is stalling the development of the technology. The infrastructure can be better primed for these technologies.

There aren't enough projects going on to get a lot of good data to share. All projects that the CEC is putting money into should provide some sort of learning. A critical mass of research from many states is needed."
Public Sector Researcher

"Virtual utility or virtual energy network projects would be very interesting."
Communication/Control Company

"Permitting is still an issue. There are a whole lot of little issues that put a lot of friction and drag on getting the DG units up and operating."
Value-Added DER Technology Reseller

"Integration can be taken further. Effective integration of DER with the distribution system to help the delivery companies is difficult because locating DG in the right places is critical. Distribution companies may have to own the assets or there has to be a mechanism by which they can control the operations of the units to support their system."
Research Coordinator

"How much DER is appropriate given the supply mix in California? How can the expansion of the infrastructure be optimized and what role should DER/microgrids play? There hasn't been a critical mass of DER to do a scalable market pilot."
Non-Profit Research Entity

"DOE is moving more toward the upstream to make the breakthroughs. So if CRN, EPRI, NYSERDA, and CEC can help fill the gap by demonstrating technologies and getting feedback, that would make all the difference."
Non-Profit Research Entity

- "Develop interconnection technology
- Address fuel testing versus type testing
- Interconnection equipment certification
- Understand voltage regulation stability
- Address grounding faults
- Establish basis for DG penetration aggregation
- Develop islanding methods and requirements

Fault current may be more of an issue in some systems than others. Some of it is related to age and some of it is related to design.

Include 1547 in Rule 21. We need to get consolidated on this. Energy security is going to be a big issue again in a year.

Education and workshops will eventually pay off. Protection engineer education would be helpful."
National Lab Researcher

"Standardization of the permit process and standardization of interconnection, particularly the technology itself is needed. Get more mass in the industry to drive down prices and develop a large stable of qualified vendors."
Third-Party DER Owner/Operator

"Research into the development of business models for DG technologies would be helpful. However, there is still needs to be some very fundamental economic and technology work to do. Reliable, large-scale energy storage would help with the economics and penetrations but movement has been slow."
Interconnection Component Manufacturer