Arnold Schwarzenegger
Governor

FOCUS III FINAL REPORT: FORGING A CONSENSUS ON INTERCONNECTIONS IN CALIFORNIA

PIER FINAL PROJECT REPORT

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California Energy Commission
Public Interest Energy Research Program

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September 2010
CEC-500-2010-031

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Commission Contract No. 500-03-012

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Acknowledgments

The authors wish to thank Chuck Whitaker, Joe Simpson, Chuck Solt, Jeff Newmiller, Scott Tomashefsky, Mark Rawson, Dave Michel, and Jose Palomo for their assistance in administering this work.

Please cite this report as follows:

Prabhu, Edan and Prabhu, Carol. 2010. *FOCUS III Final Report: Forging a Consensus on Interconnections in California.* California Energy Commission, PIER Energy Systems Integration Program Area. CEC-500-2010-031

Preface

The California Energy Commission (Energy Commission), conducts public interest research, development, and demonstration (RD&D) projects to benefit California.

The PIER Program strives to conduct the most promising public interest energy research by partnering with RD&D entities, including individuals, businesses, utilities, and public or private research institutions.

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace. PIER[s1] funding efforts are focused on the following RD&D program areas:

- Buildings End-Use Energy Efficiency
- Energy Innovations Small Grants
- Energy-Related Environmental Research
- Energy Systems Integration
- Environmentally Preferred Advanced Generation
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy Technologies
- Transportation

FOCUS III: Forging a Consensus on Interconnections in California is the final report for the Research and Development project to enhance interconnections of Distributed Generation in California by revising Rule 21. This work was performed under PIER Contract Number 500-03-012 by the FOCUS team led by Reflective Energies.

For more information about the PIER Program, please visit the Energy Commission's website at www.energy.ca.gov/pier or contact the Energy Commission at 916-654-4878.

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Abstract

California is one of the first states to have adopted a standard practice for the interconnection of distributed energy resources (DER) devices to the electric grid. In October 1999, the California Public Utilities Commission (CPUC) issued an order instituting a new DER rulemaking (CPUC R.99-10-025) to address interconnection standards. This rulemaking progressed into the rewriting of Rule 21, part of each investor-owned utility's tariff, by a working committee including representatives from the California Energy Commission and the state's electric utilities. The objective of this ruling was to arrive at a clearer and simplified utility process for the interconnection of small distributed energy resources customers to the grid. The new version of Rule 21 specified standard interconnection, operating, and metering requirements for distributed energy resources generators. [s2]The Energy Commission used a technical support contract known as FOCUS (Forging a Consensus on Utility System) Interconnection to assist in the creation of equitable and uniform interconnection standards.

This paper reports on the progress that FOCUS Interconnection project achieved to undertake the followings:

- Monitor, collect, and analyze data, and report for selected distributed generation (DG) systems chosen for diversity related to generation, grid, and customer impact concerns. The study was completed and published.
- Provide technical support for the Rule 21 Working Group to streamline interconnections to investor owned utilities in California.
- Monitor the progress of distributed generation interconnections following revision of Rule 21.

The FOCUS Interconnection project resulted in reducing the average time for interconnection of distributed energy resources for all utilities. By simplifying the interconnection rule for various small generations to the grid, the state of California will benefit from an increase in renewable energy resources and will better meet state renewable energy goals.

Keywords: Distributed generation, distributed energy resources, renewable energy, Interconnection of generation, renewables portfolio standard, photovoltaic energy, integrating intermittent renewables, Rule 21, interconnections

Executive Summary

Introduction

This project, known as FOCUS-III, was sponsored by the California Energy Commission PIER Energy Systems Integration Program to help improve the interconnection of distributed generation[1] to the utility distribution system in California.

California is one of the first states to have adopted a standard practice for the interconnection of distributed energy resources devices to the electric grid, and it has developed new distributed energy resources interconnection standards. This has progressed into the rewriting of Rule 21, part of each investor-owned utility's (IOU) tariff, by a working committee including representatives from the California Energy Commission and the state's electric utilities. The new version of Rule 21 specified standard interconnection, operating, and metering requirements for distributed energy resources generators.

FOCUS-III (2005-2008)is a follow-up to the FOCUS-I and FOCUS II projects (2001-2004) "Forging a Consensus on Utility System Integration" FOCUS-III expanded and monitored the results of the work performed under FOCUS I and II.

FOCUS III undertook four separate tasks:

1. Monitor selected distributed generation systems and their grid interconnections for their effect on the grid and vice versa.
2. Assess the changes in timeliness of interconnections in California following the revision of Rule 21 with the objective to arrive at a clearer and simplified utility process for the interconnection of small distributed energy resources customers to the grid.
3. Provide technical leadership and coordinate the process for certifying distributed generation interconnections in California, and assist in transitioning the certification process to the evolving Institute of Electrical and Electronic Engineers (IEEE) 1547 series of standards for distributed generation.
4. Provide technical and logistical support for the Rule 21 Working Group as it addresses several new issues, including orders from CPUC proceedings.

1 California has a wealth of both renewable and non-renewable distributed generation technologies. These technologies have tremendous potential to help meet California's growing energy needs as both additional generation sources and essential elements of customer choice. These technologies are also strategic components of the loading order. Benefits from using distributed generation include: improved reliability and power quality for customers using distributed generation and customers close to distributed generation sites, customer ability to reduce system peak load, and efficiency gains from avoiding line losses. For utilities, distributed generation can defer the need for new transmission and distribution infrastructure, reduce utility resource acquisition costs, and support ancillary services.

The Distributed Generation–Grid Interface Monitoring Project

The Distributed Generation–Grid Interface Monitoring effort was a major task of the FOCUS III Project. It assessed the extent to which distributed generation had any impact on the grid, if any, and vice versa. This was the first ever study of the impact of distributed generation on the grid. The impact was gauged by measuring power quality at the distributed generation set and at the distributed generation -utility interface, known as the "Point of Common Coupling" or "PCC."

With limited funding, it was decided to keep the initial sample small (17 distributed generations at 8 sites compared to several thousand distributed generation installations in the state); the distributed generation systems chosen were based on diversity and complexity. Monitoring was performed using Power Measurement's (PM's) ION 7600 and 8500 instruments, measuring voltage and current more than 15,000 times per second for each installation. The results were compared against earlier benchmark surveys conducted by EPRI (Electric Power Research Institute) and SCE (Southern California Edison) that assessed the power quality on utility distribution lines (without distributed generation). Power quality parameters measured include voltage sags[2] and swells,[3] harmonics,[4] and flicker[5]. Over two years of data (cumulatively representing over 500,000 hours) have been collected to date, representing more than 30 trillion data points. Power quality at the distributed generation systems was generally better than that of the benchmark surveys. During the entire monitoring period, there were no events of distributed generation impacting the distribution system, and the only events where the distribution system impacted distributed generation were caused by a lightning strike and a line fault. The distributed generation systems generally did not export power to the distribution system.

The distributed generation systems being installed today as shown by the sites monitored do not impact the utility grid. While the study did not plan to monitor distributed generation performance, it found incidentally that commercially installed distributed generation systems are not performing well. Even though the sample was small, during the time of the monitoring, several distributed generation units were taken off-line or abandoned following the recent natural gas price spike. Other units are off-line for long periods for maintenance. Still others are operating at partial loads. Distributed generation systems installed in industrial or commercial facilities are often left untended.

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2 Voltage sags or dips are brief reductions in voltage, typically lasting from a cycle to a second or so, or tens of milliseconds to hundreds of milliseconds. Voltage swells are brief increases in voltage over the same time range. (Longer periods of low or high voltage are referred to as "undervoltage" or "overvoltage.") Voltage sags are caused by abrupt increases in loads such as short circuits or faults, motors starting, or electric heaters turning on, or they are caused by abrupt increases in source impedance, typically caused by a loose connection.

3 Voltage swells are almost always caused by an abrupt reduction in load on a circuit with a poor or damaged voltage regulator, although they can also be caused by a damaged or loose neutral connection.

4 Power system harmonics are integer multiples of the fundamental power system frequency. Power system harmonics are created by non-linear devices connected to the power system. High levels of power system harmonics can create voltage distortion and power quality problems. Harmonics in power systems result in increased heating in the equipment and conductors, misfiring in variable speed drives, and torque pulsations in motors.

5 Starting motors under high loads also causes voltage drop which is often evidenced by flickering lights. Such voltage drop associated with motors is called voltage flicker.

A detailed report titled *Distributed Generation Interconnection Monitoring Program* was published in June 2007. It is included as Appendix A to this report.

Timeliness of Interconnections

The changes made to Rule 21 intended to make the requirements clearer and more streamlined. This task measured whether resulting interconnections were happening more expeditiously. An earlier study showed that in 2000 through 2003 interconnection timeliness had improved dramatically. This update covered interconnections in 2004 through 2007. To keep the study manageable and useful, it was decided to include in the study all DG interconnections requested under Rule 21 and all interconnections under the NEM[6] tariff that were for systems 30 kilowatts (kW) or greater. Interconnections under NEM below 30 kW have become routine and generally go forward with little delay.

The average interconnection time for all utilities followed a similar pattern for all California IOUs. From 2000 through 2003 the average interconnection time dropped significantly, from almost 400 days to about 80 days. In 2004 the average interconnection time shot up to more than 200 days but has steadily declined since then, averaging only 75 days in 2007. While the reason for the anomaly in 2004 is not clear, the overall trend is consistently downward.

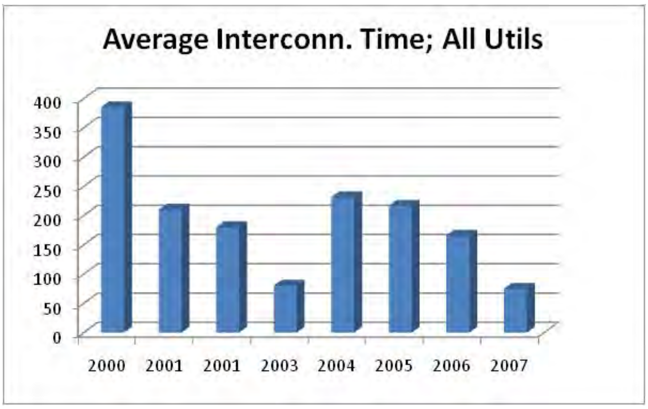

Figure 1. Average interconnection time; all utilities

Source: Reflective Energies.

The number of interconnection applications through the period 2004 through 2007 for all utilities combined stayed steady, around 300 a year. However, the total number of kW declined sharply each year. Some of this decline was probably offset by increases in small NEM and self-generated photovoltaic (PV) interconnections that were not included in this study.

6 Customers who install small solar, wind, biogas, and fuel cell generation facilities (1 MW or less) to serve all or a portion of onsite electricity needs are eligible for the state's net metering program. NEM allows customer-generators to receive a financial credit for power generated by their onsite system and fed back to the utility. The credit is used to offset the customer's electricity bill. NEM is an important element of the policy framework supporting direct customer investment in grid-tied distributed renewable energy generation, including customer-sited solar PV systems.

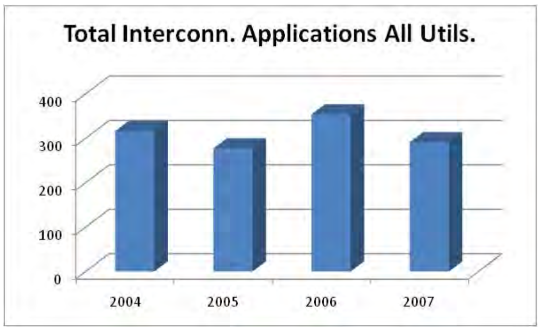

Figure 2. Total interconnection application; all utilities

Source: Reflective Energies.

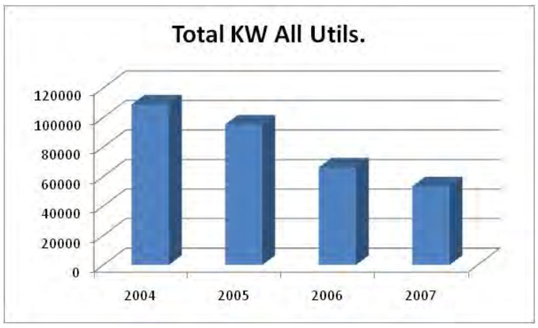

Figure 3. Total kilowatts; all utilities

Source: Reflective Energies.

The types of power plants being installed also underwent significant changes between 2003 and 2007. Internal combustion engines, micro-turbines and fuel cells, and wind declined sharply over the period, and by 2007, other than PV (which increased sharply), virtually no other power plants were being installed in California. PV systems are generally smaller than other distributed generation systems, explaining the decline in total kW being installed. If PV systems are removed from the tally, then virtually no distributed generation was being installed in California in 2007. This unintended finding is worth exploring more extensively.

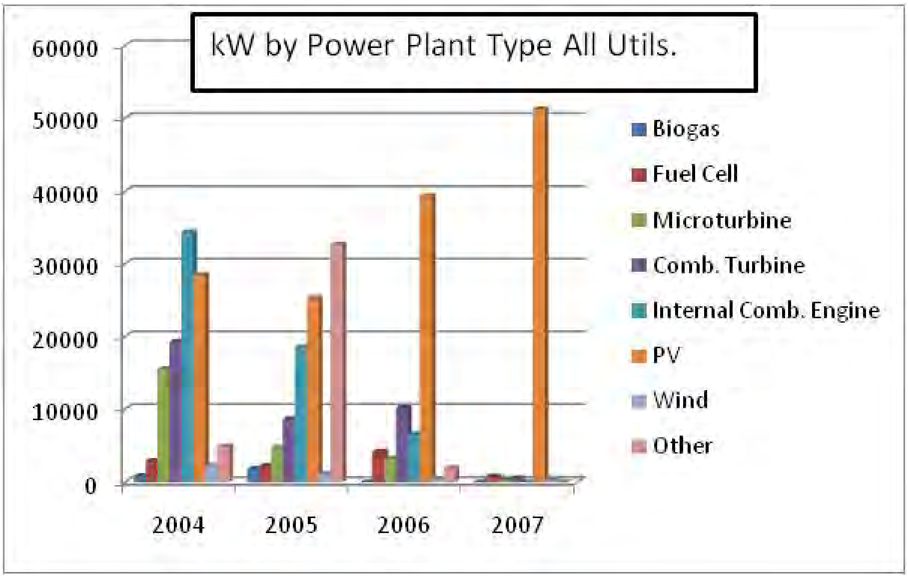

Figure 4. Kilowatt by power plant; all utilities
Source: Reflective Energies.

Requests for certification of new interconnection systems also declined over the last few years, and today the only pending request for certification is a request by Fuel Cell Energy Inc., whose global headquarters are based in Danbury, CT.

A detailed report titled *Distributed Generation Interconnection Timeliness Study: California Investor-Owned Utilities: 2004 to 2007* will be published concurrently with this report in Appendix B.

Working Group Technical Support

During the early portion of this contract, the Rule 21 Working Group met once each month. Each meeting was organized with a webcast and a detailed list of actions that were to be addressed by the working group. Issues could be brought to the group by any member by means of a short memo describing the issue. The group would discuss the issue, decide on its priority (high, medium, or low), and assign a group member to champion the issue. The champion would evaluate the issue, working with the group to assess its effects, the potential paths to resolution, and drive it to resolution. All issues were tabulated with a detailed Excel® spreadsheet that was posted on the California Energy Commission Rule 21 website.

Diverse issues were brought before the working group. Many of these were specifically related to interconnections, but several were related to tariff issues and to interpretations of several pieces of new legislation relative to solar energy, fuel cells, net energy metering, and other issues. The working group acted on interconnection issues but by mutual agreement of the members acted as a sounding board for many of the other issues.

The Rule 21 Working Group also:

- Obtained and reviewed the first-ever real data of the effects of selected commercially installed distributed generation on the grid and the effect of the grid on distributed generation by installing power quality monitors at the utility distributed generation interfaces.

- Helped to simplify and streamline the interconnection of distributed generation, improving the review process
- Helped certify systems for interconnection, assist with the integration of the national interconnection standard, IEEE 1547. The FOCUS team provided technical and logistical support to the Rule 21 Working Group.
- A cost-benefit evaluation of the efforts led by the Energy Commission to reduce the time and costs of interconnection in California.

The DG Monitoring Program

This program monitored a small sample of distributed generation systems to determine the effect of distributed generation on the grid, if any, and vice versa. It was a small sample, but it is a start. It was hoped that other similar studies will be undertaken, and the cumulative results of these studies will provide a better picture of distributed generation-grid interface behavior.

A parallel effort sponsored by the Energy Commission, known as the Distributed Utility Integration Test Program, was test, in a laboratory setting, the electrical implications of deep and diverse penetration of distributed generation into distribution systems. These two Energy Commission efforts were intended to help distributed generation stakeholders better understand the grid effect of distributed generation and lead to safer, more reliable, and more cost-effective means of interconnecting distributed generation.

It was decided to monitor the most diverse and complex systems relative to grid interaction. A set of selection criteria and a test plan were developed, reviewed by the Energy Commission and the Interconnection Rule 21 Working Group, and implemented. A total of eleven distributed generation systems monitored included one PV system, five microturbines, two fuel cell, and three IC engines, with a variety of interconnection systems from solid state to synchronous generators, spread over seven locations, two in the Bay Area and five in Southern California. Five of the interconnections are to IOUs, and one to a municipal utility. One of the systems exported small amounts of power. In addition, under construction are monitors of five more distributed generation systems (three PV and two IC engines with induction generators) at two locations.

The data gathered represent more than 230,000 cumulative hours of monitoring. Monitors were able to measure voltage fluctuations that were less than 1/15,000 of a second in duration and able to determine whether each unusual event was initiated by the grid or the distributed generation. The power quality parameters measured included voltage, frequency, waveform distortion, harmonics, flicker, and more. The results showed that for the systems being monitored, there was very little effect between the distributed generation and the grid. The power quality at all sites was far better than earlier the power quality benchmarks established by EPRI and SCE within the last decade. This does not mean that the distributed generation improved power quality. Rather, grid power quality at the points measured was better than the benchmarks, and the distributed generation did not make it better or worse. There were no instances of distributed generation affecting the grid during the entire monitoring effort. The only instance where the grid affected distributed generation was a lightning strike that damaged a fuel cell.

While the results are encouraging, the sample is small and the level of distributed generation penetration is also small. At this time, distributed generation is moving slowly into the marketplace, and the learning experience, though painful, is keeping pace with the growth and market penetration. The study is being expanded under FOCUS-III, and will seek more complex systems and a longer monitoring period. It is hoped that other studies will be undertaken to create a much larger database and higher confidence levels.

The *Distributed Generation Monitoring Report* is included as a link in Appendix A, available through the Energy Commission website.

Streamlining Interconnections in California

With support from the FOCUS team, the Energy Commission led the effort to streamline interconnections in California. The Energy Commission leadership and the desire for collaborative resolution of tough issues produced valuable results. The Rule 21 Working Group was formed, consisting of stakeholders interested in interconnection of distributed generation (utilities, regulators, distributed generation suppliers, distributed generation developers, and others). The effort was broadly divided into three areas:

- Obtain consensus among major stakeholders on the technical and administrative issues related to interconnection.
- Revise Rule 21 and its related documents: the Rule 21 text, applications, and agreements to simplify applications, review, approval, and testing of interconnection.
- Establish a process to certify systems that meet the essential requirements established for interconnection of distributed generation.

While working to achieve the above goals, the working group became a forum for stakeholders to bring in their concerns related to specific interconnections or aspects of the process that were not previously considered. Utilities streamlined their organizations to speed up interconnection handling and review processes, offered training to their own staff, and conducted seminars to educate developers on how best to go about obtaining approval for interconnection. The stakeholders talked to one another, sharing challenges and success stories. This improved dialog probably helped as much as the technical improvements.

The average time from application to interconnection dropped from an average of 300 days to an average of less than 75 days between 1998 and 2003, and continues to drop. This is happening even while distributed generation installations have been growing in number and complexity.

The FOCUS team prepared a report in early 2004 titled *Making Better Connections*. It is included as a link in Appendix A and is available through the Energy Commission website. The report evaluates these gains and the cost-effectiveness of the FOCUS effort. The cumulative value of the realized savings from streamlining interconnection in 2001 through 2003 is more than $34 million, which compares favorably to a project cost of $1,500,000.

During the time that the FOCUS work was happening, the IEEE was developing a national standard for distributed generation interconnection, IEEE 1547. To stay abreast of what was happening at the national level, the FOCUS team provided technical support to the Working Committee for IEEE 1547. IEEE 1547 was adopted but focused mainly on technical issues. Rule 21 covers many other issues, such as applications, processing, approvals, and perhaps most significantly, an analysis of the potential effect of the distributed generation on the grid. There were some differences between certain technical parameters established by Rule 21 and those subsequently adopted by IEEE 1547. The working group is evaluating the differences to make the two documents compatible.

1.0 Introduction

Distributed generation (DG) is an emerging concept that has captured the imagination of manufacturers, utilities and regulators over the last fifteen years. Several new technologies, such as solar power, wind turbines, waste fuel power plants and auxiliary generators have helped move the concept forward. Generally, DG is a power plant that is connected to the utility grid at a distribution voltage, 4 kilovolts (kV) or less. Rule 21 is the California Utility Rule that establishes the conditions and protocols under which DG may be interconnected. Rule 21 was written for large power plants that were installed in the 1980s and 1990s under standard offer contracts spawned by Public Utility Regulatory Policy Act (PURPA) regulation. Under Rule 21, the power plant owner filed an interconnection request, the utility performed a study to determine the feasibility and costs, and the interconnection generally took place at a utility substation. Almost all power plants were at least 1 megawatt (MW), and the cost and time to interconnect, while significant, were a small fraction of the overall cost of the power plant.

As photovoltaic (PV), small wind , microturbines, fuel cells and other small power systems developed, the cost and installation timeline for the power plants was much lower, and the cost to interconnect grew significantly by proportion. The cost of the utility study could be as high as the cost of the rest of the power plant.

The California Energy Commission (Energy Commission) held a Round Table conference in December 1995 to examine the value, cost-effectiveness and impediments to DG. Following the Round Table, the Energy Commission sponsored development of the California Alliance for Distributed Energy Resources (CADER), an organization that included developers, manufacturers, utilities, consultants and facilitators of DG. CADER was very active in its early years, with stakeholders aggressively pursuing their agendas in a collaborative, sometimes confrontational manner. It was generally agreed at the time that the biggest impediment to DG was the complexity and bureaucracy surrounding interconnection. The Energy Commission requested CADER to champion the simplification and streamlining of interconnections. The request was translated into action with Energy Commission PIER funding. A project called "Forging a Consensus on Utility System Interconnection" or FOCUS I was established. All stakeholders collaborated under the newly formed "Rule 21 Working Group" towards the goal under the chairmanship of the Energy Commission. Collaborative processes are slow, and in 2001 the revised Rule 21 was approved for use by all three IOUs. Unlike other Utility Rules, this Rule was identical for all three investor-owned utilities (IOUs), a proviso that was very important to manufacturers and developers tired of dealing with separate rules for each utility.

Rule 21 was a companion to the Net Energy Metering Tariff (NEM) under which utilities interconnected solar PV systems. The legislative and regulatory landscape for DG changed often between 2000 and 2007, and continues to change. NEM was expanded selectively to wind, fuel cells, dairy digesters and other systems. In some cases, NEM netting was expanded to include multiple meters, rather than a single meter. Multiple NEM systems began to be installed behind a single meter; customers renting their apartments began to install PV systems; customers began to request the right to export power; and many other such unforeseen variations cropped up. The Rule 21 Working Group became the forum for such issues, and regulators began to request that the Working Group recommend or resolve such issues through regulatory processes known as Orders Instituting Regulation.

2.0 Project Approach

The purpose of this project, FOCUS-Interconnection, was to:

- Undertake a program of monitoring, data collection and analysis, and reporting for selected DG systems chosen for diversity related to generation, grid, and customer impact concerns. The study was completed and published.
- Provide technical support for the Rule 21 Working Group to streamline interconnections to investor owned utilities (IOU) in California.
- Monitor the progress of DG interconnections following revision of Rule 21.

The FOCUS III Project undertook four separate tasks:

- Monitor selected DG systems and their grid interconnections for their impact on the grid and vice versa.
- Assess the changes in timeliness of interconnections in California following the revision of Rule 21.
- Provide technical leadership and coordinate the process for certifying DG interconnections in California, and assist in transitioning the certification process to the evolving IEEE 1547 series of standards for DG.
- Provide technical and logistical support for the Rule 21 Working Group as it addresses several new issues, including orders from California Public Utilities Commission (CPUC) proceedings.

3.0 Project Outcomes

3.1. Distributed Generation Monitoring Program

The project outcomes can be broken down into several sub-categories. The DG systems monitoring program itself was partly successful.

The data gathered represent a total of over two hundred and thirty thousand cumulative hours of monitoring. Monitors were able to measure voltage fluctuations that were less than 1/15,000th of a second in duration, and able to determine whether each unusual event was initiated by the grid or the DG. The power quality parameters measured included voltage, frequency, waveform distortion, harmonics, flicker and more. The results showed that for the systems being monitored, there was very little impact between the DG and the grid. The power quality at all sites was far better than the earlier power quality benchmarks established by Electric Power Research Institute (EPRI) and Southern California Edison (SCE) within the last decade. This does not mean that the DG improved power quality. Rather, grid power quality at the points measured was better than the benchmarks, and the DG did not make it better or worse. There were no instances of DG impacting the grid during the entire monitoring effort. The only instance where the grid impacted DG was a lightning strike that damaged a fuel cell.

While the results were encouraging, the sample was small and the level of DG penetration was also small. At the time of the study,, DG was moving slowly into the marketplace, and the learning experience, though painful, was keeping pace with the growth and market penetration. As DG projects increase, other studies will be undertaken to create a much larger database and higher confidence levels.

3.2. Timeliness of Interconnections

The changes made to Rule 21 intended to make the requirements clearer and more streamlined. This task undertook to measure whether resulting interconnections were happening more expeditiously. An earlier study showed that in the years 2000 through 2003 interconnection timeliness had improved dramatically. This update covered interconnections in the years 2004 through 2007. To keep the study manageable and useful, it was decided to include in the study all DG interconnections requested under Rule 21, and all interconnections under the NEM tariff that were for systems 30 kW or greater. Interconnections under NEM below 30 kW have become routine and generally go forward with little delay.

The average interconnection time for all utilities followed a similar pattern for all California IOUs. From 2000 through 2003 the average interconnection time dropped significantly, from almost 400 days to about 80 days. In 2004, the average interconnection time shot up to over 200 days, but has steadily declined since then, averaging only 75 days in 2007. While the reason for the anomaly in 2004 is not clear, the overall trend is consistently downwards.

The number of interconnection applications through the period 2004 through 2007 for all utilities combined stayed steady, around 300 a year. However, the total number of kW declined sharply each year. Some of this decline was probably offset by increases in small NEM and self-generation PV interconnections that were not included in this study.

3.3. Technical Leadership

The FOCUS team included several experts in power electronics, utility interconnections, and power generation. The team was closely associated with several solar and microturbine interconnections in California, and was also part of the ongoing Institute of Electrical and Electronic Engineers 1547 process for developing standards for DG interconnection. The team was instrumental in setting up in California the first ever process for certifying DG interconnection systems. Several DG interconnection systems are currently certified in California as a result.

The team also facilitated discussions between manufacturers, DG system suppliers and utilities, and one by one was able to find resolution to most of the issues that were raised by each of the stakeholders, and was able to accomplish a comprehensive overhaul of Rule 21 that was ultimately acceptable to each of the stakeholders.

3.4. Working Group Support

During the early portion of this contract, the Rule 21 Working Group met once each month. Each meeting was organized with a webcast, and a detailed list of actions that were to be addressed by the Working Group. Issues could be brought to the group by any member, by means of a short memo describing the issue. The group would discuss the issue, decide on its priority (high, medium, or low) and assign a group member to champion the issue. The champion would evaluate the issue, working with the group to assess its impact, the potential paths to resolution, and drive it to resolution. All issues were tabulated with a detailed Excel® spreadsheet that was posted on the Energy Commission Rule 21 website.

Diverse issues were brought before the Working Group. Many of these were specifically related to interconnections, but several were related to tariff issues and to interpretations of several pieces of new legislation relative to solar energy, fuel cells, Net Energy Metering and other issues. The Working Group acted on interconnection issues, but by mutual agreement of the members acted as a sounding board for many of the other issues.

The Rule 21 Working Group also:

- Participated in obtaining and reviewing the first-ever real data of the impact of selected commercially installed DG on the grid and the impact of the grid on DG by installing power quality monitors at the utility-DG interfaces.
- Helped to simplify and streamline the interconnection of DG, improve the review process.
- Helped certify systems for interconnection, assist with the integration of the national interconnection standard, IEEE 1547. The FOCUS team provided technical and logistical support to the Rule 21 Working Group.
- Completed a cost-benefit evaluation of the efforts led by the Energy Commission to reduce the time and costs of interconnection in California.

4.0 Conclusions and Recommendations

4.1. Conclusions

The FOCUS efforts did succeed in achieving major changes in the interconnections of DG in California. The process began long after the IEEE had begun its standardization process, and ended years before the IEEE standards were ready. From the 18 sites evaluated, interconnection of DG has had virtually no effect on the stability of the California electricity distribution system, a testament to the effectiveness of interconnection rules.

California now has a process to certify interconnection systems; the timeliness of interconnections continues to improve.

From 2005_to 2008, interconnection applications for fuel cells, internal combustion engines and microturbines sharply declined. While the main thrust of interconnections today is solar photovoltaic systems, there is an increasing interest and applications for interconnections by other DG developers. With this increase, new challenges have arisen in the Rule 21 interconnection process.

The Energy Commission transferred leadership of the Rule 21 Working Group process to the CPUC in 2008. The CPUC is working to determine what role it seeks for the Working Group and how to move foreword.

4.2. Commercialization Potential

This PIER project did not perform research to develop commercial technology, and there is, therefore, no commercialization potential associated with it.

4.2.1. Recommendations

Interconnection issues were perceived to be the greatest barrier to the rapid proliferation of DG. Rule 21 largely resolved many of the interconnection issues for PV, but in 2010 and the years beyond, DG resources from other technologies are expected to play a more significant role in the state’s renewable portfolio.

The proliferation of DG resources will require a new look at Rule 21 and using a facilitated Rule 21 working group is recommended. The Rule 21 Working Group was an experiment at collaboration between stakeholders who used to have a relationship that was often confrontational. The experiment was successful. After the first few months, the Working Group came together and worked to resolve issues. A key to the process was monthly meetings that enabled the group to get to know one another and come to a meeting of the minds. It was also helpful to have a group of technical facilitators whose opinions were not biased to any stakeholder and therefore credible to all parties. It is recommended that such collaborative forums be established for DG and other such multi-stakeholder issues.

4.2.2. Benefits to California

Speedier, better interconnections mean that the Project has demonstrated to provide significant benefits to California. The cost effectiveness study monetized the value to California at $15,000,000 in 2003 alone, comparing very favorably with the cost[s3] of about $750,000 incurred by the Energy Commission for the project. The benefit/cost ratio is about 20:1.

5.0 Glossary

CADER – California Alliance for Distributed Energy Resources

CPUC – California Public Utilities Commission

DG – Distributed energy

DUIT – Distributed Utility Integration Test

EPRI – Electric Power Research Institute

IEEE – Institute of Electrical and Electronic Engineers

IOU – Investor-owned utilities

NEM – Net energy metering

PCC – Point of Common Coupling

PURPA – Public Utility Regulatory Policies Act

PV – Photovoltaics

Rule 21 – Rule passed by the CPUC that defines the requirements for generating facility Interconnections

SCE – Southern California Edison

6.0 Appendices

Appendix A

Comments from SCE

SCE appreciates the effort Reflective Energies has made in analyzing data on the interconnection of distributed generation (DG) projects with the utility distribution system under the Rule 21 process. However, no conclusions should be drawn from the *DG Interconnection Timeliness Study* regarding the time required specifically by the utility to accomplish its tasks in that process, which include review, engineering, contract development and in some cases construction of special facilities to support the interconnection of the DG project.

This is because the basic metric employed in the study includes time taken by activities which are beyond the control of the utility or the regulatory process. These include the customer's DG project design, equipment procurement and installation, permitting, delays in project schedule due to changing business conditions, etc. The study does, however, provide a useful overview of the time taken to complete all aspects of the process of implementing DG projects during the years surveyed.

Comments from PG&E

PG&E has been presented with a draft report titled "DG Interconnection Timeliness Study: California IOUs: 2004 to 2007" (draft) developed by Reflective Energies as a report of the California Energy Commission. The draft was developed based on data provided by PG&E and other investor-owned utilities. As now titled and edited, this draft report is inaccurate and misleading. Key errors are:

The draft is captioned a "DG Interconnection Timelines Study," but it leaves out most net metering projects without clearly explaining that it has omitted the vast majority of DG projects.

The draft claims that Net Metering projects do not interconnect under Rule 21 (Executive Summary [ES] page 1). This is simply incorrect. Rule 21 mentions net metering literally dozens of times and sets forth a detailed process for interconnecting net metered projects.

The draft claims that the number of interconnection applications between 2004 and 2007 has "stayed steady." (ES p. 1) This is true only because the report ignores most PV projects. The number of PV projects exploded over this period. Last year, PG&E interconnected over 6,000 PV projects, more than any other utility in the US, and most took less than 10 days.

The draft states that the average time to interconnect on PG&E's system was 250 days in 2004 and 120 days in 2007 (ES p. 10, Figure 13). This suggests that generators were waiting for four to eight months for PG&E, unable to generate power while waiting for the utility. In fact, frequently, during much of this time, the generator had not submitted a completed interconnection application, had not completed installation of its generation equipment, and had not obtained building permits. The report will be misleading unless this is explained up front.

Regarding the specific findings in the draft, PG&E has the following comments.

PG&E supports the objective of determining the status of DG interconnection timeliness (cycle time) for the period between 2004 thru 2007. Reflective Energies conducted conference calls in 2008 and invited PG&E, and other investor-owned utilities to participate.

Reflective Energies presented PG&E with a number of graphs and tables and asked us to respond. PG&E expressed deep concerns regarding all of the graphs in the draft interconnection report. In particular, we expressed concerns with how the data was compiled as a number of the supporting graphs we were asked to review do not appear to have been represented in the report itself.

PG&E believes erroneous conclusions may be drawn from the report based on the level of data collected and more importantly with the omissions in data that should be included in the calculation of interconnection cycle time. Major aspects of interconnection cycle time were neither considered nor mentioned, including factors associated with customer-generator contributions to cycle time (i.e. incomplete application, project design changes, construction delays, customer service oriented utility practices, etc). Without a comprehensive inclusion of all aspects that contribute to DG interconnection projects cycle time it is extremely difficult to draw definitive conclusions as to the contributors to delays in project cycle time.

If you add the utility responses as an appendix to the final report, you need to also add to the executive summary the fact of and where the utility responses can be found. The Executive Summary should also mention of the primary concerns of the California investor owned utilities (IOU) as previously expressed during a number of conference calls on the subject and in these comments.

Within the executive summary the table entitled "Average Interconn. Time: All Utils" (ES p. 1) the results for 2004 are described as an anomaly. PG&E would challenge the assertion of 2004 as being an anomaly and would suggest the results may be due to discrepancies between the data collected for this study (i.e. 2004 to 2007) and the previous study (i.e. 2000 to 2003).

PG&E takes issue with all tables and graphs that are based on the data element of "Date Application Received." The initial application receipt date is extremely misleading in determining interconnection cycle time for a number of reasons. For example, in a majority of cases the application package from the customer-developer-integrator is incomplete (i.e., missing drawings, fees, etc.). The utility practice is to accept an incomplete application, acknowledge receipt back to the customer and communicate which elements are needed so our initial engineering review can begin. For expediency, consistency, and to optimize utility resources, PG&E requires a minimum amount of information before the technical aspects of the process begins. Allowing the customer-developer to submit incomplete applications is a utility practice that benefits our customers. Once received, our project manager, acting as the utility single point of contact, works with the applicant to further define the project milestones. As a suggestion, PG&E offers that a more accurate measure of cycle time is the number of days from the date the application package is deemed complete per Rule 21 to the date the generator is authorized for parallel operation. Although previously recommended, this was not incorporated into the study.

In the case of PG&E, the report omits PG&E's Average Days from Date Application Completed (i.e. Deemed Complete) to Authorized Interconnection Date. Although the data was provided by PG&E and recommended for inclusion in the report, it was omitted.

There is insufficient attention in the report given to outliers that would certainly skew the conclusions that may be drawn. PG&E's review of the outliers suggests they are primarily customer oriented and increase average interconnection cycle time from 50 to 100 days. As such, the data associated with those projects could be depicted differently or omitted as irrelevant.

PG&E supports the overall calculation of interconnection cycle times but suggests that any measure include all activities, both utility- and customer-developer oriented.

To reiterate, PG&E supports the objective to identify the interconnection cycle time for the period 2004-2007. PG&E recommends revising the report as described above, and continuing to work through the issues with stakeholders, as well as through the Rule 21 Working Group expected to be reinstated by the CPUC. We look forward to a more valuable report for regulatory policy makers.

Best Personal Regards,

Fred Skillman, Jr.

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Appendix B

Prabhu, Edan and Prabhu, Carol. 2010. *Distributed Generation Interconnection Timeliness Study: California IOUs: 2004 to 2007.* California Energy Commission, PIER Energy Systems Integration Program Area. CEC-500-2010-030