California Electric Rule 21 Interconnection of Distributed Resources on Secondary Network Distribution Systems

Developed by:
California Energy Commission
Rule 21 Working Group

california Distributed Energy Resource guide

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1. Introduction

Under California PUC OII XXX, the California Energy Commission was asked to review issues related to the interconnection of Distributed Resources (DR) to Secondary Network Distribution Systems to determine what changes might be facilitated in Rule 21, what guidance might be offered for Supplemental Review, and what additional data/information would be useful in establishing concrete requirements. In response the CPUC request, the Rule 21 Working Group developed a Network Interconnection Workplan, shown in Annex A. This report describes the information obtained and the conclusions reached by the Energy Commission's Rule 21 Workgroup following that workplan.

2. Background

A general description of secondary networks, including definitions, basic design and equipment, and a preliminary list of issues related to DR interconnection is provided in the DUIT report *Network Distribution Systems Background And Issues Related To The Interconnection Of Distributed Resources* attached as Annex B.

Most network systems are old; the last California Grid Secondary Network was installed in the 1970s. PG&E and SMUD have both added to their Networks, but only as Spots. Very little documentation on existing networks/design criteria. Much reverse engineering is going on to understand what you got.

Rather than installing new Grid Secondary Networks, reliability in new or expanding urban areas is more commonly provided using a system of multiple utility sources (feeders) with manual or automatic transfer switches. This system does not employ any Network style relaying and doesn't present any special DG interconnection issues.

3. Definitions

The following definitions were derived from those in the DUIT Network Report (Annex B).

Consistent definitions are critical to understanding and communicating the design and operation of Secondary Network Distribution Systems. Alternate definitions for some of the following terms may be found in different regions. These definitions represent, by consensus, the most common usage.

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Cable Limiter: An enclosed fuse for disconnecting a faulted cable in a Secondary Network Distribution System and for protecting the un-faulted portion of that cable against serious thermal damage.

Cycling: Undesirable cyclical tripping and closing of a Network Protector due to external (load) conditions. Left unchecked, Cycling may eventually lead to failure of the Network Protector. (Contrast with "Pumping").

Grid Network: A Secondary Network System with geographically separated Network Units, with the Network-side terminals of the Network Protectors interconnected by low-voltage cables that span the distance between sites. The low-voltage cable circuits of the Grid Network are typically highly meshed, supplied by numerous Network Units. Also referred to as Area Network or Street Network.

Network Master Relay: An electro-mechanical polyphase relay with two functions: 1) opening of the Network Protector when power flow is from the low voltage side to the high voltage side of the Network Transformer; and 2) closing of the Network Protector in conjunction with the electro-mechanical Network-phasing relay when transformer voltage is higher than Network voltage and leads the Network in phase angle.

Network Protector: An assembly comprising a circuit breaker and its complete control equipment for automatically disconnecting a transformer from a Secondary Network Distribution System in response to predetermined electrical conditions on the primary feeder or transformer. The device will also connect a transformer to a Secondary Network Distribution System either through manual control or automatic control responsive to predetermined electrical conditions on the feeder and the Secondary Network Distribution System. NOTE—The Network Protector is usually arranged to automatically connect its associated transformer to the Secondary Network Distribution System when conditions are such that the transformer, when connected, will supply power to the Secondary Network Distribution System and to automatically disconnect the transformer from the Network when power flows from the Secondary Network Distribution System to the transformer. [from IEEE C57.12.44-2000]

Network Protector Fuse: A backup protective device in series with the Network Protector.

Network System: A collection of Spot Networks, Grid Networks, or combinations of such Networks and the primary feeders that supply them.

Network Transformer: A transformer designed for use in a vault to feed a variable capacity system of interconnected secondaries. Note: A Network Transformer may be of the submersible or of the vault type. It usually, but not always, has provision for attaching a Network Protector. (From IEEE C57.12.80-1978). Dry type transformers are also used for Spot Network applications.

Network Unit: A Network Unit consists of primary disconnect and grounding switch, Network Transformer, and Network Protector.

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Primary Network Feeder: A feeder, radial in nature, that supplies energy to a Secondary Network Distribution transformers or the combination of a Secondary Network Distribution transformers and other radial loads. (Dedicated Primary Network Feeders supply only Network Transformers for the Grid or Spot Networks; non-dedicated, or combination, feeders supply both Network and radial loads). (not to be confused with a primary network)

Pumping: Rapid, uncontrolled, unintentional, and intolerable repetitive tripping and closing of a Network Protector, normally due to a failure in the Network Protector control circuitry. If not promptly detected and corrected, Pumping will quickly lead to failure of the Network Protector. (Contrast with "Cycling").

Secondary Network Distribution System (or "Network"): An AC power distribution system in which customers are served from three-phase four-wire low-voltage circuits supplied by two or more Network Transformers (and at least two primary Network Feeders) whose low-voltage terminals are connected to the low-voltage circuits through Network Units. The Secondary Network Distribution System has two or more high-voltage primary feeders, with each primary feeder typically supplying between 1 and 30 Network Transformers, depending upon Network size and design. The system includes protective devices designed to isolate faulted primary feeders, Network Transformers, or low-voltage cable sections while maintaining service to the customers served from the low-voltage circuits. Unless otherwise stated, in this document the term "Network" means the Secondary Network Distribution System.

Spot Network: A Secondary Network Distribution System consisting of two or more Network Units at a single site where each unit is connected to a separate primary feeder. The low-voltage Network side terminals of these Network Units are connected together with bus and/or cable, with the resultant interconnection structure commonly referred to as the paralleling bus or collector bus. In Spot Networks, the paralleling (collector) bus typically does not have any low-voltage ties to any adjacent or nearby Networks. Such Spot Networks are sometimes called isolated Spot Networks, to differentiate them from Spot Networks with Reach (see below).

Spot Network with Reach: A Spot Network with secondary voltage cable connections to one or more neighboring Spot Networks or to a nearby Grid Network. These reach connections are usually of a capacity limited to the rating of one of the Network Units supplying either Spot Network.

Underground Connector: Underground connectors located in manholes and transformer vaults that provide for multiple connections at a single junction point.

4. California Status

This section describes the Secondary Network Distribution Systems in California and the known Generating Facilities located within those networks.

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4.1. Spot and Grid Secondary Network Distribution Systems in California

Within California, approximately 22,500 customers (almost 0.2%of the State's 13.5M customers), representing 1.1%of the State's peak load, are served by secondary networks, either grid or spot. The following sections provide some of the details of secondary networks by utility.

4.1.1 Pacific Gas and Electric (PG&E)

PG&E has Network Systems located in each of the two major Northern California metropolitan areas in their service territory: San Francisco and Oakland.

4.1.1.1. San Francisco Network Distribution System

The Network Distribution System in San Francisco consist of eight 12 kV groups and two 34.5 kV groups. Each 12 kV group serves a specific geographic portion of the downtown area while the two 34.5 kV groups have no fixed boundaries. There are 4 substations that supply the network groups.

PG&E uses two types of secondary network systems. The Grid Network consists of an interconnected grid of low voltage cables that are energized from multiple primary feeder circuits utilizing 12 kV to 120/208 Volt step-down transformers. The Spot Network consists of 2 or more 277/480 Volt stepdown transformers where the secondaries are connected together. The primaries of each transformer in a Spot Network are supplied from separate feeders. A Spot Network serves only one, large customer.

Each of the eight 12 kV network groups consists of a low voltage, secondary grid and Spot Networks. The 10 secondary grids range in size from 11 square blocks to 46 square blocks. The two 34.5 kV groups consist of only Spot Networks.

By using multiple or redundant facilities, this type of electrical system provides extremely reliable service continuity and is utilized to serve the high density, commercial downtown metropolitan area of San Francisco. Types of customers include high-rise office buildings, data processing centers, major telecommunications centers for the SF Bay Area, large retail stores, plus a number of residential buildings. The majority of the load in the network is made up of only 400 to 500 high density commercial and retail customers.

In support of the network distribution system, the 4 substations are also design with multiple transformer banks and transmission feeds or supplied by multiple substation-to-substation intertie cables. All network feeders in a particular group are supplied from a common bus.

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GENERAL STATISTICS:

Area Served: 1.2 sq. miles (total S.F. area is 45 sq mi)
Historic Peak Load: 420 MVA

Network Groups: 10
Network Feeders: 57
Transformers: ~ 1100 (49% grid & 51% spot units)
Number of Vaults: ~ 650

Total Customers: 17,420
Domestic: 12,670
Commercial: 4,750

4.1.1.2. Oakland Network System Description

The Oakland Network service area covers approximately 1 square mile in the downtown Oakland area. The Network Distribution System in Oakland consists of two 12 kV groups of circuits. There are 2 substations that supply the network groups. Each of the two 12 kV network groups consists of a low voltage, secondary grid and Spot Networks.

PG&E utilizes two types of secondary network systems. The Grid Network system consists of an interconnected grid of low voltage cables that are energized from multiple primary feeder circuits utilizing 12 kV to 120/208 Volt step-down transformers. The Spot Network consists of 2 or more 277/480 Volt step-down transformers where the secondary sides are connected together as a common bus. The primary side of each transformer in a Spot Network is also supplied from separate feeders. A Spot Network usually serves one large customer or high rise building only.

By utilizing multiple or redundant facilities, this type of electrical system provides extremely reliable service continuity and is utilized to serve the high density, commercial downtown metropolitan area of Oakland. Types of customers include high rise office buildings, data processing centers, retail stores, large residential buildings and major telecommunication centers for the East Bay area. In support of the network distribution system, the two substations are also designed with multiple transformer banks and transmission feeds. All network feeders in a particular group are supplied from a common bus at the substation to achieve ultimate reliability.

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GENERAL STATISTICS:

- Area Served: 1 sq. mile
- Historic Peak Load: 82 MVA
- Network Groups: 2
- Network Feeders: 12
- Transformers: 212
- Number of Vaults: 110
- Total Customers: 1400

4.1.2 Southern California Edison (SCE)

SCE has a single Network System in the downtown area of the City of Long Beach

4.1.2.1. Long Beach Network System Description

Boundaries

The Network service area encompasses the urban downtown area of the City of Long Beach. The service boundaries of this 80 square blocks system are from Seaside Way North to 7th, and from Daisy East to Alamitos. Notable landmarks within the Network service boundary include Lincoln Park and Long Beach Plaza.

Design

The Network area is served from multiple substation transformers. Service continuity at the customer level can be maintained for a number of outage situations, including individual service transformers failures, feeder failures or even substation transformer failures. Furthermore, an additional layer of redundancy can be found for a small majority of Network customers. This additional layer is the Secondary Grid system, which ties entire vaults together in parallel at the secondary service voltage level. This added layer allows the removal of one or more entire vaults from service without any service interruptions to those customers that are connected to the Secondary Grid system. There are about a dozen Secondary Grid systems, served from seven primary feeders.

Statistics

Peak Load (MVA):	44	Total Customer Meters:	1,100
Number of Primary Networks:	1	Number of Primary Feeders:	7
Number of Secondary Grids:	12	Number of Grid Vaults:	44
Number of Spot Vaults:	8	Number of Grid Transformers:	110
Number of Spot Transformers:	20		

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Loading

The Network system is comprised predominately of high-density commercial and retail type customers.

4.1.3 San Diego Gas and Electric

San Diego Gas and Electric Company has no Grid or Spot Network systems.

4.1.4 Sacramento Municipal Utility District (SMUD)

SMUD's Network System is in downtown Sacramento

4.1.4.1. Sacramento Network System Description

Boundaries

The Network service area encompasses approximately 580 acres in the heart of the Sacramento metropolitan downtown area. The service boundaries of this 120 square blocks system are from the Sacramento River to the west, east through 21st Street, and from Q Street north to F Street. Notable landmarks within or adjacent to the Network service boundary include the California State Capital Building, Sacramento River and Old Sacramento.

Design

The Network area is served from multiple substation transformers. Service continuity at the customer level can be maintained for a number of outage situations, including individual service transformers failures, feeder failures or even substation transformer failures. Furthermore, an additional layer of redundancy can be found for a small majority of Network customers. This additional layer is the Secondary Grid system, which ties entire vaults together in parallel at the secondary service voltage level. This added layer allows the removal of one or more entire vaults from service without any service interruptions to those customers that are connected to the secondary grid system. There are a total of 10 distinct Secondary Grid systems, five from each substation.

Statistics

Peak Load (MW):	81	Total Customer Meters:	2,549
Number of Primary Networks:	5	Number of Primary Feeders:	30
Number of Secondary Grids:	10	Number of Grid Vaults:	50
Number of Spot Vaults:	114	Number of Grid Transformers:	113
Number of Spot Transformers:	309		

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While typical Secondary Grids are composed of two to four vaults with 6-8 transformers (500 kVA or 750kVA), SMUD's largest Secondary Grid employs 21 vaults with 48 transformers. SMUD's Spot vaults range in size between 2-500 kVA to 5-1000kVA transformers each.

Loading

The Network system is comprised predominately of high-density commercial and retail type customers who account for well over 90% of the total Network load. This is reflected in the daily load profiles of the Network, with peak usage occurring between the hours of 10 AM and 4 PM with a very sharp load drop off after 5 PM. Load steadily increases at around 7 AM until it reaches an apex at around 2 PM. Load then dramatically drops off around 5 PM, typical of business hours. The loading differences between weekends and weekdays are fairly dramatic, upwards of 50% in peak loading differences. Again, this is consistent with the type of load seen throughout the Network.

4.1.5 Los Angeles Department of Water and Power

The Los Angeles Department of Water and Power has no Grid or Spot Network systems.

4.1.6 Other California Utilities

There are no other Spot or Grid Network systems in California.

4.1.7 Summary of California's Secondary Networks

	MVA Total	MVA Spot	MVA Grid	Network Systems	Feeders	Vaults	Xformers	Customers
PG&E - San Francisco	420	214	206	10	57	650	1,100	17,420
PG&E - Oakland	82	42	40	2	12	110	212	1,400
SCE – Long Beach	44	20	24	1	7	52	130	1,100
SMUD - Sacramento	81	51	30	5	30	164	422	2,549
Totals	**627**	**327**	**300**	**18**	**106**	**976**	**1,804**	**22,469**

Statewide Demand in 2005	57,500	Statewide Demand Served by Networks = **1.1%**	Statewide Customers Served by Networks = **.17%**	13,500,000

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Network Systems – Systems or groupings of primary feeders serving Network loads

4.2. Distributed Resources Interconnected to Secondary Network Distribution Systems in California

Building	City	Utility	Network Type	Date Operational	Size [kW]	Generator Type	Prime Mover
Moscone Convention Center	San Francisco	PG&E	4 kV Spot Network	Mar-04	675	Inverter	PV
Elihu M. Harris Building	Oakland	PG&E	277/480 Spot Network	2002	600	Synchronous	IC Engine
199 Fremont St	San Francisco	PG&E	277/480 Spot Network	Nov-03	800	Synchronous	IC Engine
595 Market St	San Francisco	PG&E	277/480 Spot Network	Apr-04	1030	Synchronous	IC Engine
Bechtel Headquarters	San Francisco	PG&E	277/480 Spot Network	Nov-03	1200	Synchronous	IC Engine
One Market Plaza	San Francisco	PG&E	277/480 Spot Network	1Q 2003	1500	Synchronous	IC Engine
EBMUD	Oakland	PG&E	277/480 Spot Network	May-03	600	Inverter	Micro Turbines
201 Mission	San Francisco	PG&E	277/480 Spot Network	Jun-05	750	Synchronous	IC Engine
Ritz-Carlton	San Francisco	PG&E	277/480 Spot Network	Dec-05	240	Synchronous	Micro Turbines

5. Other Network Interconnection Activities

5.1. Other Projects and Sources of Information

There are a number of state and regional activities that are in the process of discussing and developing experience, data, and requirements related to Secondary Network Interconnection. The Rule 21 workgroup has been coordinating with all of the following activities, with in most cases two or three individuals from Rule 21 participating.

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5.1.1 Distributed Utility Integration Test (DUIT)

The DUIT project, run by Distributed Utility Associates is investigating the interaction of DR and the utility distribution system. An upcoming activity will be to review DR on Networks. To that end, DUIT has developed the report, attached in Annex B, to provide a basic discussion of Secondary Network design theory and begin enumerating the possible issues that need to be considered when connecting DR to Secondary Networks. More information on the DUIT project can be found at www.dua1.com/DUIT.

5.1.2 Massachusetts DG Collaborative (MDGC)

The general MDGC site is
www.masstech.org/renewableenergy/public_policy/DG/collab_overview.htm

It has some great resources in a number of areas beyond network interconnection--take a look, for example at the list of documents related to DG value on the Distribution Planning Workgroup page. Network-specific info is at:
www.masstech.org/renewableenergy/public_policy/DG/resources/network.htm

The 2005 annual report, which summarizes their 2005 activities, including networks (in Chapter 2), is at:
www.masstech.org/renewableenergy/public_policy/DG/2005_annualreport.htm.

MDGC has been hosting monthly coordination conference calls involving state energy agency personnel (primarily) and others from Massachusetts, California, New York, New Jersey

The following table lists some known DR installed on Secondary Networks in other states (from Massachusetts DG Collaborative)

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Building	City	State	Utility	Network Type	Date Operational	Size [kW]	Generator Type	Prime Mover
Dormitory Authority Headquarters	Albany	NY	NiMo	Secondary Spot Network	Dec-01, Feb-04	15	Inverter	PEM Fuel cell
Conde Nast Building	New York City	NY	ConEd	Secondary Spot	Feb-00	20	Inverter	PV
Coast Guard Building (Williams Bldg)	Boston	MA	NSTAR	Secondary Spot Network	Phase 1 Oct. '99	30	Inverter	PV
Conde Nast Building	New York City	NY	ConEd	Secondary Spot	Feb-00	400	Inverter	Fuel Cell
Coast Guard Building (Williams Bldg)	Boston	MA	NSTAR	Secondary Spot Network	Phase 2 Aug. '02	70	Induction	IC engine
Museum of Science and Industry	Chicago	IL	ComEd	12.5 kV Spot Network	Jan-03	1750	Synchronous	IC Engine
Peak Shaving/Load Control	Detroit	MI	DTE	4 kV Spot Network	operational	> 1000	Synchronous	IC Engine
Data Processing Centers	Dallas/Fort Worth	TX	Oncor	Secondary Spot Network	operational	> 5000	Synchronous	IC Engine

5.1.3 IEEE standards

IEEE Std 1547-2003 *Standard for Interconnecting Distributed Resources with Electric Power Systems*, includes brief language regarding minimum requirements for interconnecting DR to Spot Networks. Grid Networks were left for future development.

A new project, IEEE P1547.6, *Draft Recommended Practice For Interconnecting Distributed Resources With Electric Power Systems Distribution Secondary Networks*, was recently started to further develop requirements for Secondary Network Interconnection. Summary information is available at http://grouper.ieee.org/groups/scc21/1547.6/1547.6_index.html

5.1.4 EPRI White Paper

An EPRI White Paper entitled "Interconnection of Distributed Energy Resources in Secondary Distribution Network Systems" has been published and is available at www.epri.com under report number 1012922 (www.epriweb.com/public/000000000001012922.pdf).

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5.2. Existing Network Interconnection Requirements

For any new Generating Facilities to be interconnected to the PG&E's Secondary Spot Network System, PG&E requires customers to follow the requirements as described in *Secondary Spot Network System Requirements For Distributed Generation Interconnection* (PG&E's Bulletin 2004 PGM-10). This is to provide safe and reliable operation for both PG&E and customers. PG&E is developing requirements for Grid Networks (see Section 8.1.2).

Several state and regional organizations and utilities have developed requirements for Network Interconnection, including those listed in the following:

Document	Location
New York Standardized Interconnection Requirements	www.dps.state.ny.us/distgen.htm
Con Ed's interconnection web page has some network-specific information:	http://m020-w5.coned.com/dg/default.asp
Texas interconnection manual and interconnection rules 25.211 and 25.212 In particular, see paragraph h in 25.211	www.puc.state.tx.us/electric/projects/21965/21965.cfm
New Jersey's Net Metering and Interconnection Standards for Class I Renewable Energy Systems as defined in N.J.A.C.. 14:4-9	www.bpu.state.nj.us/wwwroot/secretary/NetMeteringInterconnectionRules.pdf
Mid Atlantic Distributed Resources Initiative (MADRI) and PJM's model	www.pjm.com/committees/working-groups/sgiwg/downloads/20050524-item-3-madri-interconnect-proc.pdf.

A valuable resource for interconnection information across the US, though not necessarily Network-related, is the Database for State Incentives for Renewable Energy (www.dsireusa.org/). While it does primarily address incentive programs for renewables, it also lists and provides links to interconnection requirements, state by state.

6. Issues Related to Network Interconnection

See "Vaziri Issues List.doc"

7. Costs Associated with Network Interconnection

The costs given in this section are meant to be representative of the costs one might encounter when trying to interconnect DER into a distribution secondary spot network such as exists on PG&E's distribution system and should not be taken as the actual costs

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that will be incurred. In addition, the representative costs provided below are associated with interconnecting DER into a spot network only and as such, would not pertain to interconnecting DER into a grid network. Moreover, these costs are based on averaged data received from several sources including PG&E, the San Francisco Public Utilities Commission, PowerLight Corporation and DG Energy Solutions LLC. In arriving at these costs, it should be noted that the installations reviewed to date did not require replacing or changing out the existing network protectors which if required, would only increase the DER installation costs given below. However, with the above stated qualifiers and conditions in mind, representative DER interconnection costs were deduced from data received to date from several DER installations varying in size from 400 to 1200 kW on PG&E's spot network distribution system. This review yielded the two basic cost categories which follow:

1. Special Facilities Charges
2. Taxes and Cost of Ownership Charges

7.1. Special Facilities Charge

DER installation costs are specific to the number of network protectors and relays that need replacement, and include the installed cost of a programmable controller. At PG&E, it has been determined that a programmable controller is needed to monitor network protector status so that if required, it can trip the DER system when the number of closed network protectors falls below 50% of the installed network protectors.

The range in cost per installed programmable controller has been approximately $23,000- $35,000/controller, depending on location, underground vault, etc. with historical data based on one new controller required per site.

The range in cost per installed relay replacement has been approximately $7,000-$12,000/relay with historical data based on 3 to 9 relays per site.

7.2. Taxes and Cost of Ownership Charge

As applicable, taxes are applied to the special facilities cost. In addition, there is a monthly cost of ownership charge that, if desired, can be present-worthed to develop an equivalent one-time charge (in lieu of the monthly cost of ownership charge). Depending on the application, the total of such charges in this category could be up to 93% of the Special Facilities Charge.

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7.3. Example Totals

Based on the above data and assumptions, two examples of costs to interconnect DER into a secondary distribution spot network are given below.

1. Lower-End Cost Example to Connect DER into a Spot Network – Assume that no network protectors have to be replaced and that the installed cost of a programmable controller is $30,000 and that 3 relay replacements are required at $10,000 each. The Special Facilities Charge would then be $60,000. Assuming a 90% factor of the Special Facilities Charge to account for the Taxes and Cost of Ownership Charges, $54,000 would be added to $60,000 for a total one time interconnection cost of $114,000.

2. Higher-End Cost Example to Connect DER into a Spot Network - Again assume no network protectors have to be replaced and that the installed cost of a programmable controller is $30,000 and that 7 relay replacements are required at $10,000 each. The Special Facilities Charge would be $100,000. Assuming a 90% factor of the Special Facilities Charge to account for the Taxes and Cost of Ownership Charges, $90,000 would be added to $100,000 for a total one time interconnection cost of $190,000.

Using the above methodology and extrapolating from these examples, it is estimated that the total cost to interconnect DER into a typical spot network distribution system would range from $100,000 - $200,000 per site. If only the Special Facilities Charges are considered, then the cost would range from approximately $50,000 to $100,000 per site. Finally, it should be noted that future costs to interconnect DER into spot network distribution systems could vary depending on unique field conditions encountered and new requirements that may be imposed.

8. Workgroup Recommendations

8.1. Suggested Changes to Rule 21

8.1.1 Proposed Initial Review Process Screen for Spot Networks

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8.1.2 Proposed Initial Review Process Screen for Grid Networks

The following set of draft criteria is proposed for use as a Rule 21 IRP screen for Grid Networks.

Background:

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Currently, neither the IEEE 1547 standard nor the CPUC Rule 21 has any guideline or criteria for interconnection of any type of generation units to the Secondary Grid (Area) Network System. IEEE has recently announced formation of a new technical subcommittee (IEEE 1547.6) to address the interconnection issues. Also, the Department Of Energy (DOE) and the California Energy Commission (CEC) have jointly funded a research project called Distributed Utility Interconnection Testing - Phase 2 (DUIT – phase II) to determine the concerns and perform relevant tests in the interest of setting guidelines in this area.

Interim Criteria:
On an interim basis, PG&E has developed criteria for interconnection of a small level of inverter based customer generation to its Secondary Grid Network System. Because the maximum level of generation that could be interconnected to the Secondary Grid Network System is unknown at this time, this "Trailblazer" effort should be viewed as a trial basis only, and PG&E reserves the right to suspend it at any time. PG&E has initiated the Trailblazer effort in a proactive attempt aligned with the State of California's Energy Action Plan.

Error tolerance levels are typically within 5%. Therefore, PG&E determined for this Trailblazer effort only, the aggregate generation a levels below 2% of the verifiable minimum load would be an acceptable starting point at Grid Network. This is less than half of the typical tolerance level and therefore should not compromise the safety, reliability and operation of the Secondary Grid Network System for our customers.

PG&E expects to replace the Trailblazer criteria when either the IEEE 1547 or CPUC Rule21 standards are updated to include guidelines for interconnection to the Secondary Grid Network System.

The Trailblazer criteria require that the generation meets all of the following conditions simultaneously:
1 –Proposed GF must be 11 kVA or less.
2 – Units must be "Certified" Inverter-based as prescribed by CPUC Rule 21.
3 – GF's over 1kW must be less than or equal to 50% of the interconnecting customer's estimated minimum load during the operation of the inverter.
4 – The aggregate of all interconnected units to an individual grid must be below 2% of that Grid's estimated minimum load.

Notes:

a) Condition 4 above sets an upper bound on the total capacity of generation that maybe received for a particular secondary grid. Once, this capacity has been exhausted, further interconnection applications to that grid will be denied until appropriate guidelines are added to IEEE 1547 or CPUC Rule 21.

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b) The PV units meeting the above criteria will be interconnected without any additional requirement or metering.
c) PG&E will reserve the right to suspend, change, modify, or add to the above conditions based on the results from future test reports or guidelines as they become available.
d) For PV, the minimum load refers to the Day Time minimum.

8.2. Suggested Changes to Supplemental Review Guideline

What issues do we know need to be addressed?

8.3. Topics and Issues Needing Additional Information or Testing

The following issues have been suggested as topics that could be tested to provide

- Minimum load necessary to allow NP's to reclose (Moh Vaziri)

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Annexes

Annex A Rule 21 Workgroup Interconnection Rules for Secondary Network Systems

1 Introduction

The requirements for interconnecting generating facilities to secondary network systems are different than those for interconnections to radial systems. In the secondary network system, there are technical requirements to be considered particularly with the design and operational aspects of network protectors that are not required on radial system. In California, the major secondary network systems are located mainly in the metropolitan areas of San Francisco, Oakland, and Sacramento. Several generating facility projects have been interconnected to various secondary network systems over the past few years. Due to lack of technical information and clear guidelines, there have been issues with some of these interconnections. By the current screening process in Rule 21, applications for interconnection to secondary networked systems are advanced to the "supplemental review" stage. Due to the complexities and varieties of protective schemes used in the networked systems, most of these interconnections require a detailed study. Without suitable guidelines, utility companies will have to study each project and establish requirements on a case by case basis to allow a safe and reliable interconnection of these generating facilities to their secondary network system.

There has been an interest from the California Energy Commission's Integrated Energy Policy Report committee and other stakeholders to determine if any simple and uniform rules for interconnection of DG to networked systems maybe added to Rule 21 (or to the Supplemental Review Guideline). Similar interconnection issues and the need for guidelines have also been identified in other part of United State. Some of the on-going efforts by other utilities and engineering groups addressing and working on this issue are as follows:

- ✓ Massachusetts Technical Collaborative Working group is developing network requirements for that state's DG interconnection rules.
- ✓ California Energy Commission in collaboration with DOE has initated the development of a testing program to study network interconnnections. Testing will conducted by the Distributed Utility Associates in California as Phase 2 of the Distributed Utility Integration Test (DUIT) project.
- ✓ PG&E Draft requirements
- ✓ Expand the status of these items

2 Work Plan Outline

Rule 21 technical working group has developed the following plan outline for this purpose.

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2.1 Basic Objectives:

- Define the issues
- Determine general requirements (i.e., Rule 21 Section D)
- Determine requirements for simplified interconnection (i.e., Rule 21 Section I)
- Develop Supplemental Review pathways.

2.2 Tasks:

1. Develop definitions, characteristics, and design philosophies for different types of networks to provide a common basis of understanding
   - DUIT report
   - MDGC Report
2. Identify network systems in CA
   - Location
   - Physical characteristics
3. Identify the stakeholders nationwide who may be able to provide information
   - Utilities with network systems
   - DG suppliers
   - Customers on network systems who may be interested in DG
   - Regulators
   - Network equipment providers and other experts
4. Identify and Investigate other Projects and sources of documentation
   - DUIT Network meeting and Network-related testing
   - Massachusetts DG Collaborative
   - PG&E white paper
   - IEEE 1547.6 (PAR to be submitted)
   - Manufacturer data sheets/white papers
   - FOCUS Field monitoring study
   - EPRI Study (?)
5. Identify and investigate the availability of other Rules and requirements
6. Identify and investigate existing DR on networks
7. Identify problems and solutions
   - Experience from utilities
   - Experience from system integrators
8. Investigate costs
   - Protection Schemes
   - Protector rework

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Annex B__DUIT Report on Networks