FINAL REPORT

Model Utility Interconnection, Tariff and Contract Provisions for DG

Project Team:
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June 1999

June 28, 1999

Ms. Deborah Stephens
Subcommittee Representative
NARUC
1100 Pennsylvania Avenue N.W., Suite 603
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Dear Ms. Stephens:

Subject: **Model Utility Interconnection,**
Tariff and Contract Provision for DG

R. W. Beck and Distributed Utilities Associates have completed our report on model provisions for interconnection of distributed generation (DG). The focus of our efforts was to focus on the application of DG in the traditional vertically-integrated utility. The approach used was to gather and modify standard or contract language from existing or developing sources.

Section 1 of the report discusses the background and proposed role for the model provisions. Section 2 covers our proposed provisions for technical interconnection of DG. Section 3 covers non-technical provisions and contract processes, Section 4 covers policy and related provisions and Section 5 is a summary and discussion of potential next steps.

We greatly appreciate the opportunity to assist NARUC in this important effort.

Sincerely,

R. W. BECK

Lynn R. Coles
Senior Director

LRC:mal
Attachment

NARUC

MODEL UTILITY INTERCONNECTION, TARIFF AND CONTRACT PROVISIONS FOR DG

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This report has been prepared for the use of the client for the specific purposes identified in the report. The conclusions, observations and recommendations contained herein attributed to R. W. Beck, Inc., ("R. W. Beck") constitute the opinions of R. W. Beck. To the extent that statements, information and opinions provided by the client or others have been used in the preparation of this report, R. W. Beck has relied upon the same to be accurate, and for which no assurances

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EXECUTIVE SUMMARY

As distributed generation technologies advance, existing utility and regulatory processes defining interconnection requirements are often too restrictive to allow the capture of distributed generation (DG) benefits. DG benefits have been widely discussed in the literature and range from better customer reliability, better distribution asset utilization, relief from constrained transmission, environmental benefits and others. If interconnection requirements are overly restrictive, these benefits will not be achieved to their potential. As such, interconnection standards and guidelines are evolving and being addressed from technical, procedural and policy points of view.

This report takes these evolving advances in interconnection standards and procedures and proposes a set of model technical, contract and policy provisions where possible. Where existing provisions have not been found, we discuss issues and parameters important to stakeholders. The focus of the effort is based on the traditional vertically-integrated utility structure addressing these same issues in the world of customer choice and restructuring is beyond the scope of this effort.

In addition to individual utility standards, three states have focused considerable energy on developing standardized methods of interconnection of DG – Texas, New York, and California. The Public Utility Commission of Texas (PUCT) was concerned in late 1998 that there would be a capacity shortfall over the next two summers and began an effort to develop a state-wide, standardized interconnection and net metering agreement to enable renewables and stand-by generators under a certain size to interconnect with straightforward clear procedures. The State of New York conducted a similar effort by direction of the New York State Public Service Commission (NYSPSC) from July of 1998. The NYPSC also divided the effort into technical and non-technical working sessions. The California Public Utility Commission is proceeding with an order instituting ratemaking, examining among others, the role of distributed generation and its relationship with the distribution utility. The topics addressed cover several interconnection, technical and policy issues.

The report describes the relationship among processes, standards and policies and proposes a methodology for thinking about the implied relationships. Simply addressing one of these three issues will not likely result in increased distributed generation utilization.

Technical guidelines and standards recommended are based primarily on the Texas Distributed Generation guidelines developed in late 1998 and

early 1999. The fundamental drivers of the process were to propose a technical interconnection standard that, if implemented, would allow the incorporation of distributed generation in a quick, safe and reliable manner. The technical provisions proposed in this report are not a completed technical standard. These results are only one step in a complex multi-party process to allow the beneficial interconnection of DG. These parties include regulators, customers, utilities, vendors, suppliers and others who are stakeholders in the process.

The report introduces a series of non-technical contract and tariff provisions that govern the relationship between the DG owner/operator and the distribution utility. These provisions are generally enacted in an interconnection contract or in the set of rules that define how a DG user gets to put the contract in place.

We were not able to find a model contract for these functions. We do propose and discuss issues related to studies and fees, liability insurance coverage, the application process and other requirements.

The report covers policy implications for the interconnection of DG. Policy positions on DG have been taken by several states, by the federal government, and by industry working groups. Much of this policy material is focused on utility restructuring, but still provides valuable information for the vertically-integrated utility covered in this report.

In conclusion, the model utility interconnection tariff and contract provisions for DG are proposed as the next step in resolving barriers to the interconnection of beneficial DG. We believe that this NARUC report has made substantial progress in both technical and non-technical issues and topic areas.

The report suggests a series of potential “next steps” for NARUC in DG. These include:

- Support accelerated development of IEEE SCC 21
- Explore methods of allocating benefits
- Address the issue of wires company using or owning DG
- Explore extensions of net metering
- Support development of a wider industry effort with expanded stakeholders to address procedures

SECTION 1
INTRODUCTION AND PROCESS

1.A. INTRODUCTION

As technology has advanced, smaller-scale generation options, including micro-turbines, fuel cells, wind, and solar systems show market appeal. However, it is generally recognized that significant regulatory and utility barriers may retard the delivery of benefits of these products to customers on the utility grid. At its July 1998 summer meeting, NARUC passed a resolution recognizing the benefits of smaller scale generation and supporting reduced barriers to entry for these options. This report presents the results of an investigation of existing utility and state interconnection requirements and polices regarding distributed generation (DG). For this effort, DG definition is limited to generation to be installed on low-voltage distribution systems. DG connected to the transmission system has existing standards and procedures in-place through open access transmission tariffs regulated by FERC.

Distributed Generation and Restructuring

The NARUC assignment for this effort and report addresses the vertically-integrated utility structures; development of interconnection issues and approaches under restructuring are beyond the scope of work. However, many of the technical standards and discussions in Sections 2 and 3 are valid for states with "customer choice." The framework under typical restructuring still utilizes a "wires company" or distribution services company that must maintain safety and reliability of the distribution system. Fortunately, the electrical characteristics of the network do not change instantly under competition of supply. However, under restructuring and the installation of significant DG, the characteristics of the distribution network could change and evolve over time.

The contractual and other provisions in Section 3 still remain applicable to a great extent. The approaches needed for installation and safe operation under customer choice are similar because of the continuing role of the "wires company" to serve as a regulated utility. To the extent that competitive metering and billing turn out to be competitive, changes would be needed for DG application.

Section 4, the policy portion of the interconnection is only partially compatible or consistent with restructuring. There is a lack of clear direction and definition of policy alternatives for DG interconnection. A few states are taking the lead, but are moving into new policy territory.

The authors believe a substantial industry effort will be needed to technically, economically, and contractually allow the capture and

This report describes three broad areas where interconnection requirements may block entry for smaller-scale generation for customers. These include:

- Technical interconnection requirements for operation in parallel with the utility;
- Non-technical interconnection contact terms, provisions and requirements such as hookup fees and liability coverages for insurance; and
- Policy and institutional disincentives, such as those arising from tariff prices/provisions or the regulatory structure for interconnection to the grid.

The primary focus of the study is to analyze existing standards and contract/tariff provisions and to develop a proposed set of interconnection provisions with distributed generation in mind. This approach would be for a monopoly utility and does not address the access and pricing issues for sales into a competitive power exchange. That topic is the subject of a separate NARUC study.

The end result of our investigative efforts is a set of model interconnection tariff provisions for NARUC consideration and possible adoption by state utility regulators.

1.B. PROCESS

The process we used was (1) to find the most "equitable set" of interconnection standards and contract/tariff provisions; (2) to utilize the reasonable provisions that were found; and (3) to adapt or modify provisions to more equitably handle distributed generation based on our judgement. Our rough definition of "equitable set" means meeting a relative balance between the safety and system requirements of the network owner while at the same time meeting the needs of the DG owners for reasonable arrangements. On certain interconnection provisions, we were not able to resolve this balancing issue so we included more than one potential solution. This draft report is a compilation of the gathered and developed or modified provisions that together are the Model Interconnection Tariff and Contract Provision for Distributed Generation for consideration by NARUC.

Due to tight time constraints and the need to cover the large number of applicable utilities and states, the team developed a strategy to enlist the help of others in data gathering. We developed a topic list and proceeded to request input from a core group of interested parties. Unfortunately, we did not receive much input from the interested parties' list. We also conducted a survey of selected states and utilities that appeared to be advancing interconnection standards, contract, or policy provisions.

1.C. THREE STATE EFFORTS REPRESENTED

In addition to individual utility standards, three states have focused considerable energy on developing standardized methods of interconnection of DG – Texas, New York, and California. The Public Utility Commission of Texas (PUCT) was concerned in late 1998 that there would be a capacity shortfall over the next two summers and began an effort to develop a state-wide, standardized interconnection and net metering agreement to enable renewables and stand-by generators under a certain size to interconnect with straightforward clear procedures that were safe and reliable. The PUCT established two industry working groups, one to discuss and develop a consensus approach to the hardware technical issues and a second to address a series of issues related to policy, contracts, and tariff provisions. These working groups consisted of a broad mix of utility, equipment supplier and individuals who worked hard to examine and discuss the issues at hand.

On February 4, 1999, the PUCT adopted interconnection guidelines for distributed generation. The guidelines provide a starting point for negotiations between the owner of a generating unit and the electric utility.

The State of New York conducted a similar effort by direction of the New York State Public Service Commission (NYSPSC) from July of 1998. The NYPSC also divided the effort into technical and non-technical working sessions. The New York working group made particular progress in the non-technical contract provision that would be acceptable to the generator owner and yet meet the utility needs for operation and safety. We reviewed the April 30, 1999, draft of these provisions for our report.

The California Public Utility Commission is proceeding with an order instituting ratemaking, examining among others, the role of distributed generation and its relationship with the distribution utility. The topics addressed cover several interconnection, technical, and policy issues.

1.D. ROLE OF UNIT SIZE

In our data gathering and analytic efforts, we attempted to follow the role and impact of generating unit size on interconnection standards and requirements. There is a substantial difference in impact between a 2 kW residential generator and a 1 MW industrial sized unit. In our efforts to discuss and analyze provisions, we tried to carry forward the tie between the proposed provision or contract term and size and even type of unit. However, we found little consistency in size cut-off points in the information with which we were working. Thus, we were not able to have separate/different provisions for a defined set of generator sizes. We did carry forward the size range that is applicable for the rule or provision discussed.

1.E. PROPOSED ROLE OF MODEL INTERCONNECTION AND CONTRACT/TARIFF PROVISIONS

The ability to produce a universally accepted interconnection standard and interconnection contract is beyond the scope of this effort. Instead, we have produced (1) a "work-in-progress" interconnection guideline and (2) a set of potential contract provisions. The interconnection guideline is simpler than most existing utility standards because it is functionally-based rather than hardware-based, but still providing safety and system protection. This methodology was chosen to provide flexibility in implementation of modern technologies. For the second part, we have taken existing interconnection contract provisions and discuss and adapt these to provide key model provisions that we believe represent a balance between the needs of utilities and the small generation owner/operators.

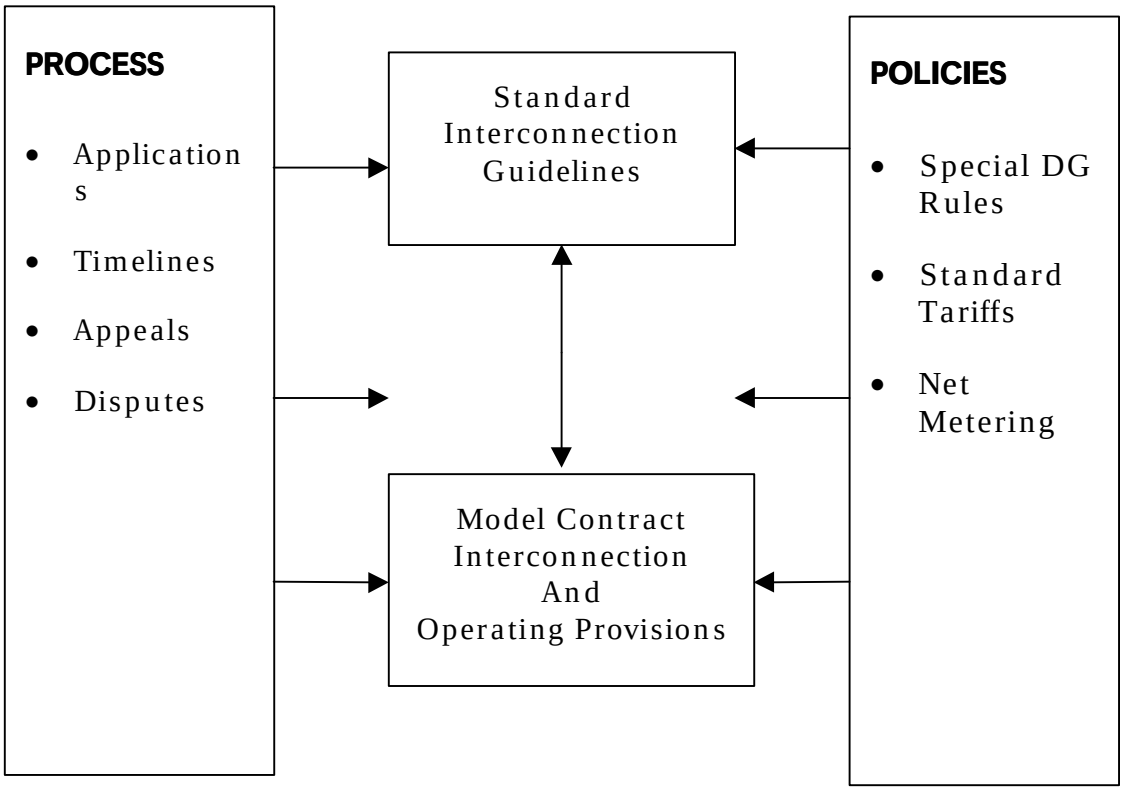
The proposed contract provisions form just part of a broader set of rules and requirements that will form the basis of interaction between the utility distribution provider and the small generation owner. As part of our effort to analyze contract provisions, we reviewed two states' proposed distributed generation application processes. By processes we mean the set of application rules, timing requirements, appeals, and dispute resolution methods put in place for distributed generation. We found no complete process that addressed all the issues in a balanced manner. Nor are we sure that a standard process would work across the country. We have prepared several proposed concepts to address the main issues with the process.

We have also reviewed many of the state rules and policies toward distributed generation and summarized these tariff, rules, and policy positions. We view these as an overlay by policy makers that would put in place incentives, rules, and requirements that pertain to distributed generation. We viewed these as a local regulatory procedure. For this section we did provide discussion of several Federal and State policies that impact a limited set of technologies.

Figure 1.1 below illustrates graphically the above discussion. The Standard Interconnection Guidelines and Model Contract Provisions are sandwiched between the policy on the right and the process procedure on the left. We believe that this format is the preferred way to use our report results.

Figure 1.1

Proposed Role Of Model Interconnection and Tariff Contract Provisions



SECTION 2

TECHNICAL INTERCONNECTION PROVISIONS

2.A. INTRODUCTION

The scope of our assignment includes the review of existing technical interconnection standards for distributed generation. By technical provisions, we mean, the hardware and unit operational procedures that relate directly to utility safety and system protection. Many of these standards were reviewed for appropriateness, fairness, and completeness. The best of these provisions were incorporated into a final model. We have included a list of other model provisions that were considered.

There are a number of technical guidelines and standards that are being developed for distributed generation. We have used known information from these standards to incorporate into this document. The format that we have adopted, for the most part, is based on the existing Texas Distributed Generation Guidelines. These guidelines were developed by an industry working group in late 1998 and early 1999. This format was adopted for several reasons:

- The format covers many topics that are of concern to the Texas Public Utility Commission, electric utilities, equipment vendors, industrial groups, consumer groups, and other interested third parties.
- It focused on a quick approval process that avoided the need for excessive amounts of submittals, yet kept a high emphasis on safety and system reliability.
- It is flexible in its approach to distributed generation standards. It reflects what limitations need to be put in place without a large emphasis on exactly how they will be accomplished.

There are several new emerging standards highlighted by the IEEE Technical Standards groups. Once those standards are completed, they should be compared for consistency with any standard produced as a result of this work. The IEEE Technical Standard will probably not be a replacement for this work since this effort provides many more topic areas of interest to a wider range of constituents than the anticipated IEEE Technical Standard would contain.

This document provides a model technical interconnection standard that, if implemented, can provide for the incorporation of distributed

generation in a quick, safe, and reliable manner. We have included expected discussion items in italics.

2.B. PROVISIONS FOR THE MODEL TARIFF

Definitions

- CBEMA Curve – A published curve that displays a recommended guideline for voltage capabilities of electronic equipment.
- Closed Transition - A means of connecting distributed generation to its load where the utility circuit and generator are paralleled for an extremely short period of time. This method of switching loads from utility to generator provides for no loss of power to the load due to the switching action.
- Disconnect – A switch type device that provides means for completely isolating one electric circuit from another.
- Distributed Generation – Small sources of electric power that are connected to the electric utility's distribution system.
- Distribution Utility – The utility or the portions of the utility that provides the wires delivery service at distribution voltages.
- Electric Storage – Devices designed to store electricity for a period of time.
- Event Recorder – A device that records the state of the electric system just before an event and for a period of time afterwards. Event recorders are usually triggered by events such as short circuits or low voltage.
- Flicker – Voltage variations on a distribution system caused by switching, load changes, or other transient disturbances. Flicker may cause problems with electronic equipment.
- Fly Wheel – A means of storing electricity via a spinning flywheel. Electricity that is stored is able to be retrieved very quickly on command.
- Fuel Cell – A means for chemically converting a fuel source to electricity. Fuel cells have no moving parts.
- Gas Turbine – A means of generating electricity using natural gas or other such gas product as a fuel source. Gas Turbines generally run in size from a few hundred kilowatts to hundreds of megawatts.
- Geothermal – A means of generating electricity using the heated water due to earth's natural heating capabilities in some locations.
- Harmonics - Voltages and Currents of frequencies that are multiples of 60 Hertz. Excessive harmonics can cause problems with electronic equipment, especially protection systems, as well as overheating of

equipment. In some cases high voltages and large currents may be caused by harmonics.

- IEEE – Institute of Electrical and Electronic Engineers – The IEEE often leads the way towards establishing standards and guidelines of many technical matters through committees and working groups composed of knowledgeable volunteers.
- IEEE 519 – Standard pertaining to allowable harmonic voltages and currents on a power distribution system.
- IEEE SCC21 – Developing standards related to interconnection of DG.
- Induction Generator – A rotating electromechanical generator that is not synchronized to the power system. It will generate power at a voltage and frequency as established by the power system, not the generator.
- Inverter – An electronic means for converting DC electricity to AC electricity.
- Islanded System – A part of the distribution system that is separated from the rest of the power grid. An islanded system, in this context, would have distributed generation as its only source of generation.
- Isolation Transformer – A means for electrically isolating one part of the distribution system from another. There is no electrical connection across an isolation transformer, only a magnetic connection.
- Microturbine – A very small gas turbine typically less than 200 kilowatts.
- One-Line Diagram – A diagram of the electrical distribution system displaying the three phases and associated controls, monitoring and protection as single phase circuits.
- Open Transition - A means of connecting a distributed generator to its load where the utility circuit and generator are never in parallel. This method of switching loads from utility to generator provide a loss of power to the load for a very short period of time.
- Parallel Operation – The utility and the source of distributed generation are operating in such a way as to provide electrical energy to the same loads at the same time.
- Photovoltaic – Electric energy from solar cells. Photovoltaic cells are DC and typically connect to the electrical distribution system via an inverter.
- Physical Isolation – A means of assuring that there are no physical conductors of any sort connecting parts of an electrical distribution system.
- Protection Systems – Electronic and/or electromechanical devices designed to provide capabilities to open circuit breakers so as to avoid

problems due to short circuits, overloads and other functions that may cause problems with the electrical distribution system.

- Provider – The owner and/or operator of the generation equipment. The provider has responsibility for the generation equipment.
- Real Time Data – Data that can be acquired with a delay no longer than a few seconds.
- Reclosing – The closing back in service of a distribution circuit after it has tripped off-line due to a short circuit. Reclosing can be instantaneous or with some time delay.
- Resonant Overvoltage – A phenomenon that causes higher than normal voltages on ungrounded distribution systems. These voltages in practice can reach 5 to 10 times the normal line to ground voltage.
- SCADA – Supervisory Control and Data Acquisition system – Provides the ability to remotely control devices such as circuit breakers and switches as well as the ability to provide data readings from remote locations.
- Stiffness (of the distribution system) – A measure of how well the distribution system resists change due to loads or other connections. A "stiff" system is the opposite of a "weak" system. The greater the short-circuit MVA, the stiffer the system. The stiffer the system, the less effect distributed generation has on the distribution system.
- Synchronize (Synchronization) – To make sure that the synchronous source of generation and the distribution system are in phase before they are electrically connected together. Failure to synchronize the two systems may result in extensive damage to facilities and cause injury to personnel.
- Synchronous Generator (Synchronous Source of Power) – A source of generation (power) that does not need to be connected to other generation in order to provide consistent voltage and energy to a load.
- Switching, Clearance and Tagging Procedures – Safety procedures used by electric utilities to ensure that the states of switching devices are not changed without following proper procedures.
- Telemetry – Electronic equipment that allows reading data remotely.
- Total Harmonic Distortion (THD) – A single number expressed in percent representing the distortion of the current or voltage sine wave caused by all harmonics of the fundamental frequency (60 Hertz) that are present on the power system.
- Transfer Trip – A signal from one location (such as at a recloser) typically sent to trip a remote circuit breaker under certain system short circuit conditions.

- VAR Support – The requirement for a certain level of Reactive Volt-Amperes in order to provide certain system power factor and/or voltage level.
- Zero Sequence Current – Current that flows through all three phases of a circuit as well as through the ground return. Commonly known as ground fault current.

2.B.1. CLASSIFICATIONS OF DISTRIBUTED GENERATION UNITS

The type and size of a distributed generating unit plays a role in the unit interconnection to the utility. Distributed generation units shall be classified in each of three areas according to type. These areas are Technology, Fuel Source, and Interface with Power System. Common technologies include reciprocating engines, hydro, wind, photovoltaic, solar thermal, geo-thermal, gas turbine, and fuel cells. Fuel sources are classified according to fossil fuel, renewables, and electric storage. Each distributed generator is either directly connected (electromechanical) or connected through an inverter. Direct connected devices are usually rotating machines that produce 60 hertz power. Inverters are usually connected to the output of a DC producing source of generation. Several inverter technologies exist and can be all classified as inverters for purposes of this document. However, some of the older inverter technologies may not be able to meet the requirements for the "modern" inverter.

The size of the unit is another critical factor that plays a role in interconnection. The units shall be classified as small, medium and large distributed generation. The small units are units less than 100 kW. The intermediate size units are 100 kW to 1 MW. Large Units are those greater than 1MW.

The table below, "Classifications of Common Distributed Generation Technologies," displays the various classifications. There are many different methods of classifications for size of units. The important issue is that this classification provides the functionality that works with other areas as defined below. Although several different standards that are completed or are in development have different classifications, many use three levels of classification. While these are similar, more work is needed in this area to determine the best borderline between classifications.

Classifications of Common Distributed Generation Technologies					
Technology	**Fuel Source**	**Interface**	**Small <100 kW**	**Intermediate 100 kW-1 MW**	**Large >1 MW**
Small Gas Turbine	Fossil Fuel Biogas	Directly Connected			X

Reciprocating Engine with Synchronous or Induction Generators	Fossil Fuel Biogas	Directly Connected	X	X	X
Geothermal	Renewable	Directly Connected		X	X
Hydro	Renewable	Directly Connected		X	X
Wind	Renewable	Inverter	X	X	X
Photovoltaic	Renewable	Inverter	X	X	
Fuel Cell	Fossil Fuel Renewable	Inverter	X	X	X
Solar Thermal	Renewable	Directly Connected	X	X	X
Battery Storage	Grid	Inverter	X	X	X
Capacitor Storage	Grid	Inverter	X	X	
Flywheel Storage	Grid	Inverter		X	X
SMES	Grid	Inverter		X	X
Microturbine	Fossil Fuel	Inverter	X	X	

2.B.2. SAFETY CONSIDERATIONS

Safety is a critical issue in the implementation of distributed generation. The additional sources of generation pose the potential safety hazards that affect electric utility workers, fire workers, rescue workers and the public safety. This standard is focused on minimizing the potential for such hazards.

The main source of safety concerns is that utility workers could believe a conductor is de-energized when in fact distributed generation is energizing it. Without proper standards and work practices, there is a potential for life threatening circumstances.

Existing utility standards for the implementation of distributed generation are based on extensive experience with generation of various sizes and types. Such standards have been established due to work practices, experienced conservative work processes, and need for generation. The standards are established in order to maintain a very high level of safety. Safety standards cannot be compromised under any circumstances.

Flexibility in implementing the present standards is needed; however, this flexibility should be focused on allowing installation of products and devices that meet the intent of the safety standards although they may not meet a particular utility's historical practices and standards.

Safe operations can be established in many ways. Existing safety practices have been in place for many years, and in many cases, these standards may exceed the need for practices that make sense for the electric industry today. Comparable or better levels of safety can be accomplished at a lower cost than many of the standards now in place. The standards proposed in this document are replacements for many of the practices and standards that electric utilities have used for many years in the implementation of large generation.

The following subsections address items that are of major concern for safety.

2.B.2.1. DE-ENERGIZED LINES

When the utility's source of electricity (exclusive of distributed generation) fails to provide energy to the system, the distributed generation must be separated from the utility's load with the following exceptions:

Exception 1: Loads that are designed to be part of the distributed generation load such as emergency or standby loads shall be allowed to be energized in a system designed for such loads.

Exception 2: Where the utility has engineered the electrical distribution system to allow such energization of loads, the loads may be supplied exclusively from distributed generation at times when the source of power fails.

2.B.2.2. ISOLATION FROM THE UTILITY SYSTEM

The distributed generator shall be able to be isolated from the utility- supplied electrical distribution system. The means of physical isolation shall consist of the following:

- The means of physical isolation shall be able to completely isolate the distribution generator from the electric utility system. This device may be located at the service entrance or somewhere between the generator and the service entrance. This device may be a disconnect switch, a draw-out breaker, fuse block or other commonly used means of physical isolation. These devices must be able to be controlled on- site and may have the capability for remote control.
- The physical isolation means must be accessible by the electric utility on a 24-hour per day basis. This can be accomplished by access to the facilities through a dedicated utility key lock or other means that will

minimize delay to the utility's access of the physical isolation means.

- The physical isolation device must provide an indicator that the device is isolated.

  Some existing requirements include a visible disconnect. Although often open to interpretation, the visible disconnect requirement typically includes a visual view of the contact to ascertain that the contact is open. This practice was put in place due to the frequent failures of early disconnect switches and breakers to be open despite their open indicators indicating that they are open. We believe that practical, modern technology will have an extremely low probability of failure of these indication units. That coupled with good work practices will lower the probability of damage or injury due to such a failure to almost zero.

- The means for disconnecting shall be able to provide for a complete open circuit. The devices must be able to be controlled on-site and also remotely.

  Although physical disconnect is a requirement for all units, this can be accomplished by different means depending on the size of the unit and type of technology involved. The source of electric energy shall be able to be completely physically disconnected and isolated from the utility system. The disconnection device shall be accessible by the distribution utility on a 24 hour a day basis.

- The means for disconnection shall either provide for a visible disconnect or an indicator that identifies the status of the disconnect. If an indicator is used, it shall be fail-safe to ensure that when an indicator denotes that the circuit is open, it is for sure open.

  Some requirements include the need for a redundant circuit breaker. This requirement should apply for major generation that is critical from an operation of the system standpoint. Therefore, we view this as a special concern that we will discuss later.

- For the purpose of assuring the safe operation of the electrical distribution system, the owner/operator of the generation shall be responsible for following safety procedures for the switching, clearance and tagging procedures that the electric utility follows. For medium and large generators, both the generator and the utility will be responsible for ensuring that the switching, clearance and tagging procedures are followed. The

distribution utility will be responsible for providing complete information about their procedure to the Owner and operator of generators in their service territory.

- For small generators, the electric utility shall provide responsibility for the safety of personnel associated with the electrical distribution and transmission system by following designated switching clearance and tagging procedures.

This tariff does not intend to conflict with National, State and Local Standards and Codes. Each entity is responsible for assuring that they meet National, State and Local standards and codes.

2.B.3. SYSTEM RELIABILITY

It is the responsibility of the generator/owner to keep within the system stability limits as defined herein. The major areas to assure system reliability include voltage support, VAr support, frequency limits, power factor, and harmonics.

2.B.3.1. SYSTEM STABILITY REQUIREMENTS

- Voltage should be maintained within +5 to –10% from nominal voltage within a 10-second time frame.

  This is open to other ranges such as – 10%. Another methodology to consider is meeting the CBEMA curve. This curve provides – 15% for long-term voltage but allows voltage excursions of up to – 35% at 10 cycles and – 75% at one cycle.

- For small sources of generation the power factor of the device shall be within the range of ± 85% power factor in order to avoid excessive drain on the utility system. In some instances, with joint agreement of the generator and the distribution utility, the power factor range can expand to a larger range.

  For intermediate size and large generators, the power factor range must be between ± (To Be Determined). In addition, the local voltage must be supported to not cause excessive voltage fluctuations. The voltages shall remain within the range of x to y for any period greater than x cycles.

- When paralleled with the utility distribution system and whenever the generator is operating equipment that is served by the utility distribution system that is not owned by the generator owner, the frequency shall be

held to 60 Hertz, ± (To Be Determined) Hertz. *(When the system is not in parallel with the utility system AND it does not feed loads other than the owner's loads, this requirement is a recommended practice.)*

- The source of electric energy shall not produce any harmonics more than is provided by Standard IEEE 519. For small and intermediate generation sources, means shall be taken by the distribution utility for mitigating the harmonic effects.

  For large generation sources, if the generating source meets IEEE 519 the distribution utility is responsible for providing the appropriate modification to the distribution system. *(This is based on the fact that if a device meeting IEEE 519 is installed and system harmonic levels are excessive, there are other sources of harmonics contributing to the problem.)*

  Harmonics may have an effect on the electrical system whether the source is large or small. Sources of harmonics include most loads, transformers, voltage regulators, etc. Generators and inverters may also be a source of harmonics. IEEE 519 produces guidelines for harmonics based on loads.

2.B.3.2. PROTECTION REQUIREMENTS

Protection requirements will differ based on the size and type of sources of generation as well as the implementation into the distribution system. The protection standards identified in the following paragraphs are put in place to establish protection for public safety and electric utility workers. These standards are not intended to provide protection to the generator equipment nor the generator's facilities.

The protection requirements shall be defined as follows:

- Minimal Protection – All generation systems
  - Overcurrent Protection
- Protection for Circuits with Reclosing
  - Inverters – Inverters shall be designed to shut down upon the detection or an indication of a short circuit and or separation from the utility circuit. If such circuitry is not designed in the circuit, as evidenced by the UL standard UL (To Be Determined), the inverters shall have the same protection equipment as the appropriate-sized units identified as direct connects.

- Direct Connects – Small generators with no inverters

  The protection system shall be designed to provide protection to ascertain that the generator isolates itself from the utility system:

  - When a short circuit occurs where the generator contributes fault current, it shall be disconnected from the distribution system in a manner that is coordinated with the other protective devices associated with the distribution system.
  - When the generator is separated from the source of utility generation and is providing voltage to part of the utility's electrical distribution system, it shall immediately separate itself from the electric utility distribution system.

    Protective systems to provide the above functions may include protection such as overcurrent protection, reverse overcurrent protection, reverse power protection, over/under voltage protection, frequency protection, or transfer trip protection.

    More detailed studies can provide information that will limit the amount of protection that is needed. See discussion on system studies.

- Direct Connects – Intermediate and Large generators with no inverters

  - When a short circuit occurs where the generator contributes fault current, it shall be disconnected from the distribution system in a manner that is coordinated with the other protective devices associated with the distribution system.
  - When the generator is separated from the source of utility generation and is providing voltage to part of the utility's electrical distribution system, it shall immediately separate itself from the electric utility distribution system.
  - Due to the larger effect on the distribution system, some intermediate and all large disconnect systems require more positive action to assure tripping. Additional relay protection in most cases requires overcurrent protection, reverse overcurrent protection, reverse power protection, over/under voltage protection, frequency protection, or transfer trip protection.

In some cases, the addition of distributed generation leads to the need for protective device coordination that is different from that needed under circumstances without distributed generation.

In the worst case situation, miscoordination can cause reliability problems due to the distribution system fuses blowing.

The source of generation shall be protected to not unduly contribute to the short circuit current and timing. The protective devices shall be coordinated with other devices to eliminate the source of generation from contributing to a short circuit in the same time or in less time than other protective devices contributing to the short circuit.

Where a distribution circuit with a reclosing scheme is used, the generator protection shall be coordinated to disconnect the generator from the utility distribution system before the reclosing scheme recloses the breaker or switch.

- If the reclosing scheme provides for an instantaneous trip with one or more reclosures, the generator shall trip off instantaneously on the sensing of a short circuit or other event that would have tripped off the reclosing scheme. (See protection to make sure the generator knows to trip offline.)
- If the reclosing scheme provides for a timed trip, the generator shall trip off line within a timing coordinated with that of the recloser. (See protection to make sure the generator knows to trip offline.)
- If the generation source is connected to the power system via an inverter, the inverter needs to be shut down according to the above rules.

Once sufficient time has passed for all the breaker reclosing schemes to perform their operations, the distributed generator may resynchronize with the power system. Under no circumstances shall the distributed generator connect to a de-energized distribution utility conductor unless that operation is specifically approved and under the guidance of the distribution utility.

All generation that provides a synchronous source of power that is to be connected to the power system shall be connected via a synchronizing scheme. The synchronization scheme employed shall ensure that the source of energy is connected substantially in phase with the power system. Under no circumstances shall the system be synchronized at a greater difference in phase angle than 15 degrees.

Inverters shall have circuitry to ascertain that power is not delivered until the phase angles are substantially in phase.

When a distributed generator or several distributed generators are separated from the utility source of energy, the system is considered an Islanded System. When the system is islanded, the generator shall be isolated from the remainder of distribution utility's load.

Care must be taken to assure that islanding of the generator does not occur. This is critical due to the potential for safety problems, voltage problems, frequency problems, etc. In some cases, a study may determine that islanding is of an advantage to the local utility. In these circumstances, the utility may opt to allow islanding under certain circumstances.

The generator owner's load may be connected to the generator as long as the generator is not energizing any conductor outside of the generator owner's facilities or location.

The operation, protection, maintenance, etc., of the generator equipment shall be totally the responsibility of the owner of the equipment. The implementation of generator equipment in a utility distribution system requires protection and operation procedures that will provide for the generation equipment to be self-protecting. These standards do not address the protection of the generating equipment.

Protection must be put in place to ascertain that the voltage produced by the generator stays within ± 10% of the rated voltage under all circumstance. If the voltage goes outside these limits, the generator shall be tripped off-line to isolate the distribution system from the generator.

Resonant overvoltages can cause serious overvoltage damage to equipment and cables. If the distribution system and connected generator are treated as a solidly grounded or a low impedance grounded system, the system must remain solidly grounded under any circumstance of switching or disconnecting that would potentially leave the generator operating in an ungrounded state, unless the potential of resonant overvoltages is lowered by the inclusion of resonant overvoltage protection.

The addition of distributed generation may create an increase in the total harmonic distortion (THD) in the distribution system. The individual generator shall meet IEEE standards for harmonic generation. In some cases, the addition of generators (or loads) can lead to harmonics

greater than those allowed by IEEE 519, although the generators meet the IEEE standards. Harmonic filters or other means of decreasing the total harmonic distortion as determined by standard practices shall be installed.

All inverter technologies may inject DC current into the AC distribution system. The amount of DC current that is injected into the power distribution shall be 0.5% or less per inverter.

Isolation transformers are not a general requirement. However, isolation transformers may provide an alternative method to mitigate effects of zero sequence current contributions and harmonics. Harmonics can be mitigated as discussed in the harmonics section. Zero sequence current is not an issue as long as proper protection is put in place to eliminate the effects of zero sequence current from consideration.

The effect that a distributed generator has on the electrical distribution is greatly affected by the number of distributed generators on the electrical distribution system and the stiffness of the distribution system before the incorporation of any distributed generation. The more short-circuit MVA available, the stiffer the circuit. The stiffer the system, the less effect the generator has on the distribution system.

The stiffness of the system ratio shall be used to determine the need for additional study implementation. This ratio is defined as:

Short Circuit Ratio = (Short Circuit KVA of Utility Grid + Short Circuit KVA of Distributed Resource) / (Short Circuit KVA of Distributed Resource) {{from IEEE Draft standard for Distributed Generation}}

If the short circuit ratio is 100 or greater, the generator shall be outfitted per the minimal requirements for its size. If the short ratio is between 50 and 100, additional study work may be required to determine the protection and generator layout that is desired. If the short circuit ratio is less than 50, extensive study efforts are required.

2.B.4. POWER SYSTEMS INTERFACE

Distributed generation may have the capability of being paralleled with the power system. This document is based on parallel operation for at least some period of time. Some areas of this document pertain to operation in an open transition system; however, many of the limitations that are needed to operate in a parallel system do not apply to an open transition system.

The generation source shall be a stable source of generation that can maintain a consistently set degree of power flow for a reasonable period of time. The generation source shall maintain a stable VAr supply and voltage support.

If the generator is to be operated in parallel with the electric utility power system, it shall have provisions for manual or automatic synchronization with the power system. The synchronization system shall be designed so that the generator will synchronize with the power system where the generator is no greater than 15 degrees out of synchronization with the power system.

Once the generator is separated from the power distribution system, it shall not be put back in parallel with the power distribution system until full voltage and power support capabilities for the distribution system are put into place.

It is recommended that 1 to 5 minutes of stable service be allowed before the generator is again synchronized with the system.

If distributed generation is connected into a networked distribution system, there are special considerations that need to be taken into account.

In most cases this would require a change in the electrical service and the network protective relays. Special protection considerations will be needed. Voltage regulators shall maintain the voltage levels within +5% and –10% of the rated voltage as tested when the generator is not in parallel with the power distribution system. When the generator is paralleled with the utility system, the voltage regulator shall be capable of providing VArs to the distribution system according to one of the following plans:

- Constant VAr Source
- Constant Power Factor Source
- Constant Voltage Source

2.B.5. CONTROL & MONITORING SYSTEMS

2.B.5.1. GENERAL

The generation control shall remain under the control of the owner/operator of the distributed generation. The generation control shall take into account coordination with the utility including system protection and operational control concerns.

The generation control may be automatically controlled, locally controlled, or remotely controlled. The controls shall allow for

quick shutdown of the generation in the situation of failure of the level of generation mechanisms or high or low frequency.

Generation control for any generator can operate in one of two modes. The first is that of providing all the generation that is available. In this mode, the generator supplies all possible output it is capable of producing. This is the most common use of distributed resources. In this mode as long as the parameters that are required such as voltage and frequency are maintained, the distributed resource will continue to operate.

The second mode is that of a variable generation source. In some cases, the distributed resource may be controlled to maintain a level of generation. The controls may be manual or automated and may be operated from a remote location.

2.B.5.2. METERING, TELEMETRY, & COMMUNICATIONS REQUIREMENTS

Metering, in general, shall be in place to determine the kWh production of the generation source. Additional metering may be required, such as kW demand, kvar, or kVA in order to provide a method of measuring the output of the generator. This metering may take place in the form of net metering or as individual metering on the particular generator. Metering shall be of the accuracy as required for the metering of other equivalent electrical services. Metering may be implemented by standard meters or by other electronic measuring devices that meet accuracy requirements.

Telemetry may be required in some circumstances to monitor the real time output and other functions of the generator. Telemetry is not required for generators that are small in size. For intermediate-sized generators, telemetry is required if the generator is operated remotely with a variable output. Large generators require telemetry if operated remotely.

Telemetry, where employed, shall be made available to the host distribution utility. Data telemetered shall include generation data. This data shall include at a minimum the total kW or ampere level per phase. The polling rate of this data shall be no longer than once every (To Be Determined) seconds.

There are other telemetry requirements include if sales or multiple generators are involved and if a transfer trip is required.

Communication systems for telemetry and metering shall be compatible for interface with the host distribution utility where such an interface is required.

There are many different methods for providing communications that may be required as part of distributed generation systems. These may include SCADA, Automated Meter Reading (AMR), wired, wireless, and Internet communication channels. This document does not preclude any methodology that will provide the required telemetry data to the host distribution utility.

2.B.6. DATA REQUIREMENTS

Data may be required under certain circumstances for purposes of recording transactions and insuring the ongoing safe and reliable operation of distributed generation. The data requirements may be classified as real time data needs, data summaries, and failure reporting.

Real time data needs are the requirements of telemetry as provided for elsewhere in the document. Real time data is needed for some intermediate and larger units to provide actual real time operation parameters such as kW.

For intermediate and large size units a log of generator operations shall be kept. At a minimum, the log shall include the date, generator time on, generator time off, and megawatt and megavar output.

Several entities require extensive data concerning the operation of the generator. This data includes failure reporting and corrective action. At least one utility requires an event recorder.

2.B.7. CERTIFICATION AND TESTING

The provider of the generation shall provide to the host distribution utility the following minimal documentation and test results. Information to be provided to the host distribution utility shall include the following for each generator:

- One-Line Diagram – The diagram shall include at a minimum all major electrical equipment that is pertinent for understanding the normal and contingency operation of the generation system including generators, switches, circuit breakers, fuses, protective relays, and instrument transformers. The diagram should include transformer connections where a transformer is required. One-line diagrams for small and intermediate size units may be a typical diagram for all units of the same design. Large units shall require application specific one-line diagrams.

- Testing Records - Testing of protection systems for intermediate size and large size units shall be limited to records of compliance with standard acceptance procedures as defined by the manufacturer of the protective devices and by industry standards and practices. These records shall include testing at time of commercial operation and periodic testing thereafter. Factory testing of protective systems of small units shall be sufficient unless the factory test acceptance procedure specifies field testing of the unit or if transfer trip is part of the protective system of the small units.

For packaged generating equipment where the protective devices are part of a manufactured assembly that has been certified (including necessary relay settings) for use by the utility, each subsequent installation of the manufactured assembly shall be deemed certified for use by the utility.

The host distribution utility has the option to initially qualify a potential generator site as a viable source of capacity and energy before signing a contract for resources. In order to assure the reliable operation of this generation they have the right to evaluate maintenance records, operating personnel, and capability of the generator as part of the contracting process. Equipment that may be reviewed includes the distributed generation source and interface equipment such as disconnect switches, switchgear, and protection systems.

2.B.8. APPROVALS

The host distribution utility and the provider of the distributed generation both have responsibilities for the successful operation of the distributed generation at each site. In order to facilitate the implementation of distributed generation, an approval process needs to be put in place that is consistent and timely. The approval process will assure that the host distribution utility agrees that the implementation of distributed generation will not unduly affect the distribution system (and in some cases transmission systems) under their charge. The approval process shall also occur in a timely manner to facilitate distributed generation projects.

2.B.8.1. APPROVAL PROCESS AND DATA REQUIRED

For intermediate and large distributed generation units the following data shall be supplied from the distributed generator to the host distribution utility:

- Equipment specifications of major equipment including generator and protection systems including the following:

- One-Line Diagram
- System Protection Data
- Generator Operating Characteristics
- Location on Utility System
- Test Data
- Synchronizing Method
- Maintenance Schedules
- Data needed to coordinate the installation with that of the host utility.
- Anticipated Start Up date

For small generators, there shall be a once-only evaluation of the technology by an independent laboratory. Once the technology is approved, it shall be an acceptable distributed generation technology that requires no further utility review. The results of the analysis of the independent laboratory shall be made available to the host distribution utility. The only submittal for approval for these small generators is the location of the generator in a common format, such as street address, and the anticipated startup dates.

When reviewing particular proposals or equipment, the utility shall take into account the intent of safety standards and the ability for the implementation to meet that intent of the host distribution utility's safety and reliability practices and procedures. The review should also take into account the approvals of equipment by other utilities across the United States. It will not be acceptable to reject an implementation due to not meeting a particular utility's standards without addressing the implementation's negative affects on safety and reliability and its conformance to utility standards and practices.

2.B.8.2. TIMING

The host distribution utility shall approve distributed generation of different sizes according to the following table:

Size of Unit	Maximum Approval (Calendar Weeks)
Small	1
Intermediate	4
Large	8

This timing is based upon the distributed generation developer providing the necessary information. If essential information is missing, the timing will be delayed. However, good faith omissions, which can be relatively easy to deal with, shall not unnecessarily delay approval of the project. If the host distribution utility rejects any implementation, it shall give full reason and explanation. Upon request by the distributed generation project developer, the Commission will review this information and provide some guidance from a regulatory perspective within one month. Any projects so rejected can be proposed at any time in the future with deficiencies corrected.

SECTION 3
OTHER NON-TECHNICAL CONTRACT PROVISIONS AND APPLICATION PROCESSES

3.A. INTRODUCTION

There are a series of non-technical contract or tariff provisions and other arrangements that have been proposed which govern the relationship between a distributed generator owner/operator and the distribution utility. These provisions are typically embodied in (1) an interconnection contract or tariff that covers the installation, operation, and maintenance of a generating unit, and (2) a set or rules and procedures that define how a user gets to put a contract into place.

This section provides two sets of discussion items. First, we propose a series of contract or tariff provisions that we believe are generally balanced between utility system needs and small generation owner needs. These sorts of provisions provide the basis for development of an installation/operating agreement. Second, we provide a discussion of application processes that are important to the viability of interconnection as they relate to application requirements, timeliness of response by both utilities and owners, and an appeals process. As discussed below, we believe small generators will not require a complex contract and procedure.

In this section we address both the requirements for a contract or tariff as well as the process, which by itself could be a substantial barrier to distributed generation. This section does not cover nor relate to the sale of generator output in the utility or into the marketplace. These issues are covered from a policy point of view in Section 4.

3.B. INSTALLATION/OPERATING CONTRACT PROVISIONS

We were not able to find a model contract that equitably covered all aspects of the installation and operating arrangement that would be in place between generation owners and the utility. We believe that the complexity of the operating agreement is relative to the size of installation. For small residential and commercial installations, a simple application/agreement should suffice. Discussion of these smaller installations are covered later in this Section. The following suggested discussions and provisions cover the primary areas that we believe

should be covered in the operating agreement with larger distributed generation installations.

3.B.1. STUDIES AND FEES

To meet the technical requirements for interconnection and parallel operation with the utility, the utility may wish to conduct technical studies for safety and system coordination and protection. While the technical need for studies and even some added system protection equipment is discussed in Section 2, we address the issue of who pays for these studies and additions when the technical needs have been determined per Section 2. As discussed in Section 2, many small and medium-sized generators can be installed safely without extensive studies and hardware additions. There is a related topic of required arbitrary fees for a customer for hooking up a generator that is not cost-based. Such fees introduce market barriers and should not be allowed.

The major question is who should pay for studies and additions when deemed necessary per Section 2, the generator or the utility? There are at least two opposing thoughts on these issues based on different perspectives. First, in the transmission arena under FERC Open Access Pro Forma rules, a new generator is generally required to pay for a system impact study and to pay for the addition of any new lines, facilities and required protection equipment. This theme suggests that the distributed generation owner should be solely responsible for distributed studies, and in some instances, the new equipment needed for the continued proper operation of the utility system.

A second viewpoint is that the generator is much like a load that is served from the system. In most utilities, a certain part of the distribution cost to connect a new customer's load is included in and blended with that class of customers. This viewpoint would then lead to the utility paying for a threshold level of studies and facilities and the generation owner paying only for the amount above the blended level. This procedure would work best under a restructured utility that offered a distribution service that the generator would continue to pay for even when not providing delivery service for distributed generation to the customer.

Utility regulators can also play a key role in enhancing and evaluating this second viewpoint. If the benefits of small generation to the distribution system can be framed in light of utility regulatory policy, there is a strong rationale to have a blended cost structure where individual costs are blended into the distribution service. This could apply in both bundled and

unbundled situations. The Texas guidelines summarize these thoughts as follows:

> " Utilities stated that each distributed generation supplier must pay the utility for the necessary distribution system upgrade. The opposing position is that the utility costs for the upgrades should be included into the overall capacity acquisition of distributed generation supply, and borne by the utility under a program that incorporates appropriate pricing of supply."

3.B.2. LIABILITY AND INSURANCE COVERAGE

The purpose of an insurance requirement by customers installing generation is a logical extension of risk mitigation by the utility. Electrical power generation can be a cause for injury and death and damage to other equipment. A required level of coverage is a realistic extension of our current world.

Working groups in Texas and in New York addressed these issues to some extent. The April 30, 1999 draft from New York's Non-Technical Working Group suggests a minimum of two million dollar liability coverage for generators up to 300 kVA. The Texas working group concluded that generation added by business and industry would likely have sufficient liability coverage for most distributed generation installations.

The Texas working group noted that residential customers may have more difficulty securing adequate coverage should a liability coverage restriction exceed the normal homeowners policy provisions. This could be a substantial barrier if coverage amounts and costs to obtain coverage are excessive. Wind, photovoltaic systems and fuel cells are the obvious technologies that would be affected by insurance issues.

3.B.3. INDEMNIFICATION

Part of the arrangement between the distribution utility and the large distributed generation owner is the risk sharing between the two parties for third party claims. The ideal arrangement would have a balance of risk in proportion to the causation of the issue. These are deemed to be legal provisions and beyond the scope of this assignment related to assessment. The New York State Working Group (non-utility) proposed the following:

3.B.3.1. MODEL INDEMNIFICATION PROVISIONS:

Obligations of Customer to Hold Company Harmless: The Customer shall hold the Company harmless against all loss or damage that Company may suffer as a result of any claims or demands against the Company made by any third party and arising out of Customer's negligence or failure to substantially perform its material obligations under this Agreement.

Obligations of Company to Hold Customer Harmless: The Company shall hold the Customer harmless against all loss or damage that Customer may suffer as a result of any claims or demands against the Customer made by any third party and arising out of Company's negligence or failure to substantially perform its obligations under this Agreement.

3.B.4. PERMITTING AND SITING

There are a series of permitting issues involved with permitting and siting of distributed generation. This would cover (1) the air quality permitting related to air emissions, (2) building code and local ordinances such as fire codes and zoning requirements, and (3) any regulatory rules requiring certification of public convenience and necessity.

This report does not cover the first two items discussed, but the regulatory rules may have a policy impact in utility ownership and installation of distributed generation. Further, if a distribution utility is not allowed to install or purchase output from distributed generation, such policies may impede the installation of these units.

3.B.5. OTHER REQUIREMENTS

The technical requirements for operations are covered in Section 2. The discussion here is centered on the makeup of the contract between the owner of a larger distributed generator and the distribution utility. There would be a series of issues covered in the contract or agreement, which may include the following:

- Compliance with technical standard
- Allowing the utility on-site inspections
- The handling of costs associated with interconnection
- Obligation of both parties to cure adverse effects
- Access rules

- Dispute resolution

3.C. APPLICATION PROCESSES

The application process is the series of organized steps to be taken by a prospective generation owner/operator who desires to install and operate distributed generation in parallel with the distribution utility's system. The utility needs to know information including location, technical and design parameters, and operational and maintenance procedures. This process will be facilitated if the process is clear, concise and not overly burdensome on any party. Simpler is better for this procedure and process. We were not able to find a complete application process that met our reasonableness standard but have identified individual components of the application process for consideration as Model Contract Provisions:

3.C.1. ESTABLISHMENT OF UTILITY CONTACT PERSON

To avoid generator owners having the confusion and trouble of getting multiple contact points at the utility, the PUC of Texas requested that staff take the following action:

> "establish a process to identify the person at each utility responsible for interconnection of distributed generation."

The State of Texas also requires the utility contact person to report information on requests back to the utility Commission.

3.C.2. APPLICATION FORM

As discussed above the role of the application form will vary depending upon the size and perhaps the complexity of the distributed generation situation. A small residential or commercial generator, with standard, approved equipment would need no more than an application with basic information and some standard terms and conditions. Such a form might contain the following:

- Name of owner
- Location on distribution system (address)
- Interconnection voltage
- Type of unit (fuel type, model number, manufacturer)
- Expected duty cycle
- Size of unit (kW)

- Name of qualified installer
- Terms and Conditions

The information provided would allow the utility to verify the equipment, and its proposed locations on the system, and ensure that the site is not a problem area. For example, too much generation at a particular location on the distribution network could be problematic.

3.C.3. APPROVALS AND INSPECTIONS

Approvals and inspections are a necessary part of interconnecting rules and standards to reduce the burden on both owner and utility. The processes should be calibrated to the situations. It is counter productive to distributed generation implementation to have unnecessary steps and procedures.

SECTION 4
POLICY AND TARIFF PROVISIONS

4.A. INTRODUCTION

This section of the report covers the policy and tariff provision implications for the interconnection of distributed generation. Policy positions have been taken by several states and are being developed in others. Further, there is a federal restructuring policy proposed by the current administration with distributed generation emphasis. We believe it is useful to describe the important activities in the a context of model interconnection policy tariff, and rulings to be considered by NARUC and the individual state PUCs.

4.B. MODEL POLICY PROVISIONS

4.B.1. TEXAS PUC

Preliminary policy positions described in the document entitled *Draft Report on Interconnection for Distributed Generation* published by the Public Utility Commission of Texas indicate:

- A desire by the Texas PUC to develop "fair and appropriate" regulatory treatment (interconnect and net metering for DG);
- Spreading recognition among key utility industry stakeholders of prospects for use of existing, customer-owned back-up generation as a viable utility peaking capacity resource, especially to address potential capacity shortfalls in the Summers of 1999 and 2000;
- Recognition of need to update and standardize regulations/rules affecting use of DG as a utility resource; and
- Continued primary emphasis on utility distribution system safety and reliability.

Recognition of a need to update state-wide, standardized interconnection and net metering agreements to enable renewables and stand-by generation under a certain size to interconnect with clear standards and procedures that ensure safety and reliability [which]...must remain top priorities.

Standardization of interconnection criteria should recognize that many features to protect safety and meet needs can be, and are, integrated with electrical conversion units that can comply with independent testing requirements, be tested on the production line and then installed in streamlined fashion on multiple sites.

[Increased standardization *and* flexibility are needed to] facilitate [cost-effective] installation of distributed generation. This flexibility should be focused on allowing installation of products and devices that meet the intent of the safety standards although they may not meet a particular utility's historic practices and standards.

[Distributed] generation systems must meet all governmental standards: national, state, and local construction and safety standards.

4.B.2. NET METERING

Net Metering (sometimes called net billing) provisions allow customers to serve their own loads and sell any excess electricity generated on-site to the utility at the retail rate. This is essentially running the meter backwards.

- 23 states have existing net metering laws. The most favorable laws include net metering for renewables and cogeneration in all customer classes for less than or equal to 100 kW of allowable capacity. The net excess generation of electricity by the customer generator if generation exceeds consumption during the billing period is purchased by the utility at the customer rate.
- In many states, utilities do not pay net metered customers for excess generation.

4.B.3. CADER CALIFORNIA ALLIANCE FOR DISTRIBUTED ENERGY RESOURCES (CADER)

Observations below are based on CADER's: Collaborative Report and Action Agenda*, published January 1998.*

Two key premises underlying CADER's policy-related distributed resource (DR) positions are: 1) existing, emerging, and advanced technologies can and will be competitive for distributed energy and power applications, and 2) the existence of an array of benefits associated with use of DRs. Furthermore, CADER participants and sponsors appear to presume that, in general: 1) to reap many benefits associated with DR use requires new types of relationships between several key stakeholders, and 2) there is a

growing need for updated rules and regulations that do not pose unnecessary impediments to DR use.

One example of an impediment CADER seeks to address is uncertainty about regulatory approval or permitting. An important way to reduce this uncertainty (and to address other impediments to appropriate DR use) is to standardize economic valuation techniques, engineering models, regulations, and rules addressing DRs.

More specifically, to eliminate many unnecessary and/or outdated institutional biases and regulatory impediments to use of otherwise cost-effective DRs, CADER identified the need to reconcile and/or coordinate among, update, and standardize the following:

- community planning processes and criteria;
- building, fire, and safety codes;
- local siting/use permitting processes and evaluation criteria, possibly including "precertification" of specific DRs;
- environmental rules and regulations, especially air emissions permitting;
- design criteria and tools used by residential and commercial developers;
- electricity "market" and pricing information forms, flows, and availability, especially historical, real-time, and projected electricity "prices" including those for transmission and distribution; hopefully prices that are location or area-specific;
- utility "back-up" charges and competitive transition charges (CTCs) associated with deregulation; and
- value, if any, ascribed to "societal" benefits associated with DR use that are not easily internalized given present or expected electricity pricing mechanisms, such as fuel diversity, energy security, reduced air emissions, etc.

4.B.4. CALIFORNIA "WORK-IN-PROGRESS"

The California Public Utilities Commission (CPUC) is embarking on what might be the most far-reaching restructuring process to date in the electric utility industry. Motivated in large part by the advent of distributed resources (small generation and storage technologies) and the California Alliance for Distributed Energy Resources (CADER), the Commission will evaluate over the next 12 to 15 months the business rules for the distribution systems of the future.

The purpose of the order instituting ratemaking (OIR) is to investigate, through a collaborative process, whether and in what manner the Commission should propose reforms to the structure and regulatory framework governing electric distribution service. A fundamental issue, in the Commission's view, is the future vision of the electric industry and the roles of distributed generation and the distribution company. Topics addressed by the Commission will cover the gamut of business, regulatory, operational and technical issues that result from fostering increased competition and market penetration of distributed generation in distribution systems.

Five California investor-owned utilities responded to the OIR with official filings: Pacific Gas & Electric Co. (PG&E); Southern California Edison Co. (SCE); San Diego Gas & Electric Co. (SDG&E) and Southern California Gas Company (SoCalGas) jointly; and Sierra Pacific Power Co. (SPP). The following summary discussion is presented to illustrate the utility positions on the OIR as a result of these filings. These positions are not suggested policies or recommended approaches, but rather, information on utility positions.

4.B.4.1. BENEFITS OF DG

Utilities can, and should, evaluate and install DG where least-cost planning dictates it is the desirable option, meeting their PBR and customer reliability goals. The Commission should ensure "reasonable cost recovery when utilities use distributed generation cost-effectively in lieu of distribution expansion" [PG&E]. Customers have had, and should continue to have, the ability to install DG on their side of the meter and to capture the resultant cost, power quality and reliability benefits, as long as customers who do not have DG are not negatively impacted. SDG&E/SoCalGas note that increased customer DG may have the indirect effect of freeing up capacity on the utility system that could be utilized for load growth and to provide standby services. In general, utilities make virtually no mention of any quantifiable <u>system</u> benefits that will result from DG penetration on the customer side, nor do they suggest the utility should compensate the DG owner for them.

4.B.4.2. PLANNING

A number of questions arise, such as: How will overall distribution system planning be done, and who will be responsible? What methods will be used to evaluate DG vs. other distribution capacity alternatives? Will peaking or

baseload units predominate, and how will their operation be coordinated with the grid? What level of capacity assurance should distribution planners use to prevent either over- or under-capacity of the distribution circuit? What will be the rules for backup service? Who will control the ancillary services market and will DGs be required to participate, especially for local needs? What is the critical unit size of a DG relative to feeder (or area) such that an unexpected outage does not threaten the integrity of the system? Different problems arise depending on location of the DG, whether close to the substation or farther out on the circuit.

4.B.4.3. STRANDED ASSETS

The utilities view customer-sited DG as necessarily causing bypass of the distribution system to at least some extent, resulting in the stranding of distribution assets both at the substation and the distribution feeder levels, and that they should be allowed reasonable cost recovery by the Commission if it occurs. Interestingly, however, SDG&E and SoCal Gas are of the "opinion that overall system load growth may outpace any load loss resulting from distributed generation. Thus, we expect the amount of distribution assets to be stranded as a result of the growth of DG to be insignificant."

4.B.4.4. REGULATORY TREATMENT OF DG

The utilities feel that DG can be addressed adequately in the present regulatory structure. PG&E's concern is that "DG should not be artificially subsidized," and the Commission should be mindful in its ratemaking and policy decisions of the "true costs" to all parties of implementing DG. Customer DG will generally lie outside the Commission's regulatory jurisdiction, except where the utility provides standby service or the customer wishes to backfeed into the grid; the latter case will require evaluation in light of applicable FERC tariffs. Tax credits or other legislative subsidies to advance certain favored types of DG, if applied fairly, would not exacerbate the regulatory asymmetry between investor-owned and public utilities.

4.B.4.5. SYSTEM INTEGRITY

If penetration of DG in the distribution system develops to significant levels, the <u>potential</u> adverse system impacts must be addressed, chiefly including system integrity, safety and reliability. Engineering standards are the primary means by which utilities maintain system integrity, safety and

reliability in a cost-effective manner; interconnection standards are the key to integrating DG with no adverse system impacts. Maintenance in particular raises short-term issues due to weather and system outages, and is best dealt with by routine programs that are actively reviewed and managed by a single, responsible authority (i.e., the UDC). Integrity is not foreseen to be as big an issue with DG as it is with competition in wires service. Utilities by and large report few, if any, significant problems related to customer generators negatively impacting the T&D system.

4.B.4.6. RELIABILITY IMPACTS

DG used for peak clipping by the utility will enhance system reliability. Customers clearly can enhance their own reliability with DG. But, as SCE states, for overall system reliability to be maintained, it is essential that the distribution system operator (i.e., the UDC) have the operational efficiency and direct control over redundant resources to provide levels of reliability that a smaller distribution operator cannot provide. This requires that "both customer-site and on-grid DG are safely integrated with the utility's system."

4.B.4.7. SAFETY ISSUES

Utilities are unanimous in their position that implementation and operation of DG should not result in "islanding," i.e., a situation in which, due to an outage or a disturbance, a self-contained area of generation and load becomes separated from the rest of the utility system. This is a safety issue because utility workers must be certain if a circuit is energized or not before they work to restore the system; this is also why utilities should have operational control over DG, which by its nature introduces additional complexity into the distribution system, and the need for more sophisticated protection systems. Also, interconnection and operation standards must address the impacts DG could have on other customers on the feeder. "The primary factors influencing the safety of utility employees and the public are protection, coordination and communication" [SCE].

4.B.4.8. ENVIRONMENTAL IMPACTS

These will be difficult to ascertain, given the multiplicity of technologies, their developing nature, and uncertain rates of market penetration. DG technologies vary, plus or minus, in the amounts of various pollutants emitted per kWh

relative to central generation. There may be local impacts due to locating DG near load centers, and reduced stack heights limiting dispersion near ground level. There will likely be issues surrounding construction, noise, visual impacts, land use and zoning. SPP notes that "siting DG in environmentally sensitive areas such as the Lake Tahoe Basin would be a less attractive option than importing power into the basin on existing or modified transmission and distribution facilities." It is unclear how the environmental agencies will deal with a large number of small units sited over a dispersed area. In any case, it should be the net environmental impact that matters.

4.B.4.9. FUEL/GAS SUPPLY

If natural gas fired DG is installed in great numbers, there will be substantial implications for the natural gas delivery infrastructure. Increased use of existing natural gas distribution infrastructure could help lower unit gas distribution costs. Planning and capital cost estimations are important, but there are also public health and safety concerns if gas is curtailed, e.g., under winter peaking conditions. Gas transportation charges for DG can be addressed within the current regulatory framework. Gas used to fire DG should be classified as noncore and interruptible during periods of high residential gas use, the same as for other electrical facilities that use gas.

4.4.B.10. WIRES BYPASS AND STANDBY CHARGES

The utilities feel that DG can result in bypass of wires service and the stranding of distribution assets, both substation and wires. Therefore, the Commission should ensure "adequate means for utilities to recover past investments in distribution facilities to the extent that these investments become stranded" [PG&E] by customer-sited DG. Standby requirements will be dependent to some degree on whether DG has "black start" capability or uses induction technologies, but the primary concern is that customers who self-generate, yet depend on the grid for backup, should pay their fair share of the fixed costs of providing distribution service in order to avoid shifting costs to other customers.

4.B.4.11. INTERCONNECTION STANDARDS

The utilities will still have the lion's share of the responsibility for maintaining safe and reliable operation of the distribution system. Therefore, interconnection

standards and practices will be of utmost importance, and while they "should be made as simple and predictable as possible" [PG&E], they should conform to "best practices" and the safety, integrity and reliability of the system must be preserved. As DG proliferates, so will the complexity of standards. Customers with DG must take on increased responsibility commensurate with their changed role: new building codes, installation oversight and consumer protection programs may be necessary.

4.B.4.12. SOCIAL, ECONOMIC AND LABOR IMPACTS

Both utility and customer use of DG can help to lower energy costs, positively benefiting all customers. Businesses can lower their costs without cutting jobs, and improve California's competitiveness over other regions. Positive employment impacts will result from local tradesmen installing and maintaining DG, although these may be offset by a corresponding loss of jobs in the UDC. There can be negative effects on local air quality, noise and visual impacts. Public purpose programs that are funded through electric rates can be negatively impacted by decreased use of the distribution system, although to the extent DG is fueled by natural gas this effect is mitigated by the public purpose component of natural gas rates.

4.B.5. EXIT FEES OR COMPETITIVE TRANSITION CHARGES

In a number of states, much discussion about distributed generation has focused on the allocation of exit fees. A load is subject to a surcharge or "tax" known as a "Competitive Transition Charge," by the utility if existing load is served by any party other than the incumbent utility, such as a distributed generator.

California currently does not impose CTC charges on loads served by self-generation that are new or incremental loads.

In the California Assembly Bill 1890, transition costs are defined as (costs for facilities rendered uneconomic by the transition to a deregulated, competitive electric structure). The bill establishes a mechanism for recovery of those costs by assessing them to customers, subject to "changes in usage" (Section 371). Changes in usage are defined as those "occurring in the normal course of business," e. g., changes/reductions in business operations, leaving the service territory, increased efficiency of cogen equipment, DSM/EE, and "fuel switching *including fuel cells*" (emphasis added). In Section 383, responsibility is given to the

California Energy Resources Conservation and Development Commission to determine whether fuel cells should be treated as fuel switching for the purposes of application of CTCs.

In Arizona, CTC's are not imposed on self-generation facilities even when the loads are those formally served by the utility.

R14-2-1607, Rule of the Arizona Corporation Commission, "Any reduction in electricity purchases from affected utility resulting from self-generation, demand side management, or other demand reduction attributable to any cause other than the retail access provisions of this Article shall not be used to calculate or recover any Stranded Cost from a consumer."

The New Jersey legislation adopted 1/7/99 determines exit fees for "on-site generators that sell only to on-site generators are exempt from paying "(SBC, MTC and Transition Bond Charges. However, the legislation goes on to state that on-site generation will be subject to all exit fees if " the amount of generation from on-site generators has reduced the kilowatt hours distributed by an electric public utility to a level equal to 92.5 percent of the 1999 kilowatt hours distributed. This policy seems to call for an artificial threshold to be placed on on-site generation.

The NJ legislation is an excellent temporary provision to encourage the limited adoption of distributed generation. It seems to open the door to substantial market penetration without penalizing distributed generation installations with cumbersome and expensive standby, exit and stranded generation fees. The 92.5% (of kWh) level is temporarily generous but seems arbitrary. What will happen when this limit is reached in several years? Several possibilities are:

- Distributed generation beyond that level is penalized to the point of creating non-economic costs and levels out. In the year the limitation is reached, a lottery would need to be held to allocate the remaining kWh of exemptions allowed under the legislation.
- The only market is 7.5% of <u>load growth</u>, which would be much less than 1% per year of distributed generation market penetration. In each year a lottery would need to be held to allocate the small number of exemptions allowed under the legislation
- The legislation is revised to remove the upper limit.
- The penalties are removed or expire, independent of distributed generation.

Once a distributed generation is exempted does it always remain so? If the new distributed generation units push the aggregate

over the 92.5% kWh limit, do all distributed generation owners pay a proportion of the aggregate penalties or just the new ones?

A further complication is the uncertainty over annual variations in the capacity factors of the aggregation of distributed generation. Would the distributed generation owners initially claim very low projected dispatch periods, but subsequently become baseload operators?

4.B.6. ADMINISTRATION BILL

4.B.6.1. ACCELERATED DEPRECIATION

The Administration's proposed Comprehensive Electricity Competition Act.

The Administration proposes to accelerate the depreciation for "distributed power property" to 15 years.

Such "distributed power property" is fairly broadly defined as:

- any distributed generation installed at a commercial, industrial or rental property, or
- any combined heat (or cooling) and power (greater than 40% useful energy output, on a BTU basis) installations at an industrial site with an on-site aggregation rating of over 500 kW.

A 50% maximum limitation is placed on the fraction of the electricity created which can be used by "unrelated persons," presumably including neighboring electricity consumers.

Other than the 500 kW minimum for CHP, these rules and limitations should not cause any concern to anyone wishing to take advantage of the accelerated depreciation.

Owner occupied residential units are of course not included.

Commercial class customers are not mentioned by name but seems to be covered under "non-residential real property used in the taxpayer's trade or business." It is not clear that industrial non-CHP units also fit this definition, making the lower limit of 500 kW on CHP irrelevant.

4.B.6.2. TAX CREDIT FOR CHP INSTALLATIONS

These provisions would add combined heat and power (CHP) to the technologies, which are allowed a tax credit in the year of their installation (only calendar years 2000, 2001 and 2002 are affected). The CHP tax credit is 8% of the

allowable installed costs of such units (solar and geothermal credits are each 10%).

Performance and quality standards of each installation are to be prescribed by several agencies including DOE and EPA.

A 50 kW minimum size and a 60% minimum system energy efficiency (on a BTU basis) is required. Very large distributed units (above 50 MW) must be over 70% efficient.

A broad range of (simultaneous) balance between thermal and electrical energy outputs is allowable.

SECTION 5

PROJECT SUMMARY AND NEXT STEPS

5.A. SUMMARY

This project has summarized pertinent existing material on distributed generation interconnection and associated tariff and contract provisions. The project also includes development of portions of the results by taking the next step of the progression leading to more utilization of distributed generation.

Section 1, Introduction and Process, introduces the reader to the subject area and describes the process used for the project. The role of the project in distributed generation interconnection is described in Figure 1.1 in Section 1. Interconnection guidelines and model tariff and contract provisions are "sandwiched" between the various application and appeal processes and the policy guidance/rules from regulators. No single set of solutions will necessarily result in reduced barriers to DG. Rather, a full, robust approach must be used to class the many boundaries in the existing situation.

Section 2, Technical Interconnection Provisions, provides a model technical interconnection standard whose objective, if implemented, is to facilitate the incorporation of distributed generation into the electric distribution system in an expedited manner without compromising the high levels of safety, stability and reliability of the system. Existing and evolving interconnection standards were reviewed and evaluated for applicability and completeness, and a Glossary of definitions was included to clarify the discussion of individual technical issues.

In order to simplify interconnection requirements where possible, distributed generation units are classified according to type, size and whether they are connected directly to the system or through an inverter. Safety issues are paramount, and are treated in detail, both in the discussion of protection systems and in regard to isolation, islanding and synchronization procedures. Protection systems are discussed at length, being one of the most important considerations for interconnection requirements. Interface with the utility for control and coordination is described, including telemetry considerations and guidelines for testing and certification of generation equipment.

The Interconnection Provisions are intended to serve as a general framework for addressing interconnection issues, and not as a purely technical specification that will serve in all cases: each utility will have

specific technical requirements in each category, and the generator owned will need to negotiate these specifications with the utility. The section on Approval Process and Data Required should serve as a useful template for speeding the approvals process, currently one of the main bones of contention when implementing distribution generation.

Section 3, Other Non-Technical Contract Provisions and Application Process, highlights several contract provisions that may be useful in balancing the needs of the distribution supplier and the DG owner.

We were not able to find a model contract that equitably covered all aspects of the installation and operation arrangement that would be in place between generation owners and the utility.

Section 4, Policy and Tariff Provisions, covers the policy and tariff provisions and implications for DG. While the field of distributed resources is growing rapidly, apparently very little consensus has been reached in regulatory forums as to the form or details for treating distributed resources issues.

Public policies, when stated, have been generally favorable to distributed resources. These policies are often vague as to how to encourage distributed resources for the common economic good or for potential system reliability and efficiency improvements. The most consistent policy on distributed resources is to ignore the issue almost entirely in restructuring debates and leave as a topic to be added in later, if at all. California is an exception where the possibilities of distributed resources have been brought to the fore by the California Alliance for Distributed Energy Resources; the ongoing OIR has even raised the issue of distributed resources policy in the context of the need for distribution monopolies. Clearly there is much more to do in distributed resource policy and regulatory development.

Since the market penetration of distributed resources has to date been slow, many of the tariff issues have yet to be addressed in a uniform manner, instead they are handled in a case-by-case basis between utilities and the customers who wish to interconnect their own distributed generation. Net metering has broken some new ground for distributed resources tariffs, but it has primarily been applied to renewables and fuel cells, limited to small units and sometimes to upper bounds of cumulative installations in a state or utility.

5.B. NEXT STEPS

The major drivers of the distributed resources concept are the economic savings of providing more supply nearer the load, either by customers or utilities.

The most concrete areas of progress to date have been in the technical aspects of interconnection of distributed resources. Here several states

have held extensive hearings and have reached limited conclusions over interim procedures for a subset of technologies and sizes. Meanwhile, IEEE SCC 21 should be supported in accelerating their efforts to resolve the most technical aspects of distributed resources interconnection to relieve the pressure from the states to do so and avoid needless or conflicting work in the area.

For customers to take advantage of distributed resources requires them to be able to install units without undue costs, in a straightforward manner, in a reasonable amount of time, but not to the detriment of the safety and security of the local wires system. The technical interconnection issues are advancing quickly but the process and non-technical issues need to be made more equitable between the utility and the customer. The customer obviously is expected to continue to pay their rates during any periods of negotiation, pay for required upgrades to the utility distribution system, and may be faced with non-negotiable exit fees, standby charges, study fees etc. Yet in many places there may be substantial utility benefits if the customer installs and operates the distributed generation unit properly. Currently we are lacking the data, approved methodology and regulatory mechanism to allow customers to determine where distributed resource units would generate such benefits and the size of those benefits. The confusion about whether distribution utilities should be allowed to own and/or operate their own distributed resources has clouded the issue of whether such benefits are substantial and how they should be awarded and allocated between the customer and the utility.

From a utility standpoint, there may be valid issues about a wires-only company owning distributed resources. This needs to be thought through carefully because the wires company may be prevented from a very economic alternative to wires upgrades if they may not consider their own peaking distributed generation solution. An even thornier issue arises if the wires company attempts to install distributed storage to handle these same distribution system peaks, here they are merely buying energy on the grid to use later at their convenience.

On the tariff side net metering for renewables is a good start, but needs to be examined more fully for other clean technologies including combined heat and power, electric and thermal storage, fuel cells, etc.

It may be valuable to assist establishing and supporting a wider industry effort in DG interconnection. Such an effort would bring together the many stakeholders needed to implement changes in today's limiting procedures. One benefit of such an approach is more resources used in a coordinated manner. Whether or not such a group is established, NARUC may want to focus on policies that bear on contractual relationships. With the restructuring of the vertically-integrated system, contractual relationships become increasingly important.