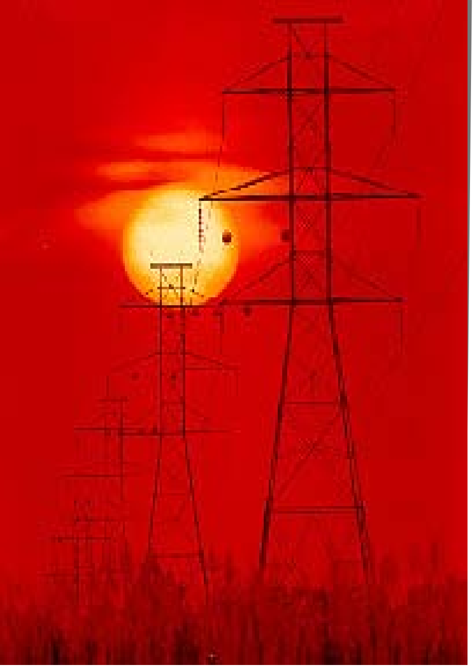

CEC Value of DA:

Distribution Automation Detailed Scenarios

May, 2007

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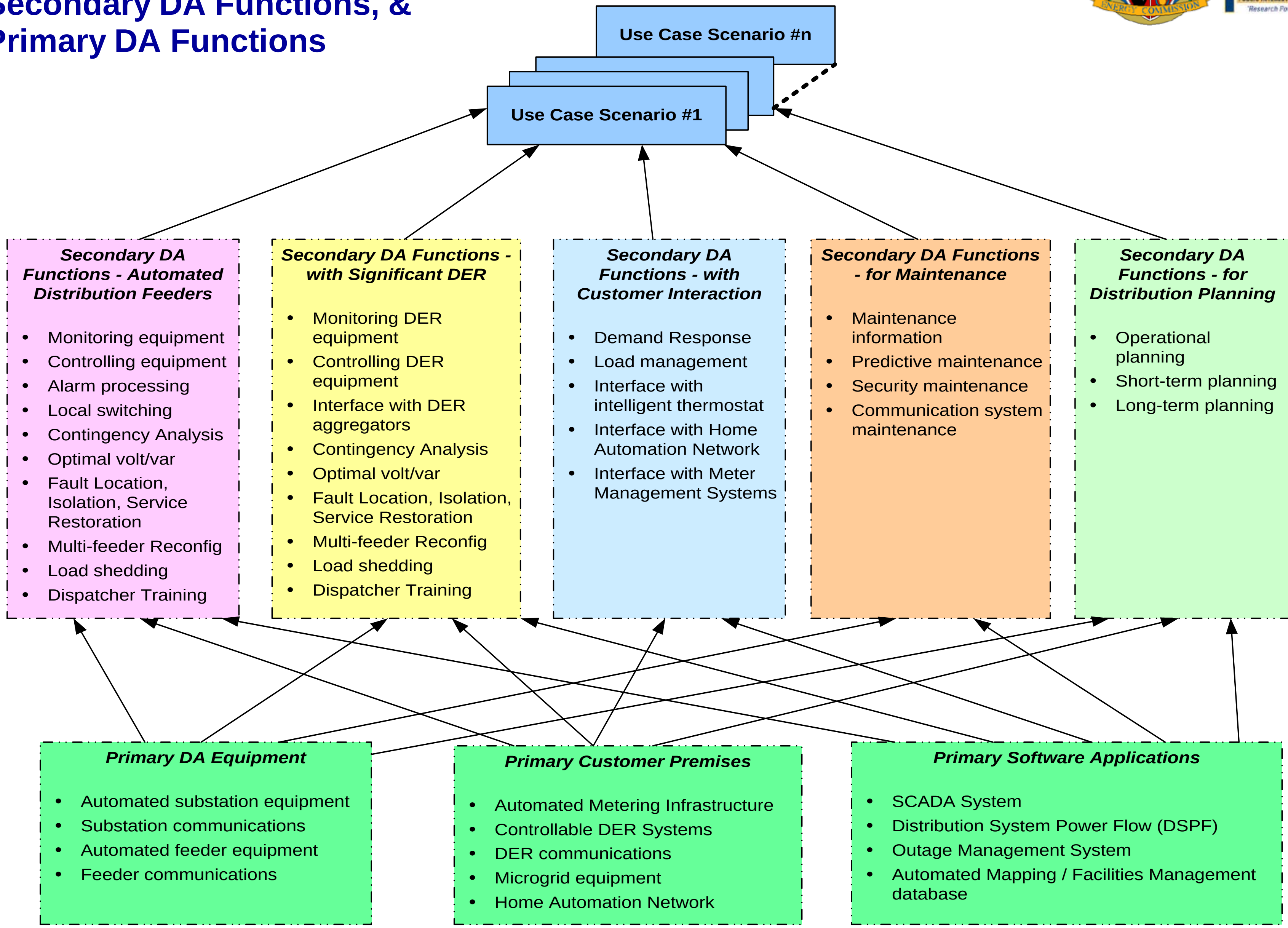
Purpose of Use Case Scenario and DA Functions Document

- The purpose of this document is to describe key Use Cases Scenarios which are built up from primary and secondary Distribution Automation (DA) functions.
  - The Use Case Scenarios each focus on specific purposes that distribution automation may be used for.
  - The supporting DA functions provide the details of how those purposes may be met.
- Although this document describes only a few Use Cases Scenarios, the DA functions may be used in many combinations to develop other Use Cases Scenarios.
- Two types of DA functions are identified:
  - Primary DA functions which typically include equipment, communications, and/or basic data systems;
  - Secondary DA functions which utilize the data provided by the primary DA functions.

Relationships between Use Case Scenarios, Secondary DA Functions, & Primary DA Functions



List of Possible DA Scenarios / Use Cases

- **#1: Basic Reliability Use Case** – Local Automated Switching for Fault Handling (e.g. IntelliTeam)
- **#2: Advanced Reliability Use Case** – FLISR with Distribution System Power Flow (DSPF) Analysis
- **#3: Efficiency Use Case** – Efficiency Assessment with DSPF Analysis
- **#4: DER Planning Use Case** – Planning, Protection, and Engineering of Distribution Circuits with Significant DER Generation
- **#5: Basic Real-Time DER Management Use Case** – SCADA Monitoring and Control of DER Generation
- **#6: Advanced Real-Time DER Management Use Case** – DSPF Analysis for FLISR, Microgrids, Safety, Market with Significant DER Generation
- **#7: Distribution Maintenance Management with DER Use Case** – Maintenance, Power Quality, and Outage Scheduling with Significant DER Generation/Storage
- **#8: Demand Response with DER Use Case** – Distribution Operations with Demand Response and Market-Driven DER Generation/Storage

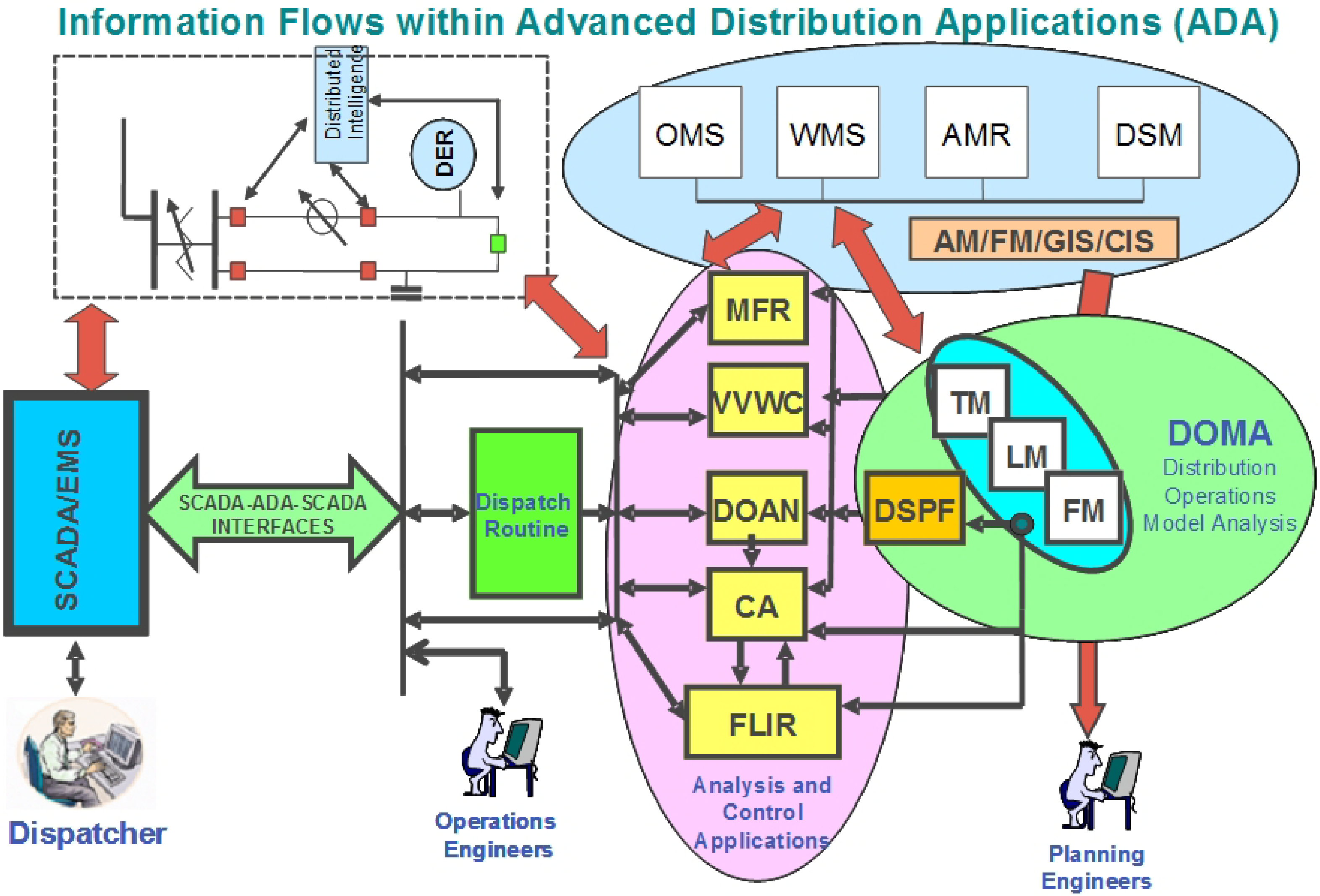
#1: Basic Reliability Use Case – Local Automated Switching for Fault Handling (e.g. IntelliTeam)

- Reliability of supplying electric energy to customers is a high priority to all stakeholders in the electric power industry: customers and society benefit directly from it, regulators therefore require high reliability, and utilities respond as cost-effectively as they can. Although manual methods have been used for years to provide certain levels of reliability, automation can provide increased levels of reliability.
- The “Basic Reliability Use Case” covers the use of SCADA to the substation, automated switches on feeders that respond to faults locally, and SCADA monitoring of these automated switches. It includes the following functions:
  - Distribution SCADA to the substation
  - Local Automated Switching (e.g. IntelliTeam)
  - SCADA communications to automated switches (fault indicators, switches, etc.)

#2: Advanced Reliability Use Case – Advanced Distribution Applications (ADA) based on Distribution System Power Flow (DSPF) Analysis

- The "Advanced Reliability Use Case" includes Secondary DA functions based on the Primary DA Distribution System Power Flow (DSPF) analysis of the distribution system in real-time and in study mode
- The key functions include the following:
  - Distribution SCADA to the substation
  - Local Automated Switching (e.g. IntelliTeam)
  - SCADA communications to automated switches (fault indicators, switches, etc.)
  - Real-time DSPF model to run power flows using real-time SCADA data
  - Study DSPF model to run power flows on sets of historical or study data
  - Fault Location, Isolation, and Service Restoration, using the automated switching capabilities and the real-time DSPF to manage fault situations
  - Contingency Analysis, using the real-time and/or study DSPF model to analyze contingencies of feeders
  - Reliability Analysis, using the real-time and/or study DSPF model to assess the reliability of feeders
  - Relay Protection Re-coordination, using the real-time and/or study DSPF model to assess protection settings
  - Multi-Feeder Reconfiguration, using the real-time and/or study DSPF model to assess feeder loading and recommend reconfiguration of feeders
  - Predictive Maintenance
  - Power Quality Management
  - Load Management

Diagram of ADA Information Flows



TM - Topology Model; LM - Load Model; FM - Facility Models; DSPF – Distribution System Power Flow; MFR – Multi-Level Feeder Reconfiguration; VVWC – Volt/Var/Watt Control; DOAN – Distribution Operations Analysis; CA – Contingency Analysis; FLIR – Fault Location, Fault Isolation, and Service Restoration;

#3: Efficiency Use Case – Efficiency Assessment with DSPF Analysis

- Efficiency of the distribution system is often considered of secondary importance to reliability, but can become of significant interest on specific feeders and substations that are handling high loads and/or variable power factor situations, so that it actually can improve reliability.
- In addition, new laws and regulatory pressures that focus on “reducing dependence on foreign energy sources” and/or “reducing greenhouse gases and other polluting emissions” may make efficiency of more direct importance in the future.
- The Efficiency Use Case utilizes the ADA’s DSPF model of the distribution system, along with real-time data from the SCADA system, to assess first the adequacy (will the equipment be able to handle the expected loads) and the efficiency (how efficiently is the power system operating and what can be done to improve that efficiency). It also includes automation to support customer-side incentives to improve overall energy usage, through demand response, time-of-use metering, and load management.
- The “Efficiency Use Case” includes the following functions:
  - Distribution SCADA to the substation
  - SCADA communications to automated feeder equipment (fault indicators, switches, capacitor banks, voltage regulators, etc.)
  - Adequacy Analysis of Distribution Operations using the DSPF model
  - Efficiency Analysis of Distribution System using the DSPF model
  - Optimal Volt/Var Analysis and Control using the DSPF model
  - Demand Response, TOU, and Real-Time Pricing to encourage conservation and direct response to the cost of generation
  - Load Management to shift load during times of high generation costs

#4: DER Planning Use Case – Planning, Protection, and Engineering of Distribution Circuits with Significant DER Generation

- Utilities have been required for many years to permit the interconnection of non-utility generation, but the pressure to interconnect these generating (and storage) units to the distribution system has increased significantly over the past few years, and is expected to increase even more rapidly in the future.
- Although no-one can predict how much DER generation and/or storage will ultimately be interconnected, it is clear that these decisions will be made more by utility customers than by utilities. This decentralized decision-making on where and how much generation will be implemented adds a degree of uncertainty that utilities have never had to manage before.
- Many DER units are small, and can rightly be viewed as “negative load” by utilities and thus be treated essentially as invisible to distribution operations (so long as they comply with the interconnection standards such as IEEE 1547, California’s Rule 21, or the utility’s requirements).
- Some larger DER units have been and will continue to be implemented, owned, and/or operated by utilities. Some DER units have been and will continue to be implemented, owned, and/or operated by customers or third parties. Over time, aggregated amounts of generation from small DER units will become “visible” in distribution operations.
- Distribution planning and/or engineering must assess each proposed DER interconnection to ensure it meets the required interconnection standards. They must also assess any impact on distribution feeders, feeder equipment, substations, distribution operations, maintenance procedures, etc. to accommodate the DER interconnection. If changes must be made, these changes must be engineered and implemented before the DER interconnection is finalized.
- The “DER Planning Use Case” includes the following functions:
  - Study DSPF model to run power flows on sets of historical or study data
  - Assessment of proposed DER interconnections
  - Monitoring/Assessment of Implemented DER Interconnections

#5: Basic Real-Time DER Management Use Case – SCADA Monitoring and Control of DER Generation

- Larger DER units and aggregates of smaller DER units are impacted by, and can impact, real-time distribution operations. SCADA monitoring and (direct or indirect) control of these DER units allows them to be “visible”, thus adding to reliability and safety of distribution operations.
- The “Basic Real-Time DER Management Use Case” includes the following functions:
  - Distribution SCADA to the substation
  - SCADA communications to automated feeder equipment (fault indicators, switches, capacitor banks, voltage regulators, etc.)
  - SCADA Monitoring and Control of DER Units
  - Supervisory Control of Switching Operations with DER Units
  - Utility Controls DER to Meet Distribution Operational Requirements

#6: Advanced Real-Time DER Management Use Case – DSPF Analysis for FLISR, Microgrids, Safety, Market with Significant DER Generation

- Advanced Real-Time DER Management involves analyzing the distribution system in real-time or "near" real-time to determine actions in response to planned or unforeseen situations that involve significant DER generation/storage. This analysis would be needed for fault location, isolation, and service restoration, protection coordination, establishment of microgrids, safety of field crews and the public during outages, power quality, market operations involving DER units, and many other activities. This type of analysis would be impossible for distribution operators to handle without support from the DSPF model that forms the foundation of the ADA capabilities. The DSPF model would need to cover not only the distribution system but also the larger DER units as well as some model of aggregated small DER units.
- The "Advanced Real-Time DER Management Use Case" includes the following functions (although it is not expected that all functions would be implemented initially):
  - Distribution SCADA to the substation
  - Local Automated Switching (e.g. IntelliTeam)
  - SCADA communications to automated switches (fault indicators, switches, etc.)
  - Real-time DSPF model to run power flows using real-time SCADA data
  - Study DSPF model to run power flows on sets of historical or study data
  - DSPF Model of Distribution Operations with Significant DER Generation/Storage
  - Adequacy Analysis with Significant DER Generation/Storage
  - Reliability Analysis with Significant DER Generation/Storage
  - Contingency Analysis with Significant DER Generation/Storage
  - Fault Location, Fault Isolation, and Service Restoration (FLISR) with Significant DER
  - Multi-Level Feeder Reconfiguration (MFR) with Significant DER
  - Efficiency Analysis with Significant DER
  - Optimal Volt/Var Control with Significant DER
  - Relay Protection Re-coordination (RPR) with Significant DER
  - Assessment of the Impact of DER during Distribution Planned Outages
  - Planned Establishment of Microgrids for Peak Shaving or Other Financial or Operational Reasons
  - Emergency Establishment of Microgrids during Power Outage or Other Emergencies
  - Post-emergency Assessment of DER Responses and Actions
  - Management of Power Quality Using DER and DA Equipment
  - Management of Market Operations with DER
  - Coordination of Distribution and DER Operations with Transmission Operations

#7: Distribution Maintenance Management with DER Use Case – Maintenance, Power Quality, and Outage Scheduling with Significant DER Generation/Storage

- Maintenance of the distribution system that includes significant DER can be a new challenge. These new challenges include the following:
  - Although DER units are now all expected to turn off or disconnect during a power system outage, those actions need to be verified for every DER unit to ensure that both utility field crews and the public are safe from presumably “dead” circuits that are actually still “live”.
  - Planned outages or even work on “live” circuits needs to be coordinated with DER operations to ensure they are able to manage the situation.
  - Power quality of circuits can be affected by DER installations – both for the better or for the worse.
  - Microgrids may need to be established before maintenance activities can commence, to avoid loss of power to customers.
  - Maintenance or loss of DER units may affect distribution system operations if significant load was expected to be supported by the DER units – financial contracts not withstanding.
  - If feeders are reconfigured to minimize the impact of maintenance activities, protection settings will need to be changed to reflect those reconfigurations, since the mix of generation and load will change.
  - Managing the uncertainties of large numbers of smaller customer-owned DER units will require more sophisticated assessments before outages or power restorations can be scheduled.
- As the number of DER units grows and as the amount of generation is derived from DER units, distribution operations will no longer be able to manage the maintenance of the system without significant support from automation.
- The “Distribution Maintenance Management with DER Use Case” includes the following functions:
  - Distribution SCADA to the substation
  - Real-time DSPF model to run power flows using real-time SCADA data
  - Study DSPF model to run power flows on sets of historical or study data
  - DSPF Model of Distribution Operations with Significant DER Generation/Storage
  - Contingency Analysis with Significant DER Generation/Storage
  - Multi-Level Feeder Reconfiguration (MFR) with Significant DER
  - Relay Protection Re-coordination (RPR) with Significant DER
  - Assessment of the Impact of DER during Distribution Planned Outages
  - Planned Establishment of Microgrids for Peak Shaving or Other Financial or Operational Reasons
  - Emergency Establishment of Microgrids during Power Outage or Other Emergencies
  - Post-emergency Assessment of DER Responses and Actions
  - Management of Power Quality Using DER and DA Equipment
  - Predictive Maintenance Application Assesses Distribution Equipment
  - Scheduling of Planned Outages
  - Management of Maintenance Assets and Schedules
  - Maintenance of Databases and Software Applications
  - Maintenance Updates to Documentation and Maps

#8: Demand Response with DER Use Case – Distribution Operations with Demand Response and Market-Driven DER Generation/Storage

- Demand response by customers can encompass many different incentive structures, but fundamentally entails two types of response:
  - Decrease load in response to higher prices, and vice versa
  - Increase DER generation in response to higher prices, and vice versa
  - With the inclusion of DER generating and storage capabilities, demand response becomes even more complex, and requires Advanced Distribution Applications (ADA) using the DSPF model. Without such automation, distribution operations with demand response would become extremely difficult if not impossible.
- The "Demand Response with DER Use Case" includes the following functions:
  - Distribution SCADA to the substation
  - Real-time DSPF model to run power flows using real-time SCADA data
  - Study DSPF model to run power flows on sets of historical or study data
  - DSPF Model of Distribution Operations with Significant DER Generation/Storage
  - Contingency Analysis with Significant DER Generation/Storage
  - Multi-Level Feeder Reconfiguration (MFR) with Significant DER
  - Efficiency Analysis with Significant DER
  - Planned Establishment of Microgrids for Peak Shaving or Other Financial or Operational Reasons
  - Management of Power Quality Using DER and DA Equipment
  - Management of Market Operations with DER
  - Coordination of Distribution and DER Operations with Transmission Operations
  - Assessment of Demand Response Requirements and Pricing
  - Assessment of Real-Time Pricing (RTP) Requirements and Pricing
  - Analysis of Distribution Performance for Customer Services
  - Automatic Meter Reading (AMR)

Categorization of Benefits

- Identify and categorize benefits:
  - Direct financial benefits (reduced capital costs, reduced O&M costs)
  - Power system reliability and quality benefits (reduced SAIDI / SAIFI, improved PQ, managing significant distributed generation)
  - Safety and security benefits (improve personnel and public safety and security)
  - Energy efficiency benefits (reduce energy losses, improve power factor, improve load factor)
  - Environmental and conservation benefits (reduce pollution, reduce greenhouse gases, cap-and-trade)

Checklist of Direct Financial Benefits

- Utilities can have direct financial benefits from distribution automation. These include the following:
  - Deferred construction – capital savings
  - Decreased field crew personnel time
  - Decreased engineering personnel time
  - Extend equipment life-time
  - Improve utilization of equipment
  - Reduce O&M expenses
  - Reduce the cost of energy generation
  - Reduce loss of revenue
  - Avoid legal and regulatory penalties
  - Participate in market operations with DA
  - Potentially participate in carbon / emissions trading

Checklist of Power Reliability Benefits

- Utilities gain benefits from improved power reliability to meet CPUC regulations.
  - Reducing SAIDI / SAIFI:
    - Shorten or avoid permanent outages (e.g. outages longer than 5 minutes) to customers
    - Decrease the number of customers experiencing permanent outages
    - Decrease the number of temporary or momentary outages
    - Decrease the number of customers experiencing temporary or momentary outages
  - Reliable management of power system with distributed generation:
    - Permit/support additional DER interconnections
    - Use DER generation/storage to improve reliability
    - Support operators in decision-making during emergencies
    - Reduce loads during emergency conditions
    - Improving power quality (voltage deviation, voltage imbalance)

Checklist for Safety and Security Benefits

- Safety is clearly important in and of itself, but can also be assessed from a monetary perspective, based on the various costs for medical, legal, regulatory, safety assessment, loss of worker's time, and retraining efforts.
- Rough estimates can be made on the costs of security breaches which may be adequate enough for estimating benefits, given the broad uncertainties of security threats.
  - Increased safety of field crew
  - Support operators in decision-making during safety or security breaches
  - Support engineers in designing systems with improved safety and/or reliability
  - Increase physical and cyber security of power system operations

Checklist of Energy Efficiency Benefits

- For utilities, energy efficiency benefits would need to be tied either to direct regulations or to the tariff structures for customers.
  – Reduce losses in the distribution system
  – Reduce peak loads for demand reduction
  – Reduce transmission losses through coordinated distribution operations

Checklist for Energy Environmental and Conservation Benefits

- For utilities, energy environmental and conservation benefits would result from compliance with regulations and potentially from cap-and-trade markets.
  - Reduce energy losses in the distribution system
  - Reduce loads for energy conservation
  - Reduce particulate pollution (SOX and NOX)
  - Reduce greenhouse gases (GHG) pollution (in line with laws SB 1368 and AB 32)
  - Reduce peak loads
  - Reduce transmission losses through coordinated distribution operations