

## Smart Grid Descriptions of Benefits

Benefit	Description
Energy Revenue	Revenue generated through the competitive energy market by buying power at low prices and selling at high prices.
Capacity Revenue	Revenue generated through the competitive capacity market for a capacity credit.
Ancillary Services Revenue	Revenue generated through the competitive ancillary services market for spinning reserves or frequency regulation.
Optimized Generator Operation	Better forecasting and monitoring of load and grid performance would enable grid operators to dispatch a more efficient mix of generation that could be optimized to reduce cost. The coordinated operation of energy storage, distributed generation, or plug-in electric vehicle assets could also result in completely avoiding central generation dispatch.
Deferred Generation Capacity Investments	Utilities and grid operators ensure that generation capacity can serve the maximum amount of load that planning and operations forecasts indicate. The trouble is, this capacity is only required for very short periods each year, when demand peaks. Reducing peak demand and flattening the load curve should reduce the generation capacity required to service load and lead to cheaper electricity for customers.
Reduced Ancillary Service Cost	Ancillary services are necessary to ensure the reliable and efficient operation of the grid. The level of ancillary services required at any point in time is determined by the grid operator and/or energy market rules. Ancillary services, including spinning reserve and frequency regulation, could be reduced if generators could more closely follow load; peak load on the system was reduced; power factor, voltage, and VAR control were improved; or information available to grid operators were improved.
Reduced Congestion Cost	Transmission congestion is a phenomenon that occurs in electric power markets. It happens when scheduled market transactions (generation and load) result in power flow over a transmission element that exceeds the available capacity for that element. Since grid operators must ensure that physical overloads do not occur, they will dispatch generation so as to prevent them. The functions that provide this benefit provide lower cost energy, decrease loading on system elements, shift load to off-peak, or allow the grid operator to manage the flow of electricity around constrained interfaces (i.e. dynamic line capability or power flow control).
Deferred Transmission Capacity Investments	Reducing the load and stress on transmission elements increases asset utilization and reduces the potential need for upgrades. Closer monitoring, rerouting power flow, and reducing fault current could enable utilities to defer upgrades on lines and transformers.
Deferred Distribution Capacity Investments	As with the transmission system, reducing the load and stress on distribution elements increases asset utilization and reduces the potential need for upgrades. Closer monitoring and load management on distribution feeders could potentially extend the time before upgrades or capacity additions are required.
Reduced Equipment Failures	Reducing mechanical stresses on equipment increases service life and reduces the probability of premature failure. This can be accomplished through enhanced monitoring and detection, reduction of fault currents, enhanced fault protection, or loading limits based on real-time equipment or environmental factors.

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Reduced T&D Equipment Maintenance Cost	The cost of sending technicians into the field to check equipment condition is high. Moreover, to ensure that they maintain equipment sufficiently, and identify failure precursors, some utilities may conduct equipment testing and maintenance more often than is necessary. Online diagnosis and reporting of equipment condition would reduce or eliminate the need to send people out to check equipment resulting in a cost savings.
Reduced T&D Operations Cost	Automated or remote controlled operation of capacitor banks and feeder and line switches eliminates the need to send a line worker or crew to the switch location in order to operate it. This reduces the cost associated with the field service worker(s) and service vehicle.
Reduced Meter Reading Cost	Advanced metering infrastructure (AMI) equipment eliminates the need to send someone to each location to read the meter manually, leading to reduced meter operations costs. AMI technology can also reduce costs associated with other meter operations such as connection/disconnects, outage investigations, and maintenance.
Reduced Electricity Theft	Smart meters can typically detect tampering. Moreover, a meter data management system can analyze customer usage to identify patterns that could indicate diversion. These new capabilities can lead to a reduction in electricity theft through earlier identification and prevention of theft.
Reduced Electricity Losses	Functions that provide this benefit could help manage peak feeder loads, reduced electricity throughput, locate electricity production closer to the load and ensure that voltages remain within service tolerances, while minimizing the amount of reactive power provided. These actions can reduce electricity losses by making the system more efficient for a given load served or by actually reducing the overall load on the system.
Reduced Electricity Cost	Functions that provide this benefit could help alter customer usage patterns (demand response with price signals or direct load control), or help reduce the cost of electricity during peak times through either production (DG) or storage.
Reduced Sustained Outages	A sustained outage is one lasting > 5 minutes, excluding major outages and wide-scale outages. The monetary benefit of reducing sustained outages is based on the value of service (VOS) of each customer class. The VOS parameter represents the total cost of a power outage per MWh. This cost includes the value of unserved energy, lost productivity, collateral damage, administrative costs, the value of penalties and performance-based rates. Functions that lead to this benefit can reduce the likelihood that there will be an outage, allow the system to be reconfigured on the fly to help restore service to as many customers as possible, enable a quicker response in the restoration effort, or mitigate the impact of an outage through islanding or alternative power supply.
Reduced Major Outages	A major outage is defined using the beta method, per IEEE Std 1366-2003 (IEEE Power Engineering Society 2004). The monetary benefit of reducing major outages is based on the VOS of each customer class. The VOS parameter represents the total cost of a power outage per MWh. This cost includes the value of unserved energy, lost productivity, collateral damage, the value of penalties and performance-based rates. Functions that lead to this benefit can mitigate major outages by allowing the

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	system to be reconfigured on the fly to help restore service to as many customers as possible, enable a quicker response in the restoration effort, or mitigate the impact of an outage through islanding or alternative power supply.
Reduced Restoration Cost	The functions that provide this benefit lead to fewer outages and/or help restore power quicker or with less manual labor hours, which results in lower restoration costs. These costs can include line crew labor/material/equipment, support services such as logistics, call centers, media relations, and other professional staff time and material associated with service restoration.
Reduced Momentary Outages	By locating faults more accurately or adding electricity storage, momentary outages could be reduced or eliminated. Moreover, fewer customers on the same or adjacent distribution feeders would experience the momentary interruptions associated with reclosing. Momentary outages last <5 min in duration. The benefit to consumers is based on the value of service.
Reduced Sags and Swells	Locating high impedance faults more quickly and precisely and adding electricity storage will reduce the frequency and severity of the voltage fluctuations that they can cause. Installing advanced reclosers that only allow a limited amount of current to flow through them upon reclosing can also reduce voltage fluctuations. Moreover, fewer customers on the same or adjacent distribution feeders would experience the voltage fluctuation caused by the fault. The benefit to consumers is based on the value of service.
Reduced CO <sub>2</sub> Emissions	Functions that provide this benefit can lead to avoided vehicle miles, decrease the amount of central generation needed to their serve load (through reduced electricity consumption, reduced electricity losses, more optimal generation dispatch), and or reduce peak generation. These impacts translate into a reduction in CO <sub>2</sub> emissions produced by fossil-based electricity generators and vehicles.
Reduced SO <sub>x</sub> , NO <sub>x</sub> , and PM-2.5 Emissions	Functions that provide this benefit can lead to avoided vehicle miles, decrease the amount of central generation needed to their serve load (through reduced electricity consumption, reduced electricity losses, more optimal generation dispatch), and or reduce peak generation. These impacts translate into a reduction in pollutant emissions produced by fossil-based electricity generators and vehicles.
Reduced Oil Usage (not monetized)	The functions that provide this benefit eliminate the need to send a line worker or crew to the switch or capacitor locations to operate them eliminate the need for truck rolls to perform diagnosis of equipment condition, and reduce truck rolls for meter reading and measurement purposes. This reduces the fuel consumed by a service vehicle or line truck. The use of plug-in electric vehicles can also lead to this benefit since the electrical energy used by plug-in electric vehicles displaces the equivalent amount of oil.
Reduced Wide-Scale Blackouts	The functions that lead to this benefit will give grid operators a better picture of the bulk power system and allow them to better coordinate resources and operations between regions. This will reduce the probability of wide-scale regional blackouts.