Better Demand Response with Distributed Energy Resources

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SUMMARY

Power DR (demand response from distributed energy resources) allows a greater number of sites to participate in DR programs, which will improve the overall DR strategy in a given utility area. Systems may also be aggregated to act as a single large distributed generation block, further increasing DR possibilities.

The aggregated mechanism with power DR is also bidirectional, meaning the central authority may employ the assets as a variable load during times of overproduction, which may be an issue in areas with high PV penetration. By coupling the speed of power electronics with the bidirectional system design, the overall grid stability may be significantly enhanced.

OVERVIEW

Demand response is a mechanism where a central power provider can reduce its maximum load. The maximum load reduction is desired for either economic reasons or stability reasons. Generally, generation plants are fired in order of power production cost so that the cheapest production provides the body of baseload power. As demand moves into peak ranges, smaller, faster and more expensive generators are brought on line to match the load; however, the cost of fuel or additional emission releases make load curtailment more economically desirable.

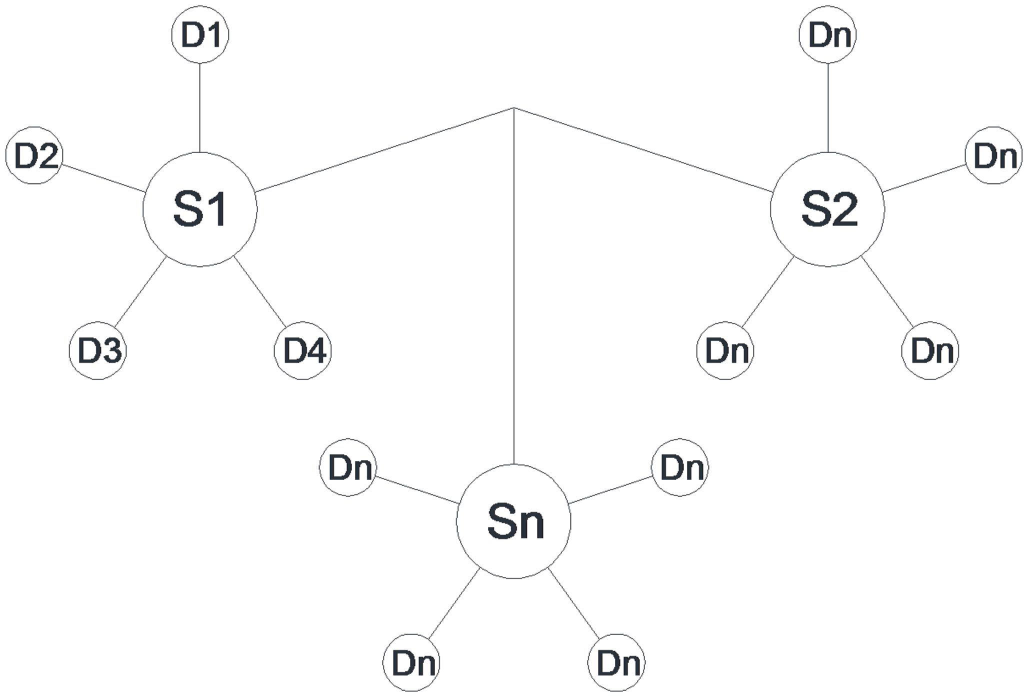
The bulk power system relies on fixed control constants such as voltage and frequency to support a safe and effective supply. To maintain control, the system must always have some reserve capacity so that instantaneous demand changes may be dealt with. As the loads approach the system supply maximum, the system stability is compromised.

Demand response can encompass several different strategies. Per Order No. 719, the Federal Energy Regulatory Commission (FERC) defined demand response to mean "a reduction in the consumption of electric energy by customers from their expected consumption in a response to an increase in the price of electric energy or to incentive payments designed to induce lower consumption of electric energy."

The definition on its face appears to be based on the pure reduction of electrical energy consumption at a time driven by economic incentives. To fully comprehend the intention of the definition, certain boundary conditions must be understood.

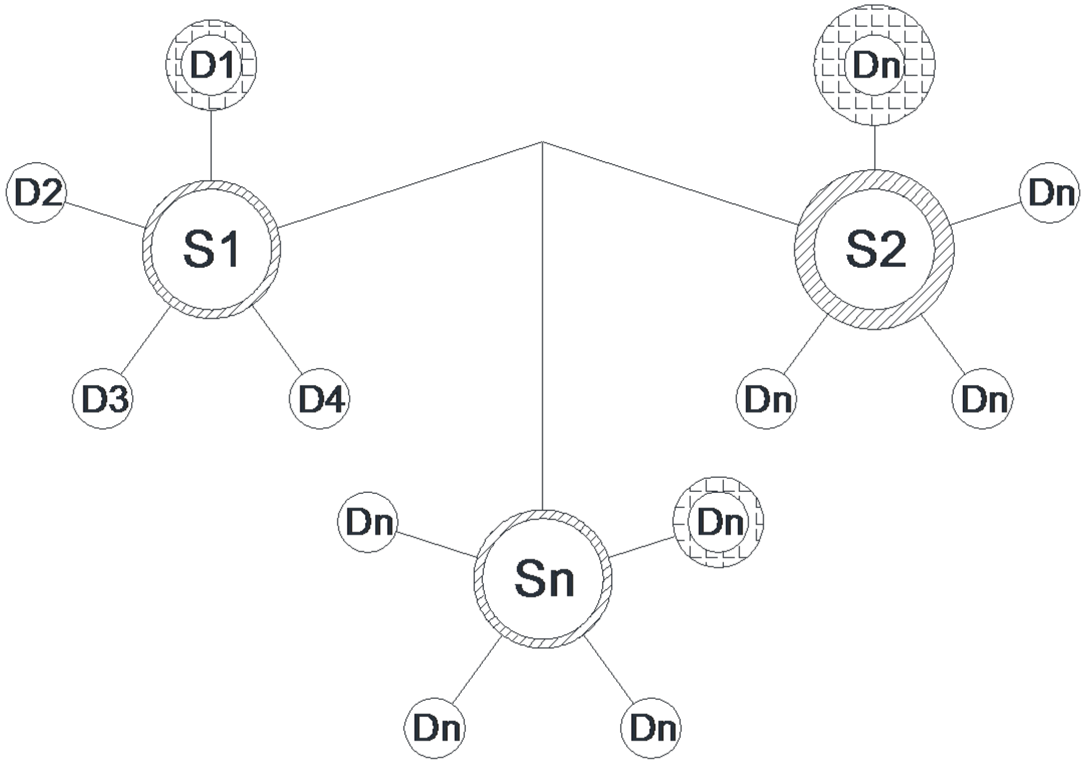
ENERGY SUPPLY AND DEMAND

Bulk power systems are made up of many supply and demand nodes. The sum of the supply nodes always equals the sum of the demand nodes such that: $\Sigma S1 + S2 + .. + Sn = \Sigma D1 + D2 + .. Dn.$ The supply always chases the demand as the supply is variable and controllable. The demand is typically only variable and random, although somewhat predictable based on historical data.



Supply and demand network; Supply (S1..Sn) is finite and Demand (D1..Dn) is not

Supply consumes resources to provide electrical power at a given cost; demand consumes electrical power to produce some convenience, social or economic benefit. Demand response seeks to align the cost associated with the production of power with the benefit of the final use of the provided power. One method of DR is a reduction in load either through real time pricing or through a fixed price contract, allowing a central provider authority to shut off certain pre-agreed systems or processes. This type of arrangement allows a limited amount of control over the system load, and the reduced demand based on pricing exactly follows the FERC definition of DR.



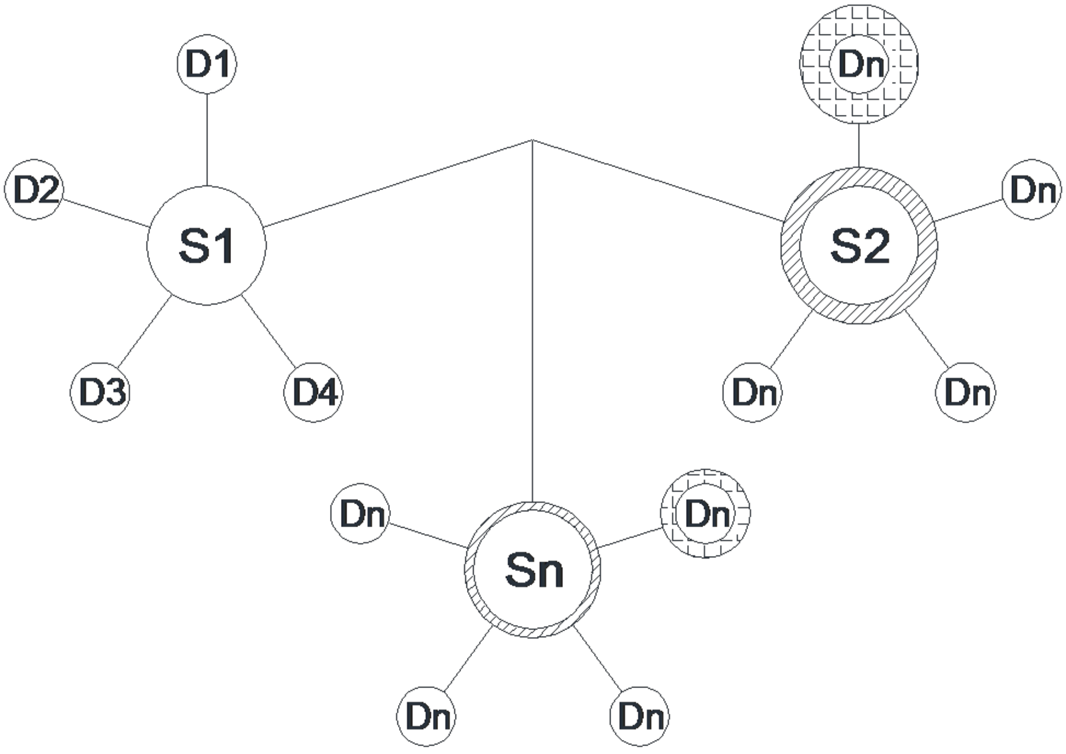
Demand has increased; supply has increased to balance the system – shaded areas

The ultimate goal of a DR event is to reduce the amount of power required from a central power provider per the first part of the definition, "a reduction in the consumption of electric energy by customers from their expected consumption….." If the economic benefit of the power consumption by the end user is greater than the additional cost of electricity, then the end user has a negative incentive to reduce consumption. If the energy supply constraint is merely an economic one, then the supplier is made whole by the increased price, and the consumer maintains a benefit of consumption albeit at a reduced rate. If the energy supply constraint is a stability issue, then the system control is not enhanced in any way by an increase in price with no corresponding decrease in consumption.

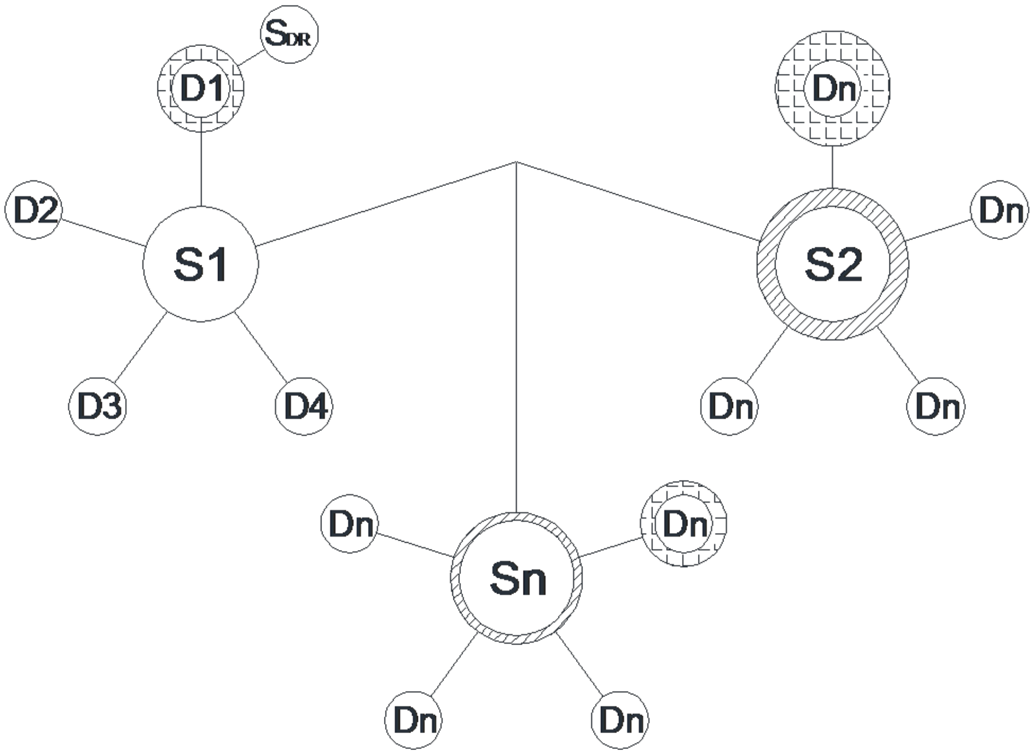
UTILIZING DISTRIBUTED ENERGY RESOURCES AS A DR STRATEGY

Distributed power injection is a DR strategy that encompasses all facets of the desired DR outcome, particularly as it relates to high-value consumer processes. Power DR is based on the reduction of supply from the central power provider by the local injection of power at a point of use. Power DR exactly follows the mathematical intent of the DR definition by adding to the supply side to maintain a balance in the system. The supply from the central provider is reduced and the overall system stability is maintained, if not enhanced, as the reserve supply capacity is increased. Power DR can come from small thermal generation, from rapidly dispatchable on-site storage, or from a combination of both.

Load shedding DR systems are employed to help augment the utility control or cost, but benefits are limited to monetary compensation to sites that can afford to reduce non-essential electrical loads at a requested time. Sites with critical processes cannot participate in load shedding DR events or incentives. Storage based systems with power DR allow a greater number of sites to participate by alleviating the connection of critical process power feeds from the central power provider.



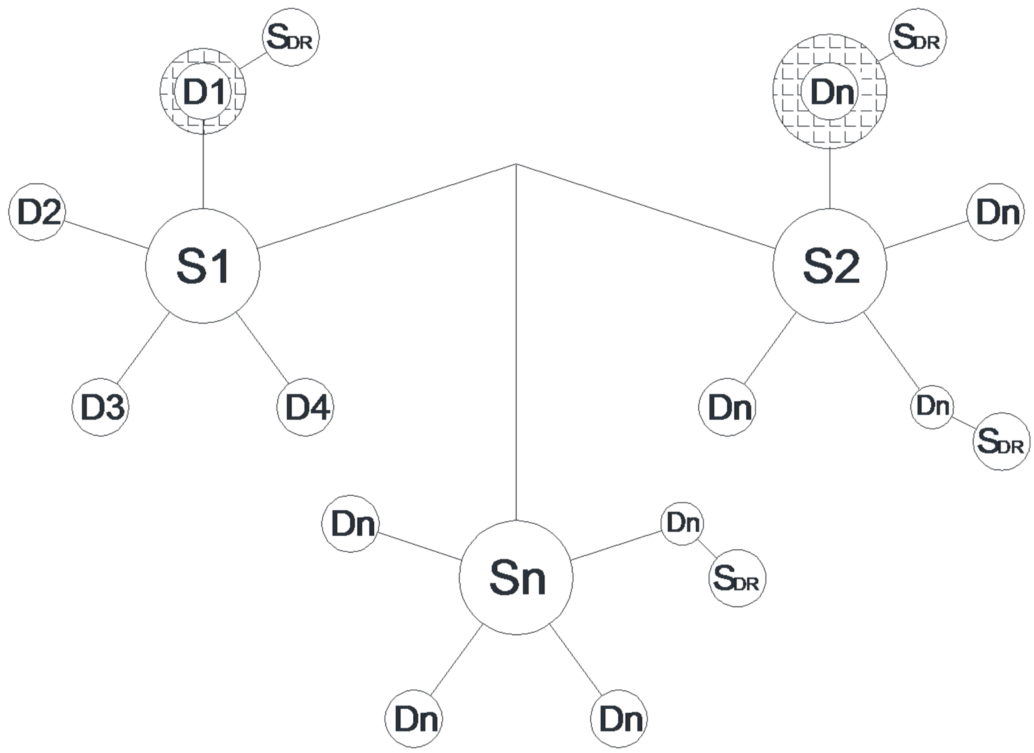
D1 reduced through load shedding, S1 reduced to follow



D1 is augmented with local supply, SDR, but no reduction in load.
The Net Effect on S1 is the same with a reduction in supplied power

Power DR allows a greater number of sites to participate in DR programs, which will improve the overall DR strategy in a given utility area. Systems may also be aggregated to act as a single large distributed generation block, further increasing DR possibilities. The aggregated mechanism with power DR is also bidirectional, meaning the central authority may employ the assets as a variable load during times of overproduction, which may be an issue in areas with high PV penetration. By coupling the speed of power electronics with the bidirectional system design, the overall grid stability may be significantly enhanced.

Storage based systems consist of energy storage, generally in the form of batteries and power electronics (inverters) that convert the stored DC energy into AC energy to couple with the grid. The inverter interfacing to the grid interact in quadrants defining real and reactive power regions. Typical solar inverters act effectively in one quadrant – positive real power. DR inverter systems usually act in at least two quadrants, positive and negative real power, as the inverters tend to recharge the storage with power from the grid. Advanced inverters operate in four quadrants offering reactive power, (VAR) support along with ordinary DR functions to augment site power quality and economics. The capability to store energy opens the potential to select the energy generation source to maximize the site and DR response economics.



Bulk power system with multiple power DR sources, some used to reduce peak loads, some used to reduce base loads. Distributed 4 quadrant systems help increase overall grid stability

LYNC DR® FOR FACILITIES WITH CRITICAL PROCESSES INTERESTED IN DR

Go Electric's LYNC DR® is a storage based energy platform predicated on the Power DR concept. LYNC DR® provides instant energy injection to the system in a DR event, helping the installation site maintain its critical processes at full power while curtailing the energy supplied from the utility. The LYNC DR® device consists of a 4-quadrant advanced AutoLYNC® power electronics and storage module coupled with an open ADR 2.0 communication portal.

The AutoLYNC® power electronics and storage behave in much the same way as a typical thermal synchronous generator with a few key differences. The AutoLYNC® is always 'ON' in a watch state with very low energy consumption. The AutoLYNC® device can provide additional site benefits such as power factor correction, (reactive power, VAR support).

The storage system can be leveraged to maximize the monetary potential of on-site renewable generation by shifting the energy from the time of production to the time of a DR event. Using renewables to supply the DR energy reduces the total utility supply and subsequent cost. In the case of thermal generation, it replaces required fuel.

The AutoLYNC® system is available in several power sizes and is expandable to cover future needs or site requirements. To enhance site capability, resilience and security, an AutoLYNC® microgrid controller may be added along with thermal generation and renewable generation assets.

The AutoLYNC® device forms the core of a full site microgrid capability, including UPS style perpetual energy transfer to critical loads in the case of a utility outage, peak shaving and islanding capabilities.

For more information on this case study and Go Electric LYNC DR® systems, contact Alex Creviston at Alex@GoElectricInc.com.