Non-Confidential CEDR Description

CEDR attempts to do only one very simple task (reduce loads during DR conditions) robustly and inexpensively. This addresses one of California's, and the world's, biggest energy problems; emergency demand management to avoid system overload and rolling blackouts.

CEDR allows using existing building power wiring to send control signals, typically introduced at the load center, to points where the sheddable loads may be selectively switched off. It is not generally required for shedding entire circuits as those can be more economically controlled at the load center, or when the cost of adding new control wiring would be insignificant compared to the money saved.

A signal generated offsite, such as by a utility company or the state ISO, is easily sent to any building with little infrastructure cost compared to the load shed. But once received, sending the signal to "sheddable" loads is much more costly. Most existing building automation and energy control systems lack the ability to shed individual loads or portions of loads, and expensive rewiring would be required. Alternative technologies, such as cellular and RF mesh networks controlling individual loads might work well but require expensive hardware costing $250 per point or more. The CEDR system can reach sheddable loads in buildings in a very low cost manner utilizing the existing building's power lines. CEDR can enhance building automation systems that are already DR enabled by extending shedding to additional loads. "Commissioning" of the CEDR system is done by wiring a switch, outlet, or adding a plug load controller between the outlet and the item to be controlled. This low tech version of commissioning is much more likely to be done correctly and maintained.

The basic CEDR system consist of:

1. Building Communication Entry Point (BCEP): The utility's DR signal must arrive at the building and be routed to the CEDR system.
2. Building-Level Receiver-Sender (BLRS): The BLRS is an electrical device that is typically installed at one location at the building, generally at the electrical panel which introduces a phase cut power line signal during DR conditions.
3. Demand Responsive Relay Receivers (DRRRs): Multiple DRRRs would be installed throughout the building. These DRRRs would be connected to individual or aggregated building loads (initially lighting loads, but ultimately non-lighting loads too) and would switch relays from load on to off when the presence of the power line signal is detected.

The Building's BCEP could receive DR signals through established or developing protocols such as Smart Meter, Programmable Communicating Thermostat, pager, cellular, Ethernet, Internet, FM sub carrier, power line communication over utility lines, etc. The utilities have been investigating this part of the system and are arriving at different preferred solutions, any of which can trigger the CEDR system with a simple relay contact closure. The CEDR program is not presently developing a BCEP solution for those reasons, though it may be economical to embed the BCEP function in the BLRS in some cases.

The BLRS introduces phase cuts onto the AC power lines to communicate that a DR even is in progress. These phase cuts are the same type produced by incandescent lamp dimmers, and are a commonly employed technology. The phase cuts used by CEDR have been selected to be large enough to be robustly decoded, but small enough to avoid power quality issues and to avoid significant dimming of un-shed loads. The phase cuts do not reduce the load's power draw (which would only be useful for incandescent lighting), they signal that the load should be shed.

To be useful, DR needs to be initially deployed in building retrofits as it will take many years before newly constructed buildings make up a significant fraction of the total load on the grid. The primary advantage of CEDR over existing technology is the ease of retrofitting into existing buildings. The only new wiring required for the CEDR system is from the BCEP to the BLRS, and this will typically be low voltage wiring used to engage a relay, and can be wireless when economical. An electrician will be required to route the AC power to the sheddable loads through the BLRS, which can be done next to, or inside, the electrical panel. This is much cheaper than installing control wiring to every ballast and load to be shed. The signal from the BLRS is carried by existing power wiring to each point of load control, avoiding the need for additional control or power wires. DRRRs are installed at each load, or group of loads, to be controlled.

Lighting circuits can be controlled by installing special DRRR light switches containing the detectors, thus minimizing the installation cost and avoiding work in the ceiling. The system is especially well suited for bi-level switching applications (common in California commercial buildings) were DRRR switches can be configured to switch one leg of a Title 24 dual level lighting circuit only if the other leg is energized. This achieves a substantial reduction in lighting load but does not leave the room without lighting. DRRRs are expected to be relatively small (able to fit in a standard switch or junction box) and cheap. Ultimately the function of the DRRR may be integrated into microprocessor controlled ballasts and appliances at minimal additional cost. DRRR outlets and outlet mounted controllers can control plug loads. The DRRR can include an optional DR indicator to let the occupants know that the load has been shed intentionally. DRRRs could be used to carry the DR signal to Programmable Communicating Thermostats depending on how the thermostats are implemented.

The current and voltage capacities of the BLRS and DRRRs are only limited by the particular installation's cost constraints. There will also be a tradeoff between capacity and cost of installation.

The CEDR system has been developed to the level of proof of concept. It is expected that the licensees will apply their engineering talent to cost optimize the system and match system specifications to the most promising commercial applications. The capacity of the system installed as a demonstration at CLTC presented as an example, but the only limits on capacity are that very large loads may be more economically served by running control wiring rather than encoding the power line. The BLRS encodes a single circuit of up to 20A at 120VAC and DRRRs are installed in a Title 24 wall switch, outlets and outlet mounted boxes that switch up to 10A at 120VAC each.

The installed cost of the a single DRRR will be too high to turn off a cell phone charger, but very cost effective for switching 20 ballasts in a bi-level switching retrofit. CEDR may be cost effective for individually controlled loads such as copiers, laser printers and coffee pots. Very large loads such as large commercial building HVAC (if not already under EMS control) will be retrofitted with more sophisticated systems than CEDR due to the larger cost avoided and typically the need for more than simply switching them off.

Typically the peak demand occurs during the afternoon when many people are working and thus have higher loads for commercial buildings and lower loads for residential buildings. The best opportunity for CEDR will be commercial buildings. Residential loads such as pool pumps and spas may be cost effective too. The rate and rebate programs established by the utilities will determine the market for CEDR. We are involving utilities in our planned next phase of a larger scale demonstration in some commercial buildings.

The CEDR system is not limited in how long it can be in DR mode. The DR events are expected to last approximately 2 to 6 hours and total less than 100 hours per year. Those figures may increase if demand continues to grow faster than supply.

See also:
http://research.ucdavis.edu/ncd.cfm?caseno=2006-650
http://cltc.ucdavis.edu/new-demand-response-technology.html
http://www.fypower.org/news/?p=591