



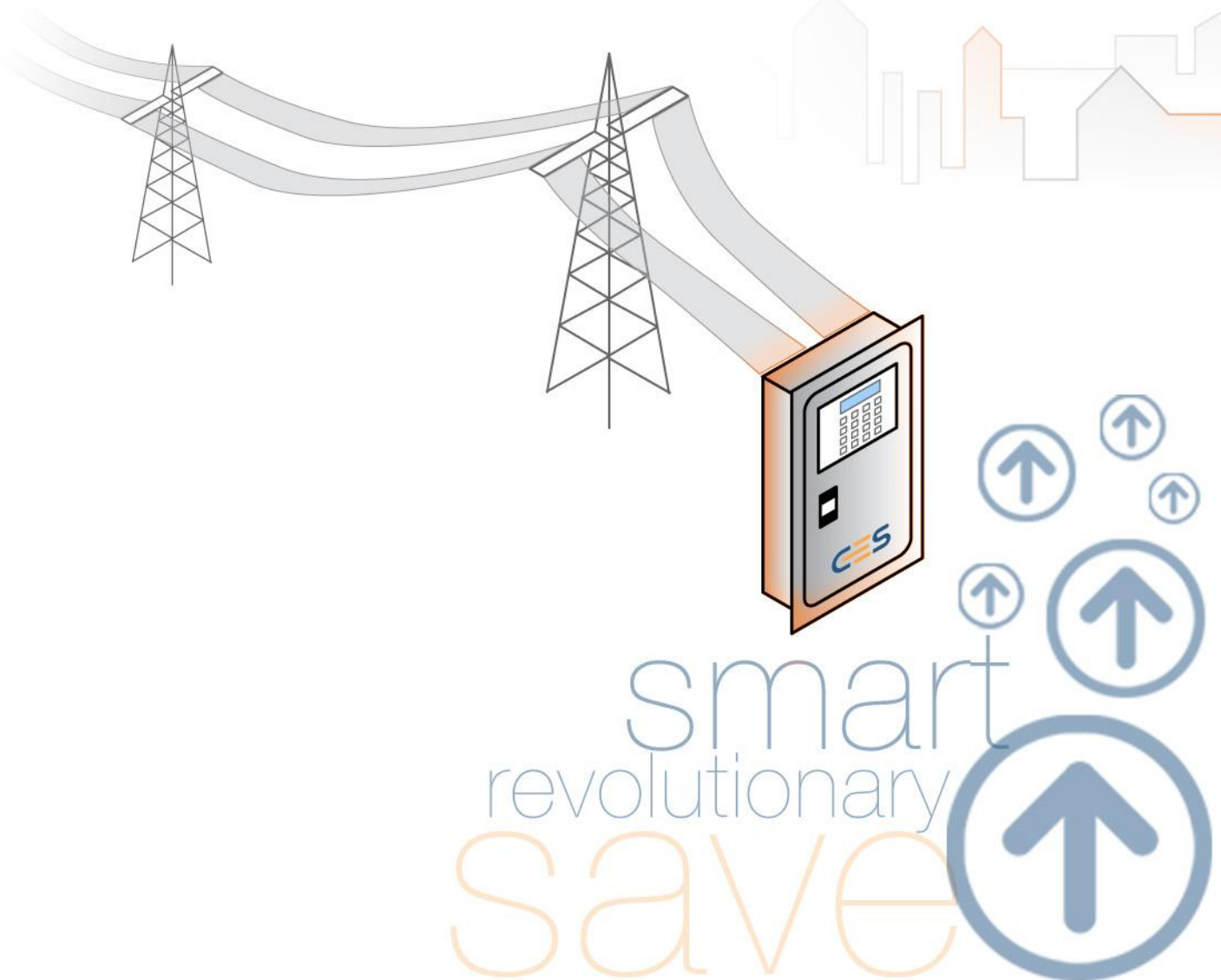
Computerized
Electricity
Systems

Peak Demand Leveling & Energy Management

Using

CES Smart Distribution Boards

(A White Paper)



smart
revolutionary
save



Table of Contents

THE ENERGY MANAGEMENT CHALLENGE - INTRODUCTION	3
CONSUMERS SIDE	3
SUPPLIERS SIDE	3
THE C.E.S. SOLUTION	4
C.E.S. SMART DISTRIBUTION BOARDS	5
C.E.S. MANAGEMENT SERVER	7
COMMUNICATION WITH CSDP	8
DEMAND LEVELING & ENERGY MANAGEMENT FEATURES	9
SUMMARY OF BENEFITS AND ADVANTAGES	11
TECHNOLOGY BRIEF	12
CSDP – CES SMART DISTRIBUTION PANEL	13
CMCS – CES CONTROL AND MONITORING SERVER	14





The Energy Management Challenge - Introduction

Managing the way energy is distributed, retailed and consumed is essential in the quest for energy efficiency in a carbon constrained world. Energy providers and energy consumers wish to increase energy efficiency for economical reasons and for protection of the environment.

This article describes a unique approach to managing energy and reducing peak demands using smart distribution boards.

Consumers Side

Today, consumers who wish to reduce their electricity bill lack the information and control capabilities required for doing so effectively.

Today, people who wish to integrate alternative power sources such as solar panels or back-up generators into the end-user infrastructure are faced with high costs of extra wiring and extra switching devices.

Today, Demand Response (DR) programs involve significant inconvenience to the end-users leading to relatively low adoption rates.

Studies have shown that successful implementation of smart control capability at end-user premises can reduce peak electricity demand by as much as 15%.

Suppliers Side

The electricity supply side is driven by economical, geo-political and environmental parameters.

Power providers are slow to adopt new technologies while aging infrastructure requires billions of dollars in investments. Volatile oil pricing - combined with the growing demand for energy in all parts of the world - impacts the business models of power providers and impacts their profitability. The growing awareness to environmental considerations, coupled with strict new regulations, is limiting the ability of power providers to build new plants. The growing demand for electricity is constantly outpacing the growth of grid capacity. As best phrased by Jim Rogers, the chairman and chief executive of Duke Energy:





" The most environmentally sound, inexpensive and reliable power plant is the one we don't have to build because we've helped our customers save energy".

The method for electricity demand management has not been significantly changed in the last three decades. Where applied, it involves complex and costly patchwork of tailored technologies at the end-user site. Typically, the implementation of such solutions is inconsistent and poorly monitored, resulting in low adoption rates and hence limited benefits for the consumer and the power provider alike.

With the continued rise in energy costs, there is a growing demand for a more efficient electricity distribution and management platform, one that will enable suppliers and consumers to derive tangible benefits from optimizing consumption and lowering peak demand. This need will become even more critical as the number of Electrical Vehicle (EV) charging facilities increases.

The C.E.S. Solution

The **C.E.S.** solution for peak demand leveling and energy cost reduction relies on the following principles:

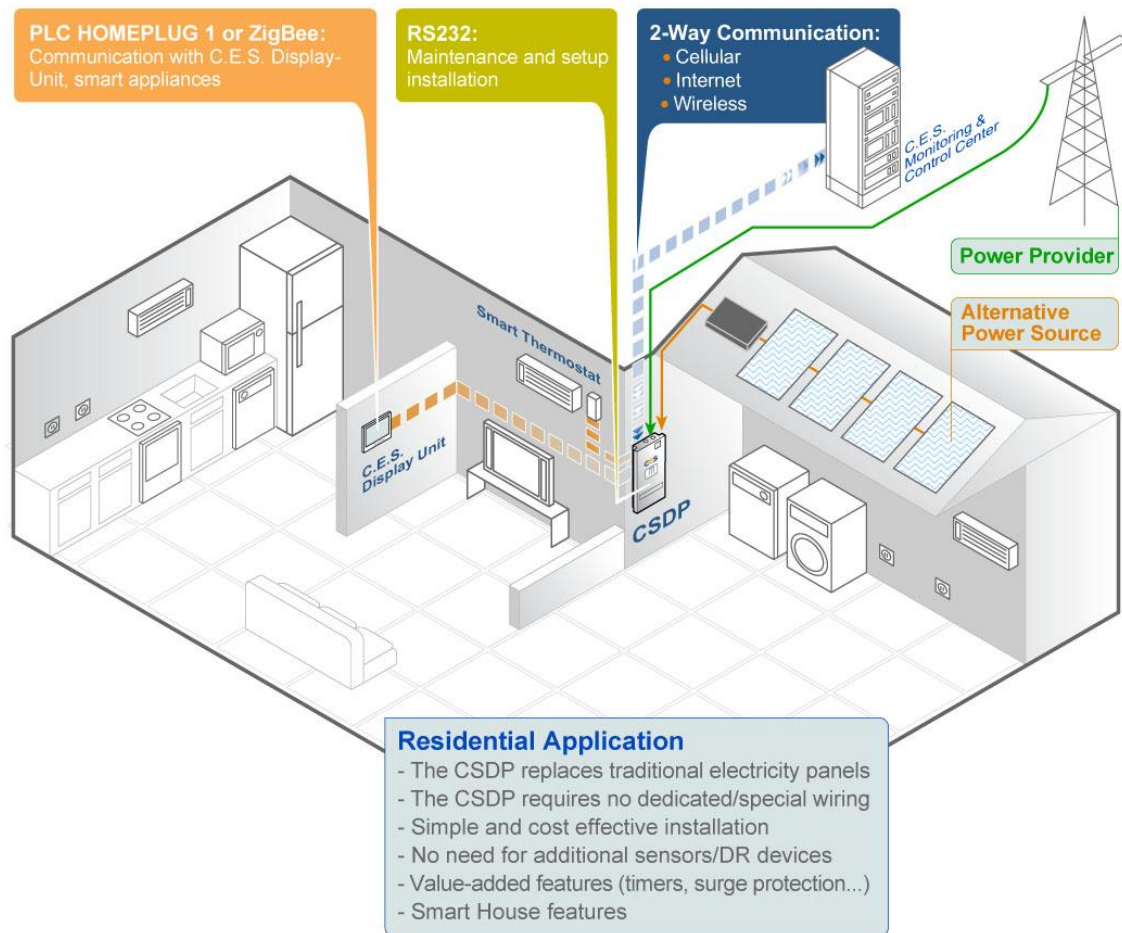
- A. Mass deployment of **Smart Distribution Boards**, each of which controls the local electricity network on the end-user premises;
- B. Central **Demand Management Server** that enables
 - Implementation of demand-limiting features and pricing schemes (see below) that yield reduced consumption during peak hour
 - Identification of excessive consumption patterns and monitoring of corrective actions
 - Real-time fault alerting, remote disconnection of wasteful appliances, remote fault analysis.
- C. Optimized utilization of **alternative sources** on premises based on price and availability.





C.E.S. Smart Distribution Boards

The CES smart distribution board, nick-named CSDP for CES Smart Distribution Panel, is installed as a regular electricity panel at the end-user's premises. It provides a central, integrative and automated energy management solution.



The **CSDP** matches the functionality of the standard electricity panel while adding safety features and smart optimization functions, local and remote management capabilities and modern web-based reporting and maintenance advantages.

The **CSDP** replaces the conventional electricity panel and provides scalable monitoring and control capabilities of energy consumption at the customer premises down to individual circuit levels. The **CSDP** unique architecture includes, in addition to standard circuit breakers, an array of highly reliable hybrid electronically-operated switches termed **smart switches**. These smart switches can be used to connect and disconnect the premises load





circuits remotely by control commands, or automatically upon current overload, short circuit, sparks and overheating. In addition, the CSDP measures the energy flowing through each circuit as well as through the supply phases.

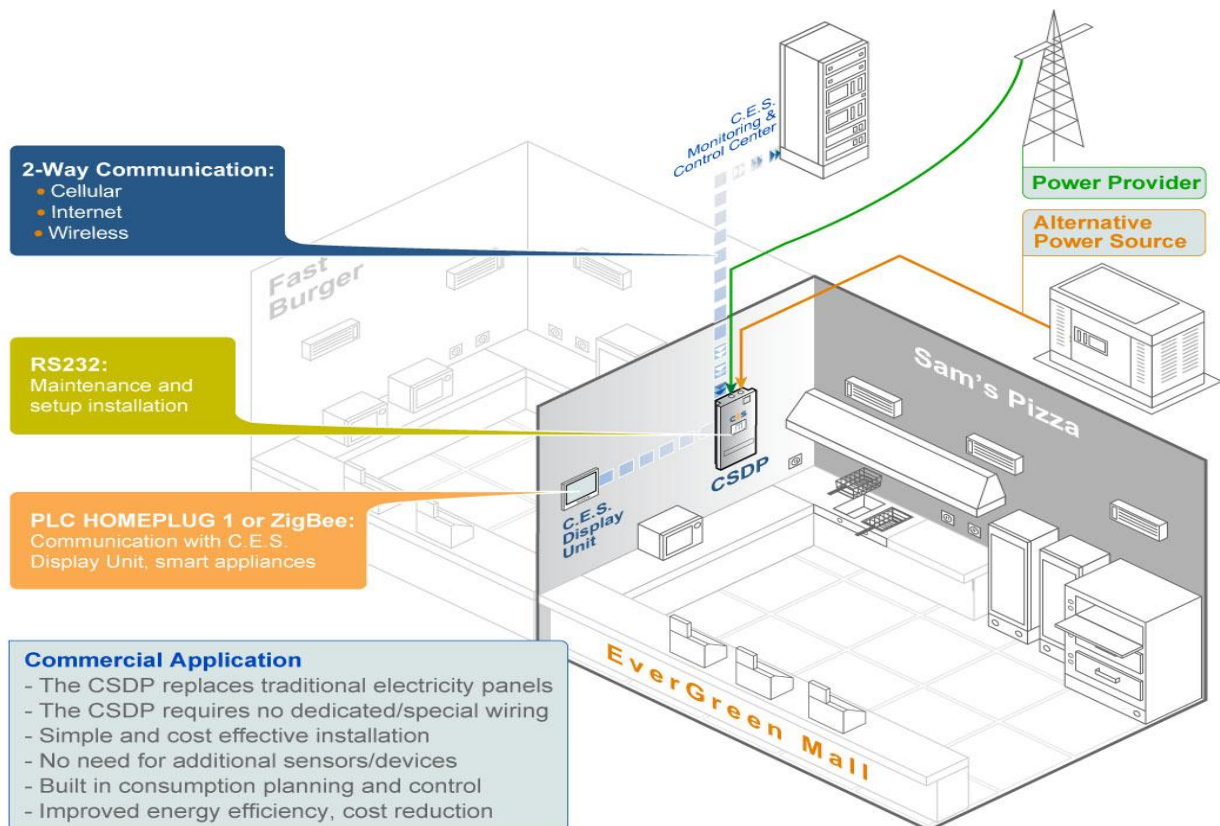
The valuable information and control options offered by the **CSDP** help users in making informed decisions about energy usage and help suppliers improve their power rate structure, power distribution systems and quality of service.

During installation, the electrician sets up the **CSDP** automatic protection and load management functions according to the unit owner's priorities.

Alternative energy sources can be connected through the **CSDP** to the existing wiring network in the premises.

Both residential and commercial models are available.

For more information see "Technology Brief" Below.

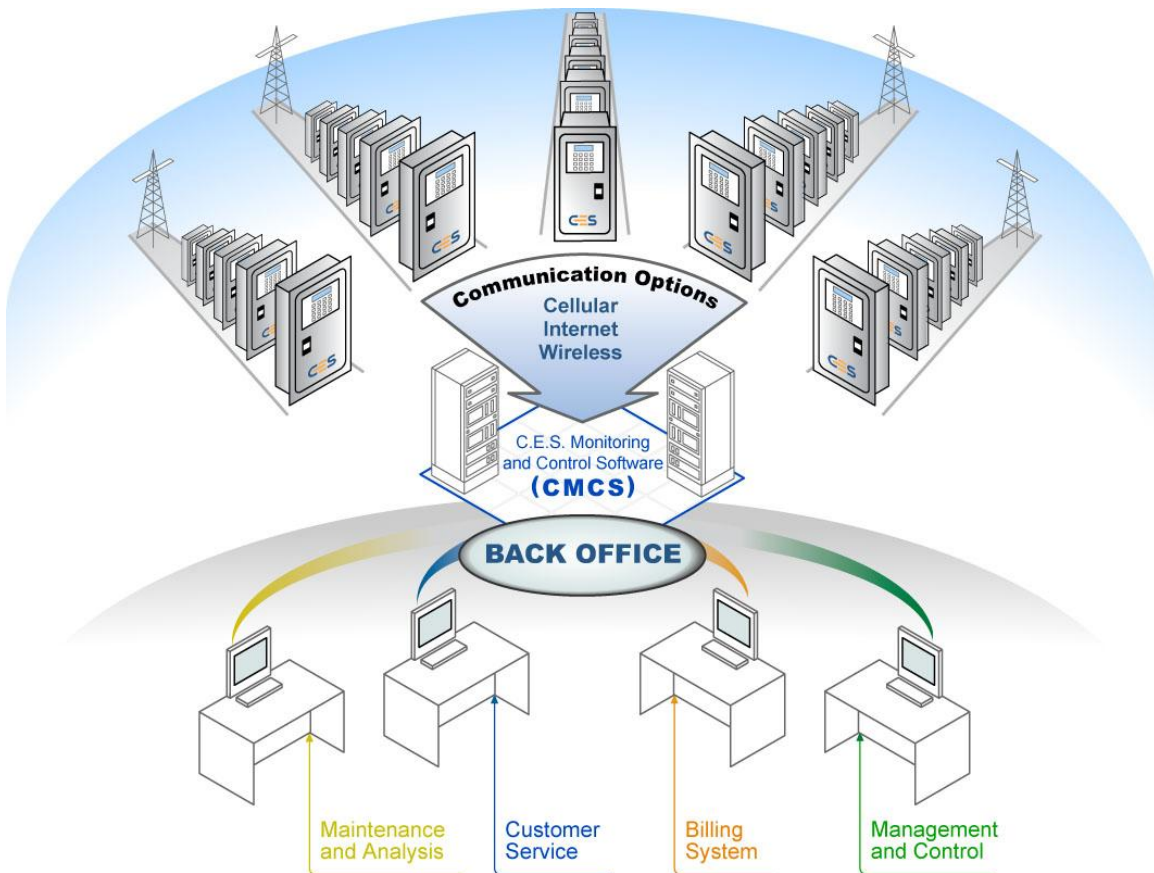




C.E.S. Management Server

The C.E.S Monitoring and Control Server (CMCS) can be located either on the WEB or inside the Energy Provider's secured zone. This powerful management application facilitates secure access to panels for remote monitoring and control; collects operational and consumption data at a frequency determined by the system administrator and stores them in a central database; sends user-defined real-time alerts if so programmed; generates user-defined reports, can exports them to spreadsheets and send them automatically to user-defined email addresses.

Energy solution providers (ESPs) such as electrical utilities, energy retailers and building managers, will use this software to improve efficiency, reduce peak demand and offer value-added services to their customers. In particular, the CSDP and CMCS are already capable of deploying smart network features, as described further below.





The **CMCS** is a modular, web-based software package, designed to adapt itself to the ESP needs. The core module facilitates data transfer to and from the deployed **CSDPs**. Layered above are the business applications, such as System admin, Setup, Monitoring and Control, Reporting, etc. The **CMCS** is designed to enable easy integration with any existing service provider control system. A set of interfaces enables smooth integration with the ESP's existing management infrastructure and back-office application.

Communication with CSDP

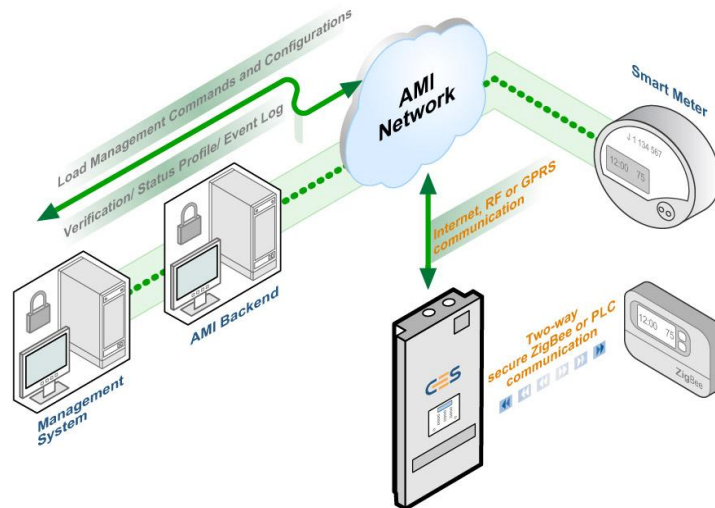
- Local communication:
 - **CSDP** comes with on-board control panel that enables the electrician to setup the unit during installation. The control panel also provides basic operational functions for the end user.
 - **CSDP** can communicate with Smart appliances by optional modems such as WiFi, Zigbee or PLC.
 - The tenant can also control and monitor the CSDP from his/her laptop through the CMCS website (see below)

- Remote Communication:
 - Remote user access to **CSDP** for management, control and data retrieval is facilitated via **CMCS** over Ethernet or GPRS.
 - CMCS offers a complete set of control commands that maximize utilization of the CSDP advanced features (see next section for a list of features).
 - Integration with an existing facility management server can be done by developing API between that server and the CMCS or between that server and the CSDPs, or both.
 - In case a Automatic Metering Instrumentation (AMI) is already installed on premises, Utility commands can be sent directly to CSDP over the relevant AMI network. The following diagram shows a typical communication configuration between the CSDP, AMI network and a smart appliance (in this case a thermostat). The Smart Meter will provide the meter functions to the utility including the actual billing information. All other actions including Demand Response, Variable Rates and any other interaction between the utility and the consumer will be done





through the CSDP, using ZigBee or PLC protocols as described above. Such communication would enable full utilization and functionality of the smart appliance/thermostat.



Demand Leveling & Energy Management Features

CES proprietary algorithms enable utilities to deploy advanced control features that are usually associated with Smart Networks, using CSDP and CMCS. Following is a brief summary of functions and services that are available for immediate implementation.

- Remote Control – User can access his/her own panel from anywhere on the Web to change the operating status of appliances in the house.
- Timer Control – User can set timers on every circuit as appropriate and change the setting remotely.
- Demand Side Management – CES unique SDB technology reduces Peak Load demand via a single command for all connected boards. When the Demand Side Management (DSM) command is sent by the utility company, the SDB disconnects electrical appliances gradually until the total demand on-site is reduced to the specified level. In the CES system, the order of circuit disconnection is fully determined by user-defined priorities; thus it is termed "Flexible DSM". A special DSM meter enables both the Utility and the user to visualize the immediate reduction in kW demand and energy consumption. Field trials have already shown that flexible DSM is effective in reducing peak demand.





- Remote Electricity Metering (AMR) – CSDP comes with a class-1 rated meter. In addition, the energy consumption of each circuit is measured in support of sub-metering applications.
- Variable Pricing – The system supports several type of pricing methods, including:
 - Fixed Price
 - Real-Time single price
 - Time-of-Use multiple prices (up to 9 week-day rates and additional Holiday rates)
- Circuit activation according to price threshold – User can set specific circuits to turn on and off automatically depending on the current price of electricity.
- Alternative Source optimization – The system is designed to accommodate either fixed or dynamic connection of Solar/Wind source to off-set demand and/or switch to emergency power generator when required. On-site utilization of solar/wind source can be optimized based on price threshold and availability.
- Pre-paid electricity – The system can be programmed to limit the consumption in case the allocated kWh per CSDP is exceeded
- Automatic switchover to surviving phases in case of a phase loss – In case of partial phase loss, the system will switch loads over to the surviving phases and report the loss of failed phase. In case of a total power failure, the system will utilize the battery backup power to notify supplier on the problem before it shuts down.
- Automatic alerts to power supplier in case of supply faults - The system can report the location of all phase losses to the network control center, yielding immediate fault isolation.
- Theft Alerts – The system can be programmed to alert on substantial difference between the energy supplied to the CSDP and the energy consumed from it.
- Remote diagnostics & maintenance - The system can support an "always-on" mode of operation. It monitors and records more than 250 fault, setup and measurement events. It can be programmed to send real-time SMS and Email alerts to authorized users. Authorized User access can be achieved from every web-connected device. System administrator can supervise all distributed panels from a single point. Technicians can access authorized units from remote location for diagnosis and setup changes.





Summary of Benefits and Advantages

The following list summarizes the benefits of the CES system:

- **Flexible, non-intrusive peak demand management:**

Support of automatic rate-driven DSM, based on user priorities, e.g.: Dishwasher will not start if price is above 20c per kWh.

Power provider can implement reliably a defined reduction in the demand by a single command.

End-user does not have to designate specific appliances for DR disconnection. When the DR command is sent from the supplier, e.g. "Reduce 10%", the **CSDP** will disconnect appliances according to its current priority settings, which can be changed at anytime by the customer. The customer is free to use any appliance within the lowered threshold.

In cases where there are smart appliances/thermostats, the **CSDP** will adjust the temperature according to the demand, instead of disconnecting the appliance.

The **CSDP** can shift an appliance from the mains to an alternative power source during DR command, instead of disconnecting it.

- **Maximal utilization of alternative energy source:**

Through the **CSDP**, the alternative source becomes an integral part of the site's energy supply and is utilized as long as it is available. Thus, the **CSDP** eliminates the need to wire specific appliances to the alternative source.

- **Enabler of advanced services to reduce Energy Service Provider operating costs:**

Real-time, remote maintenance for the customer.

Fast fault detection and fault isolation for the power provider.

Enhanced AMR.





Improved grid reliability by enabling communication between the commercial/residential electricity panel and the grid management center.

Supporting rate optimization based on wide-base statistics.

- **Total power cut-off prevention:**

The **CSDP** prevents total power cutoff in cases where the demand exceeds the maximum connection capacity.

Load management: The **CSDP** disconnects lower priority appliances to ensure supply to higher-priority appliances.

- Phase balancing: The **CSDP** provides automatic, smooth transfer of loads from one phase to another in order to avoid power cutoff. **Savings in total cost of electricity:**

Ability to plan and control electricity budget.

On-going information about electricity consumption.

No need for parallel wiring and special circuitry when installing an alternative energy source.

- **Increased safety & appliance protection:**

In addition to standard semi-automatic circuit breakers, the **CSDP** includes spark detection, protection from over-voltage and current surges (lightning).

The **CSDP** will alert or disconnect appliances in case of faulty appliance and/or degraded supply.

- **Affordable "Smart house" features:**

Timers available on every circuit.

Remote control of appliances (by phone, by Internet).

Ability to set a house quickly to other operational modes, e.g. "Out of home mode" or set the commercial space to a "Night mode".

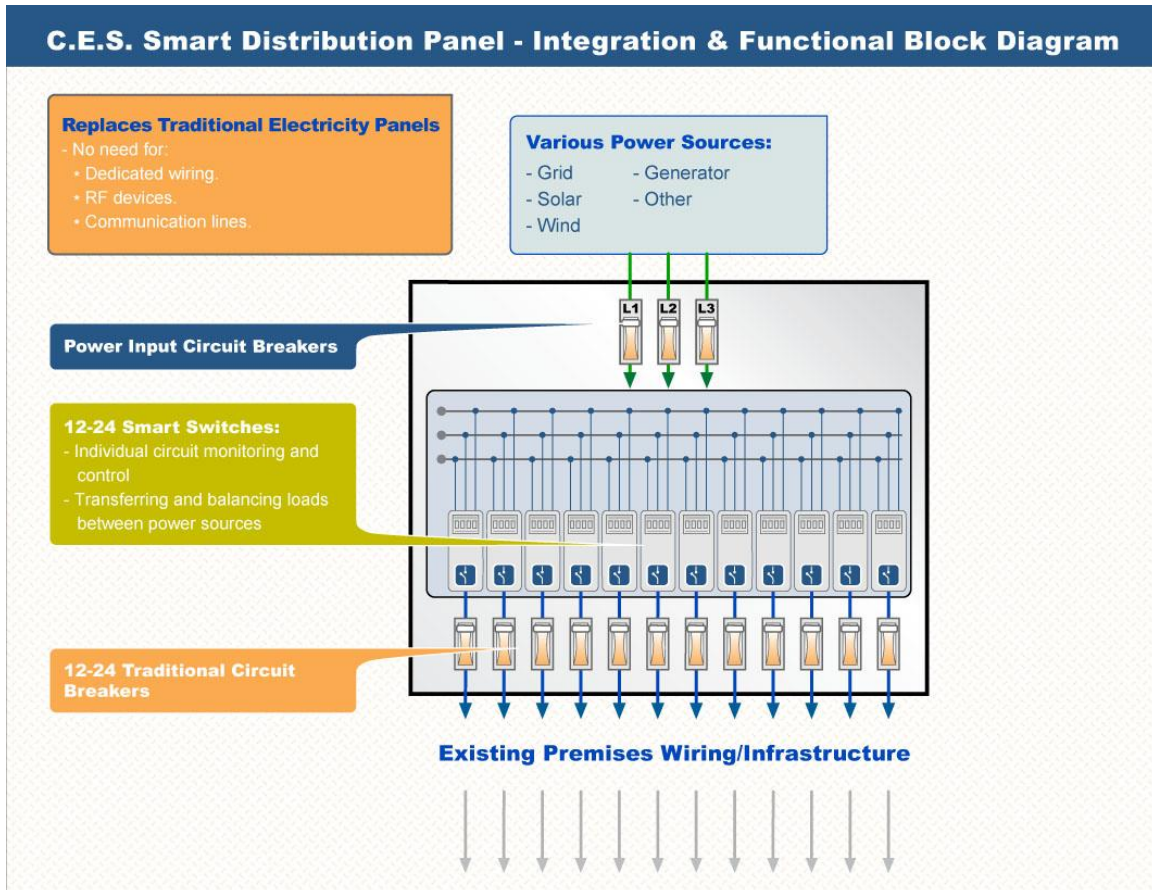
Technology Brief





CSDP – CES Smart Distribution Panel

At the core of the **CSDP** is an array of unique and patented power line arc-less switches, enabling dynamic changes in power distribution without adversely affecting consumers and/or appliances (see schematics).



C.E.S. has developed a hybrid (mechanical/solid state) smart switch, which is capable of connecting and disconnecting automatically upon current overload or short current surge detection, or manually. This smart switch is a low-cost, remotely controlled, high-current switch.

Each switch includes an electromagnetic relay device, a controlled semiconductor device, a semiconductor command circuit, a relay command circuit and an overload sensor.

Special algorithms are used for real-time monitoring and dynamic control of all electrical circuits connected to the **CSDP** based on availability and/or pricing.

Changes from normal patterns will generate alerts (for example: on a need for service, abnormal sparks or increased temperature).





The **CSDP** will have the ability to receive variable price information, allowing consumers to operate appliances when rates are low.

The **CSDP** provides real time information from residential or commercial facilities. Such information includes, for example: abnormal consumption, unstable power or frequency, power outage and more.

CMCS – CES Control and Monitoring Server

CMCS consists of 3 primary modules: Business Application, Database and User Interface. The system is developed using Web-technology (Microsoft .net toolset and Silverlight). The scalable architecture can be deployed both in a single data center and in distributed data centers.

The CMCS Front End Application is multilingual and consists of the following modules:

- **Dashboard** - A graphic representation of the CSDP and its connection to the supply network, showing near-real time status information. User can navigate to all his/her authorized CSDPs.
- **Events** – Depicts faults and other important events when they occur.
- **Metering** - Displays the electricity consumption meter of the connected CSDP unit; provides also monthly sub-metering by circuit and time-of-use metering when relevant.
- **Setup** - Allows the user to view and change the setup information of the connected CSDP unit. Some of the parameters are restricted for authorized electricians.
- **Utility** - Authorized users can send Price-setting and DSM commands to a number of CSDP units concurrently as well as view the status of all connected units.
- **Reports** - Provides access to various reports within the system. Enables both graphic and tabular output. Scheduled reports are supported.
- **Admin** – System Administrator can manage Users, CSDP units and the relationship between them.

