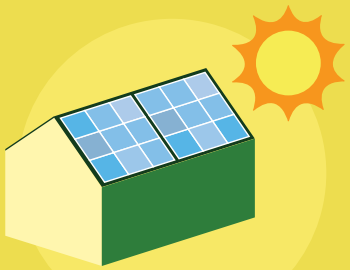
ecoblock™

POWER DISTRIBUTION 101:

KNOW YOUR *MICROGRIDS*



Solar array

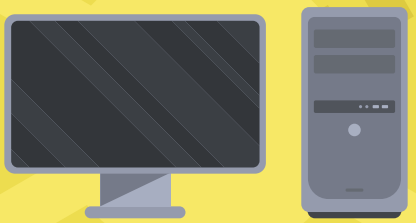
A collection of **photovoltaic (PV) solar panels** captures the sun's energy and converts it into usable, clean electricity.

Battery storage

When the microgrid operates separately from the main grid as a **"power island,"** rechargeable batteries store electricity from the solar array and discharge it during times of high energy use.

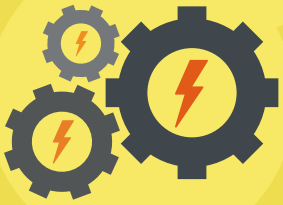
External utility grid

The microgrid is normally connected to the **main utility grid**, which connects all of the Western U.S., with many customers and large power sources. The microgrid can disconnect when there is a power outage on the main grid.



Microgrid Controller

Since the microgrid has limited resources, it needs **smart controls** to ensure that demand will not exceed the available supply. The controller can also charge and discharge the battery at the best times to minimize energy costs.

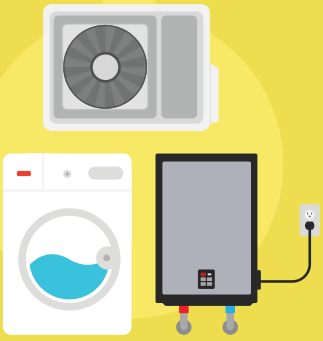


Grid forming inverter (GFI)

Inverters change the **direct current (DC)** from a battery or photovoltaic (PV) panel to **alternating current (AC)** for the grid. A **grid-forming inverter** is able to control the AC frequency and voltage for the microgrid while it is a power island. Other inverters are **grid-following** and match the voltage from the main grid.

Electric vehicles (EVs)

Electric vehicles can take several hours to charge. By **smart timing** or varying the charging rate, EV chargers can help mitigate the impact on the grid.



Energy Loads (e.g. household appliances)

Household appliances are called **loads** which consume electricity from the grid or microgrid. Some loads will have smart controls to better time their use.

01 WHAT IS A MICROGRID?

A microgrid is a **local electrical network** that includes:

+ One or more **small power plants** (in this case solar electric photovoltaic [PV] panels on rooftops),
+ A means of **storing electrical energy** (e.g. batteries)
+ **Electrical cables**
+ A **control system** to distribute and monitor the energy,
+ **Appliances** that consume this energy (e.g. residential space heating and cooling, water heating, clothes washers/dryers and dishwashers)

If there is a power outage, the microgrid can supply power to the homes that are connected.

02 HOW DO MICROGRIDS WORK?

Microgrids can be connected to, but also separated from, the **main,** or **"bulk," electric grid**. The bulk grid provides power to millions of customers, transmitting and distributing electricity from many large power plants across many states. Microgrids are essentially a miniature version of the larger grid. When they break off, or **"island,"** to operate separately, microgrids need to balance their internal supply and demand at every moment. This balancing act can be trickier to do at a small scale because the power drawn by people's appliances varies so much over time. To absorb these variations, microgrids usually include either a fuel-based **generator** or **battery storage**.

03 MICROGRID TERMINOLOGY

"The grid"

The **traditional electrical network** that serves as the primary source of power for the surrounding region(s).

Power Island

A microgrid forms a **"power island"** when it is disconnected from the main grid. **"Islanding"** is also a verb, as in: "We plan to island our microgrid during the next PSPS."

Load

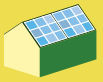
The **amount of power** demanded by electrical appliances at any given moment. Load is measured in units of **watts (W), kilowatts (kW), or megawatts (MW)**, where 1 kW = 1,000W and 1 MW = 1,000,000W.

Peak load / Peak demand

The **maximum amount of power demand** on a given day or in a given year. In California, peak load usually occurs on hot summer afternoons due to high air conditioning.

Renewable / clean energy

Energy that comes from **natural sources or processes** that are **indefinitely replenished.** The primary sources of renewable energy include biomass (e.g. organic plant and animal material), hydropower, geothermal, wind, and solar.



Distributed Energy Resources (DERs)

A catch-all term for **local power generation and energy storage device** (e.g. rooftop solar photovoltaics (PV) and batteries). DERs may include electric vehicle (EV) chargers and other controllable loads that can adjust their demand in response to the needs of the electric grid, making them a resource.

Public Safety Power Shutoff (PSPS)

When **electric utilities turn off the power** in certain areas to **reduce the risk of wildfires.** PSPS may affect at-risk neighborhoods or those supplied by transmission lines that go through fire-prone areas. PSPS are called by utilities like PG&E and Southern California Edison under extreme weather conditions.

04 WHY MICROGRIDS?

Pros

+ Provides **clean & reliable** energy
+ Solar PV is becoming **less expensive** than most forms of electric energy
+ Can **island from the main grid** as needed
+ Enables communities to be more **resilient, sustainable, & self-reliant**
+ Can help **improve the operation of the utility** by **reducing peak loads**

Cons

+ Energy storage & microgrid operation all **add cost**
+ Community-scale microgrids are a **new model** in energy markets without a guaranteed financial return
+ Must **navigate varied & nuanced regulations**
+ Rules & regulations for multi-customer microgrids are **rapidly evolving**
+ Requires **collaboration among multiple stakeholders**: electric customers, the local government, & the local utility company

Design by Eunice Chung

Sources: Sascha von Meier, EcoBlock • Microgrid Knowledge • Microgrid Resources Coalition • Pacific Data Integrators • U.S. Department of Energy • U.S. Energy Information Administration (EIA)