energy storage

Energy 2012
Bennington / Feddersen

A sustainable system by definition uses energy at or below the rate it is generally available from the environment.

However, it may be necessary for a system to:

- time shift energy usage independent of fluctuating ambient availability
- momentarily exceed the ambient power available
- and/or handle momentary interruptions of power

In these cases, energy storage will be necessary.

System energy usage is out of phase
with ambient availability:

Ambient power available

Stored Energy

System power usage
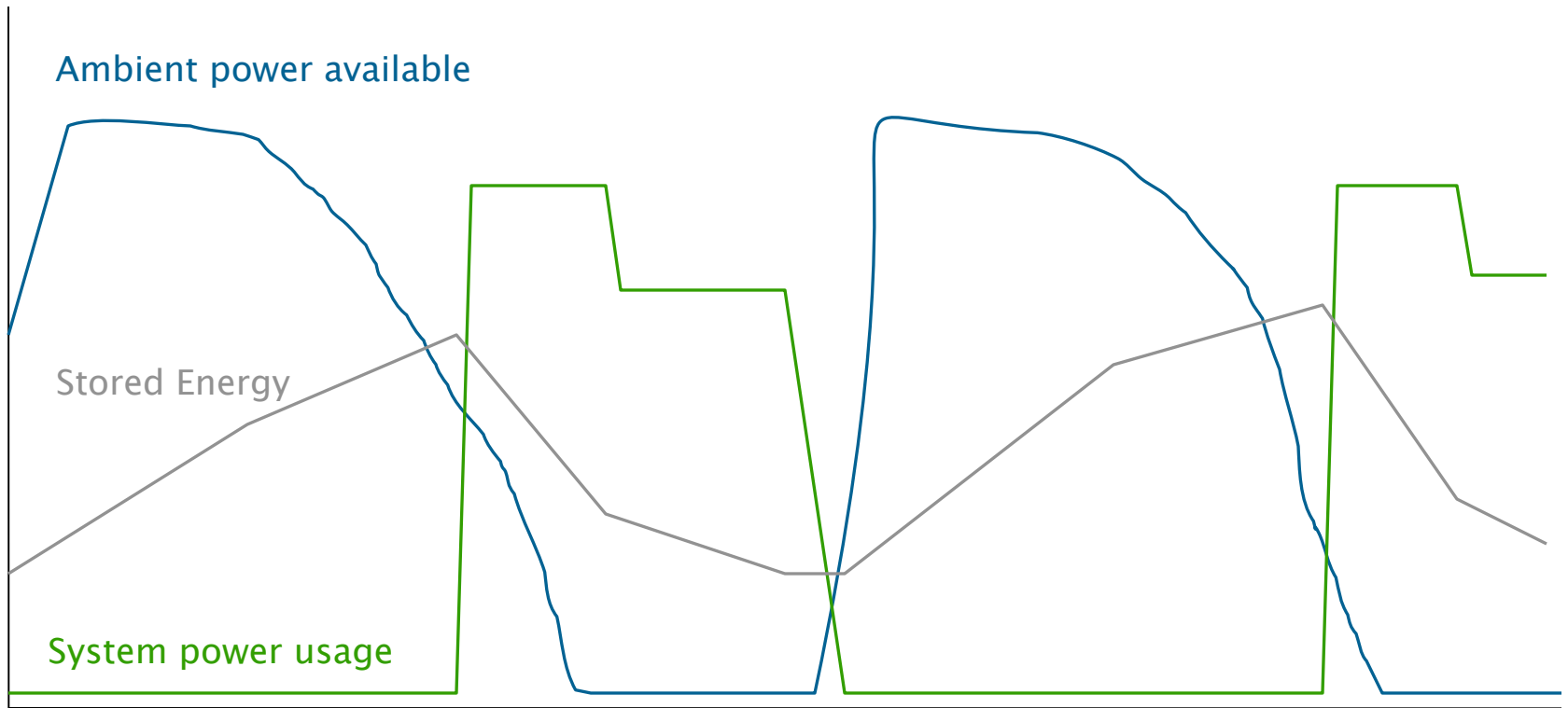
System requires higher momentary power than is available from the environment:

System power usage

Ambient power available

Stored Energy
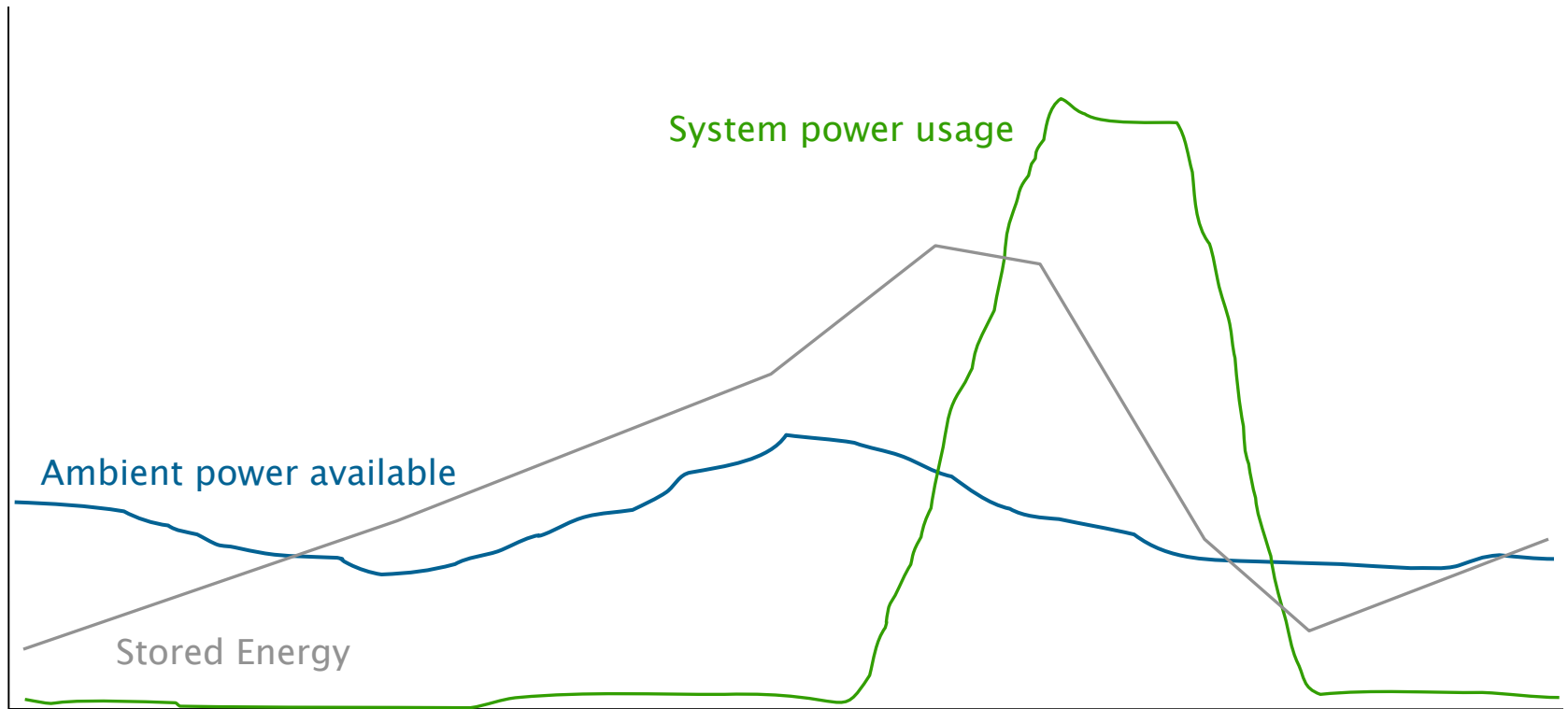
System must handle power fluctuations:

Ambient power available

System power usage

Stored Energy
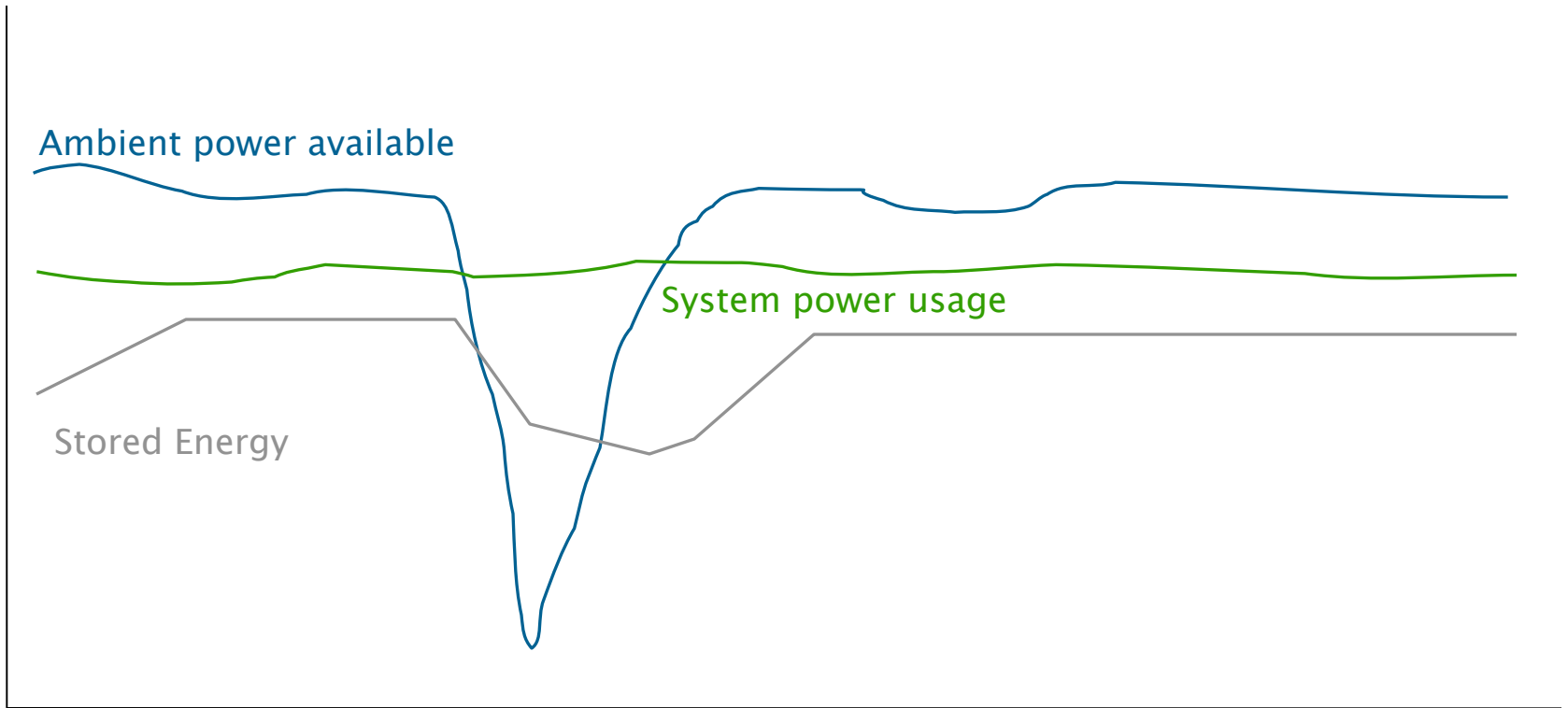
Chemical bonds (in food, firewood, fuel)

Suspended mass

Elastic deformation

Compressed fluid

Rotating mass (flywheel)

Solar Two - Mojave Desert, California

Heat

MOLTEN SALT SYSTEM

POWER BLOCK

STEAM TURBINE GENERATOR

GENERATOR   HP TURBINE   IP/LP TURBINE   CONDENSER

COLLECTOR FIELD

RECEIVER

HP Steam   Reheat Steam

Receiver Tower

Hot Salt   Superheater   Reheater

MOLTEN SALT LOOP

Steam Gen./Evaporator

1050°F

Condensate Tank

Cold Salt   Feedwater Preheaters

HELIOSTATS

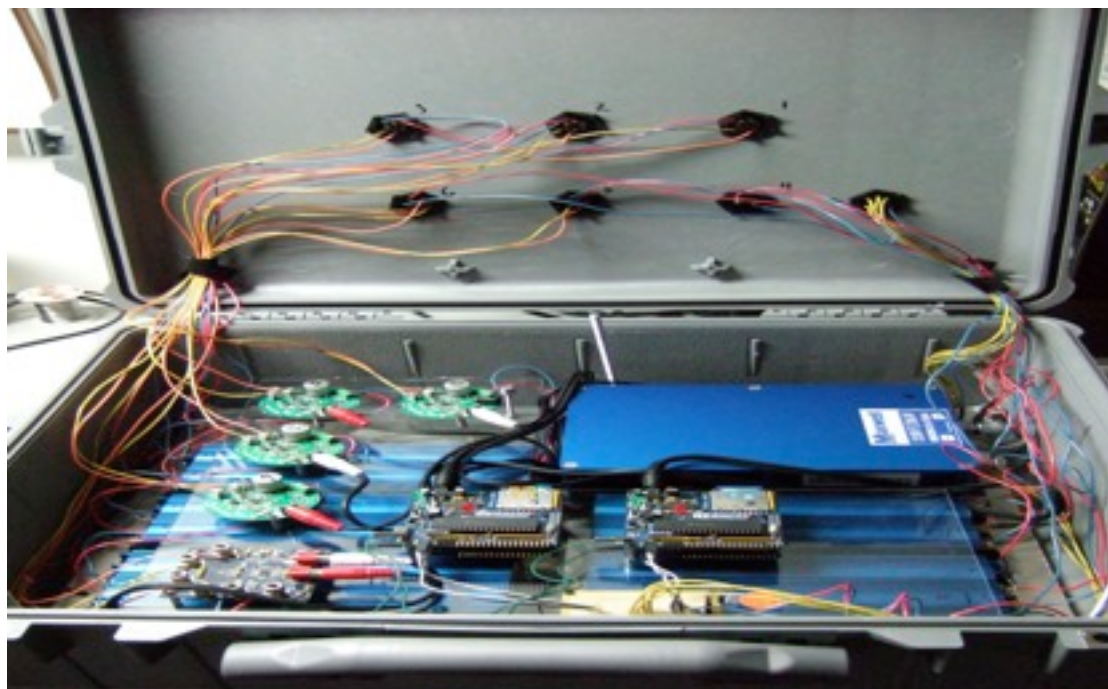550°F   STEAM GENERATION SYSTEM

THERMAL STORAGE SYSTEM

Electrical potential

Basic concepts for any energy storage:

Specific Energy : energy / mass

Energy Density : energy / volume

Specific Power : power $^{(input\ or\ output)}$ / mass

Power Density : power $^{(input\ or\ output)}$ / volume

Efficiency: energy in / energy out

NREL

Smoothing

.5 * (100 microfarads) * ((5 volts)^2) = 0.00125 joules
More about calculator.

.5 * (3300 microfarads) * ((5 volts)^2) = 0.04125 joules
More about calculator.

.5 * (1 farad) * ((5 volts)^2) = 12.5 joules
More about calculator.

Storage

*

.5 * (60 farad) * ((5 volts)^2) = 750 joules
More about calculator.

Energy in a capacitor is:

$$\frac{1}{2} C * V^2$$

* Would need 2 2.5V caps in series to get 5V.

Lots of joules

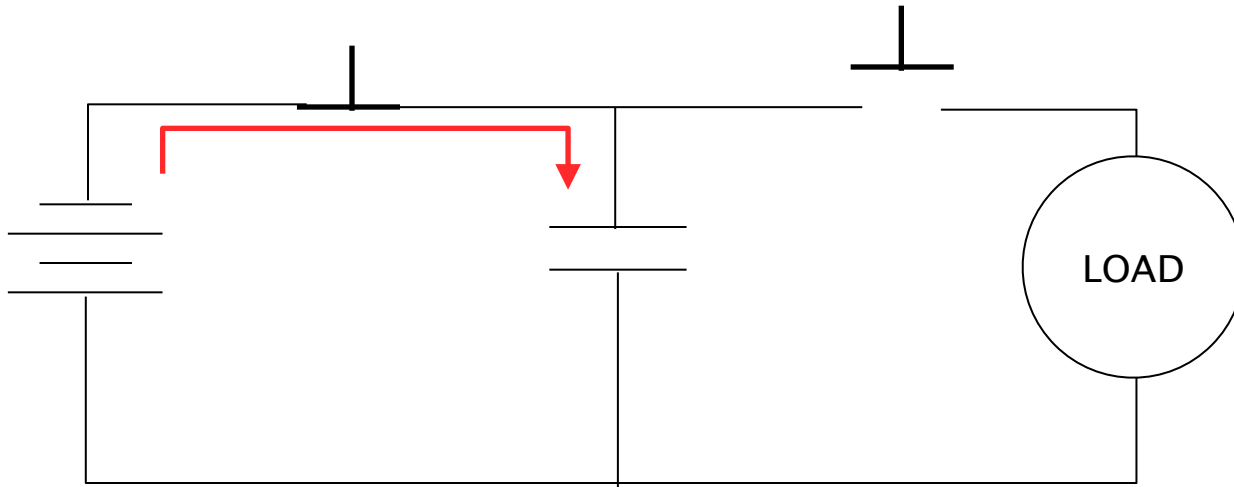Source   Storage   Load
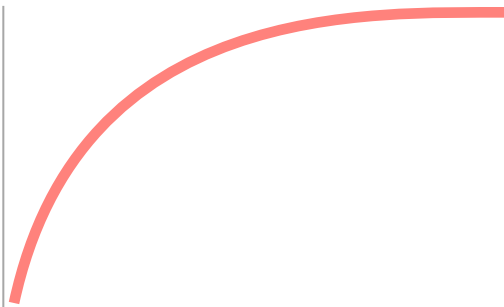   (Capacitor)
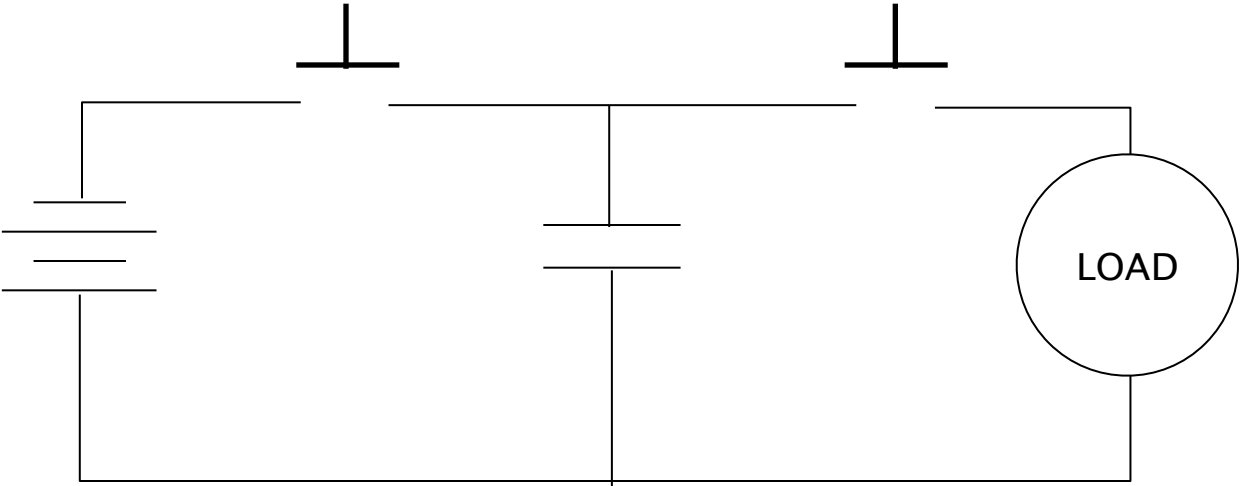
LOAD

Charging
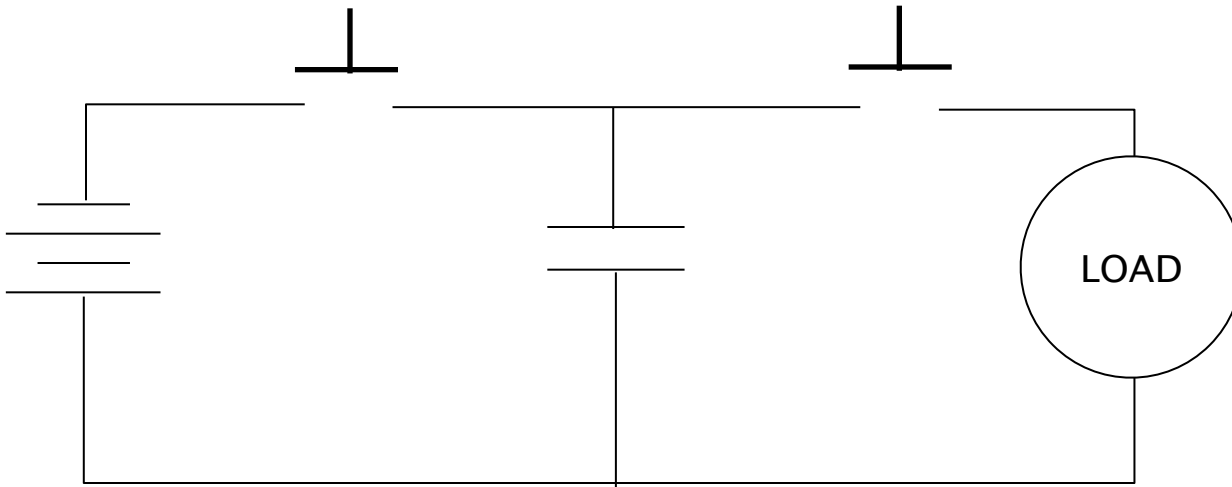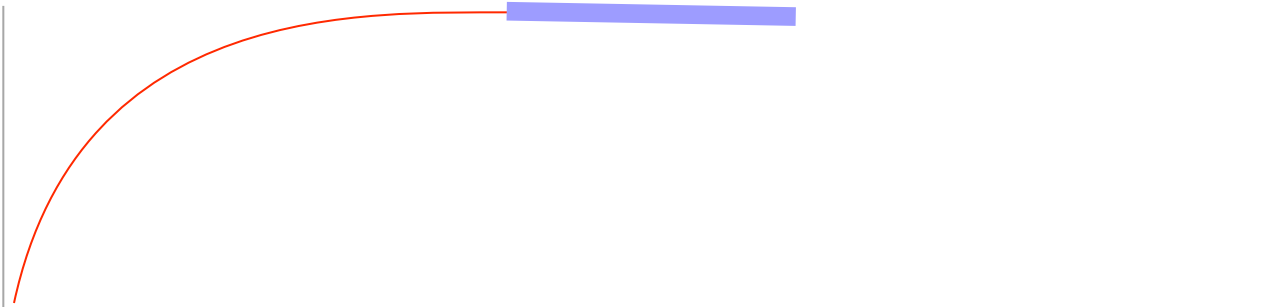
Source → Storage (Capacitor)   Load

Capacitor Voltage

Stasis

Source

Storage
(Capacitor)

Load

LOAD

Capacitor
Voltage

Discharge

Source
Storage (Capacitor) → Load

LOAD

Capacitor Voltage