ENERGY STORAGE 101

ENERGY STORAGE

- Forms of Energy
  - Potential Energy
    - Chemical,
    - Gravitational
    - Electrical
    - Temperature Differential
    - Latent Heat
  - Kinetic Energy (Momentum)
    - Flywheels
    - Moving Trains
    - Dodge ball
    - Bullets
- Energy Storage Converts Kinetic or Electrical Energy to Potential Energy for Use Later

SHORT TERM OR LONG TERM ENERGY STORAGE

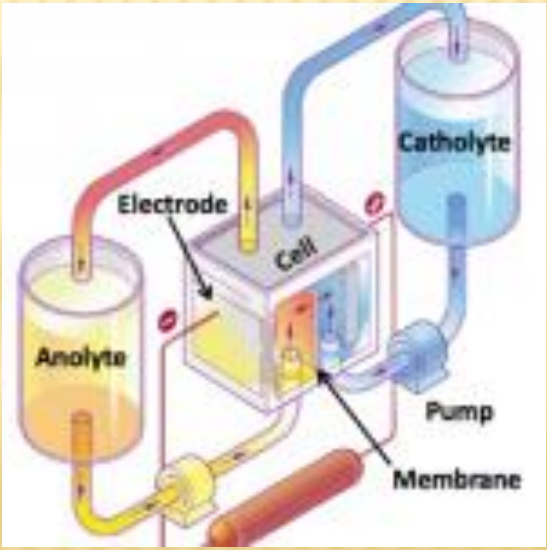
- Some technologies provide only short-term energy storage while others can be very long-term such as power to gas using hydrogen and the storage of heat or cold between opposing seasons in deep aquifers or bedrock.
- A wind-up clock stores potential energy, in this case mechanical, in the spring tension.
- Compressed Air Storage store potential energy from moving molecules.
- Battery Storage stores readily convertible chemical energy rich in electrons which can be converted very quickly into electricity.
- a hydroelectric dam stores energy in a reservoir as gravitational potential energy. This applies to Pumped Storage and the ARES train system.
- Ice or chilled water storage tanks store ice or chilled water (thermal energy in the form of latent heat) at night to meet peak demand for cooling.
- Fossil fuels such as coal and gasoline store ancient energy derived from sunlight by organisms that later died, became buried and over time were then converted into these fuels.
- Food (which is made by the same process as fossil fuels) is a form of energy stored in chemical form.

BATTERIES

- LEAD-ACID BATTERY
  - Typical battery used to start a car with an internal combustion engine
  - Also used in early electric vehicles (Lead sleds)
- NICKEL-BASED BATTERY
  - Nickel Cadmium batteries were used in early cell phones and are still used in rechargeable devices. They have memories.
  - Nickel medal hydride batteries replace nickel cadmium and are still used in rechargeable devices
- LITHIUM-ION BATTERY
  - Used in most electric vehicles and grid storage applications
- SUPERCAPACITOR
  - Potentially the future

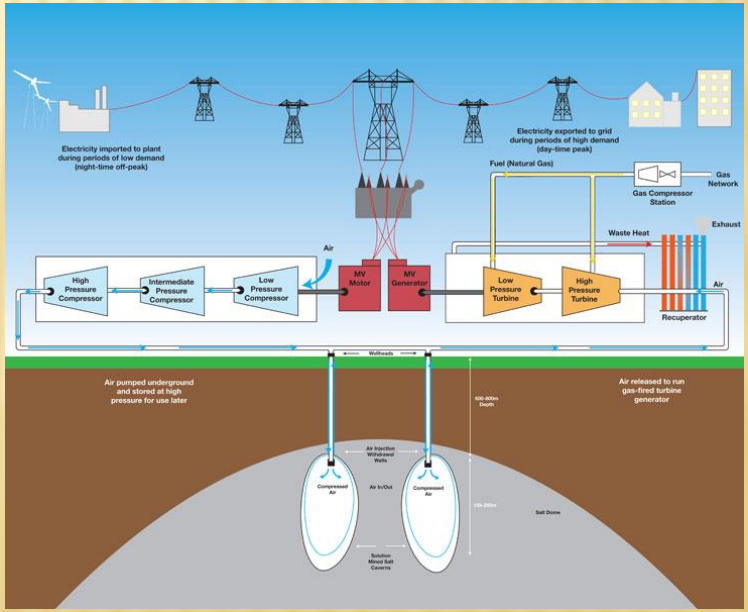
Flow Battery

- A flow battery is an easily rechargeable system that stores its electrolyte—the material that provides energy—as a liquid in external tanks. Unlike typical batteries that are packaged as fixed cells or modules, a flow battery allows the battery's power (the rate of electricity flow) to be decoupled from the battery's capacity (the total amount of energy held). As a result, users are free to tune the battery's specifications to their specific needs.



COMPRESSED AIR STORAGE

- Compressed Air Storage stores potential energy from moving molecules.
- Large scale can be stored in caverns
- Small scale can be stored in tanks
- Many applications
  - Motor starting
  - Some waste heat
- Not very efficient



ADVANCED RAIL ENERGY STORAGE

- Gravity stored potential energy in the form of a very heavy train
- http://www.aresnorthamerica.com/santa-barbara-energy-storage-resources
- A lot like pumped storage but without water

NEC BUYS GRID ENERGY STORAGE BUSINESS OF A123 SYSTEMS

- NEC Corporation announced today the acquisition of the A123 Energy Solutions business unit of A123 Systems, LLC.
- approximately USD $100 million, strengthens the energy storage capability of NEC's smart energy business, a core segment of its Mid-term Management Plan's commitment to social infrastructure. A123 Energy Solutions will be integrated into the NEC Group of companies and operated globally as a key element of its business. "NEC Energy Solutions" is slated to begin operation in June 2014 under the direction of NEC.
- With this acquisition, NEC will become the world's leading supplier of lithium-ion grid energy storage systems. A123 Energy Solutions has deployed over 110MW of its Grid Storage Solutions (GSS(TM)). Nanophosphate(R) lithium-ion cells and support all existing installations. At the same time, NEC will leverage A123 Energy Solutions' experience in commercial batteries in order to serve NEC's telecommunication carrier, enterprise and government customer base, thereby helping to drive the global expansion of NEC's smart energy business.

A TALE OF TWO COUSINS

Compact, Safe and Durable

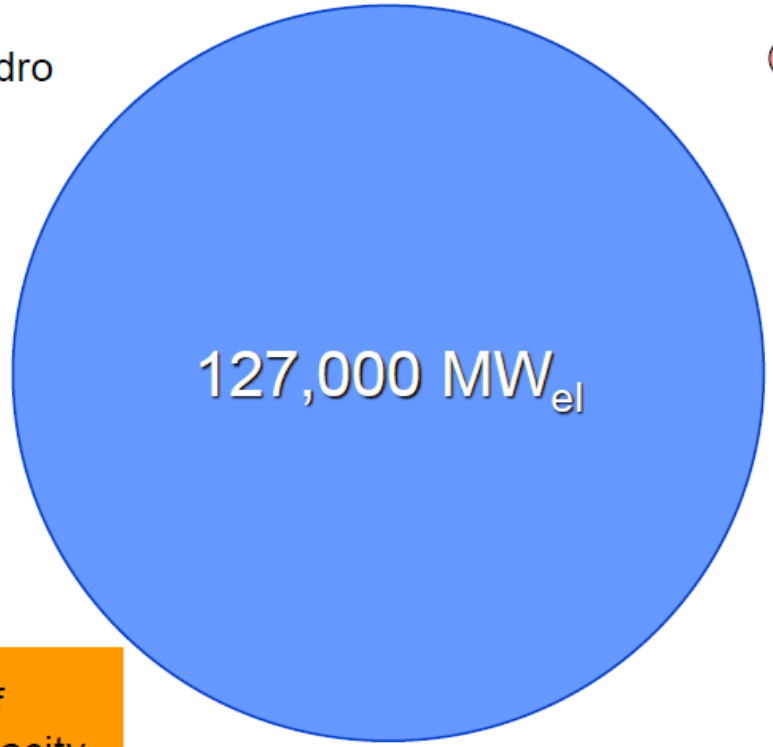
SolarCity is making the latest advancements in battery technologies available to you through our partnership with Tesla Motors. Only SolarCity's home backup system uses technology engineered by Tesla, leveraging their expertise in developing battery technologies for premium electric vehicles.

Tesla's long history of research and development has enabled a cost-effective, wall-mounted storage appliance that is small, powerful and covered by a long lasting full 10 year warranty.

The actual battery unit is about the size of a solar power inverter, and will be mounted on the wall in your garage or near your electrical panel.

The Current Landscape for Energy Storage

Worldwide installed storage capacity for electrical energy



Compressed Air Energy Storage
440 MWs

Sodium-Sulphur Battery
304 MWs

Lithium Ion Battery
> 100 MWs

Adv. Lead-Acid Battery
~70 MWs

Nickel-Cadmium Battery
27 MWs

Fly Wheels
< 25 MWs

Redox-Flow Battery
< 10 MWs

Over 99% of
total storage capacity

Source: Fraunhofer Institute, EPRI - 2012

EPRI ELECTRIC POWER RESEARCH INSTITUTE

QUESTIONS

Phill Consiglio
Southern California Edison
Phillip.Consiglio@sce.com