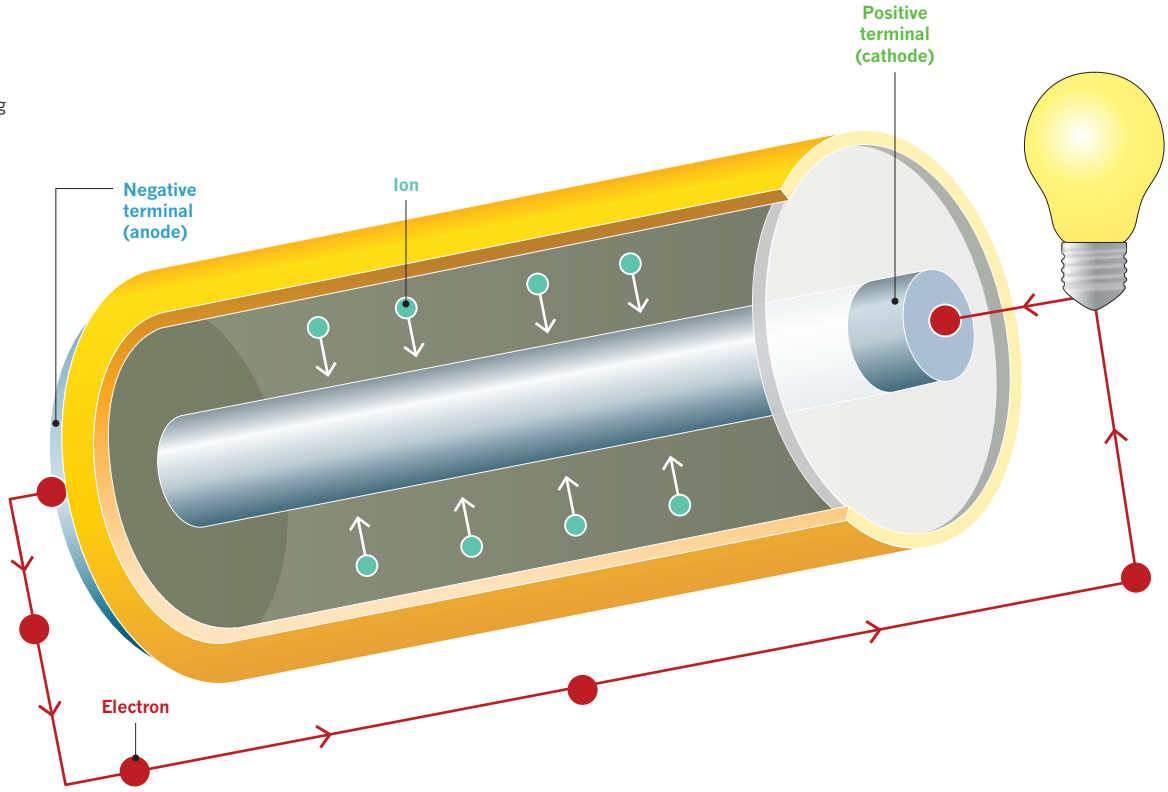
FROM GADGETS TO THE SMART GRID

Batteries are key to powering portable devices and developing a modern energy network. Researchers are scrambling to develop iterations that can overcome the current limitations.
By Sujata Gupta, *infographic by* Nigel Hawtin.

HOW A BATTERY WORKS

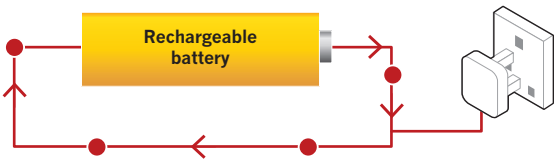
Batteries store electricity in the form of chemical energy to use when they are connected to a device.

Batteries contain a **positive cathode** and a **negative anode**. These electode terminals are made up of different materials depending on the battery type.
When a device is connected to the battery, a chemical reaction occurs that generates positively charged ions and negatively charged **electrons**. The ions flow through electrolyte to the cathode; whereas the electrons (that cannot penetrate the electrolyte) travel around the outer circuit powering a device en route to the cathode.
Disposable batteries die when the anode or cathode runs out of the chemical needed to catalyse the reaction.



RECHARGEABLE BATTERIES

When a device is recharged, electric energy from the charger (such as a phone charger plugged into a wall) is applied to the chemical system to reverse the process and restore the battery's charge. Rechargeable batteries are thought to degrade because of the irregular movement of ions in the electrolyte.



TYPES OF RECHARGEABLE BATTERIES

The lifetime, cost, energy storage and re-usability of the battery are determined by the material used. This also dictates whether the battery is best used for devices that do not consume much energy or in those that do.

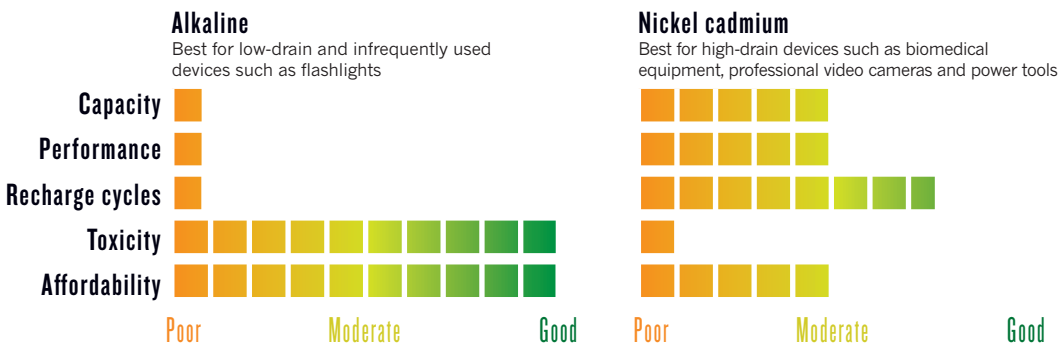
Capacity
Ability to supply electric energy

Performance
How well high-drain devices are powered

Recharge cycles
The number of times the battery can be recharged in its lifetime

Toxicity
Composition and ease of recycling

Affordability
Cost to consumer

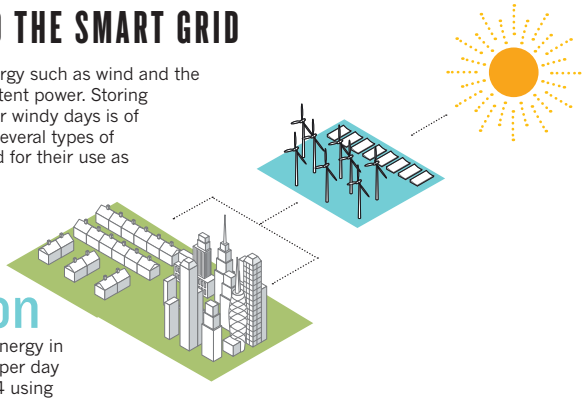


SOURCE: BATTERYUNIVERSITY.COM

BATTERIES AND THE SMART GRID

SOURCE: B. BERGER (FRAUNHOFER ISE, 2014)

Sources of renewable energy such as wind and the Sun provide only intermittent power. Storing excess energy on sunny or windy days is of paramount importance. Several types of battery are being explored for their use as grid storage.

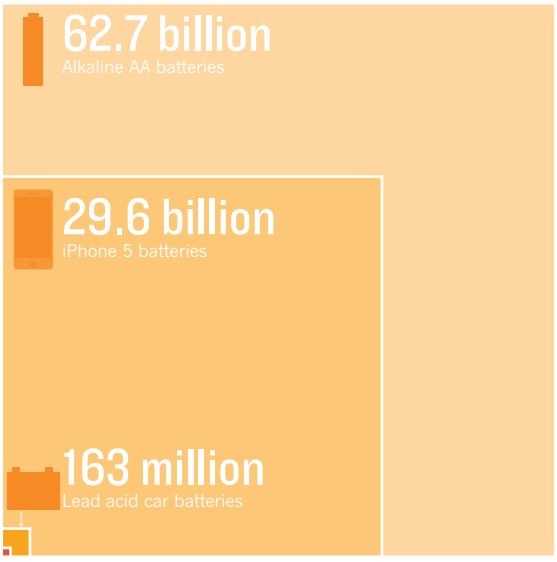


163 million
The average amount of energy in kilowatt hours produced per day in Germany in June 2014 using solar production.

17.2 million
The number of households this solar energy could power every day.

To house all that solar energy we would need:

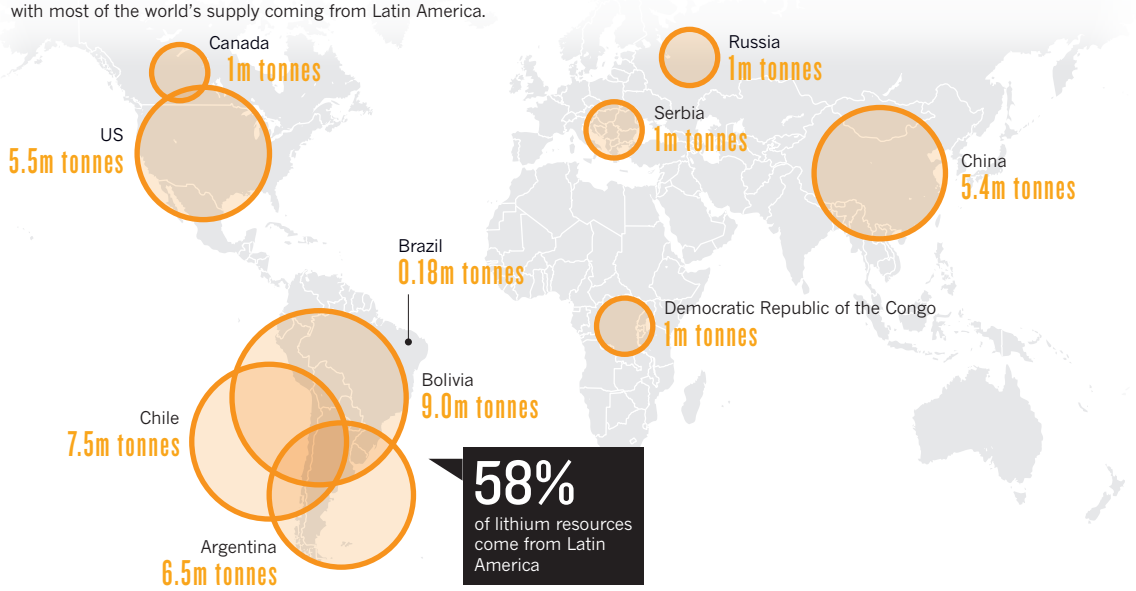
16 million
of Tesla's Powerwall home batteries.



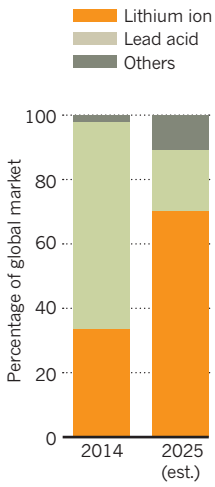
RESOURCE SCARCITY

SOURCES: MINERALS.USGS.GOV/MINERALS/PUBS/COMMODITY/LITHIUM/INDEX.HTML/BERNSTEIN.COM

Batteries contain materials that could eventually run out. Countries that are rich in these resources could one day hold the same sway as today's oil-rich countries. Lithium is one of the main concerns — demand for the metal has almost doubled in the past five years, with most of the world's supply coming from Latin America.



The rechargeable-battery market of the future looks set to be dominated by lithium-ion batteries.



Nickel metal hydride
Best for high-current draw devices, including mobile phones and laptops

Lithium ion
Best for high-drain devices such as digital cameras, laptops and mobile phones

Lead acid
Good for car batteries because they provide a high-surge current