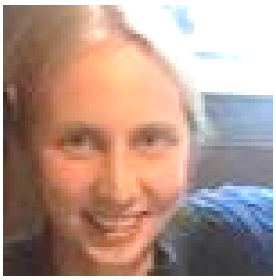
Here Comes the Sun: Harnessing the power of renewable energy

October 25, 2017

Introduction

Over the last few years, electricity generation from renewable sources has grown at a remarkable pace and is projected to almost double by 2025. As we rely more on these green energy sources, how do we transform a power source that only generates electricity when the sun is shining or when the wind is blowing into a stable, reliable resource? In this lecture, we'll discuss the current state of the energy demand in the United States, why there has been a shift towards renewable energy over the last decade, and why energy storage is critical for this shift. Next, we'll present the current options for grid-scale energy storage and why batteries are so exciting to scientists. Finally, we'll explain the drawbacks of using lithium-ion batteries for this purpose and introduce an alternative battery design called a redox-flow battery that could be a better option.

Speakers



Emily Kerr is a second year graduate student in the Department of Chemistry and Chemical Biology where she uses synthetic organic chemistry to develop molecules for redox flow batteries in the lab of Prof. Roy Gordon. She received her undergraduate degree in Chemistry at Xavier University where she researched cost-effective methods of measuring medically-important metabolites. Out of the lab, she enjoys fencing and trying out new recipes.

Justin Teesdale is a third-year graduate student in the Department of Chemistry and Chemical Biology where he uses synthetic inorganic chemistry to study energy storage and catalysis at the molecular level in the lab of Prof. Ted Betley. He has been interested in clean energy since his days as an undergraduate where he performed research aimed to use solar or wind energy to generate fuels. Now, he is a member of the Harvard Consortium on Energy and Environment where he seeks to broaden his perspective to include issues of policy and economics as they pertain to clean energy. Outside of science, Justin spends his free time relaxing on the beach during the summer, playing volleyball, and skiing during the winter!

Glossary of Important Terms

Fossil Fuel: Generally used to represent coal, oil, and natural gas.

Redox: Shorthand for describing the oxidation and reduction reactions of a molecule. Oxidation is when a molecule releases charge (electrons) and reduction is when a molecule stores charge.

Kilowatt-hour(kWh): A common unit of energy. A 60 watt light bulb uses 0.06 kWh of energy per hour.

Greenhouse Gases: Term used to describe gases that are emitted into the atmosphere that are the primary cause of climate change. These gases primarily include carbon dioxide and methane (natural gas).

Grid-scale energy storage: Energy storage system connected to an electrical power grid that is capable of storing large amounts of energy during periods of low consumption and releasing the stored energy during periods of high consumption.

Energy density: Amount of energy stored per unit volume.

Generator: Device used to convert mechanical energy (a rotor or axle spinning) into electricity.

Electrode: Solid material (typically a metal or carbon) used to conduct electricity within the battery. Single units of charge (or electrons) flow from the battery's internal chamber to the electrode and then out to an external circuit before returning through the other electrode and back inside in the battery. The flow of electrons through an external circuit is the electricity that we use!

Electrolyte mixture: Mixture that conducts electricity. Typically consists of a liquid (either water or an organic liquid) and an electrolyte, which is an ionic compound like sodium chloride (table salt).

Crossover: Transfer of an electrolyte molecule through a membrane from one side of a battery to another.

Solubility: How much of a compound that can be dissolved in a fixed amount of solution (water).

Energy: A measure of how much work a substance is able to do.

Power: A measure of how quickly a substance is able to deliver energy.

Voltage: A measure of the difference in electrochemical energy between two compounds.

Resources to learn more

Energy Kids, U.S. Energy Information Administration. https://www.eia.gov/kids/, Games and information about energy sources and energy use.

The Multitude of Technologies Needed for Electricity Storage. http://sitn.hms.harvard.edu/flash/2017/multitude-technologies-needed-electricity-storage/, Blog article from Science in the News describing the different energy storage technologies available.

Energy Storage, Department of Energy. https://energy.gov/oe/activities/technology-development/energy-storage, Information from the DOE about energy storage options.

Flow Battery. https://www.youtube.com/watch?v=4ob3_8QjmR0, Simple description of a flow battery.

Organic Flow Batteries: Electrochemical Processes for for Energy Technology https://aziz.seas.harvard.edu/electrochemistry, An introduction to organic redox flow batteries.

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