American Conservation Film Festival
In the Classroom

Switch

2013 Festival Invited Selection
Filmmaker: Harry Lynch
Length: 98 Minutes

Summary: Geologist Dr. Scott Tinker explores the energy landscape of the present to gain insight into the challenges humanity faces in the coming century as our civilization transitions to cleaner, more renewable energy conversions.

Course Mapping: Physics, Environmental Science

Curricular Keywords: Energy, Energy Conversions (Nuclear, Solar Photovoltaic Cells, Renewable, Non-Renewable), Heat Engines, Climate Change, Sustainability

Suggested Discussion Topics

Switch thoroughly surveys the major energy conversions that drive our civilization today and the technologies that promise to supply our energy needs in the future.

- Compare and contrast non-renewable and renewable energy sources.
- Discuss the intermittency problem associated with some renewable energy technologies such as solar panels.
- Debate whether renewable and green energy are the same thing.
- Discuss the scale of energy usage and how current non-renewable generation compares to renewable generation. Data from the US Energy Information Administration (www.eia.gov) may help to motivate this discussion.

Switch does a nice job of simultaneously illustrating the unsustainable and carbon intensive nature of our current energy landscape and the immense challenges of transitioning to a more sustainable energy future while combating climate change.

- Why might some environmentalists support nuclear energy while others oppose it?
- Based on the film's message, do you think humankind can curtail greenhouse gas emissions enough in the next few decades to prevent significant global climate change?
- After watching this film, how would you evaluate a claim that the world can transition to clean renewable energy in only a decade if we choose to and do not allow special interests to get in our way?

Suggested Activity

On a sunny day, the amount of solar power reaching the ground is about 1000 watts per square meter and a typical solar photovoltaic panel is about 15% efficient at converting this power to electricity. At the same time, solar photovoltaic arrays only have a capacity factor of about 15-30%, which means that due to day-night cycles and weather they will only produce this fraction of their rated capacity. For example, a 1,000-watt array will on average only produce 200 watts of power if its capacity factor is 20%. With these considerations in mind, estimate the minimum land area that must be covered by solar panels to replace a typical 1,500,000,000-watt (1.5 gigawatt) coal power station operating with a 60% capacity factor.

The 290 million watt Aqua Caliente solar power station in Arizona has a capacity factor of about 25% and covers 9.71 square kilometers. This station covers much more area than you would expect based on your calculation above. Why?

Additional Resources: The *Switch* documentary website (www.switchenergyproject.com) contains a wide assortment of videos, study guides, and educational screening materials to complement the film. Educators can also request free access to the entire film for classroom use.

The US Energy Information Administration website (www.eia.gov) is an excellent source of energy production data including data for renewable generation.

Switch features interviews with physicist Richard A. Muller whose book, *Physics for Future Presidents: The Science Behind the Headlines*, empowers the reader to think critically about many of the challenges facing our world including energy challenges.