

Poop to Power: Turning Waste into Energy and Engaging Science Literacy at Denver Zoo

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Zoos and aquariums provide an excellent environment for life science studies. However, opportunities present themselves to study the physical sciences as well. Denver Zoo's "Poop to Power" program marries the science behind the process of biomass gasification with the ample amounts of waste and 'poop' produced from live critters on zoo grounds. The resulting program is able to meet the needs of both life and physical science school standards while expanding the zoo's offerings for education programs for its newest exhibit, Toyota Elephant Passage.

The design of Toyota Elephant Passage (TEP) started in 1993 and has evolved with Denver Zoo's master plan. Although the original idea was to build a state of the art elephant facility, the sustainable incorporations have quickly changed the facility on an operational level. Incorporating a "Waste to Energy" Gasification system along with other sustainable features garnered the Denver Zoo the first "Greenest Zoo" award by the Association of Zoos and Aquariums in 2011. Gasification will convert 90% of the zoo's current waste stream into useable power to heat water and buildings in the exhibit. This effort will divert over 1.5 million pounds of visitor waste and animal poop from the landfill annually.

Education programming to highlight biomass gasification and sustainability at Denver Zoo was the next step. Denver Zoo's Education Department worked alongside the zoo's Capital Planning Department to create sustainable programming for schools and teachers that complement Toyota Elephant Passage.

The first program created was a science lab for middle and high school students that would educate them about what Denver Zoo was trying to achieve through hands on inquiry.

Rather than reading a lesson out of a textbook, students have the opportunity to be involved with a hands on, real world science as it's being applied to a new setting: a zoo exhibit. Gasification is not a new technology, but it is being applied in an innovative way to help power the Toyota Elephant Passage exhibit. By seeing science in action outside the classroom, students may feel more empowered or inspired to embrace science (Yocco, et. al 2011). Learning about renewable energy is important for this up and coming generation of students.

Gasification itself has been around for over 100 years (Hutchison, 2009). The process involves solid fuel being heated to a high temperature in a low oxygen environment. The resulting thermal chemical conversion creates syngas, a combination of carbon monoxide, carbon dioxide, and hydrogen gas similar to natural gas (NETL, 2012).

In the Poop to Power Science Lab, students design, build, and test mini-gasifiers after receiving background information about gasification. The small scale design utilizes a large juice can, soup can, and tuna can to create a reactor capable of producing a small amount of syngas. All cans are

conveniently sourced through staff and zoo commissary discards. Although Denver Zoo's actual reactor will use animal poop, students use wood pellets as their biomass. Because the conversion of solid waste to gas requires a controlled oxygen environment, students must hypothesize how many holes they need to punch in each can to optimize the reactor for syngas production. Using a thermocouple in the interior, students monitor and graph the temperature of their reactor until syngas is achieved. A quick comparison of graphs allows students to discuss which reactor design optimized the production of syngas.

The 2007 study conducted by the Institute for Learning Innovation and the Association of Zoos and Aquariums discovered that zoos and aquariums can influence visitor's attitudes towards environmental problems (Falk et. al, 2007). Specifically, visitors left the zoo feeling like they could be part of the solution, a prerequisite to conservation action. While students will not be attempting to recreate a gasification system to provide energy for their homes, Poop to Power educates about other conservation strategies such as recycling and proper waste disposal which can be initiated anywhere.

By educating visitors and school groups about Denver Zoo's process of "waste to energy" the zoo can hopefully instill positive attitudes towards our efforts. Eventually, Denver Zoo hopes the same positive attitudes will



affect long term behaviors in individuals trying to conserve or find new means of sustainable or alternate energy sources.

As more zoos attempt to incorporate sustainability components into their exhibits and the way their zoos are operated, physical science programming can take root by incorporating these efforts into education program offerings for schools. With limitations on budgets and resources, there is an increasing need for teachers to be able to justify a field trip or enrichment program outside of school grounds. STEM (science, technology, engineering, and math) has become a hot buzzword in the National Science Standards for schools (Brown, et. al 2011). By meeting the science standards on a state and national level, school administrators have a greater capacity to approve funding for teachers to bring zoo programming into their classrooms.

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