**Car Efficiency Study**

**Introduction**

Electric cars use energy that is produced in power plants. From an emissions standpoint, tailpipe emissions are replaced by emissions at power plants. What about from an efficiency standpoint: is it more efficient to produce energy for cars at a power plant than to burn gasoline in each individual car? Are electric cars more efficient in other ways? This activity will help to answer these questions.

**Objectives:**

1. Contrast “well to wheel” efficiency with “tank to wheel” efficiency for electric cars (EVs) and internal combustion engine (ICE) cars.
2. Describe two ways to store energy rather than release it as heat to the environment: regenerative braking and an innovative energy storage method of your choice.
3. Research a question related to vehicle efficiency or alternative fuel sources for vehicles.

**Part 1 Instructions**

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| Task | Description | Points |
| 1 | Read the article: “Wells to Wheels: Electric Car Efficiency”  Also posted here: <https://goo.gl/SGzmoK>  Define “well to tank”, “tank to wheel”, and “well to wheel” efficiencies (9 points)  Explain how well to wheel efficiencies differ for EVs and ICE vehicles, giving 4 supporting details (16 points) | 25 |
| 2 | **Explain Regenerative Braking**  Write a paragraph to explain how regenerative braking works (10 points)  Explain what form of energy is converted into what form of energy in the process. Contrast with the energy conversion in regular braking (10 points)  Address why cars with regenerative braking have brakes that last longer (5 points)  <https://goo.gl/SPz4FB>  <https://cars.usnews.com/cars-trucks/what-is-regenerative-braking>  Description of Prius operating modes: <http://john1701a.com/prius/prius-how.htm> | 25 |
| 4 | **Describe one additional energy storage method and one application of that method**  Write a paragraph to explain clearly how the energy storage method works. (15 points)  Describe one application of the method in 2-3 sentences. (10 points)  Start with the Energy Storage Association <http://energystorage.org/energy-storage-1>   * Hydrogen storage <https://goo.gl/h4dApW> (this involves fuel cells) * Compressed air <http://www.lightsail.com/> * Electrochemical capacitors <https://goo.gl/NfKF1j> * Flywheels <https://goo.gl/nJqSzw> or <https://goo.gl/Edc5pm> * Pumped hydroelectric storage <https://goo.gl/a8gBrU> | 25 |

**Part 2 Instructions: Choose one (Level 3 or Level 4)**

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| Task | **Level 3** | Points |
| 1 | *Answer one of the following sets of questions in a paragraph with supporting details.*  EVs have a bigger advantage over ICEs in some parts of the country.  What metric is used and why are some regions better than others? (10 points)  How does South Carolina compare and what is the electricity make-up in SC? (10 points)  <https://goo.gl/JNRWMx>  <https://www.epa.gov/energy/power-profiler>  **OR**  Renewable sources of electricity such as wind and solar are intermittent (available only during certain times of day or certain conditions).  How could flywheels solve the problem with intermittency of renewables? (10 points)  What are three advantages of flywheels over other storage methods and what is one of the innovative design features of the Velkess flywheel? (10 points)  <https://goo.gl/GGRfGY> | 20 |
| 2 | Reflection: Discuss how you think differently about energy storage or electric vehicles after completing this activity. | 5 |

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| Task | **Level 4** | Points |
| 1 | *Answer one of the following sets of questions in a paragraph with supporting details.*  This is sometimes called the “Toyota vs. Tesla” argument because Toyota is committing to develop hydrogen fuel cell cars, while Tesla has committed to electric vehicles.  Can hydrogen fuel cell vehicles compete with electric vehicles from an efficiency perspective? (10 points)  What are three advantages or disadvantages of hydrogen fuel cell vehicles compared to electric vehicles? (10 points)  <https://goo.gl/L4vPVx>  **OR**  You may have noticed from the initial article that gasoline-electric hybrids are very similar in terms of well-to-wheel efficiency to electric vehicles.  What criteria determine which car produces fewer emissions throughout the entire life cycle of a car? (10 points)  How does these criteria vary across the country, and what would be a better option in three different locations? (10 points)  <https://goo.gl/SK8h3X> | 20 |
| 3 | Reflection: Discuss how you think differently about energy storage or electric vehicles after completing this activity. | 5 |

[**http://www.afteroilev.com/Pub/EFF\_Tank\_to\_Wheel.pdf**](http://www.afteroilev.com/Pub/EFF_Tank_to_Wheel.pdf)

**this article has a great diagram showing percentages for each part. should be paired with the reading everyone starts with**

[**http://www.hybridcars.com/toyota-explains-why-fuel-cells-are-the-future/**](http://www.hybridcars.com/toyota-explains-why-fuel-cells-are-the-future/)

**state by state EV emissions**

[**https://www.energy.gov/eere/vehicles/fact-950-november-7-2016-well-wheel-emissions-typical-ev-state-2015**](https://www.energy.gov/eere/vehicles/fact-950-november-7-2016-well-wheel-emissions-typical-ev-state-2015)

**union of concerned scientists**

[**https://www.ucsusa.org/clean-vehicles/electric-vehicles/life-cycle-ev-emissions#.Wq8m5iMrK0c**](https://www.ucsusa.org/clean-vehicles/electric-vehicles/life-cycle-ev-emissions#.Wq8m5iMrK0c)

**can hydrogen fuel cell vehicles compete with electric vehicles? what are the differences in efficiency?**

**https://tonyseba.com/toyota-vs-tesla-can-hydrogen-fuel-cell-vehicles-compete-with-electric-vehicles/**

<https://www.energy.gov/articles/egallon-what-it-and-why-it-s-important>