Unit Title	**Power up for EV**
Grade Level	High School (9-12)
Unit Goal	Students will investigate how to meet demand for electricity as electric vehicles become more popular.
Unit Objectives	1. Students will be able to explain major differences between electric vehicles (EVs) and internal combustion engines (ICE) including how they work, fuel type, filling, costs, pros, and cons. 2. Students will use county, state, and national data to calculate the number of electric vehicles that will be in their county in the future. 3. Students will calculate the predicted increase in electricity demand per year (MWh) and how many wind turbines would be needed to offset this growth 4. Students will conduct an energy audit of their home. 5. Students will calculate how much electricity is used by different appliances and the cost of running those appliances. 6. Students will research EV charging stations 7. Students will calculate the costs and benefits of electric versus gas vehicles 8. Students will describe the three basic levels of the electrical grid; generation, transmission and distribution. 9. Students will develop a model of the electrical grid 10. Students will be able to identify advantages and disadvantages of different energy sources. 11. Students will lobby for what energy source would be best used to meet future energy demands in Iowa. 12. Students will be able to create a plan which would allow the current electrical grid to support the projected growth in electric vehicles.
Focus Standard	**HS-ESS3-4:** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems
Supporting Standard	**HS-LS2-7** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. **HS-PS3-1** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. **HS-ETS1-1.** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. **HS-ETS1-2**. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. **HS-ETS1-3**. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. **SS-Econ.9-12.14**. Use cost-benefit analysis to argue for or against an economic decision. **SS-Geo.9-12.16**. Analyze relationships and interactions within and between human and physical systems to explain reciprocal influences.

Phenomenon	What energy sources will meet increased electrical demand due to the projected increase in electric vehicles?
Total Time	8-10 days (45 minute lessons)
Developers	

Description: Students will evaluate electric vehicle energy usage and cost and determine what energy sources will best meet the demand given the current electrical grid.

Lesson 1 **Engage** **1 Day**	Lesson Goal Introduce the issues surrounding the increased demand for electricity that will come with the increase in adoption of electric vehicles and use real world data to estimate the number of EVs that will be in the students' county in the future. Lesson Objectives 1. Students will be able to explain major differences between electric vehicles (EVs) and internal combustion engines (ICE) including how they work, fuel type, filling, costs, pros, and cons. 2. Students will use county, state, and national data to calculate the number of electric vehicles that will be in their county in the future. 3. Students will calculate predicted demand in electricity and number of wind turbines needed to generate this increase in electricity. Lesson Summary Students will investigate the rise in demand for electricity as electric vehicles become more widely adopted. Students will analyze data sets regarding numbers of registered vehicles, predicted future numbers, and plan for additional infrastructure that will be needed to accommodate these vehicles Materials Needed ● Internet Access ● Calculator ● Any major files like handouts or instructions Prep Before Class ● Make sure students have access to internet and materials and that all links are current Daily Assessment/Homework ● Energy Audit for lesson 2 Resources ● Teacher Guide & Lesson Files
Lesson 2 **Explore** **2 Days**	Lesson Goal Conduct an energy audit to determine how much electrical energy is used in a home and determine the impact an EV would have on home energy usage. Lesson Objectives 1. Students will conduct an energy audit of their home. 2. Students will calculate how much electricity is used by different appliances and the cost of running those appliances. 3. Students will research EV charging stations 4. Students will calculate the costs and benefits of electric versus gas vehicles 5. Students will calculate the increase energy demand from an EV home charging unit Lesson Summary Students use an online website to estimate the total amount of electricity that they use in their room, home, or school. Students then calculate the increase energy usage required to add an EV charger to their home. Materials Needed

	• Internet Access • MyHome Electrical Appliance Checklist (Homework from Lesson 1) Prep Before Class • Make sure internet access is available and that all links to the career sites are active. • Make sure all students have a way to access the webpages needed for research • Have sticky notes available for Exit slip (or make Google form) Daily Assessment/Homework • Exit Slip Resources • Teacher Guide & Files
Lesson 3 **Explain** **2 Days**	Lesson Goal Students will investigate the three components of the energy grid (generation, transmission, and distribution) Lesson Objectives 1. Students will describe the three basic levels of the electrical grid; generation, transmission and distribution. 2. Students will develop a model of the electrical grid 3. Students will be able to identify advantages and disadvantages of different energy sources. Lesson Summary Part 1: Students use online resources to research methods of electricity generation, transmission, and distribution. Links and data collection are provided on a worksheet. Part 2: Students will use their information from part one to create a labeled diagram or model that explains the entire energy grid. This can be done individually or in groups and in whatever format is best for the teacher (whiteboards, paper, poster, digital, etc) Part 3: Have students present their diagrams to the class and receive feedback from peers and teachers. If possible, invite people from the community that work one the energy grid to observe and offer feedback. Materials Needed • Internet access • Materials for diagrams or 3d models. Prep Before Class • Make sure students have materials Daily Assessment/Homework • Exit Slip Resources • Teacher Guide • Files
Lesson 4 **Elaborate**	Lesson Goal Students will role play as a group of lobbyists for various electrical power plants (coal, natural gas, nuclear, hydro, wind, solar) and take turns lobbying for adoption of their

2 Days	plant to "state representatives". After hearing the lobbyists, students will devise a plan to meet the increased electricity demand from growth of electric vehicles in Iowa. Lesson Objectives 1. Students will be able to explain the process of lobbying 2. Students will be able to promote positive aspects of different electricity sources and defend their claims 3. Students will be able to object to claims about different electricity sources that are misleading or biased and be able to defend their objections Lesson Summary Students will briefly learn about the process of lobbying and identify positive and negative consequences that could arise from this process. Next, students will be randomly placed on lobbying teams advocating for the building of a specific type of electric generation plant (wind farm, solar array, coal plant, nuclear plant, hydroelectric dam, and natural gas plant). Each group will take turns lobbying to their peers to try to persuade them to choose their electricity source as the best option. Peers can challenge or question the lobbyist groups after their presentation. After all groups have lobbied, students will evaluate which one is the best. For their final assessment, students will use information learned across all lessons to create a plan for Iowa's electrical grid to handle the increased demand of electric vehicles in the future. Materials Needed ● Internet Access ● Lobby Note Guide Prep Before Class ● Before the lobbying day, make sure to prep students on how to disagree gracefully and the art of being professionally critical. Daily Assessment/Homework ● The lobbying presentation and the final project Resources ● Teacher Guide ● Files
Lesson 5 Evaluate 1 Day	Lesson Goal After hearing the lobbyists, students will devise a plan to meet the increased electricity demand from growth of electric vehicles in Iowa. Lesson Objectives 1) Students will create a plan to update the electrical grid to meet the increased electrical demand for the rise of electric cars. Lesson Summary For their final assessment, students will use information learned across all lessons to create a plan for Iowa's electrical grid to handle the increased demand of electric vehicles in the future. Materials Needed ● Internet and computer access Prep Before Class ● Make sure students have all their previous lessons on hand to use as a resource

	Daily Assessment/Homework ● The lobbying presentation and the final project Resources ● Teacher Guide ● Files
External Resources and Citations	*Electric vs Gas Cars Cost NRDC Article* - *https://www.nrdc.org/stories/electric-vs-gas-it-cheaper-drive-ev* *Electric vehicle charging Fact Sheet* - *https://www.energy.gov/eere/vehicles/articles/fact-995-september-18-2017-electric-vehicle-charging-home-typically-draws#:~:text=Most%20electric%20vehicles%20charging%20at,water%20heater%20uses%204%2C500%20watts*. *Electric vehicle pros and cons article* - *https://www.oceancrestmotors.com/why-electric-vehicles-evs* *Electric vehicle Readiness* - *https://afdc.energy.gov/pev-readiness.html* *Electrical grid 101* - *https://www.youtube.com/watch?v=CHeMbhk4Mmw* *Electricity Generation, Sales, and Capacity in US* - *https://www.eia.gov/energyexplained/electricity/electricity-in-the-us-generation-capacity-and-sales.php* *Energy Use Calculator* *https://energyusecalculator.com/calculate_electrical_usage.htm* *Generation Sources* - *https://learn.pjm.com/electricity-basics/generation-sources* *How does the power grid work?* - *https://www.youtube.com/watch?v=v1BMWczn7JM* *How do all electric cars work?* - https://afdc.energy.gov/vehicles/how-do-all-electric-cars-work *How do gasoline cars work?* - *https://afdc.energy.gov/vehicles/how-do-gasoline-cars-work* *How is electricity generated?* - *https://www.eia.gov/energyexplained/electricity/how-electricity-is-generated.php* *Hybrid electric vehicles* - *https://afdc.energy.gov/vehicles/electric_basics_hev.html* *Iowa DOT Vehicle Data* - *https://iowadot.gov/mvd/factsandstats* *Plug in Charging Stations information for research* *https://www.epa.gov/greenvehicles/plug-electric-vehicle-charging* *Plug in Charging Stations more in-depth research* *https://afdc.energy.gov/fuels/electricity_infrastructure.html* *Transmission and Distribution* - *https://learn.pjm.com/electricity-basics/transmission-distribution* *YouTube video Charging an EV* - *https://www.youtube.com/watch?v=GnmuwmxWrbY* *Zap that Energy game* - activity to learn how to reduce energy usage https://shop.need.org/products/zap-that-energy-use-free-pdf-download List any websites (including YouTube videos) used in the lesson. This includes lessons from published sources that formed the basis for one or more lessons in the unit.