

Write the Research Essay

Scoring: **Up to 70 points**
Schedule:
September to December*
Students will spend approximately **10–12 hours** writing the essay.

*Dates may vary. Check futurecity.org for specific dates.

Students research and write an essay (maximum 1,000 words) in which they choose one energy source and design a way to generate electric power for their city that does not deplete natural resources and has limited impact on the environment.

This year's topic:

Fuel Your Future

IMAGINE NEW WAYS TO MEET OUR ENERGY NEEDS AND MAINTAIN A HEALTHY PLANET.

Every day we plug in and power up, thanks to electricity. We use electricity in hundreds of ways—to warm and cool our homes, charge our phones, light our streets, run our computers, and even cook our food. It takes energy to make electricity. In fact, about 40% of the total energy consumed in the U.S. is used to generate electricity. Most of this electricity is generated by large power plants. These plants use many fuels to make electricity—but over 60% of electricity is generated from fossil fuels, such as coal and natural gas. In a world in which fossil fuels are running out and in which climate change is a growing concern, we need to find new ways to generate electric power.

Your future city will likely rely on multiple sources of energy to generate electric power. Choose one alternative energy source and design a way to generate electric power for your city that does not deplete natural resources and has limited impact on the environment.

“I learned that engineers play a big role in the production of a city.”

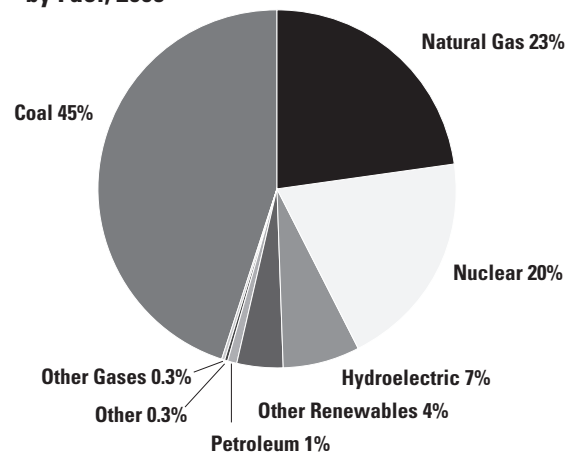
—Caroline Z., Chicago Student Team Member

Learning Outcomes

Students will be able to:

- Identify various energy sources that can be used to generate electricity
- Discuss how one energy source could be used to generate electric power for a city of the future
- Identify and analyze the risks and benefits related to using an energy source
- Recognize that perfectly designed solutions do not exist—all technological solutions have trade-offs such as safety, cost, efficiency, and appearance
- Describe the role of engineering in the development of solutions to energy needs
- Identify steps of the design process (define the problem to solve; brainstorm various solutions; select a solution; design, build, test and redesign solution; share results)

U.S. Electric Power Industry Net Generation by Fuel, 2009



Source: U.S. Energy Information Administration, Annual Energy Review 2009 (August 2010).

Guide Students' Thinking

Use these questions to help your students write a research essay that meets competition requirements.

1. What energy source will your city use to generate electricity?
2. How will your city generate and transmit/distribute electric power using this energy source?
3. What are the benefits of using this energy source?
4. How will using this energy source help offset dependence on fossil fuels?
5. Does the energy source have any environmental impacts?
6. What are the risks connected to using this energy source?
7. What will you incorporate into your design to reduce these risks?
8. What types of engineering are used in your design for generating electricity?
9. What is the role of the engineer you believe to be most useful to the creation and development of your solution?
10. As you develop your solution, how could you use the design process to help you work through problems (define the problem to solve; brainstorm various solutions; select a solution; design, build, test and redesign solution; share results)?
11. How can you represent your solution in your model?
12. Is your essay organized, well written, free of grammar and spelling errors, and no more than 1,000 words (not counting the title)?

"I learned so much about engineering this year, from research and writing to planning a presentation. I also worked on the multiple moving parts for our city. I thoroughly enjoyed the challenge and look forward to becoming a Civil Engineer."

— Logan B., Indiana Student Team Member

Draft Essay Using the Design Process

When engineers design solutions to problems, they go through a process of brainstorming, testing different ideas, learning from mistakes, and trying again. This is called the engineering design process.

The engineering design process is a great way to work through any challenge that involves creating something that did not exist before, such as building a bridge or writing an essay. You'll use the design process as a framework to guide students through researching and writing their essay solutions.

1. Warm Up: Tap into Prior Knowledge about Electricity

Launch the essay by getting kids to think about electricity. Ask them to list 10 things they did before they got to school (e.g., woke up to an alarm clock, made breakfast, checked text messages, etc.). Which of these use electricity and how?

Have students share what they already know about electricity and how it is generated and transmitted. (See the resources in the box for additional information.)

Point out that electricity is a secondary source of energy; we use many energy sources to make electricity. Ask students to list different energy sources used to generate electricity (e.g., coal, wind, natural gas, nuclear energy, hydropower, geothermal, biomass, batteries, etc.). Next, ask students to define (or provide them with a definition) of renewable and nonrenewable energy sources. Then have students identify which energy sources on the list are renewable and which are nonrenewable.

Introducing Energy and Electricity

- *Electricity in the U.S.*
http://www.eia.doe.gov/kids/energy.cfm?page=electricity_in_the_united_states-basics
Explores how electricity is generated, how it is transmitted to consumers, and the environmental impacts associated with the production and transmission of electricity.
- *Energy Sources*
<http://www.eia.doe.gov/kids/energy.cfm?page=2>
Explains nonrenewable and renewable energy sources, secondary energy sources (electricity and hydrogen), and recent energy statistics.
- *Smart Grid*
<http://www.pbs.org/wgbh/nova/tech/power-grid.html>
Explains how electricity is transmitted through the electric grid and introduces the smart grid.

Finding New Ways to Power the Future

To produce electricity, we rely on a mix of energy sources—coal, natural gas, oil, nuclear, hydropower, and other renewables. The way we use these fuels to make electricity has changed over the years. For example, just over 50 years ago nuclear energy played no role in producing electricity in the U.S., but in 2009, nuclear energy provided 20% of the fuel used to generate our electricity. The way we generate and deliver electricity is also changing. While most electricity made in the United States today is generated by large, central power plants, we are moving toward individually generated and managed power systems.

New sources of energy are being used every day and no energy source is perfect—each comes with its own set of benefits and risks. Wind power, for example, is a clean renewable energy source but wind turbines can be loud, obstruct views, and endanger the lives of birds and bats. Coal is inexpensive but burning coal produces greenhouse gases. Finding ways to maximize the benefits and minimize the risks is part of the challenge. Engineers and scientists are working to solve these problems by finding new energy solutions. What new ways can you imagine to power your future?

2. Identify the Problem, Learn the Specs

To get started, engineers define the problem they want to solve and the project requirements.

Help students define the problem by reviewing the essay topic together. How would they describe the essay problem using their own words? What are the different parts of the problem (choose an alternative energy source, describe how they would generate and transmit electricity using this energy source, analyze the benefits and risks of using the energy source, and incorporate into their design ways to reduce risks)? Remind students that the energy source they choose will likely be one of multiple sources their city uses to generate electric power.

3. Brainstorm Solutions

Next, engineers brainstorm a range of possible solutions.

Begin by having students individually write down and sketch ideas and solutions. Encourage them to think about which energy sources interest them (those in use today or being developed for tomorrow) and which energy sources would work

best for their city (e.g., consider city design features, location, landform, etc.). Then have students share ideas and brainstorm as a group.

Once students finish the brainstorming, have them settle on two energy sources to begin researching. As they research, it's likely they'll need to refine their ideas and solve problems that come up. This is part of the process. Help students get started by pointing them to the Resources on page 26.

4. Select and Design a Solution

From their initial research, have students choose one energy source to research in depth and describe in their essay. As students research, invite them to consider the following issues. Note that they should eventually select at least 2 issues (in addition to environmental impact) to discuss in their essay:

- **Energy Efficiency** (How much energy is lost as you convert the primary energy source into electrical energy?)
- **Environmental Impact** (How does the production and transmission of electricity affect the environment, such as clearing land to build a power plant, disturbance of the visual landscape, air emissions, building access roads and transmission lines, disposal of waste, etc.?)
- **Fuel Availability** (Is the energy source renewable or nonrenewable? How easy is it to obtain the fuel?)
- **Fuel Cost** (What costs are related to supplying the energy source?)
- **Generation Cost** (What costs are associated with converting the energy source into electrical energy, such as building the power plant, storing the fuel, etc.?)
- **Infrastructure: Transmission/Distribution** (How will you move electricity from where it is generated to where it will be used?)
- **Reliability** (Is electricity available whenever you want and in whatever volume you want?)
- **Safety & Security Issues** (How would you protect against energy delivery disruptions, supply shortages, and vulnerability to natural disasters—such as earthquakes—and human-caused disasters—such as cyber attacks on the smart grid?)
- **Storage** (How would you store excess electricity to use during heavy demand or when the energy source is not available?)
- **Sustainability** (Can this energy source be used to meet present energy needs, as well as the needs of tomorrow?)
- **Waste Management** (How will you dispose of associated waste?)

5. Share Results

Engineers present their work to colleagues to show how they solved a problem and learn new ideas from each other.

Now it's time for your students to write their essay—the perfect vehicle for sharing their ideas with a panel of judges and kids across the country. Review with students the essay outline which describes the sections judges will be evaluating.

Remind students that the essay should be no longer than 1000 words and they should cite at least three sources of information. Students should use a variety of sources of information, such as interviews with experts, reference books, periodicals, and websites. (NOTE: Wikipedia is not accepted as a source of research.)



For additional tips about researching and writing the essay, and to read essays from past winners visit www.futurecity.org

Check Progress

As students develop their essays, invite them to reflect on the process and evaluate their solutions (this process will help prepare them for the judges' questions). Point out interesting ideas, creative thinking, and effective teamwork. Here are some questions to help guide discussion.

- What research has been helpful in choosing an energy source and designing your solution?
- Where did you get inspiration for your solution?
- What are the intended benefits of your solution?
- What trade-offs come with your solution?
- How has the design process been helpful to you?
- What have you learned about yourself and your teammates during this process?
- What have you learned about engineering that you didn't know before?

Research Essay Rubric—Have students review the rubric on pages 27–29 and evaluate their Essay using the same questions the judges do.

Essay Outline

I. INTRODUCTION: DEFINE THE PROBLEM

Briefly describe your future city. Introduce how your city will generate and transmit all or part of its electric power using an alternative energy source that does not deplete natural resources and has limited impact on the environment.

II. DESCRIBE YOUR SOLUTION

- Describe the alternative energy source you've chosen for your city.
- Discuss how your city will generate and transmit/distribute electric power using this energy source.
- Explain why you chose this energy source for your city (benefits), especially in terms of impact on natural resources and the environment.
- Explain how using this energy source would help offset dependence on fossil fuels.
- Discuss how your design addresses at least 2 additional issues (for example, waste disposal and reliability).
- Describe some of the risks related to using this energy source, especially in terms of impact on natural resources and the environment.
- Discuss how your design will reduce the risks associated with using this energy source. It can be a new idea or an improvement on something already being done.
- Describe the engineering disciplines involved in your solution and the role of the engineer you believe most useful to the development of your solution.

III. EVALUATE YOUR SOLUTION

- Perfectly designed solutions do not exist. What trade-offs come with using your energy source to generate electricity (such as cost, efficiency, appearance)?
- Discuss why the energy source you chose is still the best solution for your city.

IV. CONCLUSION

Summarize your ideas and findings.

Competition Checklist

- Include the name of your city on each page of your Research Essay. Remember, your future city name needs to remain consistent throughout the competition. Also, please include the organization name and your team name on the essay.
- Place the word count at the end of the essay. The word count does not include the title and reference list, but does include captions of graphics and illustrations. A maximum of 4 graphics/illustrations are allowed.
- Complete the **Research Essay Form**. You can find this form on page 30 or download the writeable PDF at www.futurecity.org. *Please remember the educator or the mentor must sign the form to attest to its accuracy.*
- Use a variety of sources of information for research, such as interviews with experts, reference books, newspaper and magazine articles, and websites (Wikipedia is **not** accepted). Be sure to attach a list of at least three sources and use the Modern Language Association (MLA) format. Go to www.futurecity.org to download a MLA reference template.
- Make a copy of the Essay Form, Research Essay, and Reference List to keep with your records.
- Submit the Research Essay and Research Essay Form to your Regional Coordinator.



For submission details and deadlines go to www.futurecity.org and click on *Find My Region*.



Competition Scoring

Teams can earn up to 70 points for their Research Essay. Make sure students have thoroughly covered the six categories to maximize points:

Define the Problem	6 points
Describe the Technology	6 points
Analyze the Solution	18 points
Assess Innovation/Effectiveness	18 points
Role of Engineering	6 points
Writing Skills	16 points
Total	70 points

Scoring Deductions

- 5 points** Late essays will lose points.
- 2 points** A missing or incomplete **Research Essay Form**.
- 10 points** Count carefully—10 points will be deducted for exceeding the 1,000 word count limit.

Resources

Use these online and print resources to help students launch their research.

Energy Basics

WEBSITES:

- *Energy Kids: U.S. Energy Information Administration*
<http://www.eia.doe.gov/kids/index.cfm>
Explains the basics of energy, different energy sources (renewable, nonrenewable, and secondary), and the history of energy. Also contains a games/activities section and resources for educators.
- *Engineering for Change*
<https://www.engineeringforchange.org/solution/library/viewAll/Energy>
Visit the Solutions Library (Energy) to learn how engineers around the world are designing new ways to generate and transmit electricity.
- *How Does Electricity Affect the Environment?*
<http://www.epa.gov/cleanenergy/energy-and-you/affect/index.html>
Explores how different ways of generating electricity affect the environment.
- *NEED Energy InfoBooks*
<http://need.org/Energy-Infobooks>
Contains information about different energy resources and new technologies. Organized by subject and grade level, with “Intermediate” geared toward middle school.

BOOKS

- *Alternative Energy Sources* by Sally Morgan (Heinemann, 2009)
Discusses the pros and cons of fossil fuels and various alternative energy sources available today.
- *Energy for Keeps: Creating Clean Electricity from Renewable Sources* by Marilyn Nemzer, Deborah Page, Anna Carter (Energy Education Group, 2010)
Explains how electricity can be generated from various energy sources and introduces issues related to our current energy choices.

Innovative Energy Ideas

- *Energize Your Future*
http://www.shell.us/home/content/usa/environment_society/education/student/
Explores how we use fossil fuels and renewable energy sources to meet the world’s energy needs.

- *Engineering Go for It: What’s New?*
<http://students.egfi-k12.org/>
Contains articles about innovative engineering solutions for energy issues (use Search box to locate articles).
- *NSF: Green Revolution*
http://www.nsf.gov/news/special_reports/greenrevolution/index.jsp
Features videos of scientists and engineers who are working to develop and improve the use of clean energy sources, new fuels, and other energy-related technologies.
- *Sustainable Cities: Energy Case Studies*
<http://sustainablecities.dk/en/search-criterias/energy>
Showcases what cities around the world are doing to address energy issues and create more sustainable living.

Careers

- *Energy Kid’s Career Corner*
http://www.eia.doe.gov/kids/energy_cfm?page=activities_career_corner
- *Engineer Your Life*
<http://engineeryourlife.org/>
- *Sloane Career Cornerstone Center*
<http://www.careercornerstone.org/paths/smidthm>

Word Search Suggestions

- Alternative energy
- Clean energy
- Conservation
- Consumption
- Efficiency
- Electric Grid
- Electricity
- Electricity generation
- Global warming
- Green energy
- Nonrenewables (coal, fossil fuel, natural gas, oil, petroleum, propane, uranium)
- Renewables (biomass, geothermal, hydropower, solar, wind)
- Smart grid
- Sustainable
- Transmission and distribution

Field Trip Ideas

Visit places or interview people related to energy/electricity.

- Electric power plant
- Science center or museum
- University or college that has experts in the field
- Businesses—like a local utility, project management firms, consulting companies, or manufacturers of power equipment

Fuel Your Future Research Essay Rubric

0	1	2	3
No Points Requirements missing	Poor Poor-Fair quality. Fulfills less than 50% of requirements.	Good Average-Above average quality. Fulfills at least 90% of requirements.	Excellent Excellent quality. Fulfills 100% of requirements. Additional distinctive features.

I. DEFINE THE PROBLEM, PROPOSE SOLUTION (6 POINTS)	0	1	2	3
1. Define problem <ul style="list-style-type: none"> Introduce city Introduce electric power systems infrastructure (transmission & distribution) 	No description of city or power infrastructure.	Brief description of city and power infrastructure.	Good introduction of city and power infrastructure.	Detailed introduction of city and power infrastructure.
2. Propose alternative energy source <ul style="list-style-type: none"> Alternative energy source for power generation Possibly one of several sources used by city Offsets dependence on fossil fuels 	No description of alternative energy source.	Brief description of alternative energy source.	Good description of alternative energy source.	Detailed description of alternative energy source.
II. DESCRIBE THE TECHNOLOGY (6 POINTS)	0	1	2	3
3. Power generation with alternative energy source	No description of the generation technology or process.	Brief description of the generation technology or process.	Good description of the generation technology or process.	Excellent description of the generation technology or process.
4. Transmission and distribution of generated power	No description of the transmission technology or process.	Brief description of the transmission technology or process.	Good description of the transmission technology or process.	Excellent description of the transmission technology or process.
III. ANALYZE THE SOLUTION (18 POINTS)	0	1	2	3
5. Impact on depletion of natural resources <ul style="list-style-type: none"> Consider: harvesting, generation, distribution, waste disposal 	No discussion of impact on natural resources.	Brief discussion of impact on natural resources.	Good discussion of impact on natural resources, but could be more complete.	Detailed and complete discussion of impact on natural resources.
6. Impact on environment <ul style="list-style-type: none"> Consider: harvesting, generation, distribution, waste disposal 	No discussion of impact on environment.	Brief discussion of impact on environment.	Good discussion of impact on environment, but could be more complete.	Detailed and complete discussion of impact on environment.
7. Benefits <ul style="list-style-type: none"> Environmental and other benefits 	No discussion of benefits.	Some discussion of benefits.	Good discussion of benefits, but could be more complete.	Detailed and complete discussion of benefits.
8. Risks	No discussion of risks.	Some discussion of risks.	Good discussion of risks, but could be more complete.	Detailed and complete discussion of risks.

CONTINUED ON NEXT PAGE

Fuel Your Future Research Essay Rubric

0
No Points
Requirements missing

1
Poor
Poor-Fair quality. Fulfills less than 50% of requirements.

2
Good
Average-Above average quality. Fulfills at least 90% of requirements.

3
Excellent
Excellent quality. Fulfills 100% of requirements. Additional distinctive features.

III. ANALYZE THE SOLUTION (continued)	0	1	2	3
9. Additional issues <ul style="list-style-type: none"> Consider two issues (in addition to environmental) Transmission/distribution Efficiency Availability Cost Reliability Safety, security Storage Sustainability Waste management 	No discussion of additional issues.	Some discussion of at least one additional issue.	Good discussion of two additional issues, but could be more complete.	Detailed and complete discussion of at least two additional issues.
10. Tradeoffs <ul style="list-style-type: none"> Discuss and analyze tradeoffs (e.g., cost, efficiency, appearance) 	No discussion or analysis of tradeoffs.	Brief discussion and analysis of tradeoffs.	Good discussion and analysis of tradeoffs.	Excellent discussion and analysis of tradeoffs.
IV. ASSESS INNOVATION/ EFFECTIVENESS (18 POINTS)	0	1	2	3
11. Innovative and futuristic solution	Not innovative or original.	Somewhat original or innovative. Not futuristic.	Solution is innovative, original and somewhat futuristic.	Solution is highly innovative, original and futuristic.
12. Plausibility of solution <ul style="list-style-type: none"> Based on sound scientific principles 	Implausible or not scientifically sound.	Solution is not very plausible (science fiction).	Solution is somewhat plausible.	Solution is highly plausible and scientifically sound.
13. Accounting for identified risks	Solution does not account for identified risks. Or no risks identified.	Solution partially accounts for identified risks. Ignores major areas.	Solution adequately accounts for identified risks, but could be better.	Solution accounts for all identified risks.
14. Effectiveness of solution: reduces associated risks?	Not effective.	Solution is fairly effective.	Solution is effective, but could be better.	Design is highly effective.
15. Effectiveness of solution: limiting environmental impact?	Not effective.	Solution is fairly effective.	Solution is effective, but could be better.	Design is highly effective.
16. Effectiveness of solution: offsetting dependence on fossil fuels?	Not effective.	Solution is fairly effective.	Solution is effective, but could be better.	Design is highly effective.

Fuel Your Future Research Essay Rubric

0	1	2	3
No Points Requirements missing	Poor Poor-Fair quality. Fulfills less than 50% of requirements.	Good Average-Above average quality. Fulfills at least 90% of requirements.	Excellent Excellent quality. Fulfills 100% of requirements. Additional distinctive features.

V. ROLE OF ENGINEERING (6 POINTS)	0	1	2	3
17. Engineering disciplines involved	Engineering disciplines are not identified.	One Engineering discipline is identified.	More than one engineering discipline is identified.	More than one engineering discipline is discussed.
18. Role of an engineer	The role of the various engineers involved in developing the solution is not discussed.	The role of at least one engineer involved in developing the solution is briefly discussed.	The role of at least one engineer is adequately discussed.	The role of one or more engineers is well discussed.
VI. WRITING SKILLS (16 POINTS)	0	1	2	3
19. Organization	Poorly organized.	Fair organization.	Good organization.	
20. Maximum number of graphics • If used, maximum of 4 (does not include tables)	Exceeds maximum of 4 graphics, illustrations.		Does not exceed maximum of 4 graphics and/or illustrations.	
21. Work appears age appropriate	Work does not appear to be age appropriate.		Work appears to be age appropriate.	
22. Grammar	Many grammatical errors.	A few grammatical errors.	No grammatical errors.	
23. Spelling	Many spelling errors.	A few spelling errors.	No spelling errors.	
24. Writing skills	Poorly written.	Fair writing skills.	Good writing skills.	Exceptional writing skills.
25. List of references • At least three acceptable references • Wikipedia not recognized as an acceptable reference • Appropriate citations	No references.	Less than three acceptable references.	At least three acceptable references.	At least three acceptable references. All appropriately cited.