

NTX Future City Junior, 2022

PART 1

RESEARCH ESSAY: A WASTE-FREE FUTURE

Students write a 1,000-word essay that introduces their city and provides a solution to this year's challenge—A Waste-Free Future. Use the three principles of a circular economy to design a futuristic waste-free city.

Suggestions and Resources for Completing the Essay Assignments

See the Research Essay Outline (attached). Go over the outline with the students and have them list what they want to say in each section. Then suggest that they divide the sections so that everyone writes at least one part of the draft. When it's time to write the final version, they'll have plenty of material to work with. Also remind students that they can include up to four graphics in their essay.

Research Essay Resources (see attached forms or download from the educator dashboard or <http://futurecity.org/resources>)

- Waste-Free Future Research Questions: This resource provides background information on Circular Economy and Waste-Free design and questions for guiding student research.
- Future City Design: Questions to Consider: Students in the Junior Competition are not required to design a complete city – just focus on the solution to the waste problem in one selected area. The questions in this handout cover a wide range of city issues, but will help guide students to consider all the related aspects of their city solution.
- Waste-Free Future: Real World Case Studies: Students will find these real-life examples of technological advances both inspiring and instructive.
- City Essay Suggested Outline: This outline explains what students should include in each section of their essay and how to organize their essay.
- Waste-Free Future Resources: Coming soon (with the new Educator Dashboard).
- Review the Research Essay Rubric (attached) to make sure you understand what the judges will be looking for in your paper.
- Analyze Essays from past NTX Junior winners to give the students a strong sense of what they are aiming for in their own essays. Go to Junior Team Center (http://www.dfwfuturecity.org/team_junior.html).
- Use the Research Cards (futurecity.org/resources, filter for Research Resources & Websites) as a way for the team to document and organize the information and relevant sources that they find. Review the Research Strategies for more ideas and information on citing sources in the bibliography.

Research Essay Assignment

Students research and write a 1,000-word essay that describes the unique attributes of their city and provides a solution to this year's challenge: A Waste-Free Future.

Waste-Free City Overview

Imagine a city 100 years in the future that generates no waste and no pollution. Is this even possible? If we look to the natural world, the answer is yes! In nature, one organism's waste is another organism's food. Nutrients and energy flow in a cycle of growth, decay, and reuse. This is called a circular system.

Today's built world works as a linear system (think of it as a straight line, rather than nature's circle). This linear system follows a path of taking natural resources, making products, using them, and then throwing away anything that is left over after we are done with it – from empty water bottles to old cars. While some things in this linear system are recycled, today's approach does not have a way to capture all the resources and materials that make up the items we throw away or the waste that's created in the

original production process. This results in a lot of trash and pollution and is using up the world's natural resources.

What if cities followed nature's circular system? What if everything was reused or taken apart and remade into something else—from the house you live in, to the food you eat, the bus or car you ride in, the roads you travel on, the battery that powers your phone, and the clothes you wear? A city run on such a system would be truly waste free.

All around the world, engineers, city planners, innovators, entrepreneurs, and government leaders are using the principles of a circular economy to create waste-free cities. They are designing out waste and pollution, keeping products and materials in use, and regenerating natural systems.

The Three Principles of a Circular Economy

1. Design Out Waste and Pollution - Waste and pollution are not accidents, but the consequences of decisions made at the design stage. What if we looked at waste as a design flaw? How can we use new materials and technologies to ensure that waste and pollution are not created in the first place?
2. Keep Products and Materials in Use - We can design some products and components so they can be reused, repaired, and remanufactured. But making things last forever is not the only solution. We should be able to repurpose items or recycle materials so they don't end up in landfills.
3. Regenerate Natural Systems - In nature, there is no concept of waste. Everything is food for something else – a leaf that falls from a tree feeds the forest. By returning valuable nutrients to the soil and other ecosystems, we can enhance our natural resources.

Research Essay Requirements

- In their essay, students will present their future city – at least 100 years in the future, describe its location, and share its innovative features.
- The students will explain what their city was like in the past with the linear system: take-make-dispose.
- They will choose the most wasteful, polluting system (or systems) in the city and describe
 1. How they applied the principles of a circular economy to reduce and eliminate waste and
 2. The technology that allowed them to move to the waste-free system.
- The essay cannot exceed 1,000 words and should be free of grammatical and spelling errors.
- The essay can include a maximum of four graphics.
- The essay must cite at least three sources of information used during the idea development process. MLA style is preferred (see Research Strategies for more detail).
- 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.)

Research Essay Deliverable

- The essay must be submitted as a Word document via the Junior Team Center (http://www.dfwfuturecity.org/team_junior.html).

Competition Scoring

Teams can earn up to 60 points for their Research Essay. Make sure they have thoroughly covered these categories in the rubric to maximize points:

- Introduce City 15 points
- Problem and Solution 18 points
- Judge Assessment of Solution 15 points
- Writing Skills 12 points

Total 60 points

Scoring Deductions

5 points – Late submissions are accepted with a small point deduction (see online schedule)

10 points – For essays that exceed the 1,000-word limit.

SUGGESTED ESSAY OUTLINE

In the Research Essay, you will share your vision of your future city and your solution to the Waste-Free Future challenge and how employing the principles of a circular economy will improve the lives of your citizens.

You can use the following outline as a guide to help you organize and draft your essay.

Introduction

Briefly describe your future city. Include the location, geographic features, climate, population, etc. Include any unique, futuristic features of your city.

Eliminating Waste

Define the Problem:

- Describe what your city was like before you transitioned to a circular economy. How did waste and pollution impact your residents, environment, and economy?
- Select one of the most wasteful, polluting systems in your city and describe how you applied the principles of a circular economy to reduce and eliminate waste
 - Designing out waste and pollution
 - Keeping products and materials in use
 - Regenerating natural systems

Describe the Solution:

- Describe the technology involved in your solution to eliminate waste.
 - Highlight the futuristic and innovative aspects of this technology and solution.
 - Describe some of the risks and tradeoffs associated with the technology and the move to a circular economy.
 - Explain what types of engineering were involved and what types of engineers or technicians were most helpful.

Conclusion

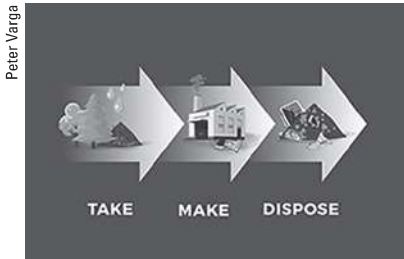
Share why people want to live in your city. Summarize what makes it a healthy, safe and satisfying place to live.

Waste-Free Future: Research Questions

For the competition, your team will use the three principles of a circular economy to design a waste-free city. Below you will find some information and questions to help start your research.

Today's Linear System

Before you start to design your waste-free future city, it is important to look at two aspects of today's linear system: how we make things (like consumer products, buildings, and food) and how we handle waste and recycling.



A linear economy follows a "take-make-dispose" path. Raw materials are collected, transformed into products that are used, and then eventually discarded as waste.

Making Stuff

Pick one commonplace item – maybe a pair of pants, your phone, a fence, even the sidewalk in your neighborhood – and research how it is made:

- What natural resources or materials are needed to make it?
- Where do the resources or materials come from? Are they mined, grown, or manufactured? Are they locally available or do they need to be shipped from far away?
- What is the process for making your item?
- Does making it create any waste or pollution?



Battery Power!

Learn how today's batteries are made in Extraction to E-Waste: The Lithium-ion battery supply chain
<https://ulxplorlabs.org/battery-supply-chain/>

- How does your item get to consumers?
- How long is it designed to last? Was it designed for a single use (a candy wrapper or bottle of water)? Or can it be used for a long period of time (a washing machine, phone, or car)?
- What happens to it when it's no longer useful? Is it recycled, reused, or is it thrown away?
- Does it cause pollution or contamination when it is disposed of?

After you have learned about how your item is currently being made, brainstorm with your teammates about what changes you might make to the production process to design out waste and keep your item and/or the materials it is made from in use longer.

TODAY'S TRASH

When people first learn about a circular economy, they might think it is just another way to talk about recycling. But it is more than that; it combines several strategies like reuse, sharing, repair, refurbishing, remanufacturing, and recycling.

Research how trash and recycling are currently handled in your city or town:

- What waste streams (types of trash) are typically found in trash?
- What happens after trash is collected?
- What role do the 4 R's (reduce, reuse, recycle, and rot) play in today's waste management system?
- How are current systems effectively using the 4 Rs?
- What are some innovative examples of how cities or companies are rethinking or reusing waste?

Learning More About Circular Economy

There are a lot of great resources. We recommend starting with the Ellen MacArthur Foundation. But don't stop there! Search the internet for examples of a circular economy in action. Ask questions like:

- What does it mean to design out waste?
- What is regenerative agriculture?
- How are cities using the three circular economy principles?
- What roles do engineers play in a circular economy?

Future City Design: Questions to Consider

Your challenge is to design a waste-free city that is set at least 100 years in the future. How does your city incorporate all three principles of a circular economy to achieve this ambitious goal? What design and planning decisions made the transition from a linear to a circular economy possible?

As you and your teammates begin to design your waste-free city, use the topics and questions below to guide your research, brainstorming, and design sessions. Remember, no city can provide everything. What are the most important features? What tradeoffs do you have to make?

City Features

- Where is your city located?
- When was your city founded?
- How would you describe the population of your city? Who lives there?
- What are your city's distinctive natural features (e.g., mountains, oceans, rivers)?
- What is the climate like in your city?
- What does your city offer for entertainment, recreation, and cultural enrichment?
- What makes your city futuristic and innovative?



Remember: Even after your city design is complete, these questions are helpful to review as you prepare for the City Q&A.

Zoning, Government & Budget

- How is your city zoned? Are the zones separate or are there mixed-use zones (e.g., commercial and residential or commercial and industrial) in your city?
- How has your city used zoning to achieve its waste-free goals?
- How is your city governed? Who makes the laws and regulations?
- What regulations does your city impose on manufacturers to ensure adherence to waste-free processes?
- How does your city fund its operations (i.e., utilities, infrastructure, and public services)?

Environment & Energy

- What energy source(s) powers your future city? For example: gas, solar, oil, wind, nuclear, biomass, biofuels, tidal, hydrogen, wave, etc.
- What are the costs and tradeoffs of different power sources?
- How has your city applied the principles of a circular economy to the production of its power?
- How have your city's circular economy practices had a positive impact on the environment?

Food & Agriculture

- Where does your city's food supply come from?
- How are local and regional farmers using regenerative food production practices? What have been the benefits and drawbacks to this approach?
- Has your city developed innovative uses for inedible agricultural by-products? Are these products or goods being used by other industries or services in your city? For example, are they being used in regenerative farming, food packaging, medicine, bioenergy, or fashion?

Industry, Manufacturing & Jobs

- What drives the economy in your city (e.g., tourism, manufacturing, education, agriculture, sports, medicine, the arts)?
- How has the switch from a linear to a circular system affected your city's economy? What tradeoffs did your city or local industries have to make?
- How have businesses and manufacturers designed waste out of their production process?
- What innovative approaches and industry practices are being used to keep products or resources in use?
- How are your city's businesses and manufacturers using renewable and reusable resources as materials?
- How has your city changed traditional supply chains in order to stop using a linear approach to manufacturing?
- What types of jobs are available to your residents?

Structures & Housing

- Where do your residents live, work, and go to school?
- How have construction practices changed to achieve your city's waste-free goal?
- What materials are used in your city's buildings? What makes them innovative? How are materials produced, used, and potentially re-used?

Transportation

- What transportation options are available to your residents? Is there more than one way to get around?
- How are goods, materials, and by-products moved around your city for use and reuse?
- How has your city designed waste and pollution out of your transportation system?
- How is your city designed to be accessible for people with mobility issues related to aging or a physical disability?

Utilities & Services

- What services does your future city provide to its residents (e.g., medical, education)?
- How does your city address the needs of vulnerable populations, including the poor, the sick, the houseless, and the elderly?
- What impact has your city's circular economy had on its utilities - such as water, sewer, waste management and recycling, electricity, Internet, etc.?

Health & Recreation

- How does your city support a healthy lifestyle for its residents throughout every stage of life?
- How have hospitals and healthcare designed waste out of their systems? Have any new medicines or treatments been created from your city's circular economy approach?
- What do people do in your city's public spaces?

Waste-Free Future: Real-World Case Studies

A Building that Cleans the Air

The ancient city of Venlo in the Netherlands has embraced the principles of “cradle-to-cradle” (C2C) in all of its new construction. Every material must be reusable, with none going to the landfill and no loss of quality. So when the centuries-old town hall needed renovating, city leaders chose instead to build a brand new one, which opened in 2016. It showcases the benefits of a C2C design, puts the city on the path to a circular economy, and acts as a model for cities around the world that want to go waste free.

The town hall boasts truly healthy air thanks to several innovations. Its solar chimney warms incoming air, creating a natural draft; no mechanical ventilation is necessary. The top floor is a greenhouse that adds oxygen and humidity to the air before it flows throughout the building. The building itself includes atriums, which aid air flow and provide natural light.

The entire northern façade of the town hall is a vertical garden. The plants provide city birds and insects a place to rest and breed. More than 100 different plants convert carbon dioxide into oxygen and clean particulates out

of the air. The plants also absorb the nitrogen and ozone generated by nearby cars and trains, making the city air cleaner. The plants also insulate the building from heat, cold, and noise.

There are even green walls in the parking garage as well as raised areas with ferns and slowly decomposing logs. The plants do their work of cleaning and humidifying the air of the parking garage, and you can even pick edible mushrooms off the walls!



Dinner Made from Air

Physicist, bioengineering researcher, and entrepreneur Dr. Lisa Dyson was looking for ways to combat climate change when she came upon some work that NASA scientists did in the 1960s and '70s. They'd discovered microbes (one-celled organisms) that use carbon dioxide to create nutrients. In their natural habitats of hot springs, these microbes are “super-charged carbon recyclers,” explains Dr. Dyson.

She brought together scientists and engineers to unlock the keys for using these microbes. They found that if you combine the microbes with elements from the air (such as carbon dioxide) and add some water and minerals, you can make nutritious food in a matter of days—with no sunlight, land, or pesticides. The process is a bit like making yogurt but in this case, scientists can make pasta, cake, meatless burgers, cooking oil, and other foods.

The protein has the same amino acids as animal protein, but it contains more vitamins and other key nutrients than meat. Tweak the process and the microbes can make biodegradable cleaners and rocket fuel, all with renewable energy.

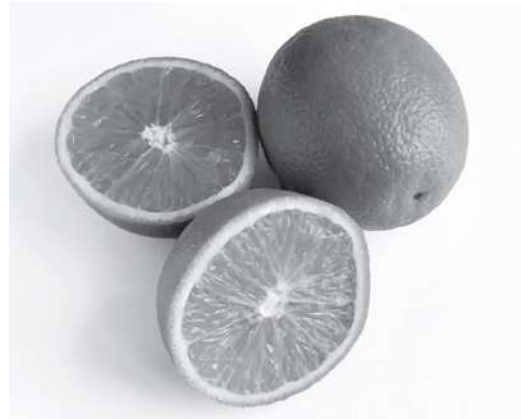
The potential of this technology is enormous. Traditional agricultural practices often generate greenhouse gases and other harmful byproducts. But these microbes can grow in vertical containers that take up very little space and produce food during any season, in any climate, and in just a few days. Food made from air uses 15,000 times less water and 1.5 million times less land than beef.

Orange Peels Insulation

Engineers in the city of Negev, Israel have been experimenting with building materials that are sustainable and more energy efficient. In particular, they have been searching for materials that will insulate buildings against the heat. Israel is a hot dry country, and its cities are even hotter because the buildings and pavement trap heat and raise temperatures to the point of being unhealthy as well as uncomfortable.

One promising new material with impressive insulating properties is a biocomposite of dried orange peels and clay. Walls made with it and a second layer of rammed earth, a traditional building material, have greater insulating properties than lightweight concrete. The houses are much more comfortable and save energy. They also make good use of Israel's orange peels—where orange juice production creates 15 million tons of orange peels every year.

In Italy, orange peels, pulp, and seeds are being made into a material called pastazzo. It is an abundant raw material—Sicily alone produces 340 tons of pastazzo a



year! Pastazzo is an effective insulator; it is also used for fertilizer, in the production of clean energy, and as compost. Using it in these ways saves the high cost of carting it to landfills.

A construction company in England combines orange peels with other kinds of food waste to make a strong building material similar to fiberboard. The company is partnering with engineers, designers, and scientists to transform the construction industry by phasing out fossil-fuel materials entirely and replacing them with bioengineered materials like the ones using orange peels.

Essay Rubric (FC Jr.)

	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 with additional distinctive features.
I. INTRODUCE CITY (15 points)				
1. City overview <ul style="list-style-type: none"> Introduce city and basic features Location, geography, climate, development, etc. 	No description of city	Underdeveloped description of city.	Clear and developed description of the city and unique features.	Clear and thoroughly developed description of city and unique features.
2. Features and innovations <ul style="list-style-type: none"> Attributes that make this city unique. 	No description of unique features.	Underdeveloped description of unique features.	Clear and developed description of unique features.	Clear and thoroughly developed description of unique features.
3. City innovation and futuristic elements	No description of innovative or futuristic elements.	Underdeveloped description of futuristic elements.	Clear and developed description of innovative and futuristic elements.	Clear and thoroughly developed description of futuristic elements.
4. Describe the city's past problems with pollution and waste of resources <ul style="list-style-type: none"> Problems associated with linear economy of take-make-dispose 	No description of past problems.	Underdeveloped description of problems	Clear and developed description of the pollution and waste problems.	Clear and thoroughly developed description of the pollution and waste problems.
5. Describe the selected system and its impact on city and citizens <ul style="list-style-type: none"> Impact of the polluting system and its effect on the city (environment, economy, etc.) Impact on health of citizens 	No identification of system or description of impact on city or citizens.	Underdeveloped description of selected system and effects on city and citizens	Clear and developed description of selected system and its effects on city and citizens.	Clear and thoroughly developed description of selected system and its effects on city and citizens.
II. PROBLEM AND SOLUTION (18 points)				
6. Describe how circular economy was applied to selected system. <ul style="list-style-type: none"> Eliminate waste Keep products/materials in use Regenerate national systems 	No description of application of circular economy.	Underdeveloped description of application of circular economy to redesign of selected system.	Clearly outlines the application of circular economy to redesign of selected system. Could be more detailed.	Clear and thorough description of application of circular economy to redesign of selected system.
7. Describe technology involved <ul style="list-style-type: none"> Innovative and futuristic 	No description of technology	Underdeveloped description of technology. Not particularly innovative.	Clear and developed description of the technology. Innovative.	Clear and thoroughly developed description of technology. Innovative and futuristic.
8. Risks, tradeoffs, and compromises <ul style="list-style-type: none"> Benefits, drawbacks, risks Tradeoffs & compromises 	No discussion of benefits, risks or tradeoffs	Description of one risk and/or tradeoff.	Description of more than one benefit, risk, or tradeoffs.	Description of more than two benefits, risks, or tradeoffs.
9. Describe benefits to citizens <ul style="list-style-type: none"> How does eliminating waste in this system benefit residents 	No description	Underdeveloped description	Clear and developed description of benefits	Clear and thoroughly developed description of benefits
10. Engineering disciplines involved	Engineering disciplines are not identified or not relevant to solution	Discusses one relevant Engineering discipline.	Clear description of more than one relevant engineering discipline	Clear and detailed description of more than one relevant engineering discipline.

Essay Rubric (FC Jr.)

	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 with additional distinctive features.
II. PROBLEM AND SOLUTION (Cont'd)				
11. Role of 1-2 engineers	Role of engineers are not identified	Underdeveloped discussion of role of one engineer	Clear description of role of 1-2 engineers involved in system and solution	Clear and detailed description of role of 1-2 engineers involved in system and solution
III. JUDGE ASSESSMENT OF SOLUTION (15 points)				
12. Selection of wasteful system for renovation <ul style="list-style-type: none"> Significance of the system and impact on city and population 	Selected system is insignificant to city.	System is relatively unimportant to city and citizens.	System and redesign are important to city and citizens.	System and redesign are crucial to the city and citizens.
13. Effectiveness and Quality of solution <ul style="list-style-type: none"> Effective solution for eliminating waste and reusing materials Applies all three circular economy principles Appropriate design and application of technology 	Not effective	Solution is somewhat effective. Technology and design need improvement.	Solution is effective, but technology and design could be improved. Good application of circular economy principles.	Solution is a highly effective, with excellent technology application. Good application of circular economy principles.
14. Innovative & futuristic technologies <ul style="list-style-type: none"> Futuristic, but reasonable extrapolation and application of technology 	Not innovative or original	Overall concept is somewhat original or innovative. Not futuristic.	Overall concept is moderately innovative, original or futuristic.	Overall concept is highly innovative, original and futuristic.
15. Plausibility of solution <ul style="list-style-type: none"> Plausible. Based on sound scientific principles. 	Implausible or not scientifically sound	Solution is not very plausible (science fiction)	Solution is plausible	Solution is highly plausible and scientifically sound
16. Tradeoffs & compromises <ul style="list-style-type: none"> Accounting for risks, benefits Assessing consequences and making logical decisions 	Does not explore tradeoffs	Some consideration of tradeoffs, but ignores major issues.	Adequate assessment of tradeoffs, but analysis and decisions could be improved.	Excellent assessment of risks, benefits, tradeoffs in the decision-making process.
IV. WRITING SKILLS (12 points)				
17. Organization	Poorly organized	Fair organization	Good organization	
18. Writing skills	Poor writing	Fair writing	Good writing	
19. Grammar & spelling	Many errors	Some errors	Few, if any, errors	
20. Maximum number of Graphics <ul style="list-style-type: none"> If used, max of 4 (does not include tables) 	Exceeds maximum of 4 graphics, illustrations		Does not exceed maximum of 4 graphics and/or illustrations	
21. List of references <ul style="list-style-type: none"> At least three acceptable references Wikipedia not recognized as an acceptable reference 	No references	Less than three acceptable references	At least three acceptable references	
22. Word count <ul style="list-style-type: none"> Does not include title, references Includes all captions and words in graphics, illustrations and tables. 	No word count at end of document or inaccurate count		Accurate word count at end of document	