Operation Smart City

OBJECTIVES

- **Apply** the scientific principles of energy transfer.

- **Implement** design concepts to draft a smart city.

- **Explore** how technology powers sustainable solutions to the challenges of modern life and expands mobility for all.

- **Name** two concepts of a smart city and how mobility for all will be improved.

- *Tech Objective Extension:* Students will use the software platform SketchUp to create their mock-up of a smart city

OVERVIEW

In this activity, students will explore the concept of freedom of mobility to investigate how this core principle can be used in creating a smart city. Students will engage in the process of learning what makes a smart city, including science and technology. Specifically, students will build a foundation of understanding how energy travels and engage in the design of a smart city that will maximize energy transfer while leveraging technology. In addition, students will learn how a smart city has been defined and will be introduced to modern examples of smart technologies used in cities. Finally, students will discuss the influence of modern technologies on everyday life and learn about the professions that focus on the study of urban planning as well as the Internet of Things.

INQUIRY QUESTIONS

- How do you define a smart city? How does new technology provide a baseline for other technologies that can be developed?

- How does understanding how energy travels and transfers help when designing a smart city?

- What makes a smart city smart?

NEXT GENERATION SCIENCE STANDARDS

- MS-ETS1-3 Engineering Design: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

- MS-PS3-2 Energy: Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

- MS-PS3-3 Energy: Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

BACKGROUND

A smart city concept integrates information and communication technology (ICT) and various physical devices connected to the IoT (Internet of Things) network to optimize the efficiency of city operations and services and connect to citizens. There are four areas represented by a smart city to ensure comprehensive development: institutional, physical, social, and economic infrastructure. In the long term, cities can work toward developing such comprehensive infrastructure incrementally, adding layers of "smartness." For this project, you will explore the power of energy transfer and the impact on technology and design of mobility.

Energy is the ability to do work, or in more simple terms: energy makes things happen. You use energy to ride your bike, play video games, bake cookies, and drive to school. Energy is exciting! Energy can be transferred from one object to another, and energy can be transferred into different forms, such as light, sound, and heat. Energy transfer takes place when energy moves from one place to another. Energy can move from one object to another, like when the energy from your moving foot is transferred to a soccer ball, or energy can change from one form to another. When the energy in a battery is used to power an electronic device, chemical energy is transformed into electrical energy, which moves along wires. This energy transfer happens quickly and on a regular basis. Energy transfer is imperative for the movement or mobility within a smart city. A smart city is a city that uses a variety of information technologies for more efficient operation, according to the needs of its citizens. The concept of a smart city is similar to the concept of a smart home, where different technologies interact with each other. In a city, this process happens on a much larger and integrated scale (Generation Science, 2020).

KEY VOCABULARY

- Energy
- Energy Transfer
- Smart City
- Internet of Things (IoT)
- Mobility
- Data

MATERIALS

- **Video Clip:** Toyota Woven City Video
- *Handout 1: Smart City Diagram* (one for each student)
- *Handout 2: Creating Smart City* Solutions (one for each group)
- Pieces of chart paper (posted around the classroom; one per group)
- Scratch note paper

TEACHER PREPARATION

- Place two pieces of chart paper around the room, one for each student group.

- Prepare the printed or projected handouts.

PROCEDURE

Engage: *Considering New Technology*

1. As you open the activity, engage students' curiosity by asking them to consider the following statement: *"When you spend time with your parents or grandparents, sometimes you may need to explain certain things that seem normal or intuitive for you."*

2. Ask students to share some examples to highlight the statement. You may consider an example like the following: *"It's hard for me to explain to my family why social media platforms are so interesting and how they are used."*

3. Share with students that there are many examples in our lives of how not all people are familiar with new technologies. These technologies develop rapidly, and more keep on appearing every year!

4. Next, ask students to write a brief response to the following prompt: *What new technologies are being created to improve people's lives? Which things do you think are really important?*

5. After students have taken a few minutes to brainstorm, take some time to share the class's list of new technologies that are making life easier and healthier for people.

Explore: *What Are Smart Cities?*

6. Next, share with the class that one way technology is making a positive impact on people's lives is by designing smart cities that better support mobility for all people.

7. Inform students that as they begin to think about what a smart city is, they should first begin by thinking about the idea of energy transfer. Ask students the following question: *Why is energy transfer an important part of a smart city?*

   Energy is the ability to do work, or in more simple terms: energy makes things happen. Energy can be transferred from one object to another, and energy can be transferred into different forms, such as light, sound, and heat. When the energy in a battery is used to power an electronic device, chemical energy is transformed into electrical energy, which moves along wires (Generation Genius, 2020). This use of energy transfer is important because smart cities will use energy to create a higher level of efficiency using energy transfer.

8. Once students have an understanding of energy and its connection to mobility, share with students the basic idea behind a smart city: *A smart city concept integrates information and communication technology (ICT) and various physical devices connected to the IoT (Internet of Things) network to optimize the efficiency of city operations and services and connect to citizens.*

9. Show the "Toyota Woven City" video to give students a better understanding of what a smart city is. Ask students to think about the following questions while they are watching the video:

   - *How do you see mobility in the video?*

   - *What technology do you see driving mobility?*

   - *How is "smart" being defined?*

10. Guide students to discuss the questions and provide a few minutes for conversations among students. It may be helpful to share thoughts and ideas as an entire class.

11. Next, hand each student **Handout 1: Smart City Diagram**. Ask students to identify the order of importance of the elements within the smart city diagram on the handout. As a class, share how this new technology or way of thinking can improve mobility for all.

12. To deepen understanding, divide students into small groups. Once organized, have students compare their findings and write their combined conclusions about the signs of a smart city. In addition, ask each group to identify where they see energy transfer occurring in the smart city and where mobility will be impacted for the greater good.

13. As you are reviewing student progress, ask each group to share their conclusions with the class. It may be helpful to ask follow-up questions that help students understand how mobility can be thought of in many different ways.
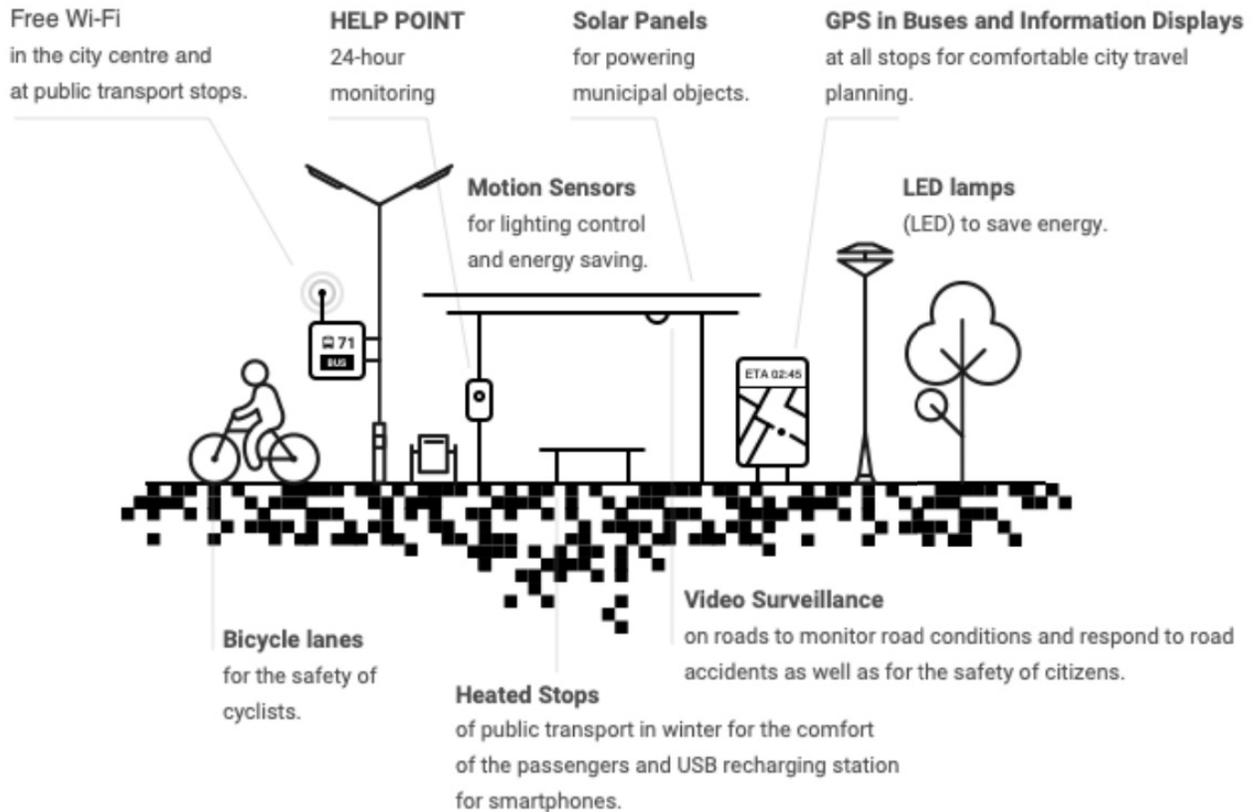
Experiment: *Create Your Own Smart City*

14. With students still in their groups, hand each group a copy of **Handout 2: Creating Smart City Solutions**. Ask students to work through the activity using the chart paper around the room. Prepare students by reminding them that they will be sharing their ideas with the class.

15. To demonstrate student learning, have students present their work to the class or have students complete a gallery walk of the designed smart cities. Students may even leave notes on other students' work highlighting important ideas or adding new thoughts.

REFLECT

16. Using scratch paper or their student notebook, have students reflect on the following questions.

- How might smart cities impact life for all people?

- What opportunities are there for new technology to make mobility easier for all people, regardless of age or ability?

Smart city

The concept of the smart city suggests that due to a real-time information gathering,
all of the city's resources can be used more productively.

Free Wi-Fi
in the city centre and
at public transport stops.

HELP POINT
24-hour
monitoring

Solar Panels
for powering
municipal objects.

GPS in Buses and Information Displays
at all stops for comfortable city travel
planning.

Motion Sensors
for lighting control
and energy saving.

LED lamps
(LED) to save energy.

Video Surveillance
on roads to monitor road conditions and respond to road
accidents as well as for the safety of citizens.

Bicycle lanes
for the safety of
cyclists.

Heated Stops
of public transport in winter for the comfort
of the passengers and USB recharging station
for smartphones.

Picture courtesy of future.io

Place the signs of a smart city in order of importance from the most important sign to the least important.

☐ Traffic control systems		☐ Emergency alert system	
☐ Smart street lighting		☐ Emergency buttons	
☐ Management process		☐ Solar battery usage	
☐ Wi-Fi		☐ Cashless payments	
☐ Smart public transport			

CREATING SMART CITY SOLUTIONS

Directions: Brainstorm with your fellow group members using the chart paper. Imagine and name your own smart city of the future and describe the mobility issue your city faces, a solution, and the benefits of your plan. Sketch your design here and place your final design on chart paper.

Name: City of _____

Issue:

Solution:

Sketch Your City:

TOYOTA