

Transportation and Sustainability

Grades 9-12

Lesson developed by the Center for Climate Protection for use in the ECO₂school Youth Leadership Program



Time: One class period 45-50 minutes

Summary:

Sustainable transportation is how we move ourselves from one place to another without depleting the world's resources. Understand how community design influences our transportation habits and contribute to greenhouse gas emissions. We need systems in place that make it easy to achieve and sustain personal change. Students will look at community design related to transportation and the design of the machines, cars, and bikes we use to transport ourselves.

Next Generation Science Standards:

ETS1.B: DEVELOPING POSSIBLE SOLUTIONS

Complicated problems may need to be broken down into simpler components in order to develop and test solutions.

ETS2.A: INTERDEPENDENCE OF SCIENCE, ENGINEERING, AND TECHNOLOGY

The fields of science and engineering are mutually supportive, and scientists and engineers often work together in teams, especially in fields at the borders of science and engineering

ETS2.B: INFLUENCE OF ENGINEERING, TECHNOLOGY, AND SCIENCE ON SOCIETY AND THE NATURAL WORLD

Modern civilization depends on major technological systems, including those related to transportation. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.

Materials:

- **Computer, projector and speakers to view the PowerPoint**
- **Copy of the Transportation and Sustainability PowerPoint**
- **Laser pointer**
- **Pencils or other small prize**
- **Teacher activity packet**
 - **Current event articles**
 - **Transportation and Sustainability Vocabulary**
 - **Calculate Your Commute Carbon Footprint**
 - **Presenter Evaluation**

Background for Facilitator and Assumed Prior Student Knowledge:

It will be helpful to have an understanding of basic climate science prior to giving this presentation. Review Climate Literacy, The Essential Principles of Climate Sciences A Guide for Individuals and Communities published by the National Oceanic and Atmospheric Association (NOAA) and the American Association for the Advancement of Science (AAAS)

The information in this unit can also be found in the notes of the PowerPoint. When using presentation mode on your computer the notes will be visible to you as a presenter. However, is it preferable to have a deep familiarity with the material so you are not reading off the slides.

Preparation:

Plan on arriving a half hour before your first presentation. Check in at the office and confirm school visitor procedures.

Set up and test all AV equipment in advance. If you are not using your own computer, check to see that it has the appropriate software to run a PowerPoint and embedded videos.

There are two swear words in the first video. Check with the teacher prior to showing the video.

Be prepared to ask students questions to facilitate the understanding of key concepts.

Introduction and Overview Slides 1-5

Facilitators note: Introduce yourself to the students. What is your name? What organization are you with? Why are you here? What inspires you to do this work?

By the end of this presentation students should have an increased understanding of how community design influences our transportation habits and contributes to greenhouse gas emissions as well as changes we can make on the personal, community, and global levels.

What is transportation? How we move ourselves from one place to another.

What is sustainability? How we live in the world and get our needs met without depleting our resources.

What does this have to do with engineering? Engineering is the branch of science and technology concerned with the design and building of machines and structures.

Today we are going to talk about both the design of our structures related to transportation and sustainability and the design of the machines, cars and bikes we use to transport ourselves.

When it comes to living in sustainable ways both are important as we move into the future.

Climate change is the biggest challenge we are facing today it is a threat to our future and future generations ability to live in a healthy sustainable way. It impacts us our planet our community and us personally so solutions also have to be addressed on these same three levels. Here in the Bay Area we can see what that transportation is the biggest GHG producer. The second biggest producer of GHGs is Industry. Most of that industry comes from refining oil again related to transportation.

Personal transportation makes up 24% of our transportation footprint- that means that how we get from one place to another has a huge impact. It also means that our behavior can have an impact. We can either be part of the problem or part of the solution.

Our world leaders have set some bold precedents in response to our changing climate. Here in CA Governor Brown set an even more aggressive carbon emission reduction goal of 40% below 1990 levels by 2030 and again 80% below 1990 levels by 2050. How do we get from this place to that. In the US, personal vehicles, consume more than 60% of the energy used for transportation. World-wide traffic crashes kill more than 1.2 million people a year.

This relates not just to environment but to other big problems like health, obesity and traffic congestion.

The ways we engineer or design our roads and community has a huge impact.

In the first half of 2015 the Federal Highway Administration logged 1.54 trillion miles traveled by motor vehicle. 80% of them were people traveling all by themselves, alone in their car.

Most trips we take are with 2 miles of our home or work

Half of all trips are three miles or less but fewer than 2 percent of those trips are made by bicycle, while 72 percent of them are driven. Private vehicles account for 60% of trips of a mile or less

We need solutions that make moving sustainably easy, safe and convenient. Solutions come when we ask good questions that lead to interesting answers. My job here today is to help frame the question and share strategies that lead to solutions.

There are different kinds of change. There is personal change and systems change. If we want real and lasting solutions we need people to try different behavior and live in ways that are healthier for ourselves and the planet. We also need systems in place that make it easy to make and sustain personal change. Finally we need people like you thinking outside the box. Figuring out what can happen next. Engineers are creative problem solvers, team players and innovators. We need people like you looking at solutions.

Personal Change Slides 6-11

Most of us are already bi-modal we use a variety of transportation strategies to get from one place to another. Mode shift is not so much about giving up completely on motor vehicles as it is about cutting back on and being strategic about when and how we use motor vehicles. Riding a bike is the fastest and easiest way to reduce your carbon footprint.

Remember that 60% of trips that are less than a mile away but we drive by car? What would happen if we walked or rode instead?

What does it take to make public transit, cheap, convenient and fast?

Facilitators note: Draw students' attention to the Power of Collective Action graphic. Point out that while we all are just individuals if we all take care of our own part there can be massive impacts and changes.

Money. Cars are expensive! Who here likes money? Who here has a job. Did you know on average students spend between \$5 and \$19 a week just getting to and from school? That is about \$300.00 a year just to go to and from school. So if you have a minimum wage job you spend 1-2 hours working just to pay to get to school. That doesn't include insurance, repair, and other car related costs. When you travel you have to pay for parking. Cutting down on driving time, sharing rides and costs is good for your pocket book.

Personal health, biking is fun, it clears your head. Its good exercise. It is recommended that teens get an hour of exercise a day. In reality only about 30% do. These are great ways to incorporate exercise into your daily routine.

The risks of being sedentary far outweigh the risks of being out and active in your community.

World wide traffic crashes kill more than 1.2 million people a year. The National Safety Council estimates in 2017 in America over 40,000 people were killed and 4.6 million more people were seriously injured on our roads.

Facilitators note: Map Your Route

This is a chance for your students to think about and describe both how they get to and from school and where they specifically get on and off campus: routes, entrances, methods of transportation. It's important to point out that making it easier for students to access their campus via the bike, walk, and public transit routes will increase the likelihood of students getting to school these ways; however, can they still choose to get to and from school in more sustainable ways? What are some ways they can make these positive changes?

Community Change Slides 12-13

More people walking and biking means fewer cars on the road it makes the commute smoother for people who are still in their cars. Drivers spend an average of 8 days a year sitting in traffic, we burn just as much gas and CO2 idling as we do driving. The city also saves money on road maintenance and repair: 11 cents for every mile you don't drive

Investments in bicycle and pedestrian infrastructure create more jobs per million dollars spend than highway projects. 9.6-11.4 compared to 7.8. Also Bike ped. infrastructure is less costly than say freeway expansion projects. Bike ped projects increase property values and increase sales tax revenues.

Community Design Slides 14-24

Now we have some information about why to walk or bike but that doesn't really address the problems of making it accessible, cheap, safe and easy. We're going to look at some strategies that city planners and civil engineers use to help address these issues.

Even with strategies for change that does not tell us which strategy is right, or what the problems are that are unique to your community. You are the people who live here every day. You are the experts in your own community. I know for example that every time it rains the driveway by that

crosswalk floods. You cannot assume that planners know the details about where you live. Much of what gets fixed in communities comes from squeaky wheel input.

You know where the potholes, cracks that make it hard for wheel chairs, mothers with strollers or friends with a broken leg or a sprain are.

Strategies:

1. Collect data and share it. Collecting information helps you deepen your understanding of the problem. Notice where the challenges are as you walk around your community. Talk to neighbors, friends and community members and listen to what they have to say. People in the community not only have the best information about the problems, they often have done the best thinking about solutions.

2. Build public spaces for cars- cars will be there. Build public spaces for people and people will be there.

Our streets are for everyone. The Complete Streets model insures that they are designed and operated to enable safe access for all users, including pedestrians, bicyclists, motorists and transit riders of all ages and abilities. Transportation agencies are changing their approach to community roads by adopting Complete Streets policies that direct community transportation planners and engineers to routinely design and operate the entire right of way to enable safe access for all users, regardless of age, ability, or mode of transportation. This makes the street network better and safer for drivers, transit users, pedestrians, and bicyclists and makes your town a better place to live.

What are some of the differences you see in the bottom picture that take the idea of complete streets into mind?

The road below is what is known as a road diet. The road for cars has been narrowed to 3 lanes to incorporate designated bike and parking lanes. Instead of having individual left turn lanes there is now a center or shared left turn lane. Even though the space for cars is less traffic is able to flow more smoothly. Car drivers are happier when traffic is flowing and they less CO2 is being emitted when commute times are less. Changes like this, re-striping, are relatively cheap compared road maintenance and expansion projects.

Sometimes good engineering is invisible. We don't pay attention when things are working we only pay attention when they are not.

3. Urban sprawl is not something we see as much in cities. Cities are by definition more compact. In a well designed city people are able to live close to where they work, go to school, socialize, and shop. The farther people are from basic services the less likely they will be to walk bike or use public transportation.

I had a neighbor who did not drive. Her husband did not drive. Everything she did had to be in walking distance unless her children were able to come drive her.

In suburban areas we call this sprawl. In urban areas we call it blight- business owners who do not invest in city communities so people have to travel to meet basic needs.

4. Believe it or not the speed limit is not just something that is there to annoy you it is there for a reason. The faster you are moving in a car the more likely that a collision will be fatal or cause serious injury. At twenty miles per hour nine out of ten pedestrians will survive a collision. This is why we have slow zones around neighborhoods, schools, parks and other places where more people are likely to be out walking. At forty miles per hour the chance of a pedestrian surviving

goes down to one in ten or 10%. By sixty miles per hour there is almost no chance of a pedestrian surviving a collision. This is why we don't let people walk or bike on the freeway. The risk is just too great.

Cities can implement low-speed zones and "area-wide traffic calming," including speed humps, curves in the road called "chicanes," curb extensions and raised pedestrian crossings. Research shows that speed humps can reduce vehicle speeds from more than 22 mph to less than 15 mph. These solutions don't just make people safer but slower traffic makes people feel safer. When people feel safe they are more likely to walk or bike.

5. How likely are you to walk (or ride) if there is no sidewalk, no shoulder and you have to walk on a road where cars travel over 40 miles an hour next to a drainage ditch. Where is this child supposed to go? Where is the safe space for him to play? If he crosses the street where is he crossing to? Where is the cross walk?

Dedicated space is not just sidewalks. Pedestrian-only streets and street plazas can also be effective tools for protecting walkers.

What could we do to improve the walkability for this child?

6. Provide a Safe connected network for cyclists.

There are 4 different kinds of bike lanes that I am going to share with you. Generally they go from most protected to least.

- Class 1 is a designed multi-use path. Cars are not allowed. In San Francisco Chrissy field is an example of this. In Sonoma County it could be the Joe Rodota Trail.
- Class 2 is a designed bike lane on a shared roadway. Bikes have their own lane but interact with cars turning and in intersections. We see a lot of these all over San Francisco and Sonoma County.
- Class 3 is a shared roadway. It is a single lane road that cyclist and cars share. There is no designated space for cyclists but there may be sharrows, speed tables or signs indicating shared usage.
- Class 4 is a new designation. It is a designated bike lane on a roadway that is separate from traffic. This used to be part of class one but then they gave it its own designation. That is why it doesn't fit in the most to least protected mold. You can also see a number of these around SF.

Studies from several cities find that injury rates go down and more people bike when there is dedicated infrastructure like off-street trails and dedicated bike lanes. When cycling networks connect to residential areas, business, retail, schools, parks and public transport hubs they are more likely to be used.

7. Safe access to high quality public transit.

By high quality I mean, cheap or low cost, frequent and convenient. How many of you use the bus or BART to get places? How long do you have to wait for a ride? What happens if you miss the bus? Can you get to the stop safely? Is it close by? These are the issues planners have to address to have a system that works well.

It's not enough to just provide this public transit, though—city planners must also ensure safe access for commuters, clearly marked crossings and easy pedestrian access. This makes it safe not just to use public transit but to get on and off public transit and safe usage to and from the station.

Currently on the floor is SB375 Sustainable Communities Strategies it is a Complete Streets bill and one of its premises is the need for low income housing around transit hubs. Low income people are far more likely to give up their cars but only if they have access to alternative transit.

High quality public transport carries more people, and experience fewer crashes than private vehicle travel. Research shows that a bus rapid transit (BRT) system can reduce traffic deaths and severe injuries by 50 percent.

These two pictures are taken in China in Guanzouh where a million people a day use their transit system. Again when it comes to engineering people don't notice until it is not working. What are some of the things they had to fix to make their transit system work?

1. Buses cannot get safely to the curb. People cannot get safely to the bus.
2. Cars cannot move easily around busses.
3. Busses cannot move easily around each other.
4. Too many buses at a single stop slow traffic.

What are the solutions?

1. Designated highway space for buses (and designated space for cars)
2. Designated passing and a stopping lanes for buses
3. Designated waiting space for pedestrians
4. Multiple locations for bus stops

8. Safe access to high quality public transit

One thing we are seeing more and more is a share economy around cars. There are several ride share or carpool apps and programs that connect people going to similar locations at similar times.

Using uber or lift allows people to move relatively inexpensively without the hassle or expense of parking.

Zip cars is a short term rental program which allows people to not own a car but only use it when they need it.

Bike share is also part of the share economy. It is a short term bike rental. These bikes are placed near transit hubs and help people travel that last mile easily and efficiently.

The last mile is a term used to describe the distance between public transit stops and your destination. Its an important part of community design. If people cannot get safely and easily from public transit to their destination they will choose a different route.

Fuel Shift Slides 25-31

Now we are going to shift from the way we look at roads to the kinds of cars we use. Fuel shift is not so much about switching the type of transportation we use to switching the type of vehicles we use. EVs offer one of the biggest opportunities to address GHG emissions from transportation, and will help strengthen both the local environment and economy. While EVs do not address the co-benefits of active transportation, personal health and traffic congestion they do offer a significant opportunity to reducing our emissions.

Total emissions reduced from EVs sold in Sonoma County through March 2015 are estimated to be over 7,000 metric tons of equivalent carbon dioxide (mtCO_{2e}). This is significant amount compared to any other single measure to reduce GHGs from transportation, and is equivalent to replacing over 180,000 incandescent bulbs with energy-efficient Compact Fluorescent Light bulbs

EV's are powerful and quiet and can go anywhere a "regular" car can go. You can fuel up at home or work and take advantage of riding in the carpool lane.

Facilitators note: Play the video. (Slide 26)

Electric vehicles are a big part of CA strategy for reducing CO2 emissions.

In March 2012, Governor Brown issued Executive Order B-16-2012, directing specific government agencies to establish benchmarks resulting in 1.5 million zero-emission vehicles (ZEVs) on California roadways by 2025.

State of California's 2013 ZEV Action Plan:

- Complete infrastructure and planning
- Expand consumer awareness and demand
- Transform government fleets
- Grow green jobs

Changing over public vehicles to electric is part of that strategy. It includes buses, garbage trucks and government vehicles.

Building infrastructure to meet the growing need for charging stations is important. A major challenge for EV market penetration is the relatively short range of the current choices in commercial EVs. All models except the Tesla have an effective range of about 80 miles. CA goal is to build a minimum network of 68 hydrogen stations to support the commercial launch of Fuel Cell Electric Vehicles between 2015 and 2017, and expand the network to 100 stations to match FCEV market growth.

Electric cars are a great example of engineering and innovation. Sometimes it is hard to remember that everything we have is just a rough draft. It is just the best thinking we have at this moment. Innovation, change, improvements are ongoing. We had the steam engine before the internal combustion engine. In the 1950s cars only got about 15 mpg. In the 1990s the Prius a combination battery/ internal combustion engine started getting 50 mpg. Now we have electric vehicles that don't use fossil fuels at all and we are starting to use hydrogen fuel cells to power trains. We don't know what that next invention, improvement or innovation is going to be or how it is going to impact our lives and the planet. But I do know it is out there waiting to happen. That is what makes engineering so exciting.

What are the needs in your community? You are the best people to answer this question. Engineering is about solutions to real problems and real questions. Sometimes the best answers come from the best questions.

Conclusion Slides 32-33

Don't forget to share what you know.

I am going to come back to those three strategies I shared with you at the beginning.

1. Start with yourself. Don't be afraid to try something new. Notice what is working and what is not and go the problems with real solutions.
2. Engage in your community. Be the squeaky wheel that motivates local officials. Join organizations that are doing work you agree with. Share what you know, do you can do.
3. Dream big. That next big solution is right around the corner waiting to be discovered. Go after it.

You never know how you will impact the people you meet or the significance they will have in your lives.

Like ECO2school on FB. Tell me your climate story. I want to know.

Facilitators note: Thank the teacher and the students for having you in their class today. Ask if there are any last questions or comments. When you have answered the last questions turn the class back over to the teacher for their next set of instructions.