Few Nexus Case Study Project

Subject: Science, Agriculture, Ecology, Social Justice
Age Range: Middle school (6–8)
Topic: FEW Nexus
Objective: To work with other students to come up with solutions to problems involving food, energy, and water systems that affect rural communities.
Materials: Posterboard, markers, scissors, glue, tape, colored paper, Google Slides (pictures of the slides are at the end of this document), Articles Needed pdf

Scenario Task Cards:
Found on pages 5–8 of this document; you will need one task card per group of 3–5 students; more than one group can work on the same scenario

Google slides:
https://docs.google.com/presentation/d/1dxyUQGAOEwtPfZjc6T5D_mTcupn87mkzxkkhjL3q3d8/edit?usp=sharing

Articles needed for the scenarios:
https://drive.google.com/file/d/1wJrtGh6-Rsoe_dlIqawNJ_9wMk8ZspWm/view?usp=sharing

Session One

Introduce FEW Nexus (Click here to access slides, or find pictures of the slides at the end of this document)

- Define "Nexus" using Marvel universe example
  - Ask students if they can define the word "nexus." Call on any volunteers and discuss whether their response is correct, close, or pretty far off.
  - Share these definitions:
    - The intersection of different ideas/systems/processes ("a connection or series of connections linking two or more things; the central and most important point or place" -Oxford Languages [SLIDE 2]
    - "A *nexus* is a central link or connection. If you happen to be at the *nexus* of something, you are right in the middle of it, like standing in the middle of an intersection." [SLIDE 3] https://www.vocabulary.com/dictionary/nexus
  - Show this image of the Marvel Universe [SLIDE 4]: https://www.flickr.com/photos/agoodfella77/39138378452. Explain that it shows how various movies and characters are interconnected. Events that take place in one movie affect situations in other movies.

Only certain characters are Nexus characters who can move among the various universes. Invite 1–2 students to explain/comment. (There's no need to be sure everyone "gets" this; it's just one way for students to access the definition, but if it doesn't help, just move forward.)

- Share this definition of FEW Nexus: "A framework representing the intersections among food, energy, and water systems, highlighting the way human actions drive change across these systems, with each action affecting the whole" (Adapted from Scherer et al., 2020). [SLIDE 5]
  - Invite students to turn-and talk to a neighbor about how they would relate the definition to Marvel. Share 1–2 explanations with the whole group.

- Share this definition of Systems Thinking: "Systems Thinking refers to a way of thinking about problems and systems as having many interrelated components as opposed to thinking of systems as separate processes. The FEW Nexus requires systems thinking to understand the various interrelated components of our food, water and energy systems." [SLIDE 6]

- Show this short video about the FEW Nexus (stop at 3:10 minutes): https://www.youtube.com/watch?v=lvl_2znvA6c [This is an alternative video; there are others on Youtube: https://www.youtube.com/watch?v=CKW_ux2Xo_w]

- Afterwards, briefly discuss the following questions [SLIDE 7]:
  - How does water provide energy?
  - How does energy make water available for use?
  - How is energy used in food production?
  - How is water used in food production?

Session Two

Introduce the FEW Nexus research project.

- Share each of the four case study scenarios. [SLIDE 8]
  - Solar Panels: A farmer must decide if they should allow solar panels to be installed on their farmland. [SLIDE 9]
  - Pipeline: A landowner must decide whether to accept an energy company's offer to build a natural gas pipeline under part of their land. [SLIDE 10]
  - Factory Farms: A community must decide whether to allow a large farm corporation to build a factory farm on the edge of town. [SLIDE 11]
  - Just Transitions: An environmentalist must find a way to convince fellow community members to train for eco-friendly careers. [SLIDE 12]

Hand students a ballot (found at the end of this document) to indicate which case they'd like to work on (first, second, and third choices). *Tally the results before the next class and arrange the groups accordingly.*

Session Three

Work on FEW projects

- Briefly introduce the Engineering Design Process model as a way scientists approach solving problems. [SLIDE 13]
    - Engineering Design Process
        - **Identify** the problem; research how it affects life; determine constraints for solution-forming
        - **Imagine** any and all possible solutions (brainstorming)
        - **Design** the solution using drawings and written steps
        - **Create** the solution according to the planned steps
        - **Test & Improve** the solution—try it out, collect data on its effectiveness, adjust the design to improve effectiveness, try it again, and keep repeating until you've come up with something that works
        - **Share** the design, testing process, data, and conclusions with others.
    - We won't be asking students to rely heavily on this model to construct their solutions to the problems presented in their case studies, but we are sharing a bit about it to familiarize them with the process so they can use it as a *general guideline* for how to start thinking about solutions.
    - If you'd like, you could share some or all of the following to help describe the Engineering Design Process to students:
        - *The Engineering Design Process refers to the process engineers use to develop solutions. Engineers generally have to work within a specific set of requirements or constraints, which are informed by the problem definition and background research. Thus, the beginning steps of the process require engineers to define the problem and do research on the problem. The rest of the process focuses on brainstorming many different solutions until one is reached after many iterations of testing and reviewing until the most ideal or optimal solution is reached.*

- Divide students into case study groups based on the results of yesterday's ballot.
    - Distribute the Scenario task cards (they are included at the end of these instructions) and a sheet of paper to each group and have them get started with these steps:
        - *Write down what you already know about the problem.*
        - *Identify who is affected.*
        - *Describe how the problem relates to the FEW Nexus.*

After they've made the list, give the folder of articles to each group (separate them by scenario first) and ask students to start researching their topic and brainstorming potential

solutions. The PDF with all the articles students will need can be found here: https://drive.google.com/file/d/1wJrtGh6-Rsoe_dlIqawNJ_9wMk8ZspWm/view?usp=sharing

Session Four

Work on FEW projects

- Ask students to consider the criteria for deciding on their proposed solutions. They can think about these questions as possible criteria, but encourage them to think about additional requirements they may want to include:
    - *Is it important for the solution to be eco-friendly?*
    - *Is it important for the solution to be cost-effective?*
    - *Does your solution need to happen in a particular time frame?*
    - *How widespread does your decision need to be?*
    - *What community-related concerns need to be considered?*

- Use any remaining time to help the students continue researching and developing their solutions and/or to begin creating a plan for presenting it. Some students may be ready to begin working on their posters, so have materials (e.g., notecards, notebook paper, scissors, glue, tape, posterboard) available.
- Encourage students to finalize their solutions and have them continuing working on their posters and their plans to present. (You may need to add an extra class period for working on the projects.)

Session Five

Project Presentations

- Have each group of students present their FEW projects to the class. (They will be especially interested in hearing from other groups that worked on the same scenario!)
- After each presentation, allow the presenting group to take two comments and two questions from the group. Show students how to offer positive comments ("I like how you..") and how to ask questions that will further everyone's thinking on the topic.
- Be sure to invite other adults (principals, counselors, other teachers, etc.) to attend these presentations!

SCENARIO 1. SOLAR PANELS

WHO YOU ARE: A produce farmer in rural southwest Virginia

THE SITUATION: In recent years, the profits from your family farm have decreased significantly. Weather patterns have become less predictable, with excessive flooding damaging crops one season and record-cold temperatures in late spring affecting your ability to plant seeds according to the normal schedule the next. At a recent town council meeting, a solar power company pitched the idea of installing solar panels on local farmland to generate clean energy that could be used to supplement the community's energy resources, reducing its reliance on coal and oil. Your family met with a representative from the company, who explained that you might be able to earn more money by selling the energy produced from the solar panels than you would have made farming.

THINGS TO CONSIDER: While you love the idea of helping the environment and securing a more stable income for your family, you aren't sure whether giving up a portion of your farm to accommodate the solar panels is the best decision. For one thing, several community members spoke out at the town council meeting against the company's plans, worried that the solar panels would be an eyesore that would diminish the beauty of the area's rural landscape. At the high school basketball game this weekend, you overheard some neighbors discussing the plans, voicing doubts about whether the panels would really be able to generate the energy and revenue promised, or if they might have some unknown negative impact on the environment. Moreover, your family has farmed the land for several generations, and you fear that agreeing to the power company's plans might make it harder for the tradition of farming to continue. You enjoy connecting with community members while selling some of your produce at the farmer's market every Saturday morning in the summer months, and you fear that if the community can no longer rely on purchasing food from you and other local farmers, they will have to import more produce from other places, which could result in more damage to the environment due to the energy it would take to package, store, and transport the food over long distances.

YOUR PROPOSAL: Please read the printed articles, then work with your group to propose a viable course of action. Prepare a proposal explaining what your decision will be. Will you install the solar panels? How much, if any, of your farmland will you devote to generating solar energy? If you decide to continue farming (instead of, or in addition to, installing the solar panels), what might you do to ensure your family can continue earning a profit despite the impact of climate change?

SCENARIO 2: PIPELINE

WHO YOU ARE: A history teacher and homeowner in rural Southwest Virginia

THE SITUATION: You work full-time during the school year, but you also own several horses and are researching the idea of starting up a venture where people who have experienced emotional or physical trauma can come and work with the horses as a form of therapy. It would be a costly endeavor, but you feel it could be a meaningful and rewarding way to help others in the community. Recently, a natural gas company has filed paperwork to begin the process of installing a pipeline that would run underground beneath your land, shortening the path between two previously existing pipelines. You have heard that they intend to go from home to home, offering a large sum of money to people who permit them to install the pipeline as planned.

THINGS TO CONSIDER: Some of your neighbors say it would be best to accept the company's initial offer, because if you don't, they will seek to have the land seized under eminent domain laws, in which case you would have to give up your land anyway, but you would receive a much smaller amount in compensation. Other neighbors warn that the installation of the pipeline could cause permanent damage to the water supply in your community, threatening the people and animals (including your horses) who need it to drink, bathe, and grow crops. A group is forming to protest the gas company's plans, saying they don't have a good enough reason to build yet another pipeline to justify the potential damage it may cause, especially when some residents' families have lived on their property for hundreds of years and they have no intention of surrendering. You've heard that the Indigenous community in a neighboring county plans to resist the pipeline project because it impinges on their rights as citizens of a tribal nation, and you don't want to be a part of something that marginalizes them in a similar way to how your White ancestors took away their rights long ago—something you teach your students about every year in school.

The money from the gas company would go a long way in helping you start the horse therapy venture, and if the company will eventually find a way to get the land whether you agree or not, you are tempted to accept their offer and move forward with your plans. However, you don't want to upset your neighbors who are adamant about not wanting the pipeline, and you fear they may have a good point about the potential damaging impact on the environment—especially the water supply. At the same time, you dread the idea of a long, drawn-out fight over an outcome that seems inevitable: given the gas company's extensive resources, you just can't see how they wouldn't get their way in the end.

YOUR PROPOSAL: Please read the printed articles, then work with your group to propose a viable course of action. Prepare a proposal explaining what your decision will be. Will you allow the gas company to build the pipeline underneath your property? If so, what steps will you take to ensure the pipeline is safe for your community? If not, will you join forces with neighbors who plan to protest the pipeline? What arguments would be most effective in explaining why a pipeline might be harmful to your community?

SCENARIO 3. FACTORY FARMS

WHO YOU ARE: A member of the county board of supervisors in a small farming community in central Virginia

THE SITUATION: Many of your community's residents are farmers who grow wheat, soybeans, and other crops that help feed people all across Virginia and throughout the United States. Your grandparents owned and ran a small dairy farm down the road from the house where you grew up, and your cousin's family is trying to keep it running today. With unpredictable weather patterns in recent years affecting everything from when farmers can plant seeds to the infiltration of insects that threaten to ruin the harvest, it's become harder and harder to make a living as a farmer. You and other community members recognize that modern farming is unsustainable without reliable internet access that allows farmers to use technology to stay on top of weather trends, test the soil to see when conditions are best for planting, and run machines that regulate the amount of water used to the optimal level. However, broadband companies have yet to reach your community with the infrastructure needed to make reliable internet feasible, and they don't feel there are enough people living nearby to justify the cost of setting this infrastructure in place. The town council has been looking for ways to generate revenue that could be used to offset the costs of establishing universal broadband access in your community, but resources are very limited. Recently, the owners of a factory farm in Indiana approached your mayor about the possibility of building a large-scale pig farm at the edge of the county, near the border created by a river separating the two locales. As part of the project, developers would donate more than enough money to the town to pay for the much-needed internet project.

THINGS TO CONSIDER: While you and the other members of the board love the idea of helping local farms by establishing the connectivity they need to be competitive in today's agriculture market, you worry that permitting a factory farm within the town limits may not be a wise investment for the community. For one thing, local pig farmers would likely be undersold by the farming company with more resources and the ability to make pork products available to consumers at lower prices. While pig farmers only make up a small proportion of agriculture producers in the county, you realize it would almost surely put those who do raise pigs out of business entirely. You have heard that factory farms in some places do not prioritize humane treatment of animals, with pigs and chickens sometimes having to share tiny spaces instead of being able to spend time outside in the open air. Recent news reports have highlighted damaging effects on the water supply in some places when factory farms fail to properly dispose of waste, and you fear the community will object to the odor that would surely result with the addition of many more pigs to the area. Still, you realize the need for broadband access is urgent, and you're not sure if your community will ever be able to afford to set up the needed infrastructure without the factory farm's donation.

YOUR PROPOSAL: Please read the printed articles, then work with your group to propose a viable course of action. Prepare a proposal explaining what your decision will be. Prepare a proposal explaining what your decision will be. Will you allow the developers to build a factory farm in your county? If so, what steps will you take to minimize the negative effects of factory farming on your community? If not, what other solutions to the problem of limited broadband access might you pursue?

SCENARIO 4. JUST TRANSITIONS

WHO YOU ARE: A group of young environmentalists returning to their southwest Virginia hometown after college graduation

THE SITUATION: Your group members have recently finished college with degrees in environmental science, public policy, business, and agriculture. You are all excited to return to your beloved hometown of Denton, Virginia, which is located in a remote area alongside the Blue Ridge Mountains in the far southwestern corner of Virginia. Denton used to be a thriving community whose residents were primarily employed by the coal mine headquartered there. Recently, however, the mine closed after its owners decided they could no longer keep up with the increasingly costly environmental regulations. Some older Denton residents were able to take early retirement from the company, and the rest of the workers were given a small severance package that will allow them to continue paying for their families' basic expenses while they try to seek work elsewhere. Unfortunately, there are not a lot of other opportunities for work in or near Denton, and community members are concerned that many residents will be forced to move, or they may stay and face poverty. You learned a great deal about *just transitions* in college, and you are eager to help your community explore some of the options that might be available for ensuring Denton residents can find good-paying jobs. At the town council meeting next week, you will be giving a presentation about some of the possible development options your town could consider, and you will be asked to give your recommendation as to which one you think will be most likely to bring prosperity back to your community.

THINGS TO CONSIDER: You realize it may be difficult, at your young age, to convince older members of the community that you have viable ideas to share, so you want your presentation to be as professional and appealing as possible. You'll need to come up with three ideas of businesses or organizations that might want to move into Denton and provide jobs and/or job training to residents who were no longer employed by the coal company. Consider tourism—would people travel to Denton to spend time in the beautiful mountains if there were some type of resort or campsite they could stay in? What about education and/or job training? Might a community college in another town want to build a satellite campus in Denton? The coal mine was a source of energy for the region. Is there a different type of energy-production facility that could be built in Denton? In many communities, former extraction sites have been repurposed into parks or hiking trails—could that work in Denton?

The possibilities are endless, but you need to come up with three ideas and help show the community how they will (a) provide jobs; (b) be environmentally friendly; and (c) be cost-effective. (That is, you can't just suggest building a gigantic waterpark unless you have an idea of who might invest in building it and who its customers might be down the road!) Be practical, but feel free to suggest seeking grants and donations from organizations and individuals who want to help communities like Denton thrive. At the end of your presentation, share which solution you recommend pursuing.

YOUR PROPOSAL: Please read the printed articles, then work with your group to propose a viable course of action. Prepare a proposal explaining what your decision will be.
What business, organization, or environmental project do you suggest for Denton? How will it provide jobs to the community? How might the project be funded?

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Case Study Project

Finding Solutions for FEW Nexus Dilemmas

Researcher Name: _____

Please rank the following scenarios in order of preference. For the scenario you'd most like to research, write a "1." For your second choice, write a "2," and so on.

☐ *Scenario One:* Solar Panels

☐ *Scenario Two:* Pipeline

☐ *Scenario Three:* Factory Farms

☐ *Scenario Four:* Just Transitions

FEW Nexus
Case Study Project

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1

NEXUS

The intersection of different ideas/systems/processes

"A connection or series of connections linking two or more things; the central and most important point or place"
-Oxford Languages

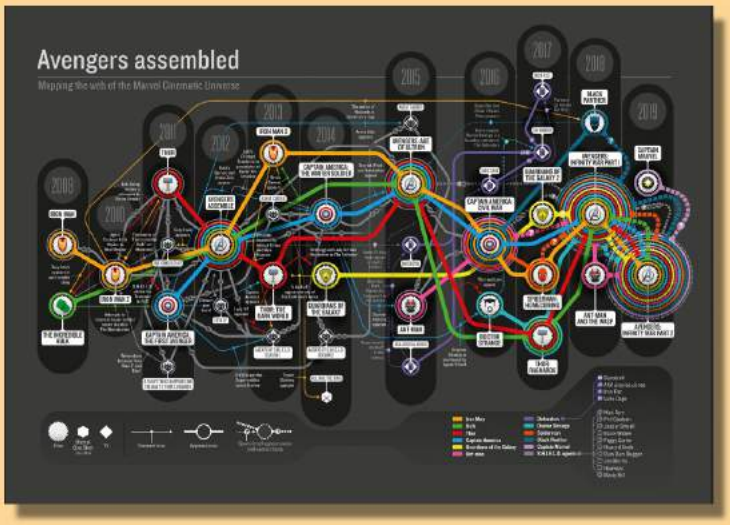
2

NEXUS

"A *nexus* is a central link or connection. If you happen to be at the *nexus* of something, you are right in the middle of it, like standing in the middle of an intersection."

-www.vocabulary.com

3

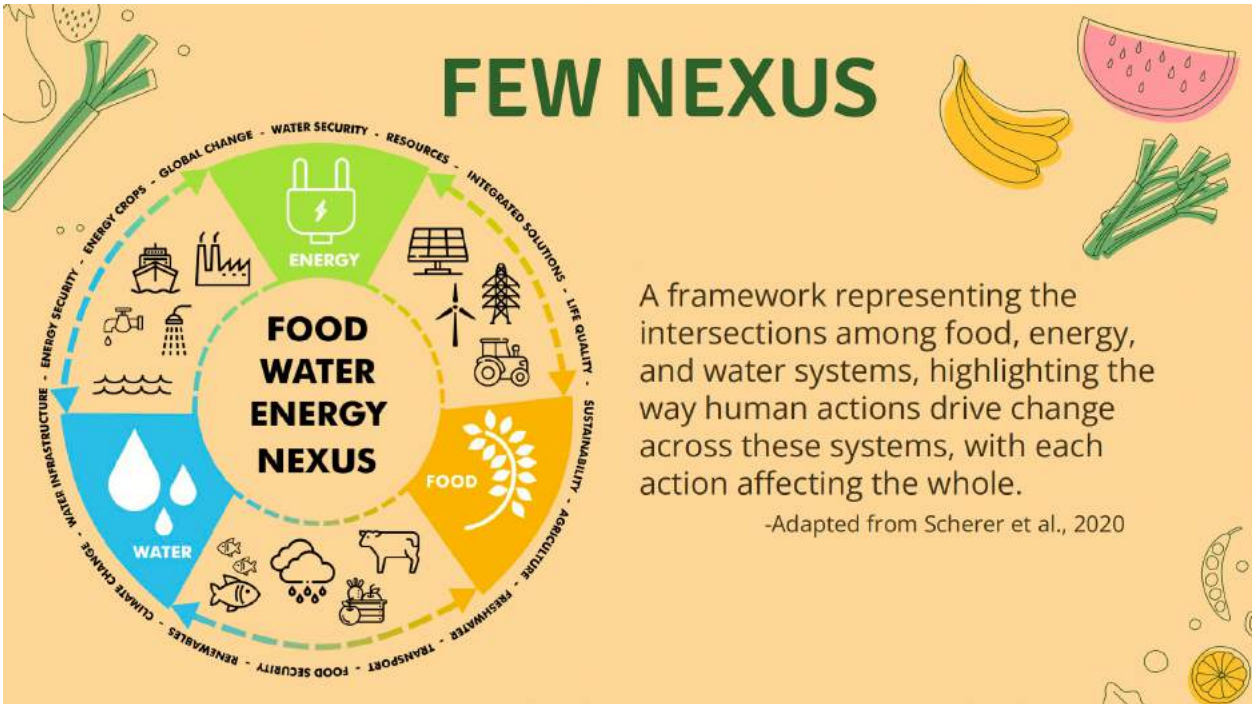


Nexus Characters

"Individuals with the ability to affect the universe around them–and in the process, the future itself, making them key figures in the continued progression of the time stream."

Lore
Merlin
Eleyn
Sise-Neg
Scarlet Witch
Leonard Tippit
Kang the Conqueror

4


FEW NEXUS
ENERGY
FOOD
WATER
FOOD WATER ENERGY NEXUS
A framework representing the intersections among food, energy, and water systems, highlighting the way human actions drive change across these systems, with each action affecting the whole.
-Adapted from Scherer et al., 2020

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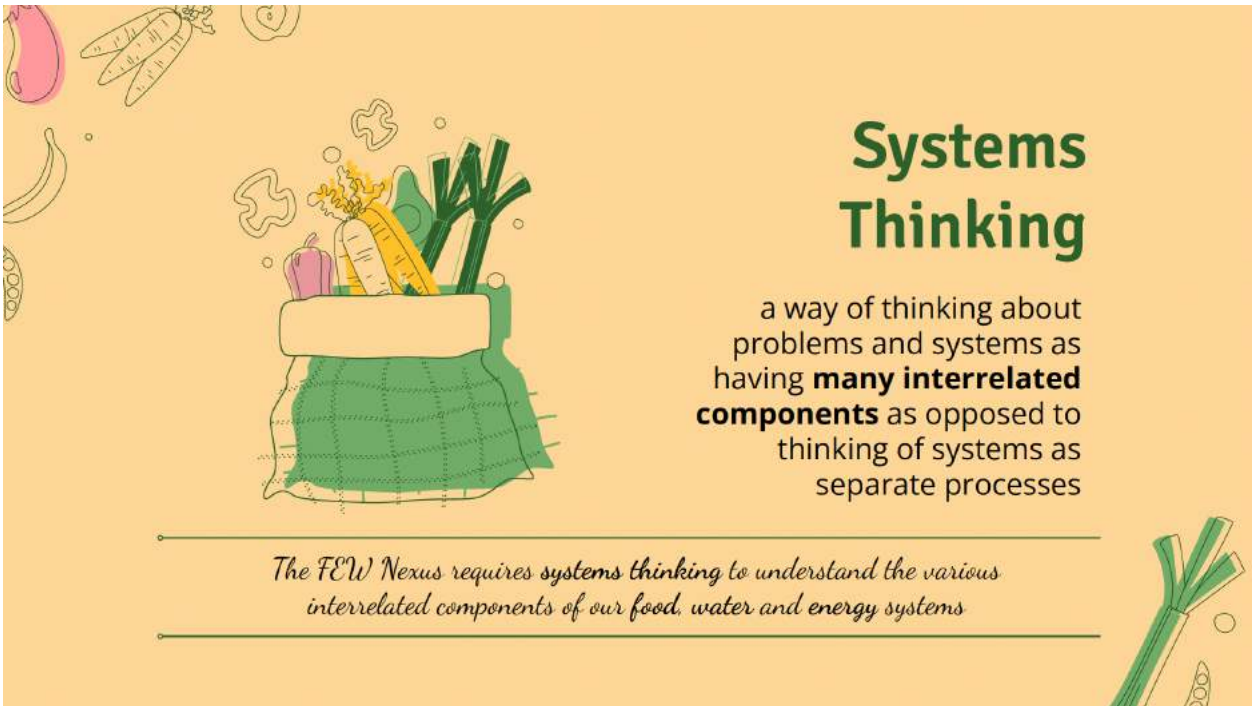
Systems Thinking
a way of thinking about problems and systems as having **many interrelated components** as opposed to thinking of systems as separate processes
The FEW Nexus requires systems thinking to understand the various interrelated components of our food, water and energy systems

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Questions to consider:

- How does **water** provide **energy**?
- How does **energy** make **water** available for use?
- How is **energy** used in **food** production?
- How is **water** used in **food** production?

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CASE STUDY PROJECT

Finding Solutions for FEW Nexus Dilemmas

Scenario 1	Scenario 2	Scenario 3	Scenario 4
Solar Panels	Pipeline	Factory Farms	Just Transitions

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Scenario 1

Solar Panels

A farmer must decide if they should allow solar panels to be installed on their farmland.

Video:
https://www.cbsnews.com/news/indoor-farming-appharvest/

9

Scenario 2

Pipeline

A landowner must decide whether to accept an energy company's offer to build a natural gas pipeline under part of their land.

10

Scenario 3

Factory Farms

A community must decide whether to allow a large farm corporation to build a factory farm on the edge of town.

Video:
https://www.wric.com/news/without-broadband-expansion-virginia-farmers-will-fall-behind-u-s-sec-agriculture-says/

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Scenario 4

Just Transitions

An environmentalist must find a way to convince fellow community members to train for eco-friendly careers.

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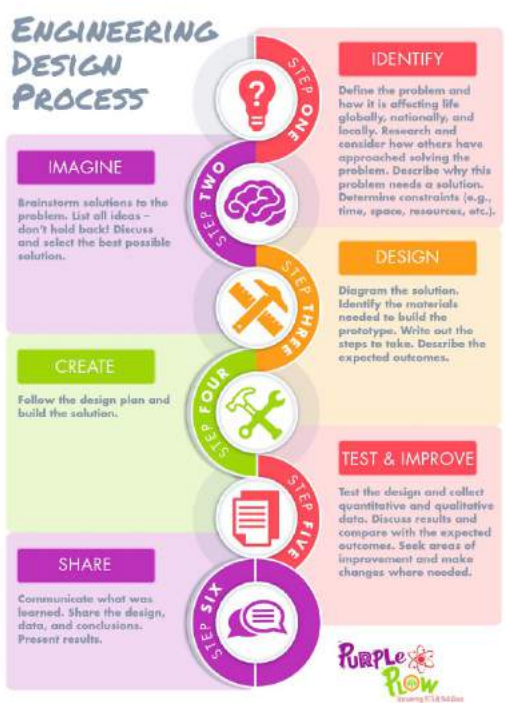

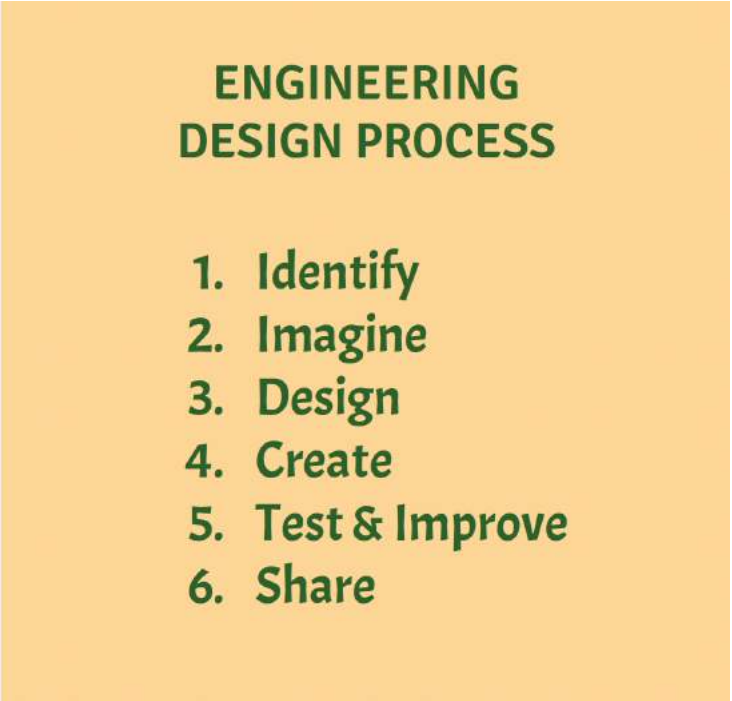

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Link to articles for each scenario:
https://drive.google.com/file/d/1wJrtGh6-Rsoe_dlIqawNJ_9wMk8ZspWm/view?usp=sharing