UNIT 2: My Energy Footprint

This unit is comprised of 6 activities that have been informed by the ENERGE Energy Literacy Framework. A guide to the ENERGE Energy Literacy Framework can be found in UNIT 0. Activities 2.1 and 2.1 introduce the topics of energy in the food system, in activities 2.3, 2.4 and 2.5 students use their own research to work out their own carbon and water footprints with respect to the food they eat, the water they drink and the energy that they consume. students will gain an enhanced awareness of the food system and foods from their region, explore the connections between personal energy choices and larger systems. Students also practice systems thinking within the context of issues surrounding our global food, water and carbon production systems. Students have the opportunity to develop their energy literacy by investigating their role within the global energy system and to consider the impact of their own energy-related decisions and actions on the wider global community. Students will engage in self-reflected learning, systems thinking, innovation and creativity and through developing their data analysis design, critical thinking, communication and collaborative skills. Ultimately, students should feel better equipped to identify solutions to reduce their carbon and water footprints. The activities in this unit are suitable for lower and upper second level students. The energy literacy characteristics, skills & competencies addressed and how the activities link to the national curricula are outlined in tables 2.1-2.3.

OVERVIEW of UNIT 2 My Energy Footprint

Table 2.1 Activities and titles are given, the time required to complete the activity and the ISCED classification.

	Activity Title	**Estimated time (min)**	**Level**	
			ISCED 2	**ISCED 3**
Activity 2.1	Energy in the Food System	30-45		X
Activity 2.2	Greener Greens?	45-60	X	X
Activity 2.3	Carbon Footprint Calculator	30-60		X
Activity 2.4	How much freshwater is there?	30-60	X	
Activity 2.5	My Water Footprint	30-45	X	X
Activity 2.6	Reducing my Energy Footprint	30-60	X	

Activities Mapped to Subjects in National Curricula

Table 2.2 Activities are mapped to subjects in National Curricula

	Activity Title	Science	Technology & Informatics	Engineering	Mathematics	Home Economics	Geography	English	Design & architecture	Civics & politics	Society & Health	Business & Economics
Activity 2.1	Energy in the Food System	X	X			X	X			X	X	
Activity 2.2	Greener Greens?	X	X		X	X	X			X		X
Activity 2.3	Carbon Footprint Calculator	X				X	X			X	X	
Activity 2.4	How much freshwater is there?	X				X	X			X	X	X
Activity 2.5	My Water Footprint	X				X	X			X	X	X
Activity 2.6	Reducing my Energy Footprint	X				X	X	X		X	X	X

Activities Mapped to Energy Literacy Characteristics

Table 2.3 Activities are mapped to Energy literacy Characteristics.

	Activity Title	C1	C2	C3	C4	C5
Activity 2.1	Energy in the Food System	X	X	X		
Activity 2.2	Greener Greens?		X	X	X	X
Activity 2.3	Carbon Footprint Calculator		X	X	X	X
Activity 2.4	How much freshwater is there?		X	X	X	
Activity 2.5	My Water Footprint		X	X	X	
Activity 2.6	Reducing my Energy Footprint		X	X	X	X

Skill & Competencies Addressed

Table 2.4 Activities are mapped according to Skills & Competencies addressed.

	Activity Title	Decision Making	Problem Solving	Design/innovating	Data Analysing	Collaborating	Communicating	Research	Critical Thinking	Numeracy
Activity 2.1	Energy in the Food System		X	X	X	X	X	X	X	
Activity 2.2	Greener Greens?	X	X		X		X	X	X	X
Activity 2.3	Carbon Footprint Calculator		X	X	X				X	X
Activity 2.4	How much freshwater is there?		X		X		X	X	X	
Activity 2.5	My Water Footprint		X		X			X	X	X
Activity 2.6	Reducing my Energy Footprint	X		X				X		X

Activity 2.1 Energy in the Food System

In this activity, students use Sankey diagrams originally adapted from a journal publication to illustrate the energy transfer through complex systems such as food production. Sankey diagrams summarise all the energy transfers underway in a process or system. The thickness of each line is proportional to the amount of energy involved. Students apply their understanding of Sankey diagrams to understand the ways in which energy is transferred and transformed throughout the USA food system. Students calculate how much energy is wasted as in the food system. Students consider whether adopting a more sustainable lifestyle (i.e., vegetarian diet) is enough to reduce energy wastage in the food system. This activity has was developed by the Centre for Advanced STEM Teaching & Learning (CASTeL) based in Dublin City University, Ireland.

Duration	
• 30-45 minutes	
Energy Literacy Characteristics addressed:	
C2	Students understand the impact that energy production and consumption have on all spheres of our environment and society.
C3:	Students are sensitive to the need for energy conservation and the need to develop alternatives to fossil fuel-based energy resources.
C4	Students are cognisant of the impact of personal energy-related decisions and actions on the global community.
Skills & Competencies addressed:	
• Critical Thinking • Problem Solving	• Communicating • Data Analysis
Subject links in National Curricula:	
• Science • Technology & Informatics • Engineering	• Home Economics • Geography • English
Level	
• ISCED 2 • ISCED 3	

Suggestions for use:

STEP 1: Introduce students to the topic:

According to statistics from the Food and Agriculture Organization of the United Nations, more than 800 million people are malnourished. According to the International Vegetarian Union:

"much of the world's massive hunger problems could be solved by the reduction or elimination of meat-eating. The reasons are livestock pasture needs which cut drastically into land which could otherwise be used to grow food and the fact that the vast quantities of food (which could feed humans) is fed to livestock raised to produce meat." (Available at https://ivu.org/).

The question is: should we all become vegetarian or vegan?

STEP 2: Give out copies of the Student Handout: Energy Flow Chart 1 to students. Ask the students if they understand what the diagram is showing them. Students can work alone or in groups.

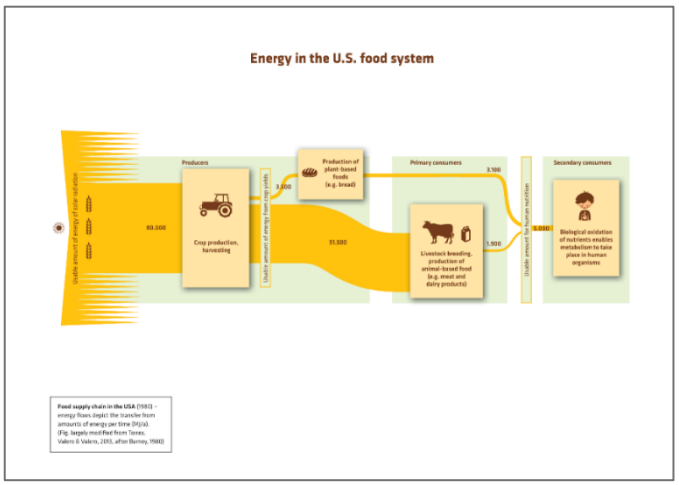


Fig. 1. Energy Flow Chart 1

Ask students the following questions:

- How much of our energy comes from plant-based foods?
- What fraction of our energy from food comes from plant-based foods?
- What fraction of energy from the sun used in agriculture do plant-based foods require?

What do you think the width of the lines represents?

- Is there something to the arguments made by the IVU?
- Do you think the energy flow chart is complete?

STEP 3: Give out copies of the Student Handout: Energy Flow Chart 2 to students.

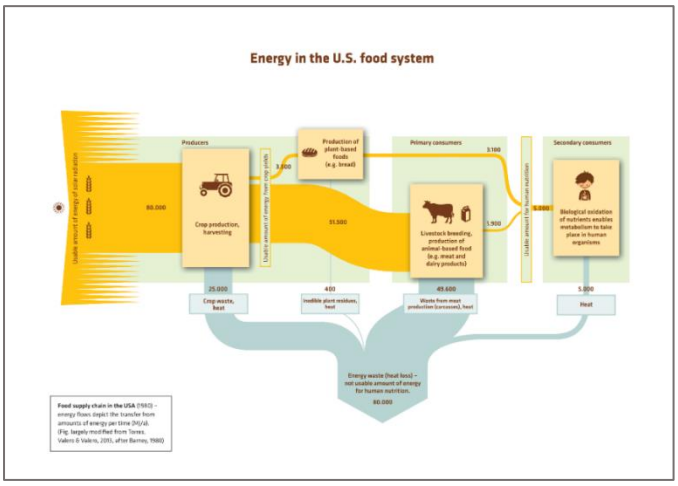


Fig. 2. Energy Flow Chart 2

Ask students the following questions:

- Where does (the rest of) the energy go?
- Do we need more energy than what is accounted for in this diagram?

STEP 4: Give out copies of the Student Handout: Energy Flow Chart 3. Ask students to students to explain differences between chart 2 and chart 3. This is also an opportunity to introduce the energy conservation principle.

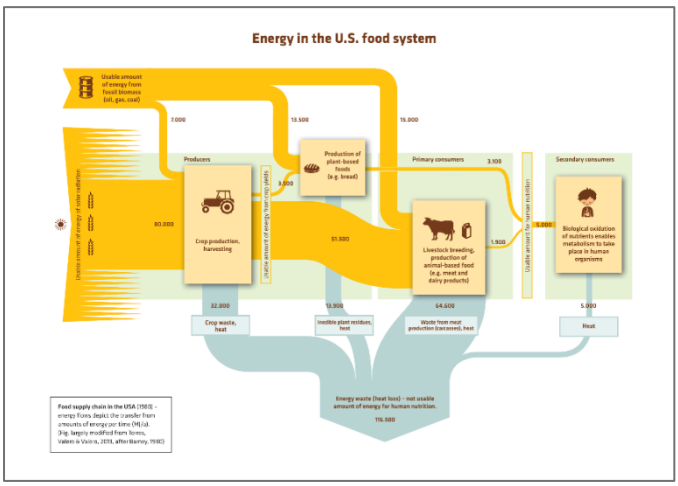


Fig. 3. Energy Flow Chart 3

Ask students the following questions:

- What if we went partly vegetarian?
- Can you calculate the implications of going partly vegetarian?

This allows students to model the effect of sustainable actions. For example, students might calculate the implications of eating meat only 6 days a week by adopting a "meatless Monday". What is important is that students are able to quantify how much of this energy and food could be saved as a result.

Extensions to Activity 2.1

1. Students read and discuss the NYT article "How to Feed the World". See Resource 1 (NYT Article).

2. Students read and discuss Resource 2 (EU Food Flow SANKEY) and write a letter to the government requesting up-to-date information for their country/the EU in which they argue why they are requesting this particular data.

Materials

- Activity 2.1 Student Energy Flow Chart 1
- Activity 2.1 Student Energy Flow Chart 2
- Activity 2.1 Student Energy Flow Chart 3
- Activity 2.1 Resource NYT Article
- Activity 2.1 EU Food Flow Sankey. Available: http://www.sankey-diagrams.com/tag/europe/

Activity 2.2 Greener Greens?

This collection of student inquiry-based research projects are designed to question ethical and sustainability issues surrounding global food production and consumption, and possible resulting impacts on climate change and biodiversity. It challenges students' assumptions that the all-year-round availability of non-seasonal fruits and vegetables is necessary through critical analyses of data, and personal case studies. Beyond this, the question of whether political or economic agreements between countries to supply and receive goods that can be sourced locally to each other, is questioned. The role of science in society is used to evaluate commercial and media-based arguments on sustainability. Students have the opportunity to increase awareness of their role and impact within the biosphere. This original source materials for this activity was developed by Confey College in Leixlip, Ireland.

Duration
• 45-60 minutes
Energy Literacy Characteristics addressed:
C2 Students understand the impact that energy production and consumption have on all spheres of our environment and society. **C4** Students are cognisant of the impact of personal energy-related decisions and actions on the global community. **C5** Strives to make choices and decisions that reflect these attitudes with respect to energy resource development and energy consumption
Skills & Competencies addressed:
• Critical Thinking • Communicating • Problem Solving • Collaboration • Decision Making • Research & ICT
Subject links in National Curricula:
• Science • Home Economics • Technology & Informatics • Geography • Mathematics • English • Engineering • Civics & Politics • Social & Health
Level
• ISCED 2

Suggestions for use:

This activity is comprised of 4 unique but connected research projects. Teachers can select **one project** to carry out with their students. Students would benefit from working in pairs or groups.

Option 1. Research Project A

- Teacher asks students about their favourite fruits or vegetables.
- Teacher asks whether they are in season or not, and if not, where they might have come from
- Students identify possible countries of origin on an atlas and features of that location in terms of climate or season that might support their choice.
- Teacher initiates an inquiry activity where students search for information about what is 'in season' at different times of the year for their country.
- Food labels are collected from students.
- Students conduct their research and prepare a presentation of their findings.

Option 2. Research Project B

- Teacher generates a discussion about how availability of different foods might have changed over the years.
- Students establish a method for collecting data about changes, (by interviewing older relatives or friends of the family- there is the possibility for a community link with local old people's homes), and countries of origin (by collecting food labels off wrappings).
- Students conduct a class discussion based on the findings of their interviews.

Note: students are frequently shocked by the differences that are relayed and fascinated by variations from town and country life-styles and those of individuals from other countries).

Option 3. Research Project C

- Students watch a short documentary on Quinoa produced by Channel 4 news (or

another suitable documentary) and are then prompted to find more information about the topics raised and raise issues of bias and reliability of data or claims made by the documentary.
- Teacher asks the students to discover whether the same is true for palm oil production (this leads to discussions about monoculture and loss of biodiversity. Students then present their initial findings to the class.

Option 4. Research Project D

- Students calculate their food miles by calculating the distance travelled by taking the capital city of the country of origin and their location. Students should also calculate the volume and mass of CO_2 produced by inputting distance travelled and mass.

  Tip: *students can use milk cartons to visualize 1 litre and extrapolate the dimensions to model the carbon dioxide emissions for a variety of items*

- Teacher can raise the issue of foreign imports of items that can be locally grown and questions whether it makes any difference where the food comes from (this always raises the carbon emissions from transportation).
- Students decide what information they need to collect that will inform them of the carbon footprint of transportation (i.e., name, mass, country of origin) and how they will present their results.
- Students can prepare short presentations to be given to school colleagues, the local community and local supermarket managers/purchasers

Materials

- Activity 2.2 Student Handout
- Computers with Internet Access
- Microsoft Office Powerpoint (optional)
- Variety of food labels from supermarket
- Data Projector
- Poster making materials

Extensions to Activity 2.2

1. Students visit a local farm/ education centre and learn about crop production

2. Students attempt to grow their own fruits or vegetables (once planted, these need to be regularly monitored)

3. Students incubate hens eggs in the classroom, turning them regularly and then watch their development for a week post hatching

Partnership Opportunities

- Families

Family choices about food consumption drive local economics. By first discussing how the availability of food types has changed over the years with older relatives and friends of the family a context for the project is set. Comparisons of town and country living, and experiences from other countries, provides a rich basis for discussion and brings learning out of the classroom. It is hoped that an appreciation of the carbon footprint of fruit and vegetables by students will impact the purchasing behaviour of their parents by encouraging the support of locally sourced produce.

- Supermarkets

Student discussions with supermarket managers, or purchasers, are encouraged to drive retail of locally sourced produce

- Education centres

Local ecological education centres that promotes sustainable organic farming and provides outreach activities provide students with a number of opportunities to integrate subject domains literally in the field. Example: Causey Farm in Ireland.

Activity 2.3 Carbon Footprint Calculator

This activity utilises the Carbon Footprint Calculator Resource developed by the World Wildlife Foundation (WWF) and allows students to compare how their carbon footprint compares to others and to see how many planets would be required to support the Earth's population if everyone lived like them. Students are encouraged to reflect on their carbon footprint by writing a short text about the result and by suggesting some solutions to reduce their carbon footprints. This activity was developed by Lycée Gaudier-Brzeska for the STi2D curriculum.

Duration
• 30-60 minutes
Energy Literacy Characteristics addressed:
C2 Students understand the impact that energy production and consumption have on all spheres of our environment and society.
C3 Students are sensitive to the need for energy conservation and the need to develop alternatives to fossil fuel-based energy resources.
C4 Students are cognisant of the impact of personal energy-related decisions and actions on the global community;
Skills & Competencies addressed:
• Critical Thinking • Communicating • Decision Making • Collaborating • Research & ICT
Subject links in National Curricula:
• Science • Geography • Technology & Informatics • Home Economics • Engineering • Civics & Politics • Architecture & Design • Social & Health
Level
• ISCED 3

Suggestions for use:

1. Students can work alone.
2. Students can complete this in-class or as a homework assignment.
3. Students should follow the instructions outlined on the accompanying worksheet to complete this activity.

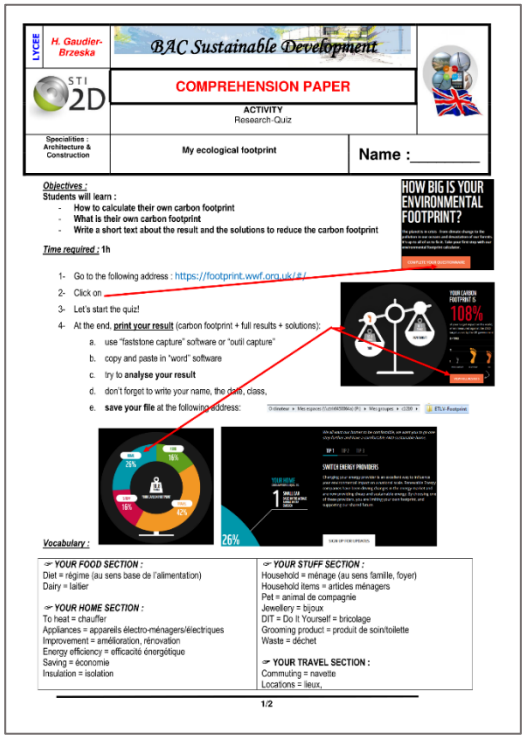


Fig. 4. Activity 2.3 Student Worksheet

4. When writing their short text, students should read the information provided in the resource section of the worksheet.

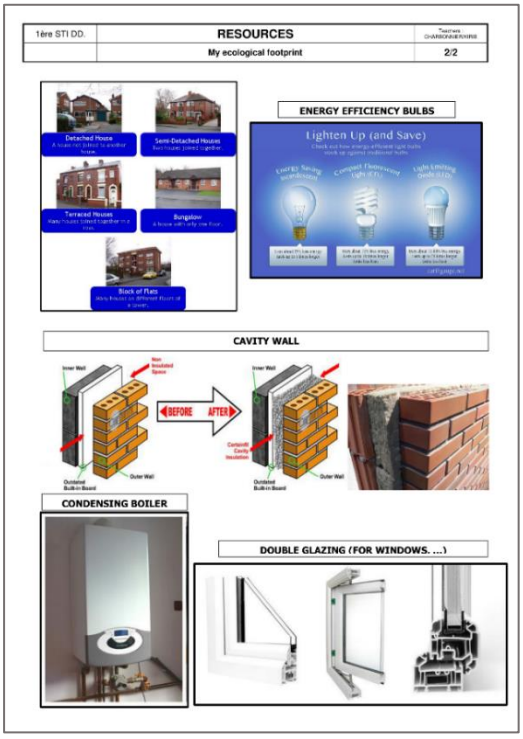


Fig. 5. Activity 2.3 Student Worksheet

Materials :

- Activity 2.3 Student Worksheet

Activity 2.4 How much freshwater is there?

This activity illustrates how scarce freshwater is and why we need to conserve it. The difficulty is in understanding, and appreciating, that the quantity of water on Earth is actually finite– there is no agency outside Earth waiting to replenish it – all our water is continually being recycled in various forms. Students will recognize that there is a lot of water on the Earth, but not much of it can be used for our drinking water and other water supply needs. Students will recognize that ground water and surface water is a very small percentage of the Earth's water. Students will gain an understanding of how much water is used on a daily basis in a household setting. Students will develop an understanding of how important it is that we take care of our water resources. Students can identify ways to conserve water.

Duration
• 30-60 minutes
Energy Literacy Characteristics addressed:
C1 Students have a grounded understanding of the science and how energy is harnessed and used to power human activity.
C3 Students are sensitive to the need for energy conservation and the need to develop alternatives to fossil fuel-based energy resources.
C4 Students are cognisant of the impact of personal energy-related decisions and actions on the global community;
Skills & Competencies addressed:
• Critical Thinking • ICT Skills • Research
Subject links in National Curricula:
• Science • Civics & Politics • Geography • Social & Health • Home Economics
Level
• ISCED 2

Suggestions for use:

1. Print out copies of the Student map and give one to each student. Alternatively, if there is internet access students can use Google Earth or Maps.

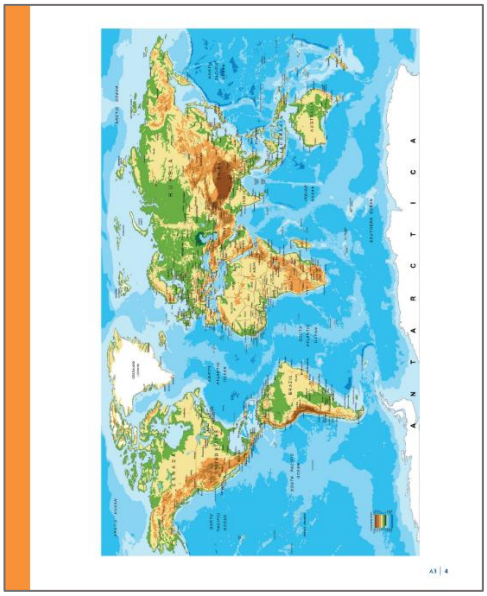


Fig. 6. Activity 2.4 Student Handout (Map)

2. Ask the class what they know about how much water there is in and on the earth. List on the board the following types of water supplies on Earth:

   - Oceans
   - Groundwater
   - Rivers
   - Icecaps
   - glaciers
   - freshwater lakes
   - Salt-water lakes
   - Inland seas
   - Atmosphere

3. Fill a large container with approximately four litres of water. Explain that this represents the total amount of water on Earth.

4. Using a pipette or a syringe, remove 90 ml of water, transfer it to one of the 100 ml beakers and set it aside.

5. Add a few pinches of salt to the water left in the large container. Explain that this water now represents the oceans, i.e. water not suitable for immediate human usage.

Note: You can explain that some countries are investigating desalination processes, but it is very expensive both financially, and in terms of energy consumption.

6. Return to the 90 ml set aside (in step 3). Add a few drops of the blue food colouring to this water. Explain that this water represents freshwater…BUT that not all this water is accessible.

7. Using the pipette remove about 80 ml of the water and put it out of reach. This represents water trapped in glaciers or too deep underground to be accessible.

8. Explain that what remains in the 100 ml beaker represents the amount of water available for daily use by the entire planet, e.g., agriculture, potable water, industry, freshwater ecosystems.

9. Explain that forecasts indicate that the world population will reach 9.6 billion by 2050 but the quantity of water available for daily use will still be represented by the quantity left in the 100 ml beaker. Ask the question, why is this?

10. Have students complete the additional extension task/activity "Availability of Freshwater" which is listed below.

Extensions to Activity 2.4

- Assign to students as a revision exercise the following e-learning activity Availability of Freshwater. This task will take 30 minutes to complete. Availability of Fresh water by The Concord Consortium is licensed under CC BY 4.0.

Materials

- Activity 2.4 Student Handout (Map)
- Availability of Freshwater Resource. Available at: https://www.nationalgeographic.org/activity/availability-fresh-water/

For the demonstration:

- Water (4 litres)
- Container (large)
- Pipette or syringe
- 2 Beakers or cups
- Food dye (blue)
- Table salt

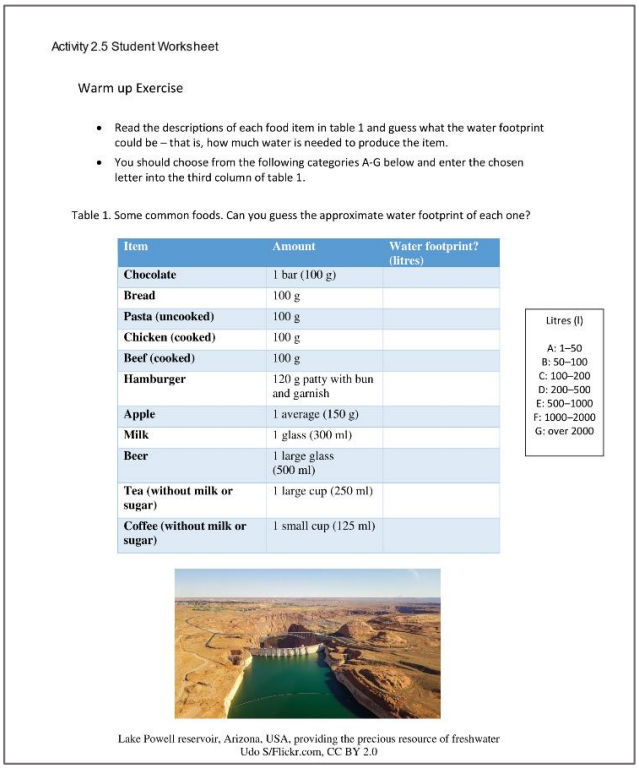
Activity 2.5 My Water Footprint

Water footprints tell us how much of Earth's limited water supplies we are using, so we can ask: how could each of us save water by making small changes to the items we consume? This activity allows students to explore the wide variation in water footprints associated with different foods, and then to apply this knowledge to finding out the water footprint of various ready-made 'lunch boxes. Students use their own numeracy skills to work out the approximate water footprints of six ready-made lunch boxes. They can use this information to think about – and maybe change – what they choose to put in their own packed lunches. This resource was developed by Sinead Kelly who is a teacher of science, biology and physical education at St Oliver's Community College in Drogheda, Ireland.

Duration
• 30-45 minutes
Energy Literacy Characteristics addressed:
C3 Students are sensitive to the need for energy conservation and the need to develop alternatives to fossil fuel-based energy resources. **C4** Students are cognisant of the impact of personal energy-related decisions and actions on the global community;
Skills & Competencies addressed:
• Critical Thinking • ICT Skills • Research
Subject links in National Curricula:
• Science • Civics & Politics • Mathematics • Social & Health • Geography • Home Economics
Level
• ISCED 2 • ISCED 3

Suggestions for use:

1. Give out copies of the worksheet to students. Have students complete the warmup exercise by guessing the water footprint of some common foods.



Activity 2.5 Student Worksheet

Warm up Exercise

- Read the descriptions of each food item in table 1 and guess what the water footprint could be – that is, how much water is needed to produce the item.
- You should choose from the following categories A-G below and enter the chosen letter into the third column of table 1.

Table 1. Some common foods. Can you guess the approximate water footprint of each one?

Item	Amount	Water footprint? (litres)
Chocolate	1 bar (100 g)	
Bread	100 g	
Pasta (uncooked)	100 g	
Chicken (cooked)	100 g	
Beef (cooked)	100 g	
Hamburger	120 g patty with bun and garnish	
Apple	1 average (150 g)	
Milk	1 glass (300 ml)	
Beer	1 large glass (500 ml)	
Tea (without milk or sugar)	1 large cup (250 ml)	
Coffee (without milk or sugar)	1 small cup (125 ml)	

Litres (l)

A: 1–50
B: 50–100
C: 100–200
D: 200–500
E: 500–1000
F: 1000–2000
G: over 2000

Lake Powell reservoir, Arizona, USA, providing the precious resource of freshwater
Udo S/Flickr.com, CC BY 2.0

Fig. 7. Activity 2.5 Student Worksheet

2. Once students have submitted their guesses provide students with the answers:

Item	Amount	Water footprint (litres)
Chocolate	1 bar (100 g)	F (1700)
Bread	100 g	C (130)
Pasta (uncooked)	100 g	C (141)
Chicken (cooked)	100 g	D (433)
Beef (cooked)	100 g	F (1540)
Hamburger + patty	120 g	G (2400)
Apple	1 average (150 g)	C (123)
Milk	1 glass (300 ml)	D (306)
Beer	1 large glass (500 ml)	C (148)
Tea (without milk or sugar)	1 large cup (250 ml)	A (30)
Coffee (without milk or sugar)	1 small cup (125 ml)	C (130)

Fig. 8. Activity 2.5 Warm up exercise solution

3. Ask students the following questions:

    - Which water footprint values did you find most surprising? Did any shock you?
    - What types of food do you think typically have high water footprints, and why?
    - What factors do you think might contribute to the water footprint of a food?
    - Why might the water footprints of similar items (e.g., coffee and tea) be very different?
    - Look at the image of the available water on Earth. What does this tell you about the need to conserve water on Earth?
    - If you were required to reduce your water footprint, what effect would this have on you and your family?
    - One-third of the world's food production ends up as waste. How do you think we should reduce our food waste to decrease the amount of water wasted?

4. Students then view the labelled lunch box photos. Each student (or group) chooses three or more lunch boxes (ideally all of them), for which to calculate the water footprint.

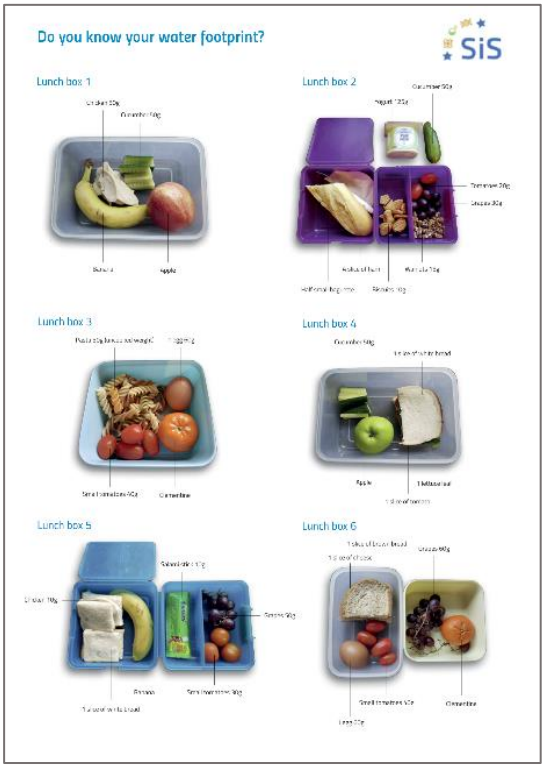


Fig. 9. Activity 2.5 Student Worksheet

5. Using the resource section of the student worksheet, students find out the relevant values per kilogram (or similar) for each of the foods shown in the lunch box photos. Using this information, students then calculate the water footprint for the amount of food shown in each lunch box and find the overall total for the complete box.

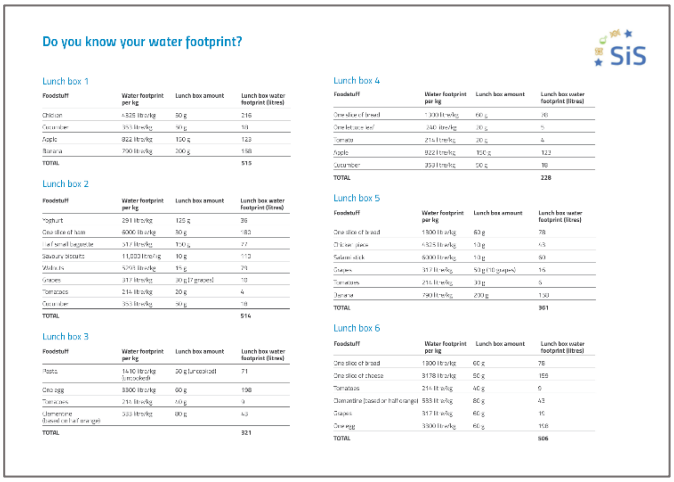


Fig. 10. Activity 2.5 Student Worksheet

6. Teachers can provide feedback to students at this stage using the supporting resource sheet 'Lunch box calculations' (see additional materials section), which provides water footprint values for each of the foods.

7. Students can then compare and share their findings. Ask students the following questions:

    - Which lunch box had the highest water footprint? Which had the lowest?
    - Which items do you think represent the best 'value' in terms of their water footprint, and which the worst?
    - Choose an item from the lunch boxes and decide whether you think that item's water footprint is sustainable over years to come. Give your reasons.
    - Think about the items you would normally choose to put in your own lunch box. What might the overall water footprint be for your normal lunch box?
    - What items in your normal lunch box have the highest water footprint? How might

you replace these with better options?

- What other ways can you think of to reduce your food water footprint? (For example, change from coffee to tea, and from beef to chicken.)

Extensions to Activity 2.4

Student Challenge: Can you design a lunch box you would like that has a water footprint of no more than 300 litres?

This could be used as the basis for a student competition, with students voting for the best lunch box: the most tempting items combined with a low water footprint.

Materials

- Activity 2.5 Student Worksheet
- Use the product gallery on the Water Footprint Network website to obtain water footprint values for many items of food and drink, and some other consumables.
- Find out more about all aspects of water footprints from the Water Footprint Networkwebsite.
- Resource: Explore water footprint values for some food items in this pictorial article from The Guardian newspaper.

Activity 2.6 Reducing My Energy Footprint

In this activity, students apply what they have learned about their carbon and water footprints to determine the size of their carbon footprint and carry out an action plan to reduce their energy footprint. Students are required to research a number of energy saving tips and students can therefore make a pledge about how they can reduce their carbon footprint by designing their ideal carbon footprint.

Duration	
• 30-60 minutes	
Energy Literacy Characteristics addressed:	
C3	Students are sensitive to the need for energy conservation and the need to develop alternatives to fossil fuel-based energy resources.
C4	Students are cognisant of the impact of personal energy-related decisions and actions on the global community;
C5	Students strive to make choices and decisions that reflect these attitudes with respect to energy resource development and energy consumption
Skills & Competencies addressed:	
• Critical Thinking • Research • Creating/Innovating	• Decision Making • Communicating
Subject links in National Curricula:	
• Science • Geography • Home Economics	• Civics & Politics • Social & Health
Level	
• ISCED 2	

Suggestions for use:

- Students can work individually.
- Students are encouraged to be creative and can design their reduced carbon footprints using powerpoint or a similar application.
- Students can present their work if feasible using Microsoft Office Powerpoint

Materials

- Activity 2.6 Student Worksheet
- The following factsheet resources available at SEAI:

  a. https://www.seai.ie/community-energy/schools/schools-documents/Post-Primary-Saving-Energy-at-Home.pdf

  b. https://www.seai.ie/community-energy/schools/schools-documents/Post-Primary-Saving-Energy-at-School.pdf

  c. https://www.seai.ie/community-energy/schools/schools-documents/Post-Primary-Saving-Energy-When-you-Travel.pdf

  d. https://www.seai.ie/community-energy/schools/schools-documents/Post-Primary-Climate-Action-Think-before-you-buy.pdf

  e. https://www.seai.ie/community-energy/schools/schools-documents/Post-Primary- Energy-and-Climate-Action-Use-Clean-Renewable-Energy.pdf