Royal Academy of Engineering

THIS IS ENGINEERING

ENGINEERING A BETTER WORLD

SolarKoodo – Safiatou Nana, Burkina Faso

A STEM resource inspired by the **AFRICA PRIZE FOR ENGINEERING INNOVATION**

SOLAR KOODO – HOW IT WORKS

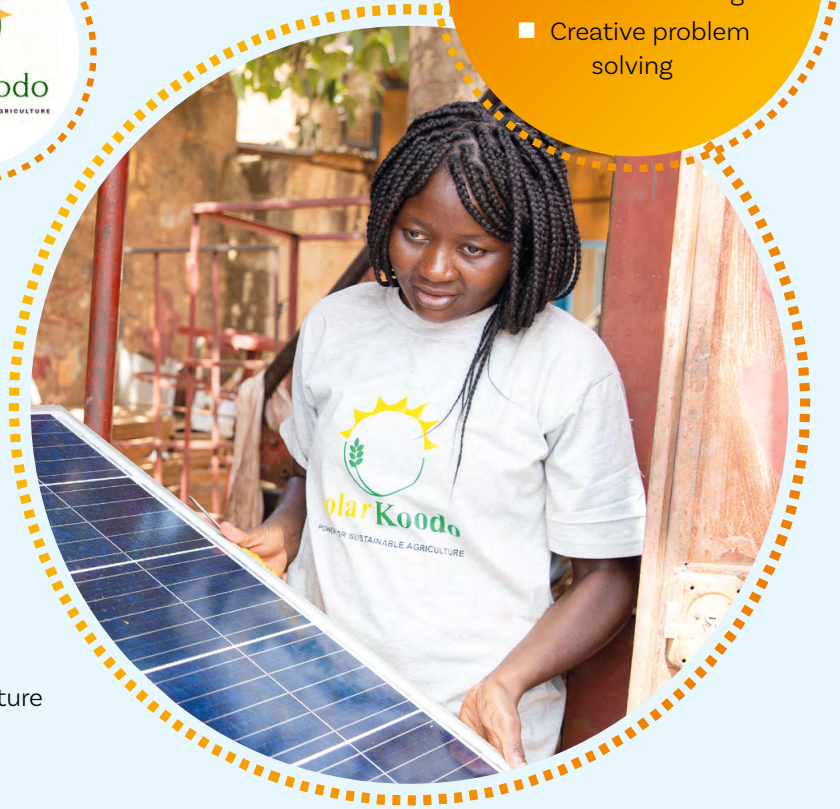
Safiatou Nana is a renewable energy engineer from Burkina Faso.

She and her team have developed a solar powered irrigation system for desert areas in Burkina Faso.

Irrigation systems supply water to land or crops to help growth.

Solar energy is used to power pumps that suction water from wells and distribute it evenly across farmer's crops.

Safiatou will work with farmers in the local area who normally use traditional methods to extract water for their crops. SolarKoodo will save them time, and could also help them to produce more crops. The solar power could also be used for other purposes.



Engineering habits of mind

- Problem-finding
- Creative problem solving

Time to reflect

Safiatou uses her engineering habits of mind. What problem has Safiatou found? How is she creatively problem-solving?

SUSTAINABLE DEVELOPMENT GOALS

- End hunger, achieve food security and improved nutrition and promote sustainable agriculture
- Ensure availability and sustainable management of water and sanitation for all
- Ensure access to affordable, reliable, sustainable and modern energy for all

Time to reflect

After you have completed the activities in this resource, reflect on how SolarKoodo works towards the SDGs (right).

COUNTRY PROFILE

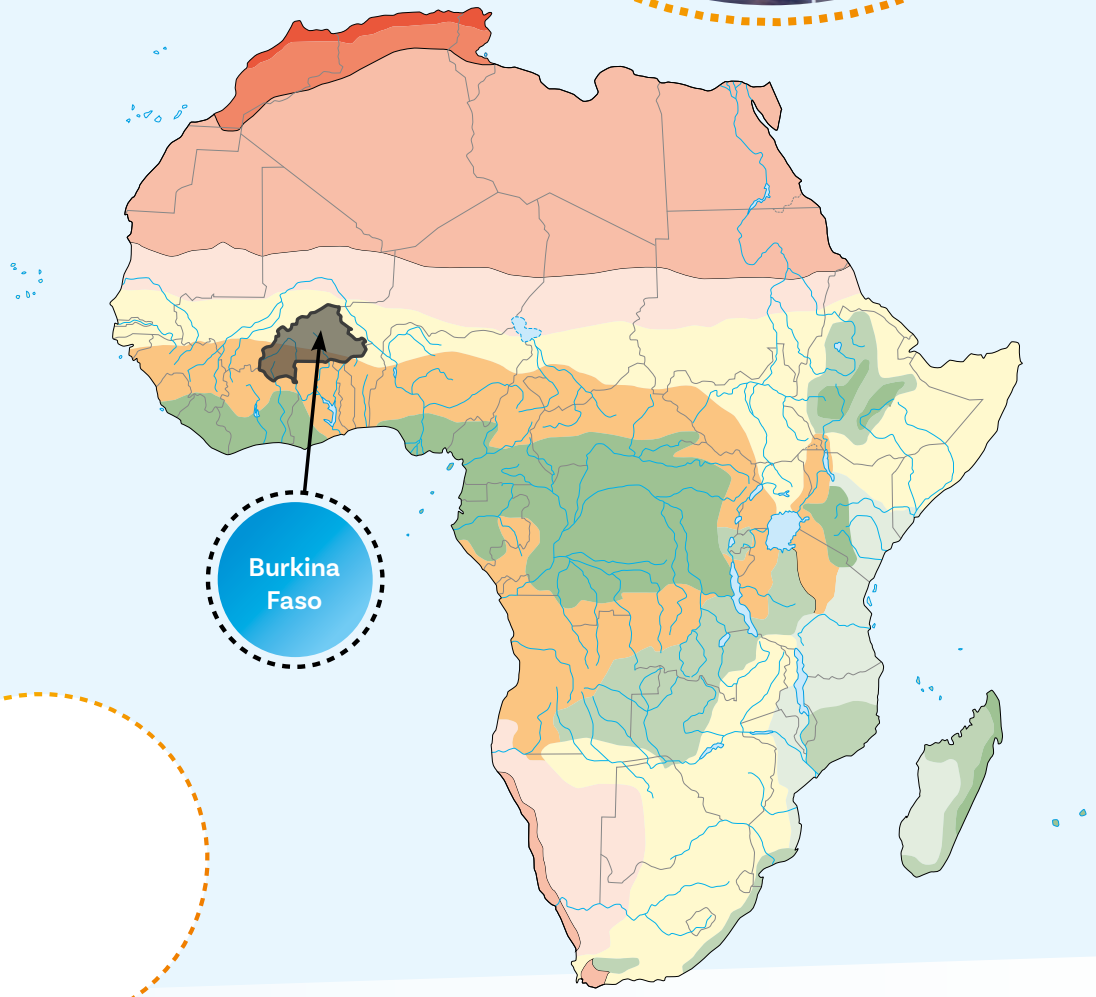
Time to research

You are an engineer working with a team in Burkina Faso. In small groups, use a computer, tablet or smart phone and visit Ducksters.com and answer the questions below.

You will create a country profile with this information.

- What is the land area of Burkina Faso?
- What is the population of Burkina Faso?
- What is the general climate?
- What is the terrain?
- What natural resources does Burkina Faso have?
- What is the main industry?

Why do you think the information you have gathered will be useful? What other information would be useful to know?



Land to grow

Soils are made up of 45% minerals, 25% air, 25% water and 5% organic matter.

Present this information in a pie chart.

44% of Burkina Faso's land is agricultural. This means that it is either used for growing crops for people or grass for grazing animals*.

How many square kilometres of the land in Burkina Faso is agricultural?

**Data taken from tradingeconomics.com*

THE WATER WE EAT

Regardless of where we live in the world, water is the most precious resource for our everyday life. We all use water for drinking, cooking and washing.

Where do you think most of our water is used?

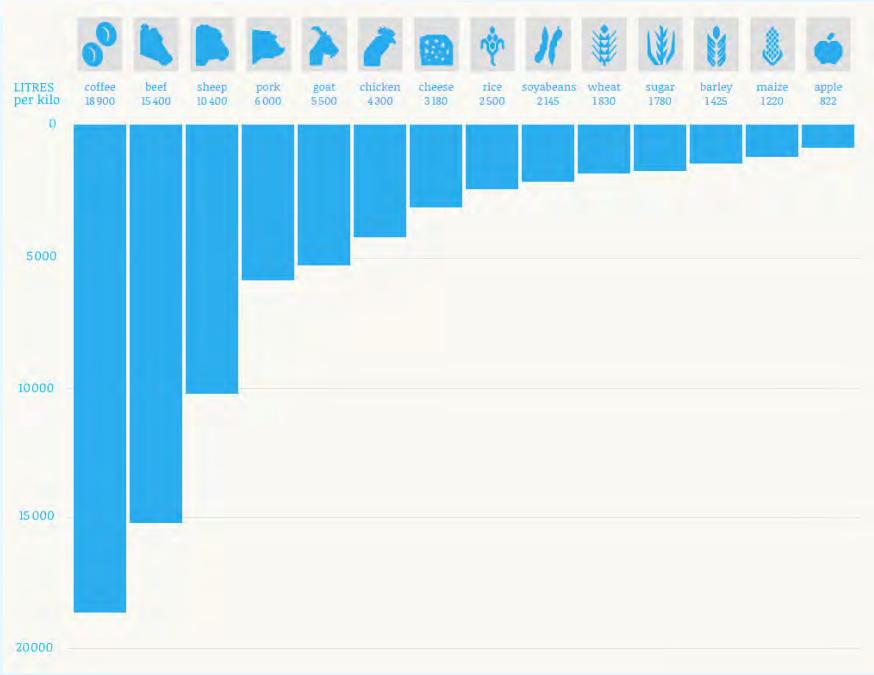
Most of the water we use goes towards producing things such as vegetables, meat, paper, clothes and shoes. In fact, almost every physical product we use needs water in some way for production.

We each consume 3800 litres of water every day!

- 137 litres at home for eating, cooking and washing.
- 167 litres for producing things such as our clothes, phones, stationery.
- 3496 litres per day is used for producing food.

What percentage of water consumption is for food production? For industrial products? For home use?

Bar chart showing how many litres of water would be used in the production of different food types.



Bar chart and information taken from www.thewaterweeat.com. Visit their website for more details on infographics about our water footprint.

Time to calculate

Take a look at the recipe for chilli con carne.

Using the bar chart above, calculate how many litres of water would be used in the production of the ingredients of this meal if it were for two people? one person? five people?

Chilli con carne

4 people

500g minced beef
250g cheddar cheese
400g maize (corn)
200g rice

Time to reflect

The bar chart shows that beef has a huge **water footprint** compared to an apple.

The **water footprint** of an individual, community or business is the total volume of fresh water to produce the goods and services consumed by that individual, community or business.

Think about your own water footprint. What changes can you make to reduce it?

WHY SOLAR POWER?

In less than 15 seconds the sun can provide as much energy to Earth as humans use in one day!

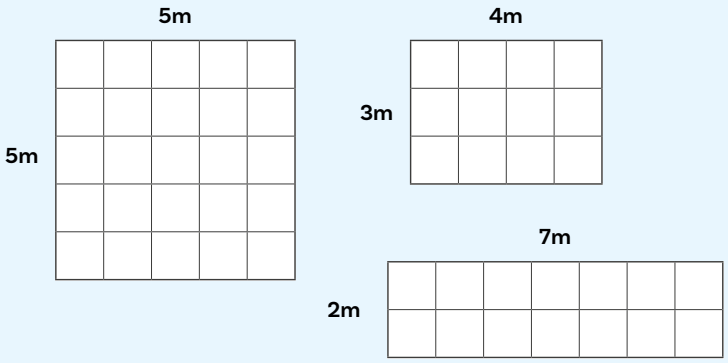
That is enough energy to melt a bridge of ice four kilometres wide, two kilometres thick, and extending the entire way from the Earth to the Sun, in one second.

Solar panels absorb sunlight as a source of energy to generate electricity.

Solar panels now convert around 19% of the Sun's light energy to power. On a clear, sunny day, one square metre of earth will receive around one kilowatt of energy.

Time to calculate

- How many watts of energy will be generated from a solar panel measuring one square metre?
- How many watts of energy will be generated from each of the solar arrays shown below?



Stretch and challenge

Write a formula that you can use to calculate the amount of energy produced from any size solar panel.

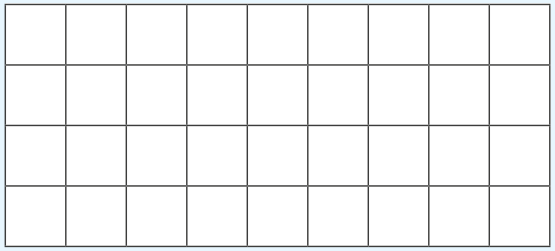
Time to investigate

You have been given 36 square metres of solar panels.

On a clear, sunny day, how much energy would these solar panels produce?

One way to position the solar panels is shown below. For your design, consider different arrangements for your solar panels so that they can be used in different settings.

How many other arrangements can you create? What is the perimeter of the solar panel arrangement below? Which arrangement would have the smallest perimeter? Which arrangement would have the largest perimeter?



***Teacher note:** divide a piece of A4 paper into 36 equal size pieces so young learners can 'tinker' with this activity.

Stretch and challenge

You are not restricted to positioning your panels in rectangles. What other arrangements are possible? How does this affect the perimeter of the solar panel arrangement?

PROTOTYPING

Time to calculate

Safiatou used a **prototype** of SolarKoodo with 12 farmers in Burkina Faso.

Before using SolarKoodo, the 12 farmers spent eight hours a day irrigating their crops and produced approximately 50 kilograms of yield per day.

Yield is the amount of seeds or grain produced on a unit of land.

She found that they produced four times the yield and it took them half the time to irrigate.

- How much yield could they produce in four hours? How much yield could they produce in 16 hours?
- How many hours would it take to produce 600 kilograms of yield?
- How many hours would it take one farmer to produce 200 kilograms of yield?
- How many hours would it take 24 farmers to produce 200 kilograms of yield?

Time to plan

Safiatou has developed a successful prototype. Throughout the design process she has been asking herself and her team the following questions.

In your groups, discuss and share two answers for each of the questions below.

- What is the need for this innovation?
- How will this innovation help the community?
- What are the advantages of this innovation?
- What are the possible risks of this innovation?

Time to build

A unique selling point of SolarKoodo is that it can be easily transported.

Either use the cart building kit in the box, or design and model your own system that can be used to easily move your irrigation system from place to place.

SOLAR-POWERED PUMP

Have a go at building your own solar-powered water pump.

Materials needed

- Solar panels
- Electric pump
- Syringe
- Foam pad
- Tub with water and empty tub
- Equipment to build circuit.

Saving energy

Safiatou wanted to extend the use of the solar panels beyond the irrigation system.

Capacitors can be used to store electrical charge throughout the day from the solar panels. In the evening, the charge from the capacitors can be used for other purposes.

Develop a system using the solar panels to charge your capacitors and then power a series of LED lights.

Time to experiment

- What is the minimum number of panels needed to make the pump work?
- What happens if you increase/decrease the number of solar panels?
- What array of panels is most/least effective?

Experiment with different arrangements for the solar panels. Are there some arrays that are more effective than others?

Explain your reasoning to your group or class.

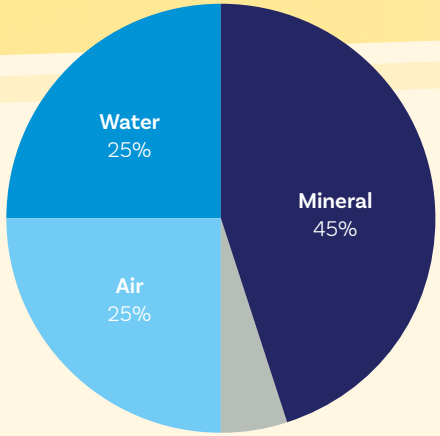
SOLUTIONS

Answers – land to grow

- 120,000 square kilometres (depending on the degree of accuracy of the land area) of Burkina Faso's land is agricultural.

Answers – the water we eat

- 3.6% of water consumption is for eating, cooking and washing.
- 4.4% of water consumption is for the productions of things such as our clothes, phones, stationery.
- 92% of water consumption is for the production of food.



Answers – why solar power

- 190 watts of energy will be generated from a 1 square metre solar panel.
- 4750 watts of energy will be generated from 5m x 5m of solar array.
- 2280 watts of energy will be generated from 4m x 3m solar array.
- 2520 watts of energy will be generated from 4m x 3m solar array.

Chilli con carne

4 people – *litres (approx.)*

500g minced beef – *7500 litres*
250g cheddar cheese –*750 litres*
400g maize (corn) – *400 litres*
200g rice – *500 litres*

Answers – prototyping

- How much yield could they produce in four hours? *200 kilograms*
- How much yield could they produce in 16 hours? *800 kilograms*
- How many hours would it take to produce 600 kilograms of crops? *12 hours*
- How many hours would it take one farmer to produce 200 kilograms of crops? *48 hours*
- How many hours would it take 24 farmers to produce 200 kilograms of crops? *Two hours*

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