



2013-2015

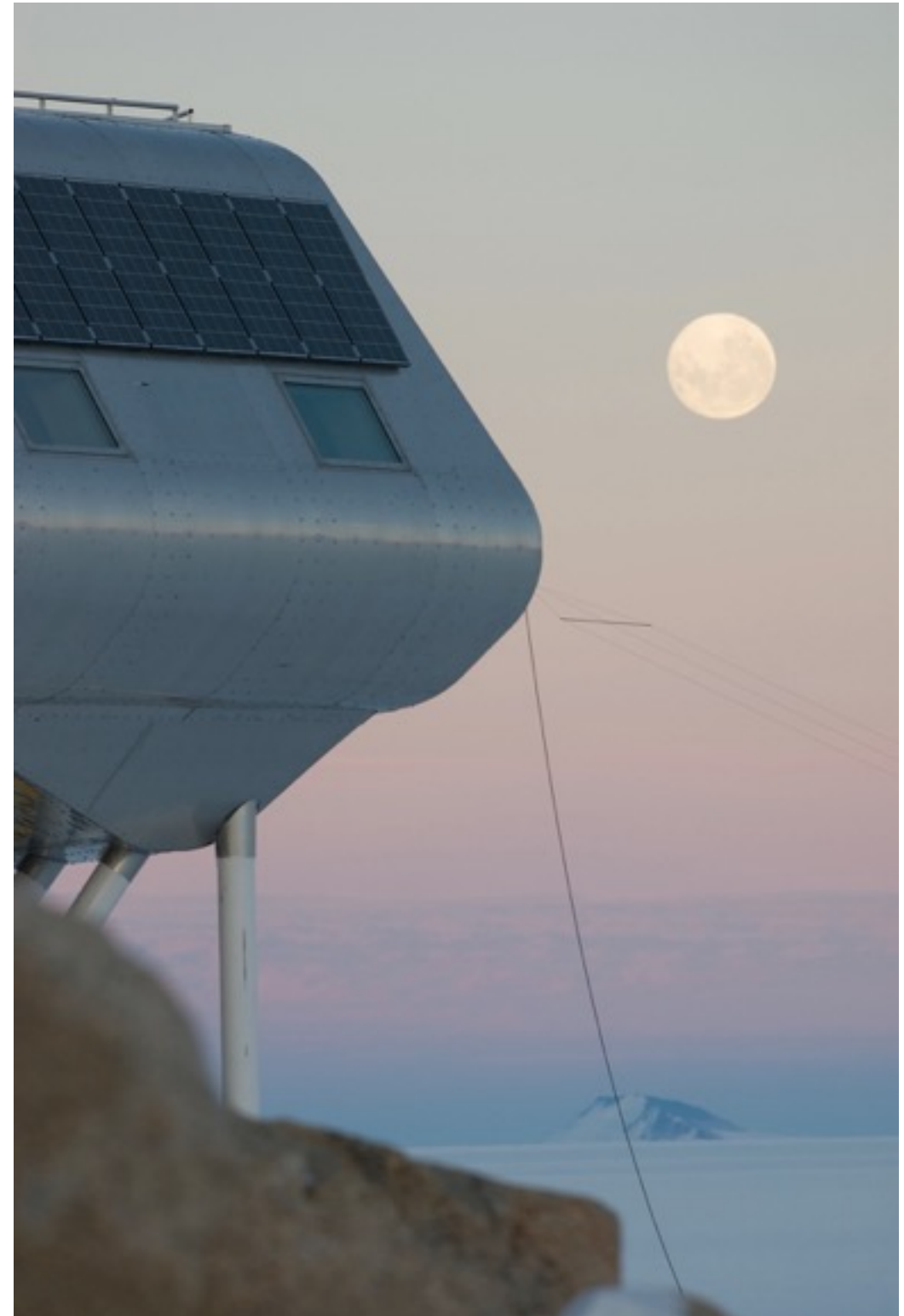
TECHNOLOGY IN EXTREME ENVIRONMENTS
PRINCESS ELISABETH ANTARCTICA STATION

START



WHAT MAKES PRINCESS ELISABETH STATION THE FIRST “ZERO EMISSION” POLAR RESEARCH STATION ?

- ▶ ENERGY DEMAND MANAGEMENT
- ▶ PASSIVE CONSTRUCTION TECHNIQUES
- ▶ RENEWABLE ENERGY
- ▶ ALL OF THE ABOVE



Incomplete answer !

TRY AGAIN

Correct!

The Princess Elisabeth Station **uses existing technologies and combines them** to be as energy efficient as possible. All of the energy is produced by solar panels and wind turbines.

NEXT



HOW IS ELECTRICITY PRODUCED AT PRINCESS ELISABETH STATION IN THE WINTER ?



SOLAR PANELS

WIND TURBINES

BOTH

NEITHER

Incorrect !

TRY AGAIN

Correct!

In winter, it is dark all of the time so the solar panels do not work.
However, the **wind turbines** will produce electricity in winter.

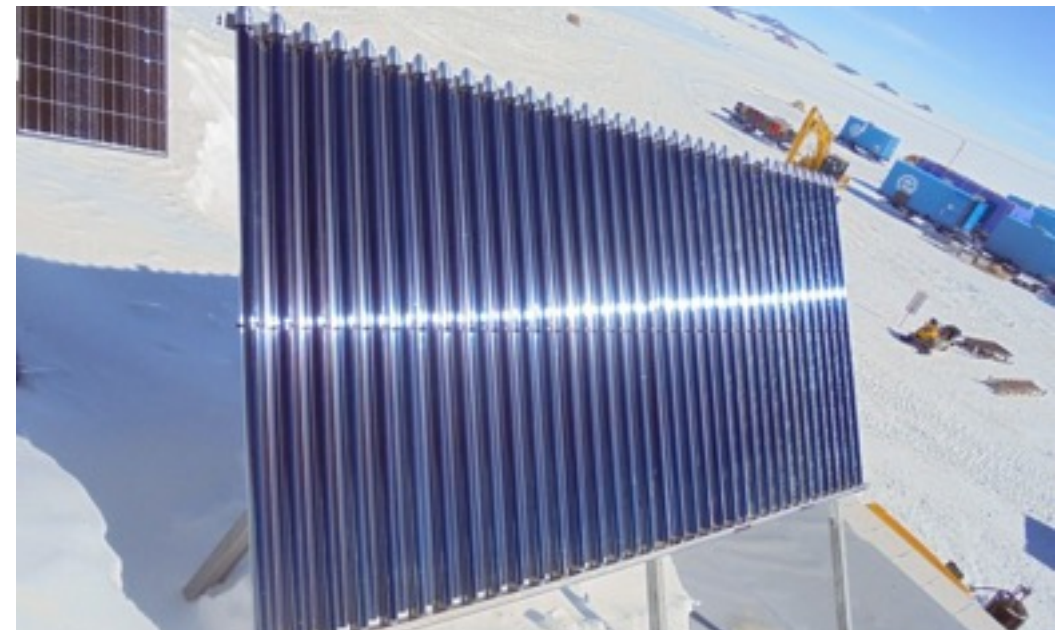
There are also two diesel generators at the station, but these would only be used for emergencies.

NEXT



PHOTOVOLTAIC PANELS PRODUCE ELECTRICITY. THERMAL SOLAR PANELS PRODUCE HOT WATER FOR THE STATION. CAN YOU SEE THEM ?

WHICH PHOTO SHOWS THE PHOTOVOLTAIC PANELS ?



Incorrect !

TRY AGAIN

Correct!

The **photovoltaic panels** convert solar energy into electricity.

There are 374 m² of photovoltaic panels installed at or around the station.

NEXT



WHAT IS THE TOTAL INSTALLED CAPACITY OF THE WIND TURBINES AT PRINCESS ELISABETH STATION ?



54 kW

10 MW

20 kW

54 MW

Incorrect !

TRY AGAIN

Correct!

Nine turbines – with a capacity of 6 kW each – produce
54 kW in total.

NEXT



PHOTOVOLTAIC PANELS AND WIND TURBINES PRODUCE DIRECT CURRENT. DIRECT CURRENT HAS TO BE TRANSFORMED TO ALTERNATING CURRENT TO BE USED AT THE STATION. WHAT IS THE NAME OF THE DEVICE THAT DOES THIS ?



TRANSFORMER

INVERTER

ALTERNATOR

CIRCUIT BREAKER

Incorrect!

TRY AGAIN

Correct!

An **inverter** is an electronic device that converts direct current into alternating current.

The Station's electrical network uses a voltage of 230 volts.

NEXT



ENERGY PRODUCTION AND CONSUMPTION AT THE STATION VARY IN TIME. AS THE STATION HAS TO FUNCTION AUTONOMOUSLY, BATTERIES PLAY A VERY IMPORTANT ROLE.

YOU ARE AN ENGINEER AT THE STATION AND YOU HAVE TO MAKE SURE EVERYTHING WORKS WELL. WHICH OF THESE SITUATIONS REQUIRES YOUR ATTENTION ?

- ▶ LOW BATTERY CHARGE
- ▶ BATTERIES FULLY CHARGED
- ▶ NEITHER
- ▶ BOTH



Incorrect !

TRY AGAIN

Not quite !

TRY AGAIN

Correct!

In the design of energy management systems, **two situations** require attention:

Batteries with low charge and low production of electricity (little wind and overcast weather): the energy management system will give **priority to essential electricity for the functioning** of the station and safety.

Batteries fully charged and high electricity production: as the station is autonomous, systems must be able to **manage the surplus energy that cannot be stored**.

NEXT



A SMART GRID IS AT THE HEART OF THE ENERGY SYSTEM AT THE STATION. IT IS A KEY ELEMENT TO IT BEING A ZERO EMISSION STATION. THE SYSTEMS ARE MANAGED BY A COMPUTER. THIS ALLOWS:

- ▶ PRIORITIZING ENERGY DEMAND
- ▶ DISTANCE MONITORING OF ENERGY MANAGEMENT AT THE STATION
- ▶ BRINGING ENERGY EFFICIENTLY TO THE USERS
- ▶ ALL OF THE ABOVE



Incomplete answer !

TRY AGAIN

Correct!

The **Smart Grid** allows requests to be prioritized based on their importance and efficiently delivers energy to end users (see chart below). It also monitors the energy management at the remote station from Belgium during the austral winter when the station is not occupied.

Energy Production

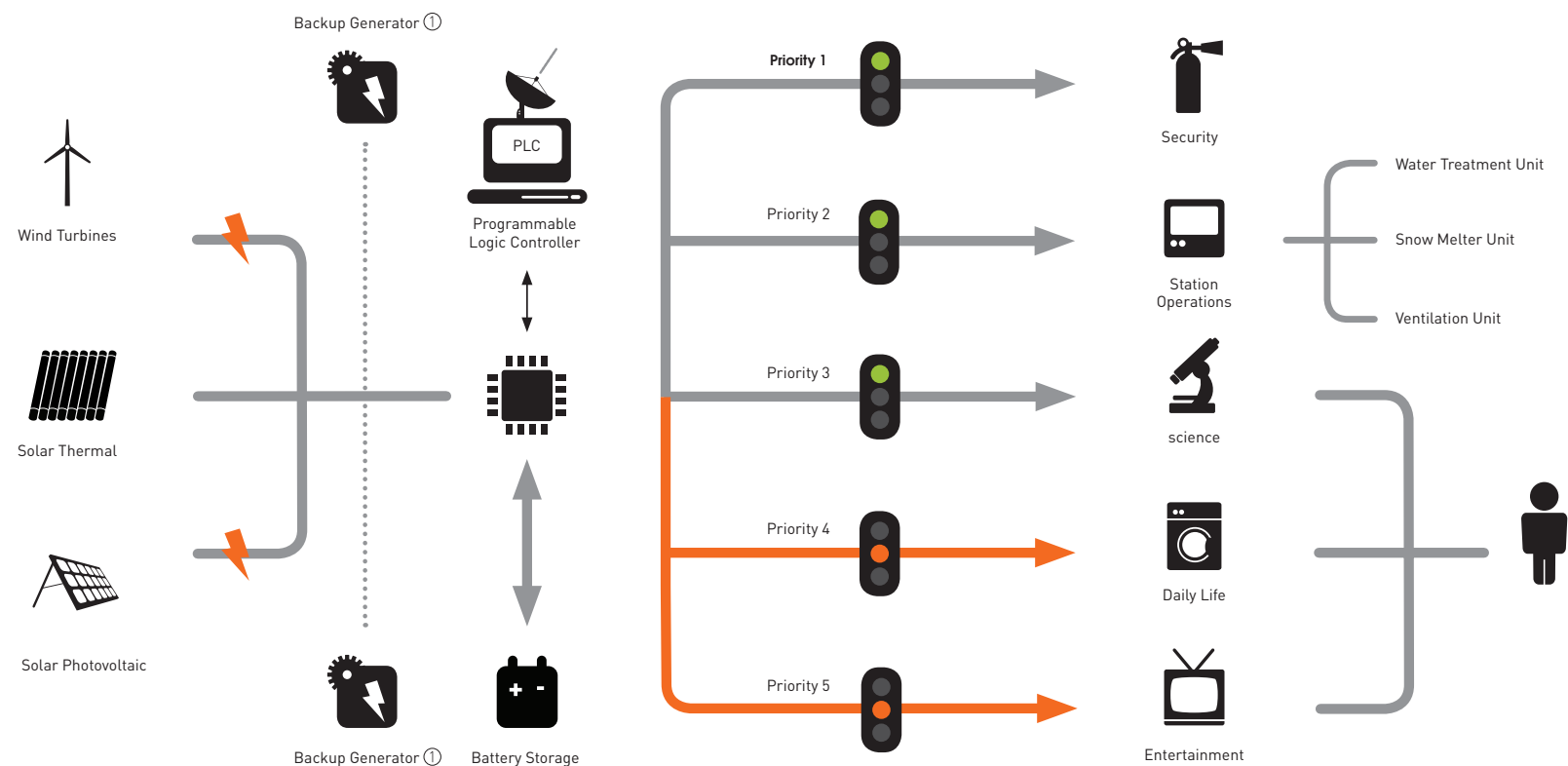
Limited Production Capacity

Control & Supply

Balance Available Energy & Cumulated Request
Dynamic Prioritization

Variable Demand

Energy Request



NEXT



WHAT IS/ARE THE MAIN SOURCE(S) OF HEATING AT THE STATION ?

- ▶ THE HEAT OF THE SUN
- ▶ BIOMASS
- ▶ GEOTHERMAL ENERGY
- ▶ THE HEAT OF THE SUN, THE STATION OCCUPANTS AND THE ELECTRICAL EQUIPMENT IN THE STATION



Incorrect !

TRY AGAIN

Incomplete answer !

TRY AGAIN

Correct!



The **sun, occupants and electrical appliances** provide the heat necessary for a comfortable temperature in the station despite the polar conditions outside.

The **shape of the Princess Elisabeth station**, external panels, insulation of walls, its orientation and arrangement of **windows** minimise the energy input required. A **dual flow ventilation** system manages the internal temperature.

The shape of the building reduces its exposure to wind and snow. The inner design features a **three-layered structure**, from the core to its outer layer: technical systems, wet rooms (which require protection from freezing) and dry rooms.

NEXT



PASSIVE CONSTRUCTION TECHNIQUES HAVE BEEN USED AT THE STATION TO ENSURE OPTIMAL CONDITIONS INSIDE THE BUILDING WHILE MAKING SURE THAT IT IS ZERO EMISSION.

IN EUROPE, WHAT REQUIREMENT NEEDS TO BE MET TO BE CLASSED AS PASSIVE HOUSING IN TERMS OF NET HEATING ENERGY DEMAND ?



$\leq 60 \text{ kWh/m}^2.\text{yr}$

$\leq 45 \text{ kWh/m}^2.\text{yr}$

$\leq 30 \text{ kWh/m}^2.\text{yr}$

$\leq 15 \text{ kWh/m}^2.\text{yr}$

Incorrect !

TRY AGAIN

Correct!

For a building to be considered passive housing, the net heating energy demand should not exceed **15 kWh / m².yr.**

Think about what you can do to reduce energy consumption in buildings at school or at home.

For more information see the [Passive House animation](#) on the IPF Educapoles website.

NEXT



DRINKING WATER AT THE STATION IS PRODUCED WITH THE HELP OF THE SNOW MELTER. WHAT SPECIFIC STEP IS NEEDED TO MAKE THE WATER DRINKABLE ?



FILTRATION

MINERALISATION

DISINFECTION

NONE

Incorrect !

TRY AGAIN

Correct!

The water from the snow melter is pure water. We must **add minerals** to be able to drink it.

The Princess Elisabeth Station has established an elaborate system of water treatment inspired by technology developed in the space sector. A bioreactor and filtration units allow the station to recycle 100% of its wastewater. Although suitable for consumption, the recycled water is used only for toilets, showers and washing machines.

Curious to know more about water production and treatment at the station? **Watch the [video](#)!**

NEXT

Well Done !

You can now do this quiz again or visit www.educapoles.org for other quizzes, teaching files and educational projects for the polar regions, polar science, climate change and sustainable energy.

START AGAIN

A project of:



Supported by the Brussels-Capital Region and Wallonia.

