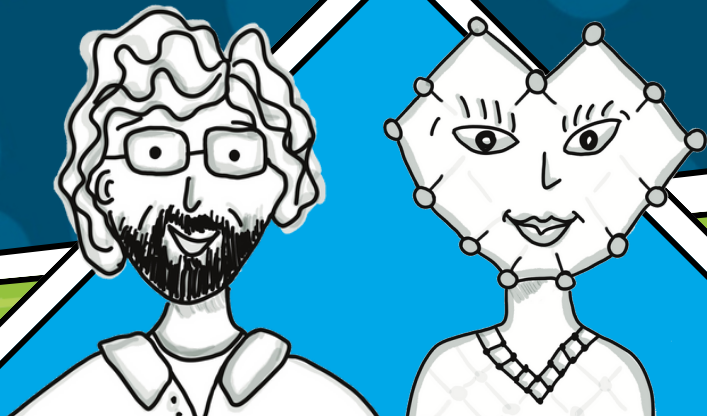


Nano the MOF  
& Professor Theodore  
save the planet!

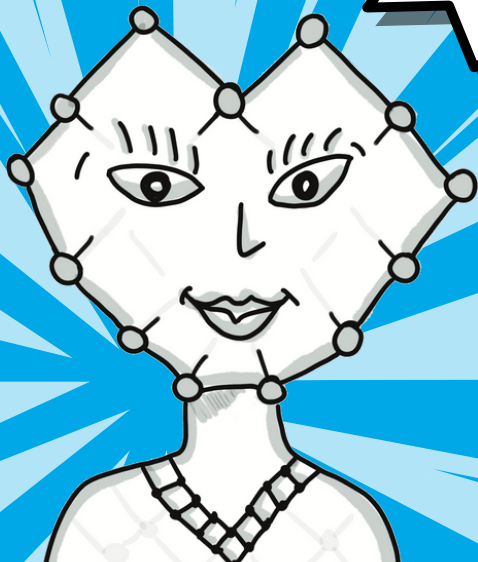




PROFESSOR  
THEODORE



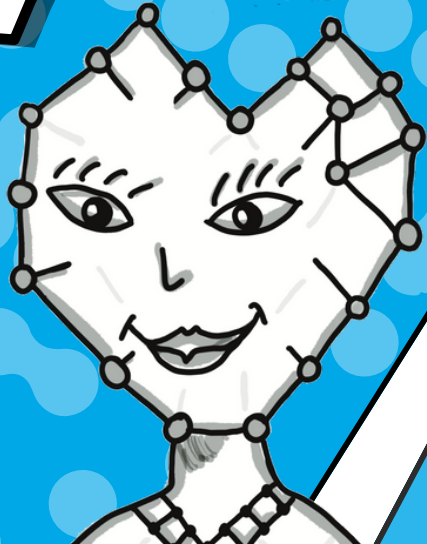
NANO THE  
MOF



Hi, I AM NANO  
THE MOF

I AM VERY SMALL  
AND I HAVE A  
SUPER-POWER!

WITH PROFESSOR  
THEODORE,  
I CAN SAVE THE  
PLANET!

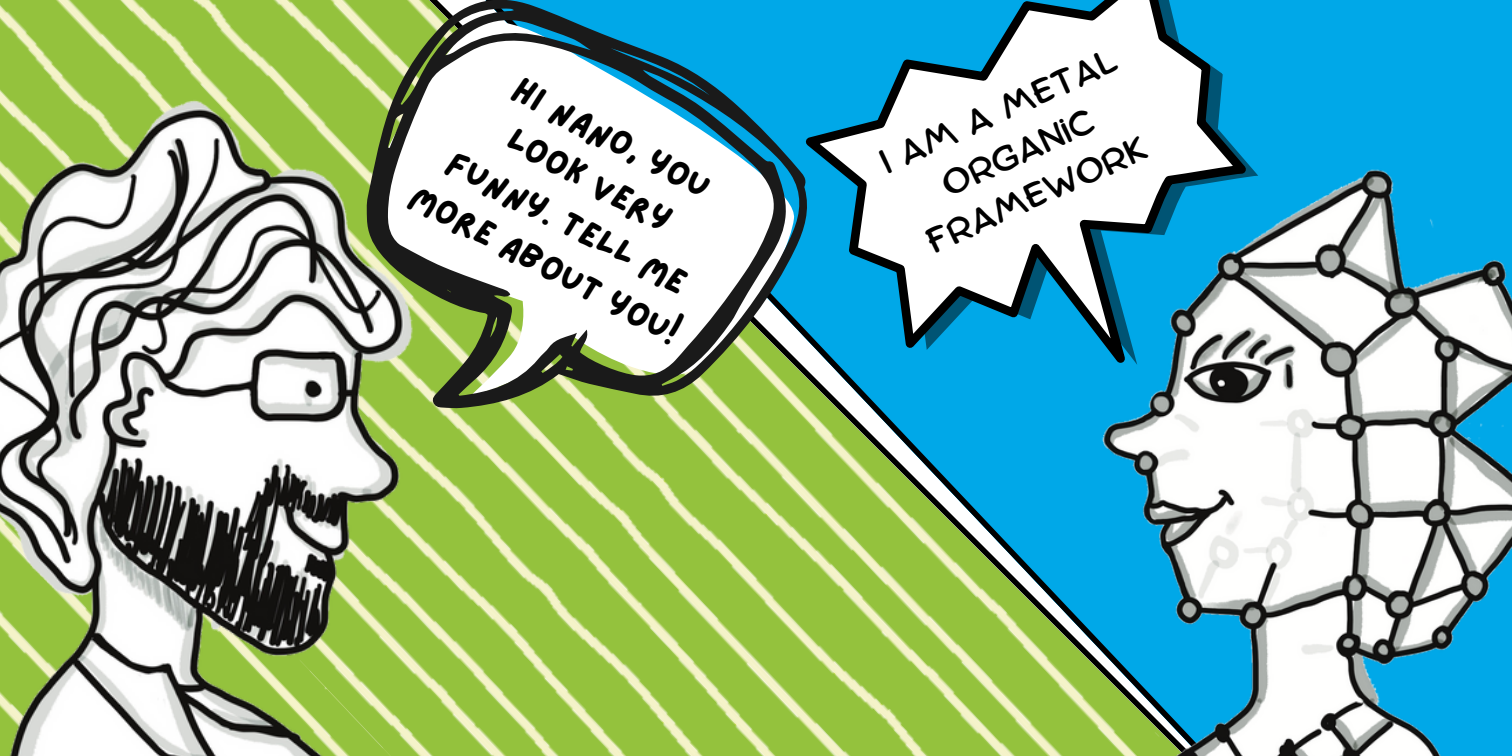


DO YOU WANT TO  
DISCOVER HOW?



# EPISODE 1

The super-power of  
Nano the MOF



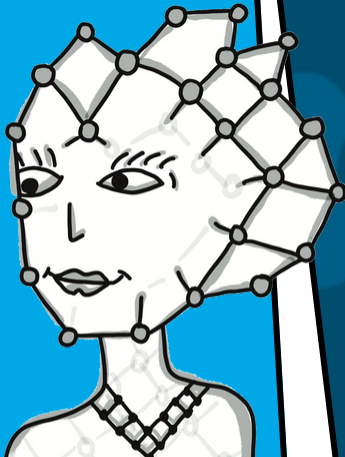
HI NANO, YOU  
LOOK VERY  
FUNNY. TELL ME  
MORE ABOUT YOU!

I AM A METAL  
ORGANIC  
FRAMEWORK



THIS IS  
INTERESTING! CAN  
YOU EXPLAIN?

THIS MEANS THAT  
I'M MADE  
OF SMALL METAL SCOOPS  
HELD TOGETHER BY  
LITTLE STICKS.



## LEARN MORE

Metal Organic Frameworks (we will call them MOFs) are solid materials, made of metallic ions (which are acting as connectors) and of organic material (which are acting as linkers between the connectors).

Organic material is made of the same molecules than living organisms (plant, animals). This means mainly carbon, oxygen and hydrogen.

# LEARN MORE

In MOFs, the geometrical structure between the metallic ions and the organic linkers creates high porosity.

This means there are empty spaces, named pores, within the MOFs. You can imagine something porous as full of tiny holes.

A character whose head and neck are constructed from a grey metal-organic framework (MOF) structure, featuring a grid of nodes and connecting lines. The character has a single visible eye and a slight smile. It is positioned in the lower right area of the image, against a bright blue background. A green panel with a large blue question mark is in the upper right, and a dark blue panel with white polka dots is in the upper left.

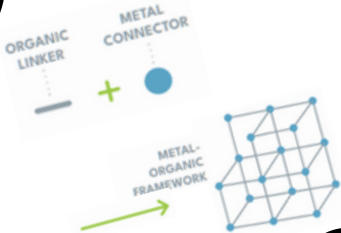
WHY ARE YOU SO SPECIAL?

A white starburst-shaped speech bubble with a thick black outline, containing the text 'I AM SUPER POROUS!'. It is located in the lower left quadrant of the image, overlapping the blue background.

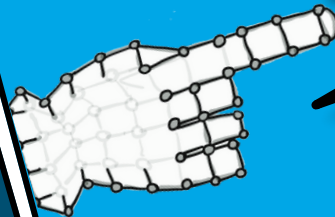
I AM SUPER POROUS!



# LEARN MORE



POROUS?



MY SKELETON IS  
MADE OF SCOOPS  
AND STICKS, IS FULL  
OF TINY EMPTY  
HOLES!

THIS MAKES  
ME VERY  
LIGHT

A cartoon illustration of a man with glasses and a beard, looking towards the right. He is positioned on the left side of the image, with a green background behind him.

YOUR TINY HOLES ARE  
HUNDRED THOUSAND TIMES  
SMALLER THAN THE WIDTH OF  
A HAIR! AMAZING!

A cartoon illustration of a woman with a face composed of a molecular structure, with atoms represented as dots and bonds as lines. She is smiling and looking towards the left. She is positioned on the right side of the image, with a blue background behind her.

THIS MAKES ME A  
NANO POROUS  
MATERIAL.

## LEARN MORE

A nanometer is one millionth of a millimeter! Nanomaterials are less than 100 nanometers wide. Things this small act in some really special ways. They have all kinds of uses, for example in electronics or medicine.

# LEARN MORE

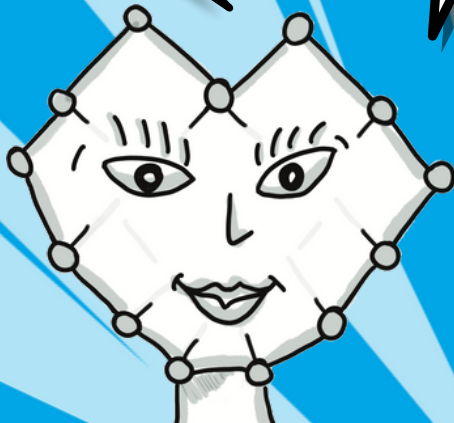
Adsorption is the sticking of gas, liquid or solid particles to a surface. The force holding these particles on the surface may be physical or chemical.

Something porous can retain particles in its pores by adsorption and release these particles later.

I CAN ADSORB THINGS!

I CAN CATCH AND STICK A LOT OF THINGS IN ME, IT'S LIKE BEING A SUPER SPONGE.

WHAT IS YOUR SUPER-POWER?



# LEARN MORE

Hydrogen is the simplest and the most abundant chemical element in the universe.

It can be used to produce electricity and to power vehicles. And this, without CO<sub>2</sub> emissions.

Because hydrogen is very light, it is very difficult to store. MOFs can store hydrogen in their pores by adsorption.



WHAT CAN YOU DO  
WITH YOUR  
ADSORPTION POWER?

I CAN REMOVE POLLUTANTS FROM THE  
AIR OR FROM WATER!

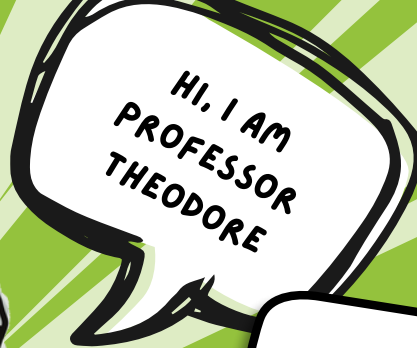
I CAN ALSO STORE A LOT OF ENERGY BY  
ADSORBING **GREEN HYDROGEN**.

I CAN CARRY MEDICINES TO THE EXACT  
SPOT INSIDE OUR BODIES WHERE THEY  
ARE NEEDED.



# **EPISODE 2**

The super-power of  
Professor Theodore



I HAVE A SUPER  
IMPORTANT MISSION!  
IT'S CALLED MISSION  
MOST-H2.

WITH MY FRIENDS FROM ALL  
OVER EUROPE, WE ARE  
WORKING TO MAKE  
NANO THE MOF  
EVEN MORE POWERFUL!



## LEARN MORE

MOST-H2 is the name of a research project. Scientists of 8 European countries are working together to find new MOFs. They improve them to store more hydrogen. They are also looking for new ways of producing MOFs, so that we can use them to store energy in the future.



# LEARN MORE


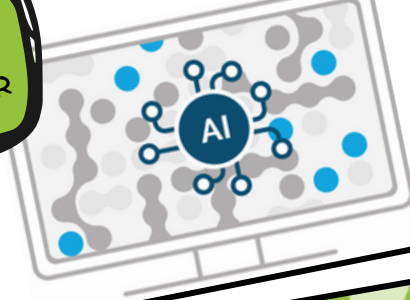
For years, scientists study MOFs and collect their results in huge data basis. With Artificial Intelligence, computers can now learn from these results. Scientists use this "machine learning" to select the MOFs which adsorb and store hydrogen the best.



WHAT ARE YOU  
DOING IN MISSION  
MOST-H<sub>2</sub>?



FIRST, LET'S  
CHECK WITH  
MY COMPUTER




WITH MY SUPER  
ARTIFICIAL  
INTELLIGENCE, I CAN  
COMPUTE AND IMAGINE  
THE BEST SKELETON  
FOR NANO THE MOF



# LEARN MORE

It is difficult to find the best composition for MOFs. The structure can be made of different metals and many different organic linkers, which gives to the MOFs very different properties. It is also very difficult to produce MOFs and to make them as porous as possible. In the laboratory, chemists make different chemicals react together to produce the desired MOFs. This is named synthesis.



WE ARE BREAKING OUR  
BRAINS TO BUILD A NEW  
SKELETON FOR NANO THE  
MOF.  
SO, SHE WILL HAVE THE  
MAXIMUM ADSORPTION  
POWER!

THEN, WE ALL GO IN  
OUR LABORATORIES

WITH MY FRIENDS,  
WE HAVE A  
FANTASTIC IDEA!



WE CONCENTRATE  
THE POWER  
OF NANO THE MOF  
IN CUBES!

AND WE CAN  
MEASURE THIS  
POWER WITH THE  
NEW TOOLS WE  
ARE BUILDING.

## LEARN MORE

The higher the surface in the pores of a MOF, the more hydrogen it can adsorb. This can be done by compacting the MOFs in a monolith. This is a very stable and solid form, like a cube. In this monolith form the MOFs can adsorb much more hydrogen than when he was produced in a powder form.



# EPISODE 3

How Nano the MOF  
and Professor Theodore  
save the planet!



NANO THE MOF,  
THE PLANET IS  
THREATENED BY  
CLIMATE CHANGE!

WE NEED CLEAN  
VEHICLES, PURE AIR  
AND NO CO2 EMISSIONS  
ANYMORE.

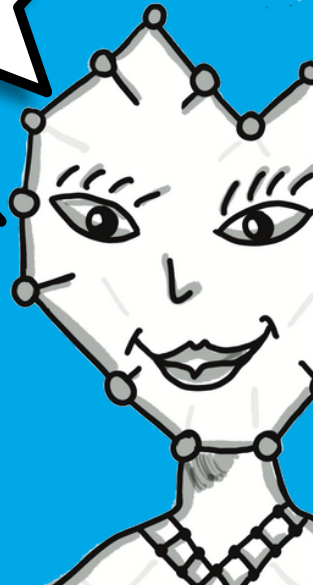
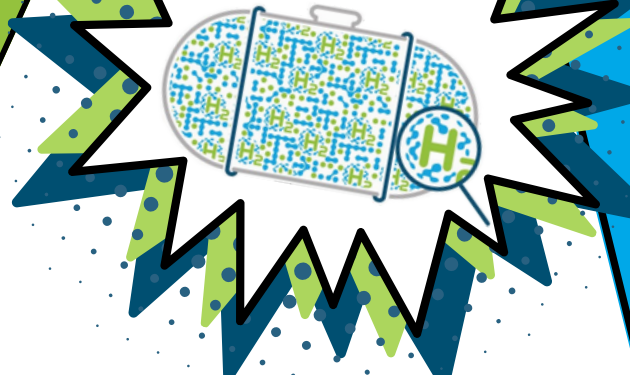
WITH MY NEW  
SUPER-POWER I  
CAN HELP!

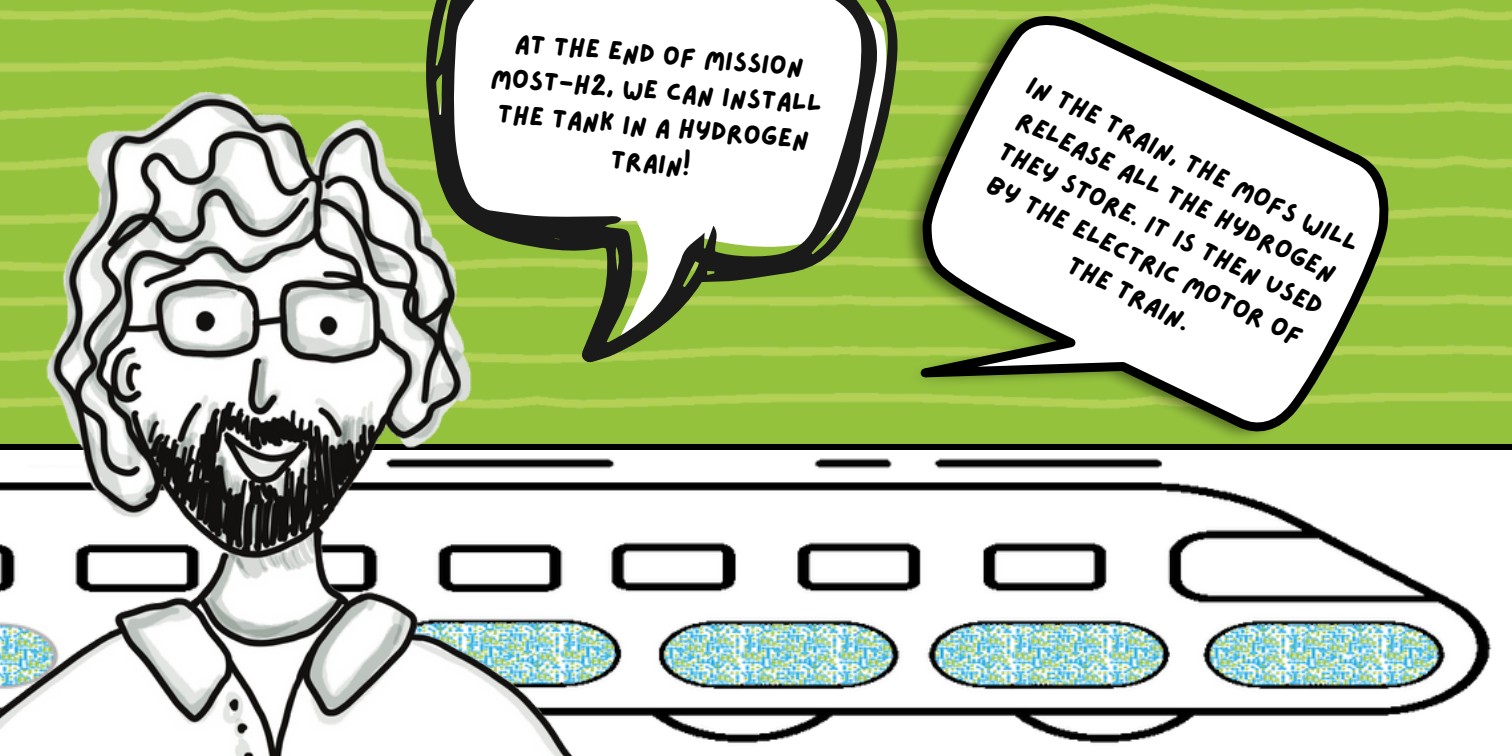
LET'S START WITH  
USING HYDROGEN IN  
TRAINS.



DURING MISSION MOST-H<sub>2</sub>,  
WE FIRST NEED TO FIND AN  
EASY AND FAST WAY TO  
PRODUCE A LOT OF MOFS LIKE  
YOU!

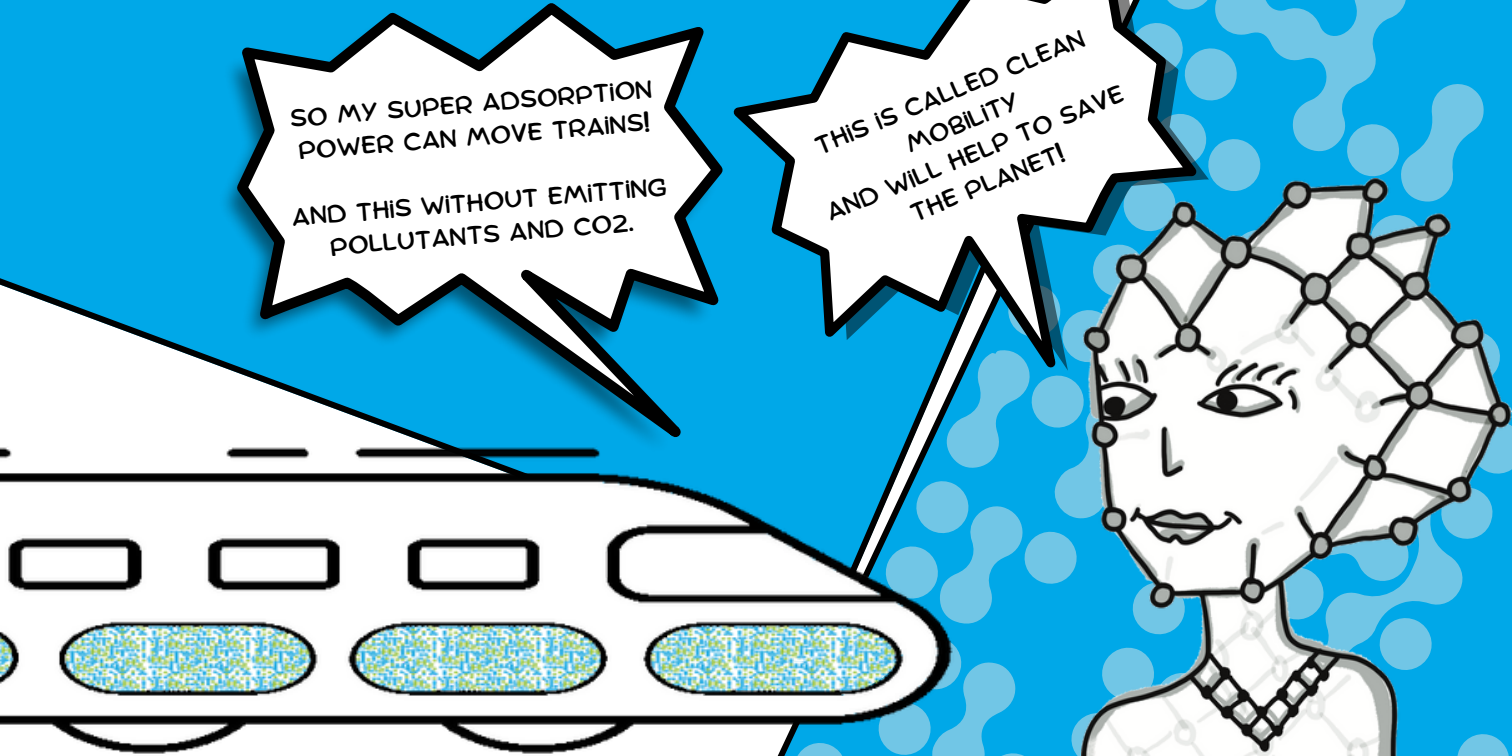
AND THEN WE BUILD A TANK  
TO PUT THEM IN.  
IN THIS WAY, THEY CAN SAFELY  
STORE AND TRANSPORT A LOT  
OF GREEN HYDROGEN.





AT THE END OF MISSION  
MOST-H<sub>2</sub>, WE CAN INSTALL  
THE TANK IN A HYDROGEN  
TRAIN!

IN THE TRAIN, THE MOFS WILL  
RELEASE ALL THE HYDROGEN  
THEY STORE. IT IS THEN USED  
BY THE ELECTRIC MOTOR OF  
THE TRAIN.



SO MY SUPER ADSORPTION  
POWER CAN MOVE TRAINS!

AND THIS WITHOUT EMITTING  
POLLUTANTS AND CO<sub>2</sub>.

THIS IS CALLED CLEAN  
MOBILITY  
AND WILL HELP TO SAVE  
THE PLANET!









# **THANK YOU**

Nano the MOF and Professor Theodore got  
a lot of money from the European Union  
for helping to save the planet.  
They say: "Thank you!"



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# SOURCES

For writing the "Learn more" sections, the authors used  
vocabulary.com, kids.kiddle.co, academickids.com and  
similar sources