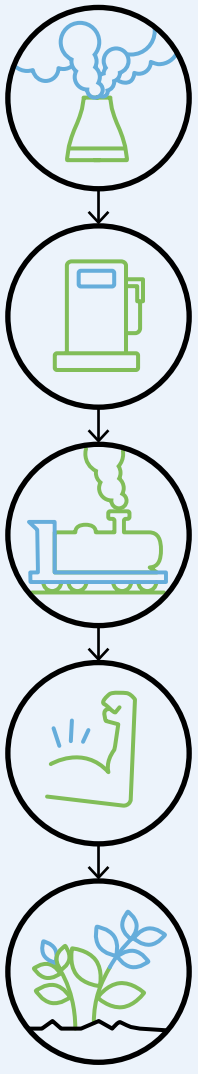
PHOTOSYNTHESIS 2.0

Plant Power
for the Future



Before
nuclear power

Before
oil & gas power

Before
steam power

Before even
manpower

**There was
plant power**

Photosynthesis, the greatest and most fundamental source of power, remains largely untapped at a time when we face enormous challenges in terms of food, energy and climate change. So why are we not we making more of it?

MORE WITH LESS?

We all learnt about photosynthesis at school, but photosynthesis is much more than a simplified theory in our science textbooks. It is the foundation of life and the engine of agriculture – and there is so much more potential to be gained from this source of plant power.

It is important to consider that:

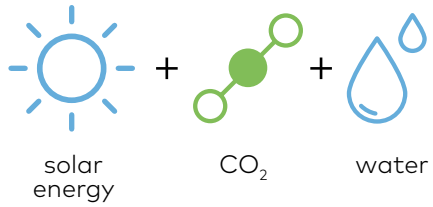
- Global demand for food will grow by at least 70% by 2050.
- On our current trajectory, the Earth's resources will not suffice.
- We have to produce more and healthier food…
- …and biomass to fuel a bioeconomy to mitigate the effects of climate change…
- …without using additional land and with limited water resources…
- …while reducing our environmental impact and maintaining biodiversity.

In other words, we have to produce more with less. To get farther, we need to rev up the engine.

LIFE ON EARTH

The Photosynthesis 2.0 initiative offers an answer to many of these challenges.

Photosynthesis is the basis of life on Earth. A remarkable biological process which uses three readily available ingredients…



… to produce chemical energy (stored as carbohydrates), the building blocks of plants and the oxygen we breathe.

Photosynthesis is therefore a source of unlimited, sustainable energy, one that offers enormous potential in terms of both feeding the World's population and driving forward the bioeconomy.

ONE IN TEN

Over the last half a century, the yield increases achieved by conventional plant breeding have remained steady at about 1% per year. To meet the expected food needs of a global population we will need to double yields by 2050 – a year on year yield increase of 1.7%.

Achieving this major rise will require a transformative new technology to significantly boost crop yields. Improved photosynthesis can become that game changer, transforming agriculture, creating new technologies and removing the threat of food insecurity.

Models calculate that 10% of sunlight received by the Earth could be captured and converted to chemical energy by photosynthesis. And yet, crucially, only around 1% of light is currently being harnessed in this way in typical agricultural systems.

You don't need to be a scientist to recognise the massive benefits that would be within reach if we knew how to improve photosynthetic systems.

FAR-FETCHED? CERTAINLY NOT

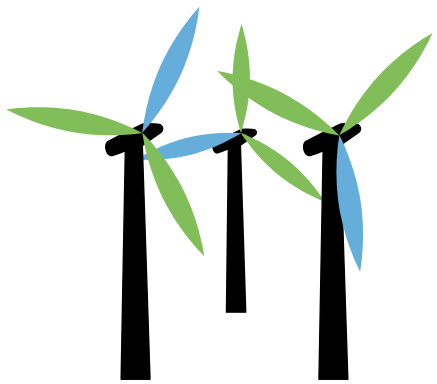
We know what needs to be done and how we can do this

For some of this we already have proof of concept, and guess what? It works!

We know how to get new discoveries from the lab into the field

Now we need the resources to put these ideas into practice

Much remains to be learned and many important applications still need to be developed. While we know the principles of how the engine of life works, we still lack sufficient detailed knowledge of photosynthesis to allow us to master and transform it, creating a powerful engine for agriculture.



THE TIME IS NOW

Investment in fundamental, multi-disciplinary research into this complex biological phenomenon has been sadly lacking. As a result, and to continue the power analogy, many of our crops are running on old two-stroke engines. It's high time they were running on high-horsepower, super-efficient hybrid motors.

Europe has tremendous expertise in photosynthesis and the associated plant sciences. So far this community has not had the opportunity to come together and pioneer the transformation of photosynthesis.

The time has come for a broad-based, pan-European initiative to improve and harness photosynthesis

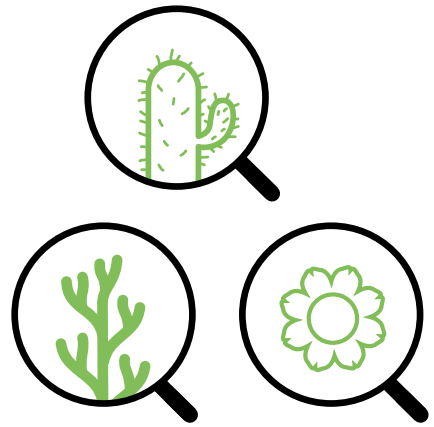
The time has come to generate Plant Power for the Future

The time has come for Photosynthesis 2.0

GIVING EVOLUTION A HELPING HAND

Photosynthetic organisms inhabit nearly all ecosystems and corners of the globe, from algae growing under the polar ice to cacti proliferating in extreme deserts and small flowering plants like edelweiss growing on high Alpine peaks. Some plants are known to be real photosynthetic powerhouses.

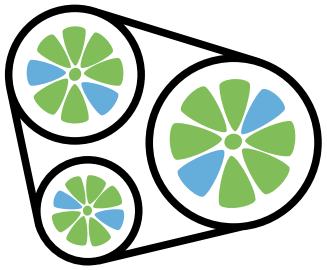
It is clear that the process of photosynthesis is highly adaptable and flexible. Selecting for plants with modified leaves and leaf canopies can provide further gains.



MAKING PLANTS WORK FOR US

The carbon fixed by photosynthesis is used to form diverse organic compounds. There are often trade-offs in the products made: we grow potatoes for their starch, pine trees for their cellulose, and algae for their sugars and oils for biofuel production. By understanding the diversity of reactions and pathways, we can modify them in order to optimise the outputs for the desired products.

Moreover, many of the plant products that are of critical importance to human health, particularly vitamins, are produced and have evolved because of their role in photosynthesis. It is possible to improve the photosynthetic traits and nutrition value of key crops simultaneously.



LOOKING TO THE FUTURE

Challenges related to food, energy and the climate can be directly addressed via fundamental research into photosynthesis. They include:

Higher food yields

Production of more nutritious foods

Optimisation of carbon assimilation for the bioeconomy

Capture and storage of more carbon dioxide to mitigate climate change

The fundamental question that needs to be solved is how efficient plant production (more with less) can be achieved, first by fine-tuning and second by redesigning photosynthesis. We need to:

Understand all the parts and how they interact together

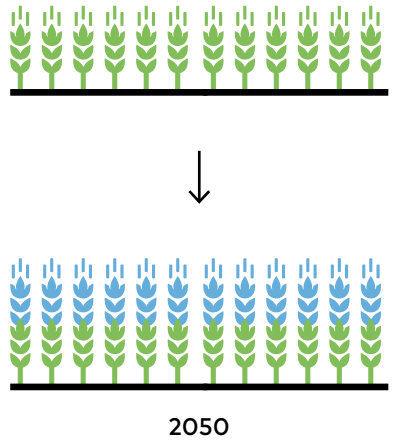
Predict and fine-tune them to generate higher efficiency

Rebuild the engine of life

PAUSE FOR THOUGHT

When CERN was first proposed, the goal was to understand the nature of matter. Without knowing what the practical or applied aspects would be, European policymakers understood the importance of understanding the building blocks of matter. Today, the impact of what was learned by the CERN initiative is enormous.

We believe that research into photosynthesis has similar potential in the world of biology. The path to applications relevant to food, energy and the climate is quite clear and the time to tackle these issues is now.



HOW?

Our goal is to understand, predict and fine-tune interactions and rebuild photosynthesis as the engine of life. But that is not all, you cannot put a big engine into a normal car! You also have to reinforce the car itself and at the same time you want it to run as efficient as possible.

For our future crop plants this means that we have to make them more robust, also to withstand the negative effects of global climate change, like rising temperatures, extreme weather conditions such as droughts, floodings and heatwaves, changing precipitations patterns and deterioration of soil. We need to make our plants more resource use efficient so that they make optimal use of the available water and minerals.

To realise this all, we have a focused and ambitious plan aimed at doubling crop yields by 2050; Photosynthesis 2.0

We will combine science and expertise from across Europe. The experimental work will extend from nano-scale of electrons and molecules right up to plants in the field. We will work together with industry, farmers, consumers and all other partners in the food production chain to future proof our agricultural system.

Who we are

The Photosynthesis 2.0 initiative has been founded by scientists from 14 European academic institutions (see back) and currently is supported by 51 universities, research institutes and international initiatives from 17 EU Member States and beyond.

We are an open consortium and welcome new members and participants from academia, industry, government, NGO's and other stakeholder organizations.

Written contributions for sub-programmes and enabling technologies were made by the following researchers (with their affiliations). List presented in alphabetical order.

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Visit our website for more information:
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