Light-driven enzymes

- Enzyme systems that runs on solar energy

Energy and Environment

- A class of enzymes known as lytic polysac-charide monooxygenases LPMOs can be be boosted 100-fold by the energy of light.
- The enzymes are simply combined with a pigment such as chlorophyll and irradiated for a short period of time, whereupon the enzymes oxidize their substrate.
- The basic mechanism is the same as in photo-synthesis, but here carbon is oxidized, thus the reverse reaction of photosynthesis
- Potential and possible applications are plenty, examples are: Biofuels, biochemicals, nano-materials, diagnostic assays, photodynamic therapy etc.

Lytic Polysaccharide Monooxygenases (LPMOs)

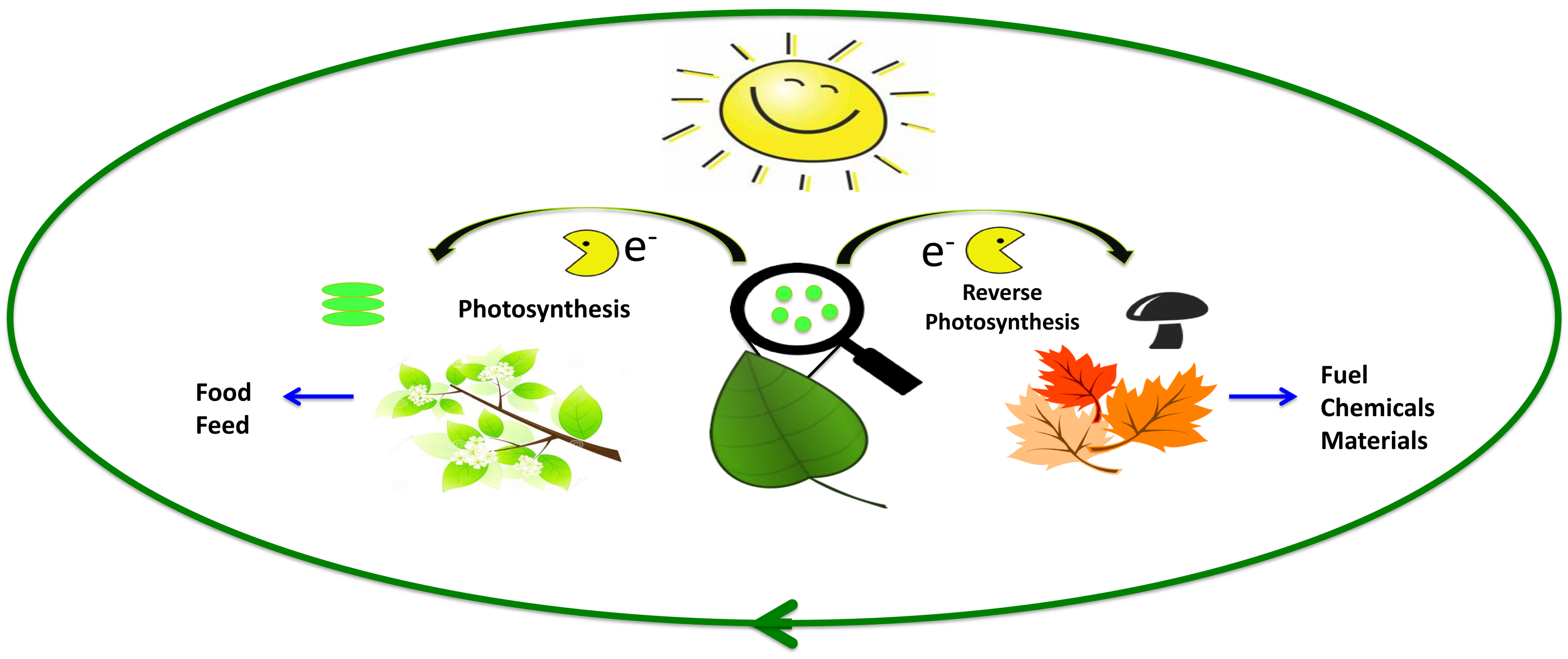
Enzymes found in fungi, bacteria, viruses and even rotifers

Oxidative cleavage of cellulose and other carbohydrates

Single copper ion in active site

Dependent upon electron donation

Industrially produced



Solar light capture happens when, the rays of the sun meets the plant's chlorophyll, which absorbs the light energy by "lifting" an electron into a higher orbital. The energy of the sunlight excited electrons fuels the growth of plants, but the electrons may also move into the reverse photosynthesis process. In this process plant degrading fungi and bacteria apply enzymes to utilize the energy of the sun for breaking down the plants, as part of the natural carbon cycle. We may develop reverse photosynthesis for among other use in light-driven industrial processes making fuels, chemicals and materials from biomass.

Value proposition/USP
A new and unique way of boosting oxidative enzymes by the use of light has been discovered. By simply combing a monooxygenase enzyme with pigments e.g. derived from chlorophyll, and exposing them to light, the activity of the enzymes can be increased up to hundredfold. This makes it possible to oxidize otherwise hard to degrade carbohydrates such as cellulose as well as hemicellulose, starch and potentially keratin. The technology may also be developed for light-driven oxidation of methane to methanol. The potential of directly using the energy of light to drive biochemical reactions opens a new world of production technologies and products

Business Opportunity/Objective/commercial perspectives
The light-driven enzyme system can generally be used to oxidize carbon compounds. This can among other be applied for boosting the existing production of biofuels and biochemicals, surface activation of pulp & paper materials and production of prebiotic oligomers. Another opportunity lies within the use of reactive oxygen species produced by the enzymes for biocide or therapeutic applications.

Technology description/technology Summary
The system is composed of an enzyme, a pigment, a reductant and a substrate e.g. cellulose. The components are mixed and light is applied for 10 min to 1 hour. The optimal strength of the light applied is typically 10% of the light on a sunny day. The products can be separated or further processed in the same reactor. Different variations with e.g. immobilized pigments are possible. All the components needed for the light-driven enzyme technology are available as commercial products

Development phase/current state
The technology has been fully demonstrated and partly optimized at the laboratory scale. Synergy between light-driven oxidation and conversion of cellulose has been shown. The main parameter for optimization and adaptation of the light-driven reactions is the type of pigments applied, why further work focus upon pigment adaptation and development.

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Intellectual property rights
The invention is covered by PCT patent application PCT/EP2016/066804 filed 14 July 2016