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Photofuel - Biocatalytic solar fuels for sustainable mobility in Europe

Deliverable D2.5

Strains and processes for synthesis and excretion of medium chain-length alcohols and alkanes

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Editorial		
Deliverable №:	D2.5	
Title	Designed strains, at least one producing and excreting a liquid alkane and a second producing and excreting a medium-length liquid alcohol, allowing a transition from TRL2 to TRL4 in cyanobacteria and microalgae	
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Publishable Summary

The overall objective of the PHOTOFUEL project is to deliver a sunlight-driven biocatalytic process that generates engine-ready fuel. The 'biocatalytic' aspect of this concept means that the biological part of the process has to consume CO_2 from the atmosphere, convert that CO_2 into engine-ready fuel and excrete that fuel outside the cell, thereby allowing continuous conversion of CO_2 into fuel and its removal from the production system. Thus, many capabilities need to be accomplished. In this deliverable, the task was set to create biological cells that produce engine-compatible fatty alcohols and alkanes, and to make sure that the fuel is excreted outside of the cell.

The work was divided into four separate tasks: (1) Conversion of CO_2 into free fatty acids, (2) conversion of acids into alcohols, (3) conversion of acids into alkanes and (4) excretion of alcohols and alkanes outside of the cell, with the following outcome:

- High-yield conversion of CO_2 into free fatty acids, fatty alcohols, fatty alkenes and fatty alkanes were achieved.
- A large number of pathways and variants thereof were evaluated.
- In general, the excretion of the fuel molecules was dependent on chain-length and functionalization.
- The addition of solvent overlay did in some cases overcome the chain-length barrier for excretion of highly hydrophobic molecules, and it also aided the recovery of the more water-soluble products and its separation from the water phase.

An example demonstrating the consequence of product target choice, is shown below - only 1-octanol accumulates exclusively outside of the cell.

Further work is needed to identify suitable enzymes and to optimize the overall process. The lack of cellular excretion for longer chain-length products be due to physico-chemical barriers for which there may not exist any biological solutions.