ALBERTA INNOVATES

CLIMATE CHANGE INNOVATION AND TECHNOLOGY FRAMEWORK

Awardee Summary

CCITF PROGRAM	Clean Technology Development
PROJECT TITLE	Intensification of methane-consuming bacteria towards production of advanced biofuels
SECTOR	Methane Emissions Reduction, Waste to Value-Added
ORGANIZATION	University of Alberta
PROJECT LEAD	Dominic Sauvageau
AI PROJECT ADVISOR	Pat Guidera
GRANT AMOUNT	$99,400
START DATE	TBD
END DATE	TBD

PROJECT OBJECTIVE: To accelerate the industrialization of methanotrophic bacteria for the bioconversion of methane waste into isoprenoids, a diverse class of organic molecules with a large number of potential commercial uses, including as biojet fuel and specialized fuel additives. Specific project objectives are to: 1) Bioprospect and expand isoprenoid production by methanotrophic bacteria using natural and synthetic biology approaches; and 2) Develop an adaptive control fed-batch strategy for high-density cultures for production of isoprenoid biofuels from methane.

PROJECT PROFILE: Climate change creates a strong motivation to reduce industrial emissions of greenhouse gases (GHG). Methane is a common low-value industrial by-product with a global warming potential 28-36 times greater than CO2 based on a 100-year period. Methane is an unavoidable byproduct of many industrial processes, including in the energy and agriculture sectors (important drivers of the Albertan economy), and current mitigation technologies remain limited; methane is sometimes recovered for energy production or simply flared. Fortunately, methane can also serve as feedstock for methanotrophic bacteria, which consume methane as their carbon and energy source and convert it to value-added products such as advanced biofuels. Unlike first generation biofuels, this approach does not impact the food supply chain, and it has a lower carbon footprint than petrochemical processes. Importantly, it turns a negative value byproduct (methane off-gas) into a revenue-generating product (biofuels).

The overall goal of this project is to accelerate the industrialization of methanotrophic bacteria for the bioconversion of methane waste into isoprenoids, a diverse class of organic molecules with a large number of potential commercial uses, including as biojet fuel and specialized fuel additives. The bioproduction pathway to isoprene, the precursor to isoprenoids, and isoprenoids themselves is present in several methanotroph species, including Methylomicrobium album BG8, which, given its genetically diverse and

robust character, is an ideal initial vector for process development and industrialization. Despite the presence of the isoprene pathway, natural production is at low yield, and a system for highly efficient and reliable isoprenoid biosynthesis has yet to be developed in methanotrophs. Further optimization of both strain and process are thus necessary for successful implementation at industrial scale. To this end, the specific project objectives are to: 1) Bioprospect and expand isoprenoid production by methanotrophic bacteria using natural and synthetic biology approaches; and 2) Develop an adaptive control fed-batch strategy for high-density cultures for production of isoprenoid biofuels from methane.

The first objective will be aimed at applying the knowledge gained from previous work with M. album BG8 and other candidate methanotrophs; to survey known species for expansion of isoprenoid products and pursue strain optimization for their production, including genetic engineering to optimize pathways. The second will aim to develop an optimized fed-batch process for methane bioconversion to isoprenoids in methanotrophic strains. This will be done through development and implementation of adaptive control feeding strategies, ensuring efficient methane bioconversion and increases in yield and productivity. This technology will broadly benefit Albertan industries in two ways: through production of commercially and economically relevant bioproducts, and through mitigation of greenhouse gas emissions, diverting methane waste-streams from release back into revenue-generating biofuels.

GHG EMISSION REDUCTION SUMMARY: