

Leiden University:

Ongoing research projects in collaboration with the fossil fuel industry

#### Introduction

This list includes research in collaboration with the fossil fuel industry that has come about with external funding. It has taken some time to compile because we wanted to take every possible care, and we also had to ask permission from the partners with whom we collaborate, some of which are private organisations, to make the data publicly available. In drawing up this inventory, we use the following definition: *Fossil industries are companies engaged in the exploration, extraction and exploitation of fossil fuels*. Research projects currently being carried out in collaboration with the fossil fuel industry are included in the list. The list is a snapshot in time and concerns the state of play in August 2023, and will be updated if necessary. Where possible the financial scope of a project is included in the list. The financial scope of the ESRF project, the ARC-CBBC project and the bilateral projects has not been included because the nature and/or the contract of these (private) collaborations restrict the publication of competition-sensitive details. Where possible this information will be added later.

#### Research consortia

- **Advanced operando spectroscopies for atomic-scale insight into the electrocatalysis of fuel cells and electrolysers**

**Dutch Research Council (NWO) project - Tenure Track programme - ECCM Electrochemical conversion & materials**

**Duration: 1 October 2020 to 30 September 2025**

**Total NWO grant: 950,000 euros max.**

Public-private Top Sector Energy programme, with partial private funding at the programme level from companies including Shell. In this NWO-ECCM project, research is being conducted into catalysts for electrolysers and fuel cells. Electrolysers use electricity to produce green hydrogen. This hydrogen can be used to make the industry greener, for example by replacing coal in steel production, or to absorb fluctuations in green energy production. This is an NWO grant, with indirect funding from private partners.

- **Elucidation of sintering mechanisms of cobalt during Fischer-Tropsch synthesis**

- **European Synchrotron Radiation Facility / Leiden University**

**Duration: 4 October 2021 – 3 October 2025**

Based on the Fischer-Tropsch-synthesis process, Leiden University, jointly with ESRF and Shell, is investigating the formation of clean, synthetic hydrocarbons from carbon monoxide and hydrogen. This process will be investigated using X-ray diffraction and X-ray absorption spectroscopy, thereby elucidating the structure and chemical composition of the catalyst during the chemical reaction.

- **NEASQC - NExt ApplicationS of Quantum Computing**

**Horizon Europe – EXCELLENT SCIENCE - Future and Emerging Technologies (FET)**

**Duration: 1 September 2020 – 31 August 2024**

**Total EU grant: 4,671,332.50 euros**

The NEASQC (NExt ApplicationS of Quantum Computing) project brings together academic experts and industrial end-users to investigate and develop a new breed of Quantum-enabled applications that can take advantage of NISQ (Noise Intermediate-Scale Quantum) systems in the near future. NEASQC is use-case driven, addressing practical problems such as drug discovery, CO<sub>2</sub> capture, smart energy management, natural language processing (technology to enable computers to use natural human language), breast cancer detection and solving mathematical problems relating to probabilistic risk assessment for energy infrastructures such as sustainable electricity networks. NEASQC aims to initiate an active European Community around NISQ Quantum Computing by providing a common toolset that will attract a wide range of industrial users. Participants: AstraZeneca, Atos, Cesga, EDF, HQS, HSBC, ICHEC, Tilde, TotalEnergies, Universiteit Leiden, University of A Coruña, Université de Lorraine.

- **New Chemistry for a Sustainable Future: Mechanisms of alcohol formation during electrocatalytic CO<sub>2</sub> reduction**  
**ARC-CBBC Advanced Research Center Chemical Block Consortium**  
**Duration: 15 June 2021 – 14 June 2025**  
**Advanced Research Center – Chemical Building Blocks** (a public-private organisation for research into circular chemistry)  
 Leiden University is involved in an ongoing project from the ARC-CBBC consortium, as part of the multilateral Chemistry for a Sustainable Future programme. The project is examining how carbon-based fuels can be synthesised from CO<sub>2</sub>, water and (green) electricity, for the benefit of energy transition.  
 Consortium: ARC-CBBC, Shell, multiple universities and companies, NWO, Government of the Netherlands, ChemistryNL
  
- **SUNER-C: SUNERGY Community and eco-system for accelerating the development of solar fuels and chemicals**  
**Horizon Europe CSA**  
**Duration: 1 June 2022 – 31 May 2025**  
**Total EU grant: 3,997,646 euros**  
**Leiden University grant: 200,005 euros**  
 SUNER-C is a project coordination and support action funded by Horizon Europe on the next generation of energy carriers to replace fossil fuels.  
 Consortium: EU-project (CSA) partnership of 31 organisations, including Total Energies  
 The EU-funded SUNER-C project will shed light on the potential uses of solar fuels. Bringing together 31 organisations from a variety of sectors and across the EU, the project will speed up the development of solar fuels and chemicals. By replacing fossil-derived fuels and chemicals with renewables and carbon recycling, SUNER-C aims to contribute to the creation of a circular economy.
  
- **Release Reversible Large Scale Energy Storage**  
**Duration: 1 September 2020 – 31 August 2026**  
**Total grant: 10,226,127 euros**  
 In a consortium with other research universities and universities of applied sciences and, among others, Shell and Gasunie, Leiden University is conducting research into three technologies: electrolysis, the process in which water is converted into hydrogen and oxygen; converting CO<sub>2</sub> into hydrocarbons; and the design of flow batteries. This research will serve the energy transition.  
 Consortium: Leiden University, Delft University of Technology, University of Twente, Utrecht University, Eindhoven University of Technology, University of Groningen, Tilburg University, Shell, Gasunie, Vattenfall, and 30 other parties including NWO.

#### **Bilateral research partnerships**

- **Basic research into quantum algorithms**  
 TotalEnergies supports basic research on types of computations that may be improved by using quantum computing. The research is primarily oriented to generic combinatorial optimisation.
  
- **Quantum algorithms for chemistry**  
 Leiden University and Shell are investigating how quantum computers can be employed to simulate complex interactions between molecules. Foreseen application areas include the development of environmentally friendly fertilisers, novel medications or the conversion of CO<sub>2</sub> into fuels.

- **Reinforcement Learning Lab for Sustainable Energy**

This lab aims to develop novel Artificial Intelligence methods and technologies to assist us in the renewable energy transition and reduce energy consumption. Areas addressed are energy efficient smart homes, smart energy grids that can cope with peak loads caused by renewable energy sources and optimising renewable energy production in wind parks or hydrogen power plants. This lab consists of four subprojects: model-based reinforcement learning; offline reinforcement learning; memory, attention and exploration; graph-based reinforcement learning and multi-agent reinforcement learning.

- **Collaboration on Catalysis research for conversion of CO<sub>2</sub> into fuel**

Industrial PhD project (external PhD candidate). This PhD project aims to develop knowledge on catalyst-based electrochemical systems to transform CO<sub>2</sub> and CO in carbon products. For example, mass transport models for new catalysts will be targeted.

### ***Donations***

#### **Donation from Aramco Overseas**

Leiden University accepted a donation of 100,000 US dollars from Aramco Overseas Company at the start of 2022. The funding is intended for research and outreach in the field of Arabic history and culture. This has been used, among others, to organise a series of lectures and a culture market by the Leiden University Centre for the Study of Islam and Society (LUCIS). This project will be completed this year and will not be extended.