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## **Draft Project plan for the CEN Workshop on**

**"Testing and evaluating the  
performance of devices for  
electrocatalytic reduction of  
CO<sub>2</sub> to CO"**

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**Requests to participate in the Workshop  
and/or comments on the project plan are  
to be submitted by  
17 July 2023 to [sjenkel@une.org](mailto:sjenkel@une.org)<sup>1</sup>**

Recipients of this project plan are kindly requested to name all patent rights known to them to be relevant to the Workshop and to make available all supporting documents.

**Madrid, 12 June 2023 (Version 1.0)**

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<sup>1</sup> Applications for participating in the Workshop and comments on the project plan that are not received by the deadline do not need to be taken into consideration. Once constituted, the Workshop will decide whether or not to consider the comments received in good time.

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## Summary

The application of (photo)electrocatalytical technologies for the reduction of CO<sub>2</sub> to CO holds immense relevance for our current and future society with regard to sustainable methods to mitigate CO<sub>2</sub> levels in the atmosphere and to reduce the dependence on fossil feedstocks. Electrocatalysis offers a promising solution by using renewable energy sources, such as solar or wind, to drive the electrochemical conversion of CO<sub>2</sub> into CO. This process not only helps in the utilization of CO<sub>2</sub> as a valuable feedstock but also offers a viable pathway towards carbon neutrality.

The Horizon 2020 project SUNCOCHEM (Grant Agreement number 862192) addresses the need of the EU Chemical Industry for highly competitive and integrated solutions enabling the carbon-neutral production of energy and high-value chemicals from solar energy, H<sub>2</sub>O (water) and CO<sub>2</sub> (carbon dioxide). The conversion of CO<sub>2</sub> into chemicals occurring in an (photo)electrochemical device is divided in two half reactions, namely water oxidation and the reduction reaction CO<sub>2</sub> to CO (carbon monoxide).

The objective of this Workshop is the development of a new standard, CWA (CEN Workshop Agreement), on procedures and protocols for testing and evaluating the performance of devices for electrocatalytic reduction of CO<sub>2</sub> to CO. The application of the new standard is intended to simplify both the comparability between different technological solution and the representation of the impacts of changes in individual technologies in a standardized and concise manner, in order to support the further development of (photo)electrocatalytical devices.

The present project plan explains how this new standard, CWA, will be developed, how the workshop will be disseminated and how a wide range of relevant interested parties will be involved throughout the development of the CWA and after its publication.

## 1 Status of the project plan

**Draft project plan** for public commenting (Version 1.0)

This draft project plan is intended to inform the public of a new Workshop. Any interested party can take part in this Workshop and/or comment on this draft project plan. Please send any requests to participate or comments by e-mail to [sjenkel@une.org](mailto:sjenkel@une.org).

All those who have applied for participation or have commented on the project plan by the deadline will be invited to the kick-off meeting of the Workshop on **2023-07-20**.

## 2 Workshop proposer and Workshop participants

### 2.1 Workshop proposer

Person or organisation	Short description and interest in the subject
Bart van den Bosch Avantium N.V.	Avantium is a pioneer in the emerging industry of renewable and sustainable chemistry. Avantium seeks to take part in the opportunities of the transition towards a circular economy, with the goal of creating value for its stakeholders and society as a whole. Avantium's mission is to aid the transition to a fossil-free world by developing groundbreaking products on the basis of re-newable feedstock instead of fossil resources.  Specific interest is in the utilization of CO <sub>2</sub> as feedstock to produce sustainable carbon compounds. Avantium has proprietary technology for CO <sub>2</sub> conversion to polymers and to carbon monoxide (CO). CO is a large-scale chemical in the current economy, and the use of CO is expected to grow when moving to a more sustainable economy. Besides replacement of currently used fossil-based CO, examples of emerging technologies for CO are the electro-reduction of CO to

	<p>carbon materials (e.g., ethylene, C<sub>&gt;1</sub> alcohols, acetic acid) and the production of sustainable fuels.</p> <p>Although the research in CO<sub>2</sub> electroreduction to CO is extensive, there is no standardized method for evaluating process performance. Such a standard would progress the field by enabling proper comparison of different technologies.</p>
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## 2.2 Other potential participants

This CWA (CEN Workshop Agreement) will be developed in a Workshop (temporary body) that is open to any interested party. The participation of other experts would be helpful and is desired. It is recommended that:

- researchers in the field of electrocatalysis and CO production from CO<sub>2</sub>
- designers
- manufacturers
- testing laboratories

take part in the development of this CWA.

## 2.3 Participants at the kick-off meeting

The following persons or organisations already signed up to the kick-off meeting prior to the publication of the draft project plan.

Person	Organisation
Workshop proposer and proposed Workshop Chair Bart van den Bosch	Avantium N.V.
Proposed Vice-Workshop Chair Simelys Hernandez	Politecnico de Torino
Hilmar Guzmán	Politecnico de Torino
Maria Navarro	Fundacio Eurecat
Miriam Diaz de los Bernardos Sánchez	Fundacio Eurecat
Adrianna Nogalska	Fundacio Eurecat
Boyan Iliev	IoLiTec Ionic Liquids Technologies GmbH
Thomas Schubert	IoLiTec Ionic Liquids Technologies GmbH
Freddy Liendo	Hysitech S.r.l
Angelica Monica Chiodoni	Istituto Italiano di Tecnologia - IIT
Babu Radhakrishnan	Helmholtz-Zentrum Berlin für Materialien und Energie
Mariajosé López Tendero	Laurentia Technologies SLL

Person	Organisation
Sara Cavaliere	Université Montpellier
Workshop secretariat Steffen Jenkel	Workshop secretariat Asociación Española de Normalización, UNE

### 3 Workshop objectives and scope

#### 3.1 General

SUNCOCHEM, Photoelectrocatalytic device for SUN-driven CO<sub>2</sub> conversion into green CHEMicals, is a research project funded by Research Executive Agency of the European Commission under Grant Agreement number 862192.

The SUNCOCHEM project aims to provide the chemical industry with an alternative to produce oxo-chemicals without using raw materials derived from carbon or oil. The project will develop a photoelectrocatalytic tandem reactor to manufacture valuable chemical oxo-products from renewable energies based on CO<sub>2</sub>, H<sub>2</sub>O and solar energy.

The conversion of CO<sub>2</sub> into chemicals, but also fuels, using energy derived from renewable source has the potential to reduce the use of fossil feedstocks. If such conversion is performed electrochemically, two half reactions, namely water oxidation and the carbon dioxide reduction reaction. The effectiveness of a catalytic system depends on the energy efficiency, the selectivity to the desired product, the purity of the product and the system stability. For both reactions to proceed forward, a significant input of energy is needed, in the form of electrical power, which is converted into energy stored in the chemical bonds of the compounds produced. The total energy required for this electrochemical conversion depends on the energy efficiency of the catalysts and on the electrical and ionic resistances in the system. Additionally, the selectivity of the catalyst is influential on the energy demand for this conversion. This catalytic selectivity also affects the percentage of CO<sub>2</sub> that is effectively utilized for the desired product and the amount of undesired side products. Another KPI that is influential for the overall process energy demand is the purity of the produced CO. A high purity CO reduces the required efforts for energy-demanding purification. In the workshop we develop a standard for determining these most influential KPI's for the electrochemical conversion of CO<sub>2</sub> to CO.

The production of CO from CO<sub>2</sub> could provide a sustainable CO production method as alternative for the currently dominant fossil-based technologies. The Reverse Water Gas Shift (RWGS) reaction is a relatively mature process to perform the CO<sub>2</sub> to CO conversion. This reaction, however, requires the input of hydrogen, which must be produced in a separate process. Electrochemical conversion of CO<sub>2</sub> to CO is an alternative process which could convert CO<sub>2</sub> to CO in a single conversion process, thereby reducing the number of unit operations. Such a process is currently not industrially applied and still in development phase. Many different technologies for electrochemical CO<sub>2</sub> conversion to CO are developed. As there are many applications for CO and many different sources of CO<sub>2</sub>, different technologies for CO<sub>2</sub> electroreduction to CO could serve different CO application areas and thus have different desired characteristics.

A standard for determining various process characteristics, or KPI's, is required. Currently, various KPI's are poorly defined and the determination of KPI's differs throughout various publications. To enable proper comparison between technologies we propose this standard.

#### 3.2 Background

The existing and under-development standards that are relevant for the project were identified in the very early stages of the project to be considered during the project works. The relevant standardisation committees were addressed to inform their officers of SUNCOCHEM objectives and to evaluate and follow the best way to promote the transfer of the results of the project to future standards.

However, there was no existing standard or ongoing standardization work supporting or directly related with performance evaluation of electrocatalytic devices with regard to CO<sub>2</sub> reduction, hence the motivation for this workshop to develop a method that provides for this.

Today, performances of devices reported in scientific literature are done in a non-standardized way. This leaves room for multiple interpretations of, for instance, energy efficiency, activity and product purity.

Designers and manufacturers of electrocatalytic devices will benefit from the future CWA as it will allow comparability of different technological solutions for the different fields of applications.

### **3.3 Scope**

The planned Workshop specifies procedures and protocols for testing and evaluating the performance of devices for electrocatalytic reduction of CO<sub>2</sub> to CO. This is done by specifying test methods for the determination of the performance with regard to production rate per electrode area, purity of the produced gas/product gas composition, stability of the reactor and energy consumption.

The planned Workshop is applicable to devices for electrocatalytic reduction of CO<sub>2</sub> to CO.

The planned Workshop does not specify requirements for the construction or the performance of devices electrocatalytic reduction of CO<sub>2</sub> to CO. It is therefore not limited to specific constructive solutions of such devices or to specific fields of application of CO<sub>2</sub> reduction.

The planned Workshop is intended to be used by organisations and persons developing or using such devices.

### **3.4 Related activities**

The subject of the planned CWA is not the subject of a standard at present.

However, there is one thematically related technical committee, CEN/TC 386 "Photocatalysis". Experts active in CEN/TC 386 will be invited to join this Workshop.

Existing terminology standards in the fields of photocatalysis (EN 16981:2021) and corrosion of metals and alloys (ISO 8044:2020) as well as standards developed by ISO/TC 158 "Analysis of gases" and CEN/TC 238 "Test gases, test pressures, appliance categories and gas appliance types" will be considered as far as possible.

Another valuable terminology source is IUPAC Recommendations 2011 (Glossary of terms used in photocatalysis and radiation catalysis).

## **4 Workshop programme**

### **4.1 General**

The kick-off meeting is planned to take place on 20 July 2023 as virtual meeting.

Please see the Draft Agenda for the kick-off meeting.

The number of virtual meetings will be discussed at the kick-off meeting. Currently, it is planned to hold virtual meetings every 3 weeks; during these meetings the content of the CWA will be presented, discussed and approved.

The CWA will be drawn up in English (language of meetings, minutes, etc.). The CWA will be written in English.

### **4.2 Workshop schedule**

The Workshop schedule is given in Table 1 and will be modified in the kick-off meeting and adapted as long as the Workshop progresses.

Table 1: Workshop schedule (preliminary, to be discussed at kick-off meeting)

CEN/CENELEC Workshop	May 2023	June 2023	July 2023	Aug 2023	Sept 2023	Oct 2023	Nov 2023	Dec 2023	Jan 2024	Feb 2024	March 2024	April 2024
<b>Initiation</b>												
1 Proposal form submission and TC response												
2 Project plan development												
3 Open commenting period on draft project plan												
<b>Operation</b>												
4 Kick-off meeting												
5 CWA(s) development												
6 Open commenting period on draft CWA(s)												
7 CWA(s) finalised and approved by Workshop participants												
<b>Publication</b>												
8 CWA(s) publication												
<b>Dissemination (see 7)</b>												
<b>Milestones</b>												

Key

- |                                   |  |
|-----------------------------------|--|
| <b>K</b> Kick-off meeting         | <b>A</b> Adoption of CWA by Workshop       |
| <b>M</b> Workshop meeting         | <b>P</b> Publication of CWA by CEN         |
| <b>V</b> Virtual Workshop meeting | <b>D</b> Online distribution of CWA by CEN |

## 5 Resource planning

All costs related to the participation of interested parties in the Workshop's activities have to be borne by themselves. There is no fee for registration in the Workshop.

## 6 Workshop structure and rules of cooperation

### 6.1 Participation in the Workshop

The Workshop will be constituted during the course of the kick-off meeting. By approving this project plan, the interested parties declare their willingness to participate in the Workshop and will be formally named as Workshop participants, with the associated rights and duties. Participants at the kick-off meeting who do not approve the project plan are not given the status of a Workshop participant and are thus excluded from further decisions made during the kick-off meeting and from any other decisions regarding the Workshop.

As a rule, the request to participate in the Workshop is closed once it is constituted. The current Workshop participants shall decide whether any additional members will be accepted or not.

Any new participant in the Workshop at a later date is decided on by the participants making up the Workshop at that time. It is particularly important to consider these aspects:

- a) expansion would be conducive to shortening the duration of the Workshop or to avoiding or averting an impending delay in the planned duration of the Workshop;
- b) the expansion would not result in the Workshop taking longer to complete;
- c) the new Workshop participant would not address any new or complementary issues beyond the scope defined and approved in the project plan;
- d) the new Workshop participant would bring complementary expertise into the Workshop in order to incorporate the latest scientific findings and state-of-the-art knowledge;
- e) the new Workshop participant would actively participate in the drafting of the manuscript by submitting concrete, not abstract, proposals and contributions;
- f) the new Workshop participant would ensure wider application of the CWA.

All Workshop participants who voted for the publication of the CWA or its draft will be named as authors in the European Foreword, including the organisations which they represent. All Workshop participants who voted against the publication of the CWA, or who have abstained, will not be named in the European Foreword.

### 6.2 Workshop responsibilities

The Workshop Chair is responsible for content management and any decision-making and voting procedures. The Workshop Chair is supported by the Workshop Vice-Chair and the responsible Workshop secretariat, whereby the Workshop secretariat will always remain neutral regarding the content of the CWA(s). Furthermore, the Workshop secretariat shall ensure that CEN-CENELEC's rules of procedure, rules of presentation, and the principles governing the publication of CWA(s) have been observed. Should a Workshop Chair no longer be able to carry out her/his duties, the Workshop secretariat shall initiate the election of a new Workshop Chair. The list below covers the main tasks of the Workshop Chair. It is not intended to be exhaustive.

- Content related contact point for the Workshop
- Presides at Workshop meetings
- Ensures that the development of the CWA respects the principles and content of the adopted project plan
- Manages the consensus building process, decides when the Workshop participants have reached agreement on the final CWA, on the basis of the comments received
- Ensures due information exchange with the Workshop secretariat
- Represents the Workshop and its results to exterior

The Workshop secretariat, provided by a CEN/CENELEC national member, is responsible for organising and leading the kick-off meeting, in consultation with the Workshop proposer. Further Workshop meetings and/or web



conferences shall be organised by the Workshop secretariat in consultation with the Workshop Chair. The list below covers the main tasks of the Workshop secretariat. It is not intended to be exhaustive.

- Administrative and organisational contact point for the Workshop
- Ensures that the development of the CWA respects the principles and content of the adopted project plan and of the requirements of the CEN-CENELEC Guide 29
- Formally registers Workshop participants and maintains record of participating organisations and individuals
- Offers infrastructure and manage documents and their distribution through an electronic platform
- Prepares agenda and distribute information on meetings and meeting minutes as well as follow-up actions of the Workshop
- Initiates and manage CWA approval process upon decision by the Workshop Chair
- Interface with CEN-CENELEC Management Centre (CCMC) and Workshop Chair regarding strategic directions, problems arising, and external relationships
- Advises on CEN-CENELEC rules and bring any major problems encountered (if any) in the development of the CWA to the attention of CEN-CENELEC Management Centre (CCMC)
- Administrates the connection with relevant CEN or CENELEC/TCs

### **6.3 Decision making process**

Each Workshop participant is entitled to vote and has one vote. If an organisation sends several experts to the Workshop, that organisation has only one vote, regardless of how many Workshop participants it sends. Transferring voting rights to other Workshop participants is not permitted. During voting procedures, decisions are passed by simple majority; abstentions do not count.

If Workshop participants cannot be present in the meetings when the CWA or its draft is adopted, an alternative means of including them in the voting procedure shall be used.

## **7 Dissemination and participation strategy**

The Workshop proposal, the draft project plan, the draft CWA as well as the published CWA will be disseminated to relevant stakeholders and bodies for consultation:

- Standardization committees related to the scope of the CWA;
- other EU-funded projects and initiatives related to the SUNCOCHEM project and the scope of the CWA, especially projects participating to Road2GreenChem Cluster (<https://stories.nuigalway.ie/road-2-greenchem/index.html>): FlowPhotoChem, DECADE project, Solar2Chem and Ocean project as well as LICROX project (<https://licrox.eu/>)
- SUNERGY Initiative (<https://sunergy-initiative.eu/>)
- CO2 Value Europe (CVE) (<https://co2value.eu/>)
- SPIRE
- European Cluster on Catalysis
- European Federation of Chemical Engineering (EFCE)
- European Energy Research Alliance (EERA)
- European Chemical Industry Council (CEFIC)
- Raw materials Initiative

In addition to the CCMC website, the draft CWA as well as the final CWA will be advertised on the SUNCOCHEM project website and social media channels and in some SUNCOCHEM partners' websites to raise awareness. Interested parties are requested to contribute through commenting of the project plan or draft CWA (short term) or through direct participation in the Workshop (long term).

## 8 Contacts

- Workshop Chair/Workshop proposer:

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