# Science Communication Plan of the COST Action CYPHER, CA22151

## VERSIONS AND HISTORY OF CHANGES

| Version | Date of adoption by MC | Notes (e.g. changes from previous versions) | Lead author(s)* |
|---|---|---|---|
| 1 | April 12th, 2024 | | Corinna Schulze-Netzer |
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** The Science Communication plan is developed, updated and its implementation monitored under the overall supervision of the Science Communication Coordinator, and in close collaboration with other relevant contributors.*

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## 1. SUMMARY

In public discourse, combustion is often seen as outdated and blamed for climate change. However, it's crucial to rethink its role, especially in energy-intensive industries like cement and steel production. We need to start a dialogue on how to rapidly decarbonize these sectors. Using synthetic fuels, low-emission combustion techniques, data models, and digital twins presents a realistic path to combat climate change. Our aim is to inform and engage high-school and early engineering students, policymakers, NGOs, and researchers in this conversation. Through various communication channels like a webpage, LinkedIn, and emails, we seek to highlight available solutions and promote collaboration. By adhering to FAIR principles and organizing events like symposia and webinars, we aim to facilitate knowledge sharing and drive innovation in sustainable technologies. Creating standardized databases for high- and low-order models is vital for achieving our goals and facilitating collaboration within the CYPHER network and with other interested parties. Sharing these databases is crucial for effective communication, dissemination, and utilization of research outcomes.

# 2. GENERAL AIM AND TARGET AUDIENCES

In the public debate and opinion, combustion is often considered an outdated technology that drives climate change. When discussing decarbonization, electricity production, and the transport sector are often the focus. These two sectors are, based on today's know-how and progress, likely to be replaceable by renewable electricity harvesting and electrification. In this debate, often the CO2 emission from the energy-intensive industries, whose products like cement, steel, and glass are everyday items and souring us in building, and the need for energy storage technologies are neglected even though this sector poses great potential for a rapid, at least partial decarbonization. In the urgency of reducing CO2 emissions as fast as possible to avoid any additional 0.1C warming, we need to start a debate on these industries and available solutions. For rapid decarbonization, using synthetic fuels as an energy career, mono or co-combustion of these, and shifting to low-emission combustion regimes with the help of data models and digital twins poses a realistic opportunity to fight climate change. This modern use of technology contradicts the recent narrative of combustion as an outdated and environmentally detrimental technology synonymous with pollution and climate change. Our communication aims to inform the public debate about the opportunities and necessity for combustion. It focuses on high-school and early engineering students to motivate them to choose the needed engineering and data science education to contribute to this transition. Further, we aim to reach policymakers and NGOs to support this fast (partial-) decarbonization in official strategies and policies and their communication with the public. With this professional network, we aim to support the transition of producing industries with know-how and serve as a discussion, collaboration, and innovation platform for industrial R&D and interdisciplinary researchers. Due to the currentness of actions, we aim to bring together combustion experts and data experts to create digital twins and knowledge to drive decarbonization.

Figure 1 overviews the groups addressed, the communication tools, and the messages. The upside-down pyramid symbolizes the size of the target group. The different groups are explained and discussed in the following section.

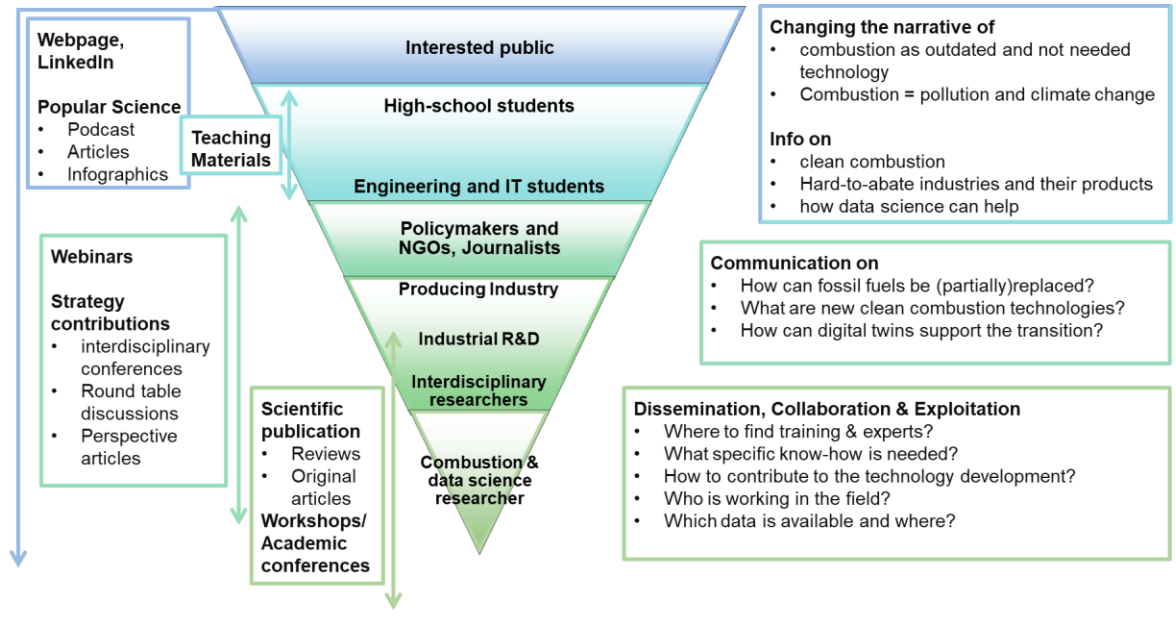


*Figure 1: Overview of communication target groups, tools and messages.*

**The interested public, high-school students, engineering, and IT students:** The message is clear to these groups: combustion isn't just a relic of the past but a realm ripe for innovation. Providing infographics via social media, popular science articles, and podcasts aims to increase the understanding of and solutions to the challenges faced by hard-to-abate industries, such as steel and cement production. By creating targeted teaching materials for teachers and lectures, we aim to inform students who decide on their study program and course selection. By harnessing data science's power and the opportunities within sustainable technologies, these students can explore how combustion must be part of the green transition. This communication aims to encourage the new generation of engineers and data experts to take on the challenges and gain relevant knowledge urgently needed to realize decarbonization in the hard-to-abate sectors.

**For policymakers, NGOs, journalists, and the producing industry:** We want to shift the conversation to pragmatic and available solutions for transitioning away from fossil fuels and fostering clean combustion technology. Fossil fuel replacement strategies, such as synthetic fuels and low-emission combustion technologies, and their short-term realization through data science, advanced numerical tools, and digital twins take center stage. Effective communication and collaboration among stakeholders are vital for driving policy changes and public attitudes toward them. We aim for dialogue with NGOs as they can drive public opinion with high impact. The consortium aims to support the producing industry with know-how on the technical challenges and broaden the acceptance of short-term (partial) decarbonization by policymakers, NGOs, and the public.

**For industrial R&D, interdisciplinary researchers, and combustion & data science researchers:** Dissemination, collaboration, and exploitation of knowledge are paramount. Access to training, workshops, and expertise accelerates technology development. We emphasise interdisciplinary collaboration between engineering and data science to accelerate digitalisation and short-term implementation of sustainable technologies. Contributing to technology development requires active dissemination of findings. We aim to combine our expertise to write comprehensive reviews and perspective articles. Workshops, webinars, and conferences aim to discuss and team up with industrial research and development.

This consortium involves key players in the field and aims to valorise expertise and results through the access and cataloguing of available data sets, source codes and numerical methods.

# 3. PLAN FOR THE COMMUNICATION OF ACTION RESULTS

The main communication channels of the CYPHER cost action are the webpage, the LinkedIn page[1], and internal communication emails. When finalising the first version of the communication plan, a webpage[2], visual identity and LinkedIn page have already been established.


*Figure 2 Variations of the Cypher logo.*

*Table 1: Webpage content and target groups. * denotes actively created content and deliverables by CYPHER.*

| **Webpage** | **Interested Public** | **High school students** | **Engineering and IT students** | **Policymakers** | **NGOs** | **Journalist** | **Producing Industry** | **Industrial R&D** | **Interdisciplinary researcher** | **Combustion & data science researcher** |
|---|---|---|---|---|---|---|---|---|---|---|
| Popular science content* | X | X | X | X | X | X | X | X | X | X |
| Materials for teachers* (various languages, using infographics) | | X | X | | | | | | | |
| Perspective pieces* (links, access, announcements) | | | | X | X | X | X | X | X | X |
| Contact person | | | | X | X | X | X | X | X | X |
| **Event info** | | | | | | | | | | |
| • Webinars | | | | X | X | X | X | X | X | X |
| • Round tables | | | | X | X | X | X | X | X | X |
| • Workshops and training schools | | | | | | | | | X | X |
| • Conferences | | | | | | | X | X | X | X |

[1] https://cypher.ulb.be/
[2] https://www.linkedin.com/company/99099381/admin/feed/posts/

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| • General meetings | | | | | | | X | X | X | X |
| • Others | | | | | | | | | | |
| Database/overview of available data sets* | | | | | | | | X | X | X |

With the webpage, we aim to provide information to different target groups, as outlined in Figure 1. Information on the working groups, central roles (incl. contact info) and our mission is already in place. An “Activities” section is designated to inform about events (see table 1 Event info)

The **popular science content** needs to be developed. The aim is to build on infographics that can serve multiple purposes – use on the webpage, in social media, in teaching materials. The development is divided into two phases:

**Phase 1: Development**

***Who?*** Designated subgroup of WG 5
***When?*** First 1.5 years
***Outcome****?* Infographics, supporting text for the webpage, teaching materials (pptx slides, an interactive unit using Mentimeter, Kahoot or similar)
***What is needed?*** Budget for infographics, formation of a subgroup

**Phase 2: Translation and use in popular science articles**

***Who?*** Designated local ambassadors
***When?*** Remaining action course
***Outcome?*** Content available in various languages and article offers
***What is needed?*** National contacts

One result of the working group's activities is to provide a detailed overview of available and **open-access datasets**, both existing and newly created, suitable for code benchmarking, digital tween development, and other academic uses (see also section 5). The webpage will serve as a valuable tool for accessing these datasets efficiently. For this, a dedicated section will be established to comprehensively list datasets and their links to the original data sources. The webpage will not provide storage options for new data sets due to the necessary long-term commitment for data management and not the foreseeable size of the relevant data, where a single data set can be in the size of Terra bytes. Further, we do not aim to replace or compete with an open data publishing platform but to make the search for data and their use by the community more efficient. Accompanying the dataset collection will be review articles to offer further insights and context (see also section 4).

Social media is one of the main sources of information nowadays. CYPHER will mainly communicate via ***LinkedIn*** since most of the target groups are reachable via this platform. With LinkedIn being a professional development and networking platform, stakeholders such as industries, the public sector and researchers of any field can be reached. Other professionals and later-stage students looking for jobs can also be reached. This group represent a good part of the general public. With this strategy, two groups were not reached. The general public needs to be more active on LinkedIn, as well as high-school and early-stage students. We aim to reach out to these groups via public science contributions to existing podcasts and online and printed magazines. Students are addressed via the teaching materials presented by their lectures, which are expected to be on LinkedIn. Further strategies will be developed over the action period. Table 2 gives an overview of information and target groups to be reached through LinkedIn.

*Table 2: LinkedIn channel content and target groups.*

| **LinkedIn** | **Interested Public** | **High school students** | **Engineering and IT students** | **Policymakers** | **NGOs** | **Journalist** | **Producing Industry** | **Industrial R&D** | **Interdisciplinary researcher** | **Combustion & data science researcher** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Infographics** | X | | | X | X | X | X | X | X | X |
| **Insight into research (Research as art)** | X | | | X | X | X | X | X | X | X |
| **Distribution of teaching materials** via lectures and teachers | | (x) | (x) | | | | | | | |
| Announcements | | | | X | X | X | X | X | X | X |
| • Webinar & round table | | | | | | | X | X | X | X |
| • General Meetings | | | | | | | | | X | X |
| • Workshops | | | | | | | | | X | X |
| • Conferences | | | | | | | X | X | X | X |
| • Calls (STSMs, abstracts, paper) | | | | | | | | | X | X |

## Implementation and use of the LinkedIn account

***Who?*** All core group members have access to the LinkedIn account; everyone is encouraged to send content to be posted via a core member
***When?*** Over the whole period, events to be announced 3 month ahead with reminders 2 weeks and 1 day before the event (use automatic scheduling
***What is needed?*** Input from responsible subgroup (e.g., local meeting organizer, webinar organizer, communications subgroups, …)

**Research as art**[3]: To extend the interesting content that catches interest from stakeholders in the field but also a larger audience group that is unfamiliar with our daily research, we aim to publish aesthetic pictures and videos. To engage the CYPHER members and their research groups, we establish the best picture and best video awards. The send-in pictures and videos, together with a short description of the concept research, will be shared via our LinkedIn account. The winner of the contest will be invited to the next general meeting to present their research in plenum. With this activity, we combine serval aims of CYPHER, bringing new perspectives and insights to a large audience and promoting and giving an opportunity to young researchers.

**Implementation research as art:**

> ***Who?*** Designated team in WG 5
> ***When?*** Twice a year, after the general meeting, publishing of winning pictures and runners-up every 2 weeks
> ***Outcome?*** Informative and attention-catching post
> ***What is needed*?** Reserved budget for the invitation of the winners, responsible sub-group

The **generated popular science content** and other research content, also from individual action members, will be further made available through existing channels and through the "local ambassador concept. On the base of the developed materials and the member's own research, we aim for podcast contributions as guests to existing podcast series, for example, NTNUs Energy Transition Podcast (in English). Further developed content will be offered in national public science online and printed magazines and on the COST media channels.

**Implementation popular science**

> ***Who?*** Local ambassadors in WG 5
> ***When?*** Aim and message of CYPHER (years 1-2), popular science after completion (years 3-4 in the cost action),
> ***Outcome?*** Podcasts and articles with similar messages and content in various languages
> ***What is needed*?** Local ambassadors and a coordinator

# 4. PLAN FOR THE DISSEMINATION OF ACTION RESULTS

CYPHER is committed to promoting FAIR (Findable, Accessible, Interoperable, and Reusable) publishing practices. We believe that research outputs should be readily discoverable, easily accessible, compatible with various systems, and reusable to foster collaboration and innovation in the scientific community. Hence, we will publish our report openly available on our webpage and aim for open access for all review and perspective articles. To make our findings accessible to the audience beyond scientific journals, we plan webinars after the finalization of the report. These webinars will be conducted via Zoom (licenses available at most universities, e.g. at host ULB). The webinars will be recorded and made available after through YouTube and linked on the webpage.

Our deliverables consist of roadmaps, guidelines, reports and opinion/perspective articles. The relevant deliverables are listed in Table 3. Many involved universities have existing open access agreements with the major academic publishers; if the leading authors of the reviews

[3] Research as art: revealing the creativity behind academic output (theconversation.com), accessed 2024-03-20

and perspective articles cannot benefit from such an agreement, we allocate a budget in the communication and dissemination état or aim for Open Research Europe publications.

*Table 3: Dissemniantin deliverables, responsible working groups and publishing methods.*

| No | deliverable | month | WG1- Renewable and synthetic fuels combustion | WG2 – High-fidelity combustion simulations and data analytics | WG3- Hybrid physics-based data-driven models | WG4 – Digital twins | published open accessible on webpage | Review article (open access) | Perspective article (open access) | Other public assessable channels | Webinar |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | Report on multi-fidelity data fusion for the construction of self-updating digital twins | 12 | | | | X | X | X | | | |
| 5 | Roadmap for the integration of renewable synthetic fuels in existing energy-intensive industry infrastructures. | 18 | X | | | | X | | | X | X |
| 6 | Guidelines for the implementation of renewable synthetic fuels in combustion experiments and data collection. | 18 | X | | | | X | | | X | X |
| 7 | Report on low-dimensional manifolds identification and topology optimisation for constructing reduced-order models. | 18 | | | X | | X | X | | | |
| 8 | Report on unsupervised algorithms for the optimal local selection and simplification of modelling approaches. | 24 | | X | | | X | X | | | |
| 9 | Report on strategies for optimal sensor placement in experiments and integration between physical and soft sensors. | 30 | X | | | X | X | X | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | Position paper on strategies to assimilate data from operating systems at low cost/impact | 30 | | | X | | | | X | | |
| 11 | Report on renewable synthetic fuel combustion experimental data in various laboratory and industrial-like configurations. | 48 | X | | X | | X | X | | | |
| 13 | Position paper on hybrid physics-aware data-driven models for renewable synthetic fuel combustion. | 48 | | X | X | | | X | | | |
| 14 | Position paper on self-updating digital twins and cyber-physical infrastructures of large combustion systems | 48 | | | X | X | | X | | | |

To further disseminate research conducted by consortium members, we will organize mini-symposia, co-host workshops, and training schools and dedicated sessions at larger conferences.

Organization of workshops and training schools are associated with the working groups:

**A2.1** Organize an annual meeting on numerical methods for high-fidelity simulations of RSF's combustion, mainly oriented to the scientific community

**A3.1** Organize periodic workshops on physics-based data-driven methods for RSF's combustion

**A4.2** Organize a meeting on digital industrial solutions, oriented to enterprises and policymakers.

# 5. PLAN FOR THE VALORISATION OF ACTION RESULTS

By adhering to FAIR principles, we are dedicated to fostering transparency, reproducibility, and impact within scholarly work, thereby advancing knowledge for the betterment of our society. One pivotal initiative to strengthen these principles is the implementation of Deliverable 12: the systematic collection and categorization of both new and existing datasets accessible through links on our webpage. This approach aims to significantly enhance the discoverability and usability of research data, broadening its accessibility to a broader audience. Improved access and awareness of research data will facilitate direct reuse by researchers and industries, fostering innovation and collaboration. Consequently, promoting data reuse not only contributes to more sustainable utilization of resources but also facilitates the direct valorization of research outcomes and existing datasets.

The data set is hereby presented by scientific technology data available under Attribution CC BY license. No personal data is part of these data sets; hence, no ethical issues arise. In the compilation of the data, unpublished data and code will be uploaded to data-sharing platforms or git hubs and tacked with a DOI number. This procedure will allow us to share consortium members's data and work while offering an established method of crediting.

*Table 4: Main valorisation tools and their connection to the working groups.*

| No | Deliverable /Task | month | WG1- Renewable and synthetic fuels combustion | WG2 – High-fidelity combustion simulations and data analytics | WG3- Hybrid physics-based data-driven models | WG4 – Digital twins | published open accessible on webpage | Review article (open access) | Perspective article (open access) | Other public assessable channels | Webinar |
|---|---|---|---|---|---|---|---|---|---|---|---|
| D12 | Collection of high-fidelity simulation data on renewable synthetic fuel combustion in a wide range of operating conditions. | 48 | X | X | | | X | | | X | |
| T1.4 | Generate experimental datasets to be exploited by WG3 and WG4 | 18 - 48 | X | X | | | | | | X | |
| T2.4 | Generate variable-fidelity datasets to be exploited by WG3 and WG4 | 18 - 48 | X | X | | | | | | X | |

Creating databases with agreed formats and codes for high and low-order models for use with the CYPHER network and other interest groups is a shared aim for the working groups and a necessity for reaching our postulated goals. Hence, the sharing of these is an important tool for communication, dissemination, and valorisation.

***Data and code sharing***

***Who?*** Designated working group members WG 1 - 4
***When?*** Over the action time
***Outcome?*** Open accessible data, in agreed formats, searchable
***What is needed?*** coordinated use of
a) existing open available platforms e.g., github.com, zenodo.org
b) resources provided by involved institutions (if available)
c) other resources

E.g.: WG2 shared data on the ML for Fluid Dynamics Website:
https://www.ercoftac.org/events/machine-learning-for-fluid-dynamics/workshop-test-cases/

To enhance our collaboration and research potential, we will organize a world café session at the second general meeting to foster networking and the formation of a research proposal consortia on the bilateral and European levels.

**World café for project consortia**

***Who?*** Organizers 2nd general meeting
***When?*** During the 2nd general meeting
***Outcome?*** Identification of potential project partners and formation of consortia
***What is needed*?** Allocated time during the meeting schedule, preparation of the event