Research School for Negative Emission Technologies NETs@Helmholtz

Next Level Ramp Up of Direct Air Capture and Storage DACStorE

NETs@Helmholtz Research School Module Handbook

As of: 03.03.2026

About the DACStorE Project

The latest Intergovernmental Panel on Climate Change report shows the unavoidable requirement of negative emissions pathways to reach the 2-degree climate target. More in-depth transformation scenarios of members of the consortia show that land usage change and reforestation alone will not solve the problem. Instead, large scale negative emissions technologies are required; amongst those, Direct Air Capture and Storage (DACS) seems promising.

Therefore, the goal of the project DACStorE is to prepare for a large and sustainable scale-up of DACS technology. Six Helmholtz-Centers and the TU Berlin investigate technical solutions for CO2-capture from ambient air and its storage in geological formations. In an open technology approach three promising DAC technology paths are investigated, compared, and further developed into prototypes. A major focus is on reducing energy requirements and improving scale-up opportunities by developing and testing suitable materials, plant designs and operational concepts. Additionally, requirements posed by large-scale industrial manufacturing are addressed already in the early development phase. In addition to these technical properties, the economic and ecological aspects of the technologies are investigated, including societal acceptability and legal framework conditions.

About the NETs@Helmholtz Research School

The **NETs@Helmholtz Research School** is a graduate program under the **DACStorE Project** (visit **dacstore-project.com**). This program is designed for scientists, working on the DACStorE project or under the supervision of DACStorE scientists. The school focuses on **Negative Emission Technologies (NETs)**. The comprehensive approach fosters transdisciplinary thinking and networking and a critical but open mindset while providing the tools to conduct good scientific practices and pursue a fulfilling career. A strong focus is on technology and knowledge transfer, thus providing the next generation of researchers with the necessary skills to make a visible impact to the ramp-up of negative emission technologies.

To attract and support diverse and highly qualified talents, **travel grants** are available to facilitate participation in conferences, workshops, and research visits, ensuring equal access to professional development opportunities.

Promoting **diversity, inclusion, and work-life balance** is an integral part of the program. Dedicated measures address **cultural and gender awareness**, while **family support services** help ensure that participants with caregiving responsibilities are equally able to engage in research activities.

Participants benefit from a strong foundation in the field through core formats such as the lecture *"Fundamentals of Negative Emission Technologies"*, with a focus on DACS, and a **webinar series** highlighting current developments and challenges in NETs. In addition, the research school offers **tailored workshops and training**, which can be developed in response to participant needs — covering topics such as life cycle assessment, socio-economic modeling, communication, or policy engagement.

The research school places a strong emphasis on **transdisciplinary exchange**. Structured formats such as **yearly retreats**, **peer mentoring**, and **international exchange programs** encourage collaboration across disciplines and institutions. At the same time, participants are encouraged to initiate and shape their own ideas through **self-organized projects**.

To support the **transfer of scientific knowledge into societal impact**, certain formats are included such as **DACS-Talks**, **stakeholder workshops**, and dedicated **training in science communication**. Participants also could explore application-oriented paths through **entrepreneurship support** and engagement with real-world challenges.

By combining disciplinary depth with transdisciplinary collaboration, and scientific training with practical skills, the **NETs@Helmholtz Research School** creates an environment where early-career scientists can grow into experts who contribute to shaping the future of carbon removal.

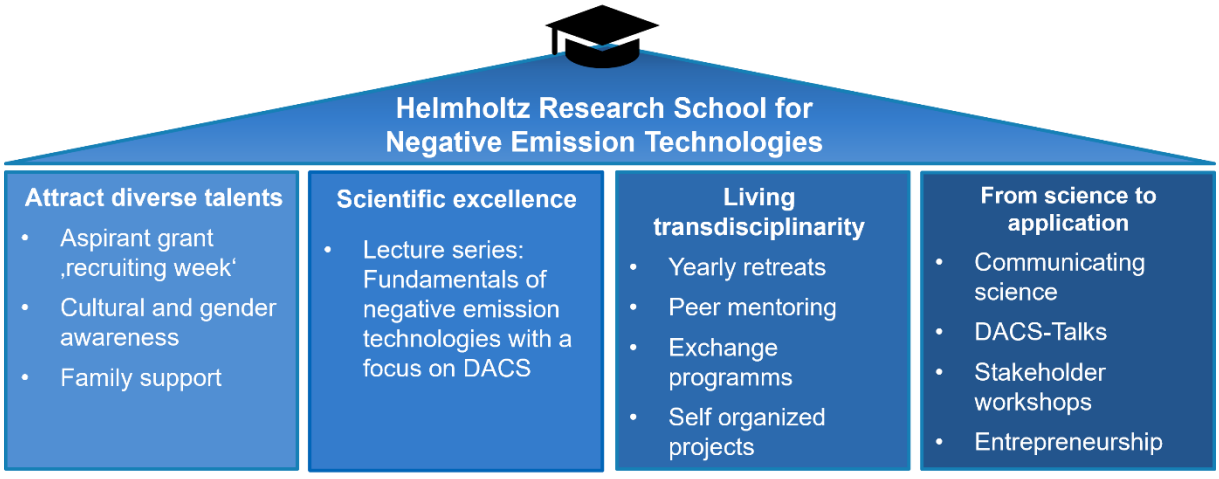

Figure 1: *Core areas of the NETs@Helmholtz Research School*

Research School Project

Overview

The Research School Project allows PhD students to undertake self-organized projects in teams of 2-4, working independently from their own PhD research topics. These interdisciplinary projects aim to increase societal awareness of NETs, encouraging creative solutions that bridge scientific knowledge with public engagement.

Goals and Competencies

Participants in the NETs@Helmholtz Research School will develop:

- **Interdisciplinary and transdisciplinary skills** for comprehensive problem-solving.
- A strong foundation in **scientific communication, project management, and teamwork**.
- **Promote DACS technology for society**, and promote the DACStorE project to the scientific community, or the society
- Technical skills for **implementing NETs solutions** and promoting DACS (Direct Air Capture and Storage) technologies.

Possible Project Outputs

Projects should focus on knowledge transfer and may include:

- **Educational tools**: Experiments, lecture notes, or practical courses.
- **Exhibits and Demonstrations**: Prototypes for workshops, such as the 'Girls macht MI(N)T' initiative, exhibits for fairs and outreach events, interactive visualizations for DACStorE.
- **Community Engagement**: Events with, or for, citizens, workshops, games, apps, podcasts, or videos.
- **Publications**: Articles, white papers, instructional content for schools or universities.

Project Process and Requirements

1. **Team Formation**: PhD students form teams of 2-4 members to collaborate on a chosen project.

2. **Proposal Writing**: Teams draft a brief proposal (approximately 2 pages) that includes a budget, timeline, and necessary supervisor signatures.
3. **Submission and Review**: Proposals are submitted to the Research School Steering Committee, who evaluates them for feasibility and impact.
4. **Presentation**: Teams present their proposals in an online meeting to receive feedback.
5. **Funding Decision**: The Steering Committee votes on project funding, with an average budget allocation of approximately €10,000 per team.

Evaluation Criteria

- **Value to Society or to the DACStorE Transformation Hub**: Projects should contribute positively to public understanding of NETs and awareness of the DACStorE project.
- **Timeline and Feasibility**: Projects are expected to be completed within one year, with flexibility in work hours as determined by the team.
- **Sustainability:** Project applications should include a description of a possible path towards implementation and sustainability (future impact and availability after the project ends).

Lecture Series: Fundamentals of Negative Emission Technologies with a Focus on DACS

Overview

This lecture series offers a comprehensive foundation in the field of Negative Emission Technologies (NETs), with a specialized focus on Direct Air Capture and Storage (DACS). The curriculum explores key concepts, techniques, and considerations related to CO_2 capture and storage, equipping participants with the scientific knowledge and technical skills required for effective DACS implementation.
By addressing both the practical methodologies and the broader impacts of DACS, this series aims to deepen participants' understanding of how NETs can contribute to climate solutions.

Curriculum Topics

The principal investigators of the DACStorE project take turn giving a lecture about their part of the DACStorE project, including an introduction into the topic aimed at an

interdisciplinary audience, and further information, or suitable own research. At least 1 scientist per project partner will give a lecture.

Scope and Framework Conditions

- **Duration**: 1.5 hrs per lecture (60 min. lecture + 30 min. discussion)
- **Frequency**: Once per month during the semester lecturing period
- **Availability**: The lecture will be recorded and made available to the research school members for later reference.
- **edX course**: An edX course will be developed based on the lecture series after its termination. edX is an American massive open online course provider created by Harvard and MIT to host online university-level courses to a worldwide audience.

DACS Talks

Overview

As part of the DACS Talks, early-career scientists from the DACStorE project present their latest findings in a virtual lecture format. Each session features recent insights and advancements in Direct Air Capture and Storage (DACS), followed by a lively discussion. These talks provide a valuable platform for knowledge exchange, fostering collaboration and feedback among participants and contributing to the ongoing development of NETs research.

The DACS Talks are also part of the DACStorE Transformation Hub, serving as events for information exchange and interaction with the DACStorE Network.

A 1-on-1 coaching in science communication is offered for the preparation of the presentation.

For information on past and upcoming DACS Talks, please visit www.dacstore-project.com/de/transformation-hub/dacs-talks.

Goals and Competencies

- **Educate the Scientific and Public Community:** To share knowledge and research insights to inform and engage both scientific peers and the broader public.
- **Serve as a Liaison with the Transformation Hub and Industry Partners:** To act as a key point of contact, fostering collaboration and knowledge exchange between academia, industry, and innovation hubs.
- **Enhance Presentation and Discussion Skills:** To build expertise in preparing and delivering effective talks, including managing engaging discussions with diverse audiences.

- **Advance Science Communication Skills:** To develop the ability to convey complex scientific concepts in clear, accessible, and impactful ways for various audiences.

Retreat

Overview

Each year, a one-week-retreat is held. All research school members are invited to meet in person. All expenses are covered by NETs@Helmholtz. The focus of the retreats is on developing transdisciplinary thinking, gaining transferable skills, and building community. A PI-day ensures interaction with PIs from the DACStorE project.

The retreat program is organized in a 3-year program with 2 cohorts of members (cohort 1 in DACStorE project years 1-3, cohort 2 in DACStorE project years 3-5). Due to the 5-year duration of the DACStorE project, the program in year 3 will overlap, offering both the content from the first retreat and the third retreat.

Goals and Competencies

- **Build Community:** To connect participants from across Germany to create a strong and supportive network.
- **Encourage Collaboration:** To promote teamwork across different disciplines to support the DACStorE research work and spark new ideas and approaches.
- **Engage with PIs:** To enable exchanges with PIs from the DACStorE project for guidance and knowledge sharing.
- **Hands-On Learning:** To organize field trips to give practical experience and increase motivation.
- **Develop Transferable Skills:** To help participants build skills such as science communication, teamwork, and project management.

Retreat Program

First Retreat (First project year)

This retreat serves as both a community-building and skill-building event, laying the foundation for ongoing collaborative work.

Key content:

- Onboarding of new participants
- Team-building exercises to strengthen cohort dynamics
- Discussions on core values such as diversity and inclusion
- Peer mentoring through 'S-teams' (Success Teams)

- Science Communication Training with a focus on the DACS Talks

Second Retreat (Second project year)

The second retreat aims to prioritize experiences and skills essential for sustaining productivity and fostering a healthy academic life, as well as consolidating PhD community and exchange with the DACStorE project.

Key content:

- **Mental Health Awareness**: Resources and techniques for maintaining well-being, managing stress, and creating a balanced, supportive research environment.
- **Research School Project**

Third Retreat (Third project year)

This retreat is designed to equip participants with the tools and insights needed to transition successfully to the next stage of their careers, whether in research or beyond.

Key content:

- **Career Planning**: Guidance on identifying career paths within academia, industry, or alternative fields, as well as strategies for building a strong professional network.
- **Entrepreneurship**: Workshops introducing the fundamentals of entrepreneurship, including idea generation, business planning, and pitching, to empower scientists interested in launching their own ventures.

Transferable Skills Courses (JuDocS)

With JuDocS, the Jülich Center for Doctoral Researchers and Supervisors, we offer support and orientation to more than 1,000 doctoral researchers and more than 400 supervisors at Forschungszentrum Jülich. Link to the website.

By providing onboarding, qualification opportunities, project monitoring, and counselling, we aim to foster high quality standards for all doctoral projects and to facilitate the productivity of our doctoral researchers and supervisors. Furthermore, we closely cooperate with active researchers, thematic graduate schools, interest groups and university partners to identify current needs and to continuously adapt our activities accordingly.

Fireplace Talks

Fireplace Talks are an informal discussion format where experts share their experiences, knowledge, and perspectives in a relaxed atmosphere. In this open setting, participants can ask questions and engage in personal exchanges. The goal of Fireplace Talks is to provide inspiring insights into scientific, professional, and societal topics while fostering direct dialogue between researchers, professionals, and the community.

Webinars

To broaden early-career scientists' horizons, a webinar series called "Current Developments in Negative Emission Technologies" will be established. This regular series will cover various technologies and measures in the field of negative emissions. The goal is to bring fresh insights from outside the research community. Experts from research, industry, and politics will be invited to discuss DACS-related topics. For example, CO2GeoNet, a network focused on CO2 storage, could give a guest lecture on the latest developments in the field of storage.

Research stays at other institutions

The research school provides funding for a stay at another institution if the researcher identifies a relevant task for their dissertation that justifies the exchange. This promotes transdisciplinary work and independence, as researchers must prepare by selecting a suitable topic. For example, a researcher from the assessment project could visit a lab working on the technology they are studying, helping them write the "state of the art" section. Similarly, a researcher working on technology development might gain insights into system assessment or acceptance by visiting a relevant institution. This exchange fosters collaboration and benefits the overall project.

S-Teams

As part of the onboarding, 'S-teams' of four people are formed and are getting trained in peer mentoring for building valuable teams to support each other throughout the PhD period. The teams initially follow a 12-week program after continuing on their own.

Diversity and Inclusion

- **Financial Support:** Funding is available to assist with childcare and parental leave, enabling equal participation for all researchers.
- **D&I Statement:** A clear and concise statement is published on the website, outlining the research school's commitment to fostering an inclusive and equitable environment.
- **Behavioral Expectations:** A document is provided to define expected behaviors and guidelines for fostering respect, fairness, and inclusivity within the community.
- **Recruitment:** The recruitment process is designed to be fair and unbiased, promoting equal opportunities for candidates from diverse backgrounds.
- **Training:** Workshops and training opportunities are offered to PIs and PhD students covering supervision, diversity and inclusion, such as unconscious bias training, prevention against sexual violence, working in / leading diverse teams, and sensitizing for diversity in science)

Further support and training opportunities

Travel Funding

Travel funding helps researchers attend conferences and events to expand their knowledge and network.

Funded Travel Opportunities:

- **Stay at Other Institutes:** Work at different research institutes to collaborate and learn new ideas.
- **Attend Conferences:** Go to conferences to share research, learn, and connect with others.
- **S-Team Meetings:** Participate in S-Team meetings to exchange ideas and get feedback.
- **Mentoring and Shadowing Visits:** Visit others for mentoring and shadowing to learn from their experience.

1-on-1 coaching for first manuscript

We provide personalized 1-on-1 coaching sessions to guide researchers through writing and refining their first manuscript.

Missing methods trainings

We provide training sessions to cover any missing research methods and techniques, as identified by the PhD candidates and their supervisors.

Participation Requirements and Next Steps

Association with the DACStorE Project:

An early-career scientist may join the NETs@Helmholtz if the following conditions are fulfilled:

- Full member: PhD or postdoc funded by DACStorE project
- Associated member: PhD or postdoc supervised by a DACStorE PI, but not funded by the DACStorE project, or PhD or postdoc supervised by a PI of a DACStorE-affiliated Institution.
- Associated member: scientist (M.Sc.) with no current intention of pursuing a PhD, working at a DACStorE partner's institute.

Approval Process:

The application form must be handed in to the NETs@Helmholtz office for approval.

- For full members, supervisors must approve participation
- For associated members, supervisors must approve participation, and the NETs@Helmholtz Office will evaluate thematic suitability of the PhD project. In case of incertitude, the Research School Steering Committee will vote on membership.

Research School Certificate

Upon completing the NETs@Helmholtz Research School, participants receive a **Research School Certificate**, formally recognizing their academic and professional development throughout the program.

This certificate highlights key aspects of the participant's journey, including:

- **General Information**: Details such as the participant's name, birth date, host institution, and primary supervisors, providing an official record of their affiliation with the DACStorE project.
- **Research School Program Activities**: A summary of the participant's engagement in core program components, including transferable skills courses,

lectures, webinars, and retreats. It records significant learning experiences such as peer mentoring (S-Teams), contributions to DACS Talks, and completion of a Research School Project. Each of these activities is documented with the respective dates and hours dedicated, reflecting the participant's commitment to their training.

- **Professional Contributions**: The participant's broader academic and practical contributions, such as poster presentations, talks, international conference participation, workshops, and research stays. Additionally, any publications and other notable contributions related to the DACStorE project.

Figure 2: *Example of the Research School Certificate*

Achievements to qualify for a certificate of participation

- Attend at least 1 retreat
- Regularly attend the lecture series, webinar series and fireplace talks
- Give 1 DACS Talk
- Attend 6-8 days of Transferable Skills Courses (certificates of comparable classes will be accepted)

Research School Structure

The Helmholtz Research School for Negative Emission Technologies is governed by the steering committee, headed by the research school spokesperson. A scientific and an administrative coordinator implements the program. A student speaker represents the PhD candidates.

Key responsibilities:

- The **administrative coordinator** handles tasks such as maintaining the website, supporting recruitment efforts to attract diverse candidates, reviewing applications for support (e.g., stays at other institutions, parental leave), managing

logistics for conferences and retreats, and organizing training events and webinars.

- The **scientific coordinator** is responsible for the organization of the lecture series and the development of the edX curriculum, focusing on scientific education.
- The **steering committee**, led by the spokesperson, includes representatives from Helmholtz Centers, the partner university, and PhD students. They support the spokesperson in overseeing the research school, ensuring compliance with PhD training guidelines, and recommending competence training events.

Spokesperson
Prof. Dr.-Ing. habil. Roland Dittmeyer
Institut für Mikroverfahrenstechnik, Karlsruher Institut für Technologie

Student Speaker
Phillip Kahl
IMD-2, Forschungszentrum Jülich

Contact Information

For more information about the NETs@Helmholtz Research School, please visit our official website:

Website: www.dacstore-project.com

For specific inquiries, you may also contact:

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Feel free to reach out for any questions or further details regarding the program, upcoming events, or participation requirements.