ORIENTED BASIC RESEARCH

PROJECT DESCRIPTION FOR PROPOSALS TO ACRP 2023 (16TH CALL)

VERSION: 23.05.2023

Table 1: Key data of the project

Call	*Austrian Climate Research Programme (ACRP), 16th Call*
Project title:	*Implications of climate change and changing biomass burning patterns for Austrian air quality*
Project acronym:	*Biomass_CC_AQ*
Applicant:	*Environment Agency Austria (EAA, Umweltbundesamt)*
Project leader:	*Christian Nagl*
Austrian project partners:	*University of Natural Resources and Life Sciences (BOKU), Institute for Meteorology and Climatology (BOKU-Met)* *GeoSphere Austria, Department of Environmental Meteorology*
International project partners:	*none*
Thematic area:	☐ Thematic area 1: Understanding the climate system and the consequences of climate change ☒ Thematic area 2: Specific support for Austria's policymakers ☐ Thematic area 3: Transformative change
Description of costs: (consistent with eCall)	– Total costs in Euro: 348 572€ – Requested funding in Euro: 348 572€
Project duration:	From 06.24 to 06.26 Project duration in months: 25

Declaration	Previous or ongoing projects of the applicant thematically relevant for the current application: ☐ 1st Call of the ACRP (Project acronym(s): _____) ☐ 2nd Call of the ACRP (Project acronym(s): _____) ☐ 3rd Call of the ACRP (Project acronym(s): _____) ☐ 4th Call of the ACRP (Project acronym(s): _____) ☐ 5th Call of the ACRP (Project acronym(s): _____) ☐ 6th Call of the ACRP (Project acronym(s): _____) ☐ 7th Call of the ACRP (Project acronym(s): _____) ☒ 8th Call of the ACRP (Project acronym(s): GOAL - KR15AC8K12551) ☒ 9th Call of the ACRP (Project acronym(s): SHIFT KR16AC0K13367) ☐ 10th Call of the ACRP (Project acronym(s): _____) ☐ 11th Call of the ACRP (Project acronym(s): _____) ☐ 12th Call of the ACRP (Project acronym(s): _____) ☒ 13th Call of the ACRP (Project acronym(s): TRANSREAL KR20AC0K18063) ☐ 14th Call of the ACRP (Project acronym(s): _____) ☐ 15th Call of the ACRP (Project acronym(s): _____)

	This application is a resubmission within the ACRP: ☒ no ☐ yes (Project acronym of the first submission(s): ...)

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ABSTRACT

In Austria, use of biomass for the provision of space heat is widespread and biomass from wood plays an important role in phasing out the use of fossil fuels to decarbonise the energy use in the building sector. However, biomass combustion is attributed with higher emissions of particles and particle-bound pollutants compared to combustion of oil and gas.

There is a conflict of objectives between switch to renewables by use of biomass and lowering the concentration of particles in ambient air in order to protect human health. This conflict of interest will become even more challenging with the implementation of the upcoming revision of the Ambient Air Quality Directives. The revised Ambient Air Quality Directive foresees considerably lower limit values for particulate matter ($PM_{2.5}$ and PM_{10}) to approach the air quality guideline levels by the World Health Organization, WHO. The proposed limit values are currently being exceeded in many regions, the WHO air quality guideline levels for PM_{10} and $PM_{2.5}$ in almost all regions of Austria.

A data-based resolution of this conflict of objectives at regional level has not been carried out so far – mainly due to uncertainties regarding spatially distribution of heating technologies, fuels used and emission factors. Furthermore, no emission scenarios are available on local/regional levels.

These data gaps pose the risk that measures will be taken unilaterally in favour of one target and that the resulting lock-in effects will cause high costs. The results of this project will support decision makers on national, regional and local level and users in the interdisciplinary balancing of the objectives.

The project identifies in a first step regions in Austria with (a) concentrations at risk for exceeding the future $PM_{2.5}$ and PM_{10} air quality limit values and WHO guideline levels, and (b) a – current and potentially future – high share of biomass burning for space heating. As a next step, the project will improve – for the identified regions at risk – the completeness and quality of data about type and amount of fuel used, types and technologies of heating appliances and emissions. This is done in close cooperation with experts of administrations at federal province and local level.

Based on improved data on technologies and fuel use in the regions at risk scenarios will be developed to show options to improve energy efficiency, reduce greenhouse gas emissions and $PM_{2.5}$ and PM_{10} simultaneously. These scenarios will be developed in close cooperation with the federal province at local level and will be consistent with national scenarios. As a result, datasets of spatially resolved emissions are available for selected scenarios (with additional measures scenario, transition and intermediate).

In the next step, these emission scenarios will be used for model simulations of current and future $PM_{2.5}$ and PM_{10} concentrations, considering 2030 as the year in which future air quality limit values should be complied with and to analyse the

changing future climate, for the years around 2040. This will be done by two Chemical Transport Models in different setups, thus allowing assessing the uncertainty of the model results. Model simulations will be done for the whole of Austria and for selected regions by 1 × 1 km². The results for 2030 together with the emission scenarios can be used by the administrations of the federal provinces and municipalities within their planning competencies – e.g. for legally binding development of air quality plans, for setting objectives in the strategic energy and climate planning or in the local development concepts. Furthermore, the model results can be used as boundary conditions for high resolution local air quality models. The model results for the years around 2040, which represent air quality in a changing climate, can be used for long-term strategic planning of air quality to achieve WHO air quality guidelines, space heating and energy spatial planning. All final datasets will be made available via open access data platforms. As the datasets for current and future emission-scenarios are consistent with national emission inventories and energy statistics, these datasets can be regularly updated and improved.

Two stakeholder workshops are planned, the first will focus on improving datasets and scenarios. At the second stakeholder workshop, the results will be presented and discussed. Stakeholders will come from municipal (local), provincial and federal level as well as from statistical offices. This will be the basis of the policy recommendations for those regions, for which model simulations indicate exceedance of air quality objectives. All the results will be laid down in the final project report. Scientific papers will disseminate the results within the scientific community.

1 QUALITY OF THE PROJECT

1.1 State of the art – current level of knowledge

This project addresses the scientific fields spatially resolved current and future emissions from small scale space heating appliances and biomass district heating and modelling of air quality. The results of this interdisciplinary work will fill gaps in data and knowledge on political, administrative and scientific level.

The supply of space heating contributes by about 19% to direct greenhouse gas emissions (without emission trading), 51% to $PM_{2.5}$ and 27% to PM_{10} emissions in Austria (Umweltbundesamt 2023f, 2023b) (stationary sources of CRF/NFR 1.A.4).

Biomass-based heating systems, along with district heating and heat pumps, are the most important technologies for the transformation of the energy system to renewables in the building sector, thus reducing fossil fuel use and greenhouse gase (GHG) emissions (Umweltbundesamt 2023f; BMK 2023a; Umweltbundesamt 2023e).

In Austria, biomass traditionally has a high share in the provision of space heat, mainly due to the high forest reserves and the importance of the wood processing industry. Since 2005, the final energy consumption of biomass for space heating has increased by about 5% up to 20% share. About 45% of district heating (including combined heat and power, 2005: 23%) is provided by biomass (Statistik Austria 2023c). The sales figures for biomass boilers in Austria are subject to strong fluctuations every year – the decisive factors are prices for biomass, oil and gas, the design of public funding programmes, and the development of the boiler market in neighbouring countries. Overall, the use of biomass continuously supports the phase out of fossil fuels.

The transformation of the energy system is driven by EU targets – above all the goal of climate neutrality by 2050, with the intermediate target of a 55% reduction in EU-wide GHG emissions by 2030.[1] Important regulatory instruments are the directives on renewable energy, on energy efficiency and on the overall energy performance of buildings (European Parliament and the Council of the European Union 2018, 2010).

National targets in the building sector are to phase out the use of oil by 2035 and to phase out fossil gas by 2040, as well as to increase the thermal efficiency of the building envelopes (Regierungsvorlage Nr. 1773; Bundesregierung 2020; BMK 2023c, 2023b).

[1] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/delivering-european-green-deal/fit-55-delivering-proposals_en

The current energy scenarios of the Environment Agency Austria (EAA, Umweltbundesamt) show that if the necessary additional measures (with additional measures, WAM scenario) are implemented, final energy consumption in the building sector can be reduced by 19% by 2040 compared to 2021. In the Transition scenario, which indicates a further transformation of the overall energy system (especially through increased energy efficiency), the reduction in final energy consumption is 30%. Biomass consumption is reduced by 11% (WAM scenario) and 25% (scenario transition), respectively over the same period. Experts in the field assume that despite declining biomass consumption, the number of biomass heaters will remain at a high level or will even rise slightly (Umweltbundesamt 2023e).

Biomass burning for space heating is, however, a relevant source of health relevant air pollutants, esp. of particulate matter ($PM_{2.5}$, PM_{10}), Black Carbon (BC), ultrafine particles (UFP), carbon monoxide, nitrogen oxides, and polycyclic aromatic hydrocarbons (PAH) (Umweltbundesamt 2018a, 2023b). The range of emission factors is high: On the one hand, there are efficient, automatically operated (and more expensive) pellet central heating systems, which cause comparable low emissions; on the other side there are manually operated small combustion appliances, which cause high emissions, especially when non-standardised and inadequate fuels are used or when other operating errors occur (EEA 2023a). One important instrument on European level to address heating systems is the Ecodesign Directive with the relevant Commission Regulations for space heaters and boilers (European Commission 2015a, 2015b; European Parliament and the Council of the European Union 2009). It is current knowledge that the ambition level of these two implementing Commission Regulations has to be raised – the process is currently ongoing.[2] Nevertheless, the long lifetime of manually operated systems result in a slow uptake of new appliances if no further measures are implemented.

Ambient levels of $PM_{2.5}$ and PM_{10} in Austria are caused by primary PM emissions from various sectors, secondary particle formation from precursor substances (mainly SO_2, NO_x, and NH_3 as well as volatile organic compounds) and transboundary air pollution transport. Biomass combustion as one of the major sources for primary and secondary PM can therefore lead to increased ambient air concentrations of the mentioned pollutants during the heating season, especially in regions with adverse dispersion conditions (Umweltbundesamt 2023g; EEA 2023b).

Rapid and thorough phase out of fossil fuel use for space heating by use of biomass in small scale firing installations can therefore – at first sight – interfere with the goals of emission reduction and protection of human health.

In October 2022 the European Commission published a proposal for a revision of the Ambient Air Quality Directives (AAQD) (European Commission 2022).[3] The proposal

[2] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13687-Energy-efficiency-ecodesign-requirements-for-solid-fuel-local-space-heaters-review-_en

[3] https://environment.ec.europa.eu/publications/revision-eu-ambient-air-quality-legislation_en

foresees considerably lower limit values[4] for several air pollutants, including $PM_{2.5}$ and PM_{10}, compared to the present Directives, to approach the air quality guideline levels[5] by the World Health Organization, WHO (WHO 2021). Air pollution in general is the highest environmental risk factor for human health in Europa (EEA 2022; WHO 2021; European Commission 2022); $PM_{2.5}$ in particular has by far the biggest impact on human health of all main air pollutants given the prevailing concentrations in Europe and Austria (EEA 2023b). Therefore, the focus of this project will be on $PM_{2.5}$ and PM_{10}.

The proposed limit values, which should be complied with from 2030 onwards, are currently being exceeded in some parts, the WHO air quality guideline levels for $PM_{2.5}$ and PM_{10} in large parts of Austria (Umweltbundesamt 2023g). These exceedances can result in severe health impacts (EEA 2022; Spiegel 2022). In the last four years, $PM_{2.5}$ and PM_{10} concentrations did not decline further, in contrast to the period 2005-2018.

In addition, Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants foresees national $PM_{2.5}$ emissions to be reduced by 46 % compared to 2005 from 2030 onwards (European Parliament and the Council of the European Union 2016). Current emission projections for Austria show that this reduction targets could be closely met (Umweltbundesamt 2023c).

The conflict of objectives for reducing fossil fuel use in space heating on one hand and improving air quality on the other poses a challenge for environmental policies in the near future. To be able to use all options to avoid or mitigate this conflict of objectives – including measures to reduce energy consumption and increase energy efficiency, implement energy spatial planning and in particular by use of a regionally differentiated mix of best available heating technologies - a significant improvement in the data situation is necessary.

1.2 Results from other projects

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[4] Annual mean limit values: $PM_{2.5}$: 10 µg/m³, PM_{10}: 20 µg/m³. Daily mean limit values (not to be exceeded more than 18 times per year): $PM_{2.5}$: 25 µg/m³, PM_{10}: 45 µg/m³

[5] Annual mean guideline levels: $PM_{2.5}$: 5 µg/m³, PM_{10}: 15 µg/m³. Daily mean guide level (99 percentile): $PM_{2.5}$: 15 µg/m³, PM_{10}: 45 µg/m³.

Existing results and deliverables obtained from publicly funded projects with participation of applicants and/or consortium members that provide the basis of or feed into the proposed project.

Table 2: Results and deliverables from other national and international projects

Funding provider	Project number/ acronym	Title	Description of results already obtained and relevant deliverables (verifiable results/products of R&D work) in terms of synergies and differentiation from the proposed project	Location and type of documentation (e.g., link to homepage, publications, conference proceedings, interim reports, final reports, etc.)
BMK	AVH 03735-013	Austria´s National Air Emission Projections 2023 for 2025 and 2030	The report covers the results for projections of the air pollutants SO_2, NO_x, NMVOC, NH_3 and particulate matter ($PM_{2.5}$) under the scenarios WEM (with existing measures) and WAM (with additional measures). It updates the previous projections for air pollutants published in 2021.	Project report available at: https://www.umweltbundesamt.at/studien-reports/publikationsdetail?pub_id=2494

Funding provider	Project number/ acronym	Title	Description of results already obtained and relevant deliverables (verifiable results/products of R&D work) in terms of synergies and differentiation from the proposed project	Location and type of documentation (e.g., link to homepage, publications, conference proceedings, interim reports, final reports, etc.)
BMK	AVH 20244-001, 20742-001	Wärmezukunft 2040	EAA developed a local pathway for the decarbonization of heat provision in the buildings sector by 2040 and for further efficiency improvements by 2050. Municipalities have been classified according to 10 energy space types distinguishing urban and rural areas, the growth dynamics and the type of heat supply. Assumptions regarding development, for example gross floor area, climate data and population were made. Results show the required level of renovation activities, the necessary extent of fuel switch (biomass, district heat, renewables) and the quality of new construction to be achieved.	Report not published (Umweltbundesamt 2021). Summary available at: https://www.bmk.gv.at/themen/klima_umwelt/energiewende/waermestrategie/waermezukunft2040.html

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BMK	AVH 02764-506, 02013-010	Energie- und Treibhausgas-szenarien 2023	EAA creates scenarios at regular intervals about the development of energy consumption and GHG emissions for the EU reporting requirement within the framework of the Governance Regulation. The report compares the three scenarios WEM (with existing measures), WAM (with additional measures) and Transition (climate neutrality for Austria in 2040).	Available at: https://www.umweltbundesamt.at/studien-reports/publikationsdetail?pub_id=2503
BMK	AVH 21160	National energy and climate plan	BMK is supported in providing the progress report and the update 2023 for the national energy and climate plan	https://www.bmk.gv.at/themen/klima_umwelt/klimaschutz/nat_klimapolitik/energie_klimaplan.html
BMK	AVH 02019-018	Reduktion der Benzo(a)pyren-Belastung (reduction of B(a)P concentrations)	The main source of PAH emissions in Austria is wood burning in households, especially manually operated stoves. Detailed benzo(a)pyrene emissions were calculated and a pollution map for Styria was created using dispersion modelling.	Project report, available at: https://www.umweltbundesamt.at/studien-reports/publikationsdetail?pub_id=2211

Funding provider	Project number/ acronym	Title	Description of results already obtained and relevant deliverables (verifiable results/products of R&D work) in terms of synergies and differentiation from the proposed project	Location and type of documentation (e.g., link to homepage, publications, conference proceedings, interim reports, final reports, etc.)
BMK	AVH 21083	Austria´s Informative Inventory Report (IIR) 2023	The report, which is annually updated, presents a comprehensive and detailed description of air pollutants emission trends and the methodologies applied in the Austrian Air Emission Inventory. With the IIR 2023, Austria complies with its reporting obligations under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP) and Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants. This includes a gridding of emission data (see https://www.ceip.at/the-emep-grid/gridded-emissions)	Project report, available at: https://www.umweltbundesamt.at/studien-reports/publikationsdetail?pub_id=2473
BMK	AVH 20696-002	Luftgütemessungen in Österreich 2022 – Jahresbericht (annual air quality report)	The annual report documents the results of air quality measurements in Austria for the year 2022. The analysis includes all air pollutants regulated in the Austrian ambient air quality act (IG-L) as well as a trend analysis.	Project report, available at: https://www.umweltbundesamt.at/studien-reports/publikationsdetail?pub_id=2491

Funding provider	Project number/ acronym	Title	Description of results already obtained and relevant deliverables (verifiable results/products of R&D work) in terms of synergies and differentiation from the proposed project	Location and type of documentation (e.g., link to homepage, publications, conference proceedings, interim reports, final reports, etc.)
BMK	AVH 21004	Bundesländer Luftschadstoff-Inventur 1990-2021 (emission inventory for the federal provinces)	The inventory assigns the national emissions data from the Austrian air pollutant inventory to the individual federal provinces for the years 1990 to 2021. The report is annually updated.	Project report, available at: https://www.umweltbundesamt.at/studien-reports/publikationsdetail?pub_id=2501
FFG - ASAP18	893432	GHG-KIT	The overall goal of GHG-KIT is to develop methods and prototype a supporting system for integrated GHG accounting and monitoring based on satellite information products. The preparation of emission inventories and the atmospheric modelling of GHGs are important tasks in the project.	https://ghg-kit.at/
FFG – ASAP13+ 14	911918	APP4AQ	Satellite data together with other air quality data (surface measurements, emission data, model results) were used to demonstrate the added value for environmental assessment studies.	https://projekte.ffg.at/projekt/2975612

Funding provider	Project number/ acronym	Title	Description of results already obtained and relevant deliverables (verifiable results/products of R&D work) in terms of synergies and differentiation from the proposed project	Location and type of documentation (e.g., link to homepage, publications, conference proceedings, interim reports, final reports, etc.)
FFG - ASAP7	828290	AQA-PM	In this project, the consortium made use of different data sources (satellite and in-situ measurements and models) to obtain particulate matter initial conditions (3D-distribution) to be used for subsequent improved PM_{10} air quality forecasts. Additionally, emission data from regional Austrian authorities were further processed and harmonized to use them together with European emission data sets. The expertise gained in emissions data processing and air quality modelling in AQA-PM is relevant because it is a requirement to make data from emission inventories comparable to remote sensing data.	https://www.sciencedirect.com/science/article/abs/pii/S135223101300856X
KPC	KR18AC0K14686	ATtain-O3	In this project, the consortium provided ozone air quality projections under future climate scenarios for Austria. The modelling expertise gained in this project along with the decadal climate fields established will facilitate the selection of modelling episodes in the proposed project.	Project report, available at: https://www.klimafonds.gv.at/wp-content/uploads/sites/16/B960252-ACRP11-ATtain-O3-KR18AC0K14686-EB.pdf

Funding provider	Project number/ acronym	Title	Description of results already obtained and relevant deliverables (verifiable results/products of R&D work) in terms of synergies and differentiation from the proposed project	Location and type of documentation (e.g., link to homepage, publications, conference proceedings, interim reports, final reports, etc.)
KPC	KR20AC0K18151	Future_Capacity	In this project, the consortium investigated the local impact of extremes in degraded air quality and heat stress for Austria. The high-resolution modeling expertise acquired in this project will aid PM projections proposed in the current project.	Project report, available at: https://www.klimafonds.gv.at/wp-content/uploads/sites/16/C163521-ACRP13-Future_Capacity-KR20AC0K18151-ZB.pdf

1.3 Degree of innovation

1.3.1 Problem and research need

Climate and air quality are inextricably connected (Schneidemesser et al. 2020; Schneidemesser et al. 2015) and risks emerging from climate warming and degraded ambient air are particularly large within urban environments and their surroundings (e.g., (Schneidemesser et al. 2019)).

Use of biomass for space heating might create a conflict of interest/objectives regarding reducing GHG emissions and protection of human health from air pollution.

This conflict of interest needs to be addressed on the level of federal provinces, municipalities and cities, which are increasingly required to develop local and regional energy plans and integrate them into local development concepts (e.g. e5 municipalities, municipalities in climate and energy model regions, municipalities with the obligation to draw up heating plans, climate-neutral cities).

This conflict of interest can also be evident in regions where local biomass (for example from the private small forest management) is available as a cheap resource and where there is currently a high share of fossil fuel use.

Air quality planning to ensure compliance with limit values and to approach WHO guideline levels require area-wide data on current pollution levels as well as scenarios for future levels. Air quality data is available at specific locations from air quality monitoring stations. Even though the monitoring network in Austria is quite dense, these stations provide point data only. In addition, biomass burning for space heating can result in high and spatially diverse pollution levels, especially in villages and rural areas. Hence, there is at present no consistent spatial area-wide information about current and future air quality available. Model simulations can provide such information; however, it requires reliable input data, i.e. emission data from major sources. Furthermore, Europe-wide model simulations from EMEP[6] or CAMS[7] for $PM_{2.5}$ and PM_{10} typically underestimate monitored ambient PM concentrations and have a high uncertainty, especially in alpine valleys and basins (Tuccella et al. 2012; Copernicus 2023; EMEP 2023). This is due to shortcomings in uncertainties of emission data and their spatially attribution, in modelling secondary particle formation, and in the representation of the alpine topography. However, the latter are amongst the regions in Austria that show highest concentrations of PAHs and, partly, PM (Umweltbundesamt 2023g, 2017). In addition, these international model applications cannot be used by the consortium e.g. to simulate different

[6] https://emep.int/mscw/mscw_moddata.html

[7] https://atmosphere.copernicus.eu/

emissions scenarios or for future climate episodes which is one of the reasons why the partners will apply their own CTMs in the frame of the project.

The currently available information and data does not allow for a spatially differentiated assessment of the present state and future scenarios. There are uncertainties regarding distribution of heating technologies, fuels used and emission factors. To tackle this challenge, the available data about the emissions of particulate matter ($PM_{2.5}$ and PM_{10}) from the space heating sector needs to be improved.

So far, energy and climate scenarios are available on national and regional level; however, air quality planning requires scenarios for the local level as well. Therefore, research is also required regarding future scenarios for biomass use on local level. Such local scenarios need to comprise estimates of the future use of biomass – differentiated in logwood, wood chips and pellets, the future distribution of technologies for energy use and future emission factors. In addition, such scenarios need to be consistent with national scenarios and datasets, and need to be regularly updated and improved. Such scenarios are currently not available.

All the above-described shortcomings hamper informed policy decisions to transform the space heat sector towards fossil-free fuel use in a sustainable and healthy way.

1.3.2 Goals

This project will provide for a regionally differentiated calculation of emissions and emission scenarios that are necessary as a key policy support. Based on spatially disaggregated emission inventories, $PM_{2.5}$ and PM_{10} concentrations in ambient air will be modelled. The spatially resolved data on emissions and air quality will enable policy makers to set appropriate measures in due time for decarbonising the space heating sector and at the same time protecting the health of the population in regions where compliance with future air quality limit values and with WHO guideline levels in the long-term may be difficult to achieve.

Appropriate measures can include switching to district heating, heat-pumps or biomass technologies with very low emissions.

In particular, this project aims at improving the quality of the data for emissions of air pollutants $PM_{2.5}$ and PM_{10} from space heating (including biomass district heating) to allow for developing scenarios for reducing these emissions.

The task of assessing future effects of transforming the space heating sector (including biomass district heating) comprises the following steps:

- Identification of regions in Austria with concentrations at risk for exceeding the future AAQD limit values and WHO guideline levels for $PM_{2.5}$ and PM_{10}. “Vulnerable” regions are those with a current high share of biomass burning

for space heating, but also those regions with a high share of fossil fuel use where biomass use might increase due to a switch to renewable energy.

- Improving the completeness and quality of data about type and amount of fuel used, and types of heating appliances where this fuel is used for these regions in cooperation with administrations in federal provinces and regions at risk.
- Spatial allocation to 5x5 km² and 1x1 km² grid of actual 2022 emissions and of energy and emission scenarios for the years 2030 to 2050 (With Additional Measures, WAM, and Transition).
- Stakeholder consultation with regions at risk to collect local data on biomass burning appliances, district heating and future development for improvement of gridded emission datasets.
- Developing improved datasets of nation-wide GHG (CO_2, CH_4, N_2O) and air pollutant emissions ($PM_{2.5}$, PM_{10}) from space heating (including biomass district heating) for 2022 as well for projected years 2030 to 2050 with 5 x 5 km² resolution.
- Developing improved datasets of GHG (CO_2, CH_4, N_2O) and air pollutant emissions ($PM_{2.5}$, PM_{10}) from space heating (including biomass district heating) for 2022 as well for projected years 2030 to 2050 covering regions at risk with 1x1 km² resolution.
- Modelling the impact on air quality ($PM_{2.5}$ and PM_{10}) with 1x1km² resolution of current (2022) and future ambient (years around 2040, therefore emissions until 2050 are needed) air concentrations in regions at risk of exceeding proposed limit values and WHO air quality guidelines to allow for informed decisions in policy making in these regions to achieve both climate change and air quality objectives.
- Developing policy recommendations based on the project results. Dissemination of the results and recommendations at a stakeholder workshop, the final report and scientific papers.

1.3.3 Degree of innovation and associated risk

For EAA, the project will result in datasets for air quality, emissions and emission scenarios, which are currently not available, but which are necessary for air quality planning and decision-making, especially on federal province and regional level regarding climate change and energy. This requires developing methods to improve, combine and disaggregate existing data from different sources. Thereby, the following results will be used for the future work of EAA (which is to support transforming the economy and society in order to ensure sustainable living conditions):

- Identification of regions where there is a risk of non-compliance with future limit values for $PM_{2.5}$ and PM_{10}, and WHO guideline levels due to biomass burning from space heating;
- Spatially resolved (current data and scenario data) on heating appliances (differentiated into 22 technologies) and fuel use;
- Spatially resolved emission data, which are consistent with national emission data and energy statistics, thereby allowing regular updates and improvements.
- Use of these datasets for air quality planning, energy and climate strategies for better support of decision makers, especially on the level of federal provinces and regions.

BOKU and GeoSphere Austria will expand within this project their air quality modelling expertise. Furthermore, both partners will expand their role as providers of policy relevant air quality projections and a scientific advisor in air quality control and legislation. Specifically, the following results will be used:

- Time-slice simulations for PM air quality in Austrian target regions following European (TNO) and national (developed within this project) emission data sets (only BOKU);
- Assessment of the role of meteorological variability, past and future, for Austrian PM air quality (only BOKU);
- High-resolution estimates of ambient PM burdens emerging from point sources;
- Projections of future stagnation frequency under different climate scenarios as driver of ambient PM air quality;
- Evaluation of state-of-the-art chemical mechanisms in CTMs with focus on PM, and thereby spearheading the analysis of the role of chemical mechanisms as source of uncertainty in future PM air quality projections.

On a federal province and national levels, the project will provide new results, which can be used for air quality planning, policy development, decision-making and communication:

- Development of appropriate and data-based measures to reduce GHG emissions in the space heating sector and protect human health on local, regional and local level from impacts of air pollution, including:
    - avoiding lock-in effects (e.g. by fostering heating technologies, which fit to the local situation/requirements);
    - develop criteria for effective and efficient funding programmes;
    - allow for tailor-made energy and spatial planning;
    - allow for better communication with municipalities and citizens

There is no or a very low economic risk associated with this project. Technical risks are lack of robust and reliable data on spatially resolved heating appliances, fuel use

and emission factors on a local level. Possible actions include the elaboration of gap-filling strategies such as application of typical building-related parameters and spatial patterns from regions of the same spatial energy type and with sufficient data available. This partly generic information will be supplemented by expert judgment and validated against stakeholder interviews (e. g. chimney sweepers).

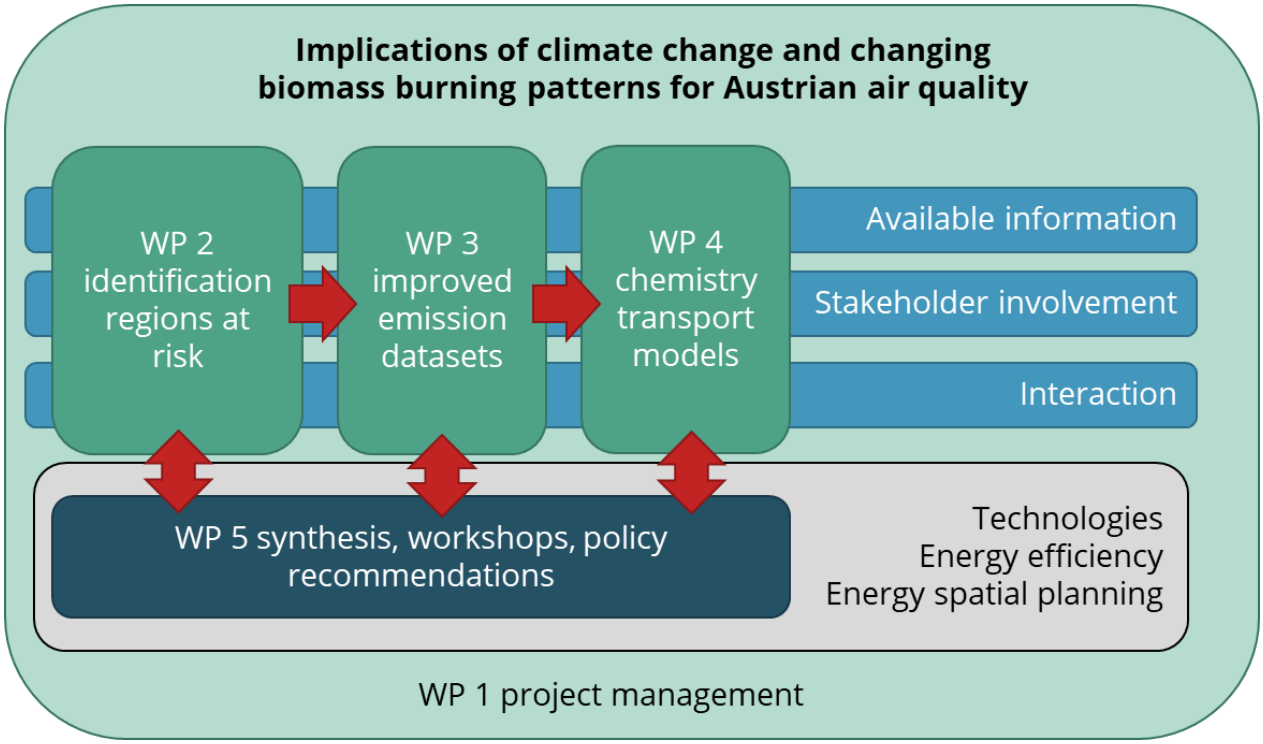
Model results, especially of complex pollutants such as PM, do have a high uncertainty. We address these uncertainties by using the same model (WRF-Chem) with different settings by two institutions (GeoSphere Austria and BOKU), and use of a further model (CAMx) by Charles University, Prague. We will drive CAMx with WRF-Chem meteorological fields to avoid any uncertainties in air quality outcomes due to weather and climate representation, thus differences between WRF-Chem and CAMx in different settings will correspond solely to the chemical mechanisms applied.

To ensure the quality of the deliverables and their timely delivery, the following quality assurance measures will be applied:

- To minimize risks and costs associated with project management, the project will be implemented by EAA together with well experienced external partners (BOKU and GeoSphere Austria).
- The project manager is experienced in managing complex projects with a very good track record in meeting project targets and objectives.
- The suggested project team consists of experts who have relevant in-depth experience, including air quality assessment, air quality modelling, emission calculations for the space heating sector, scenario development, and transition of the energy system. In case an expert becomes unavailable, the EAA is able to provide qualified substitution.
- Each report will be reviewed by a quality controller who is not part of the core team writing the report. As EAA has several experts available for each of the tasks, the project manager will be able to select additional reviewers for each topic, if needed.
- Meetings will be held bi-monthly to review project status and progress as well as on a demand-driven basis to ensure the timely delivery and high quality of the outputs.

1.3.4 Methodology

The methodological approach for achieving the project aims is shown in the schematics below:



Regions being at risk of exceedances of the proposed limit values and WHO air quality guideline levels will be identified based on air quality monitoring data of recent years, information about the contribution of biomass use in space heating, and, if available, information/estimates on a future shift from fossil fuel use to biomass. Existing model simulations, source apportionment studies, energy statistics etc. at regional, national and European level will be included in this assessment (WP 2).

A preliminary identification of the impact of space heating in general and biomass use in particular on PM levels will be based on these model simulations and existing studies (e.g. (Umweltbundesamt 2017, 2018a). This information will allow us to preselect regions at risk of exceeding future AAQD limit values by 2030 and WHO guideline levels in the long run (WP 2).

In WP 3, GHG and $PM_{2.5}$, PM_{10} emissions from heating appliances and biomass district heating of federal provinces emission inventory data and projected national emission scenario data for 2022 will be spatially disaggregated and compiled in a first step to a 5x5 km² raster using modelling and several proxy datasets (see details in WP 3 description). For selected regions, which have been identified in WP 2, a 1x1 km² resolution dataset will be developed as required for WP 4.

For spatial disaggregation of national emission scenarios, proxy data for projected years 2030 to 2050 will be extrapolated with guiding variables.

Local data on biomass burning appliances (fuel use, share of technology and building-related data), on district heating and information on future development acquired during stakeholder consultation will be incorporated for regions at risk (according to WP 2).

The regional emission datasets will be prepared for modelling of pollutant concentrations (WP 4) as 1x1 km² raster datasets for all days of relevant winter months at hourly time resolution using heating degree days and typical load profiles.

In WP 4 the impact of different emission scenarios as well as of climate change on the future of the PM distribution, including the formation of secondary aerosols in Austria will be assessed by the Chemical Transport Models WRF-Chem (Grell et al. 2005) and CAMx (Ramboll 2022).

WRF-Chem with online comprehensive gas-phase chemistry and aerosol mechanisms (Grell et al. 2005) is a limited-area, non-hydrostatic, terrain-following community model for applications at meso-scale. CAMx is an Eulerian photochemical CTM (Ramboll 2022) and requires, as a standalone offline model, a "meteorological driver" to govern transport, diffusion, deposition and chemistry. In the proposed project CAMx will be driven meteorological fields of WRF-Chem. Both models will be run nested for the Austrian subdomains selected (at 9x9km² to 3x3km² to 1x1km² grid). The final target resolution for Biomass_CC_AQ will be the 1km scale in agreement with the novel emission inventory developed by EAA.

The consortium has rich experience in air quality forecasts and transient simulations with these CTMs. Among others WRF-Chem has already been used to quantify the role of traffic and ammonia emissions in secondary aerosol formation in parts of Austria (e.g., (Uhrner et al. 2014; Lackner et al. 2014; Scherllin-Pirscher and Flandorfer 2016; Liu et al. 2023). (WP 4)

Within WP 5, administrations, experts and stakeholders will be addressed and involved to discuss possible improvements of emission datasets. Two stakeholder workshops are planned to support the development of strategies and recommendations related to improving datasets and scenarios. Stakeholders will come from municipal, provincial and federal level. The second stakeholder workshop aims at presenting and discussing project results. One major focus will be the presentation and discussion of the policy recommendation. We will also use workshops to identify suitable ways of disseminating project results together with participating stakeholders.

Furthermore, we plan to provide two presentations at the Austrian Climate Days (2025, 2026). Further bilateral or multilateral exchanges are foreseen, if necessary. The dissemination of project outputs will build upon available and well-established communication channels of EAA such as social media accounts, press-releases, and websites. Next to the final report, we will prepare open access scientific papers and a CCCA factsheet to disseminate project results.

1.4 Integration of gender-specific aspects

This project does not relate directly to people but to regional and national administrations, and to the policy level. Gender issues therefore only play a minor role in the proposal and implementation phase, even though gender can play a role in space heating aspects such as energy poverty. However, these aspects are beyond the scope of this proposed project. Therefore, no direct gender-specific aspects have to be taken into account. However, when involving stakeholders (WP 5) in workshops, we will ensure a balanced gender ratio among the participants. In addition, the rules of the gender guidelines such as by BKA[8], BMBWF or BMK are applied to all documents, presentations and communication in general (BKA 2021; BMBWF 2018).

1.5 Consideration of sustainability effects

The planned project contributes to ecological, social and economic sustainability goals of the European Green Deal, which aims at transforming the EU into a modern, resource-efficient and competitive economy, tackling amongst others the aim of net zero GHG emissions by 2050 while simultaneously achieving zero pollution goals and protecting biodiversity.

The project directly relates to SDG "3.9.1 Mortality rate attributed to household and ambient air pollution". The health effects of ambient air pollution are mainly driven by $PM_{2.5}$. (EEA 2022; WHO 2021). Therefore, a reduction of ambient $PM_{2.5}$ levels due to a reduction of emissions from space heating with the help of improved and specific data will clearly contribute to lowering the mortality rate attributed to ambient air pollution. Furthermore, the project relates to SDG 11.6.2 "Annual mean levels of fine particulate matter (e.g. $PM_{2.5}$ and PM_{10}) in cities (population weighted)". Both SDG indicators are closely related to the Zero Pollution Action Plan of the Green Deal (e.g. the zero pollution target for air quality: by 2030 the EU should reduce by more than 55% the health impacts (premature deaths) of air pollution (COM(2021) 400 final)[9]).

In addition, the project is related to SDG 13.2: "Integrate climate change measures into national policies, strategies and planning" by providing improved emission data for space heating.

[8] https://www.bundeskanzleramt.gv.at/agenda/frauen-und-gleichstellung/gleichbehandlung/sprachliche-gleichbehandlung/sprachliche-gleichbehandlung-frauen-maenner.html

[9] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021DC0400 „Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Pathway to a Healthy Planet for All EU Action Plan: 'Towards Zero Pollution for Air, Water and Soil'"

A mix of technology options is available for the switch to renewable heat generation (e.g. heat pumps, district heating, biomass, solar heat and suitable combinations of technologies), the results of the project will support the decision-making process regarding technology options – both on political, administrative and user level. The results of the project also enable regionalization of national data and energy scenarios. Measures described in strategic planning documents (national energy and climate plan[10], national air pollution control programme[11]) can thereby be implemented on local and regional levels by using the methodology and the results of this project.

The methodology allows for continuous further development, i.e. improved data can be implemented, thus reducing the uncertainties of the model calculations.

[10] https://www.bmk.gv.at/themen/klima_umwelt/klimaschutz/nat_klimapolitik/energie_klimaplan.html

[11] https://www.bmk.gv.at/themen/klima_umwelt/luft/luftguete/luftreinhalteprog.html

1.6 Quality of planning

1.6.1 Overview and description of work packages

Overview of work packages

Table 3: Overview of work packages

WP No.	Work package title	Duration (month)	Start MM/YY	End MM/YY	Planned result
1	Project Management, Quality assurance	25	06/24	06/26	Final report
2	Identification of regions at risk of exceeding future AAQD limit values and WHO guideline values	6	06/24	11/24	List of regions currently affected by high $PM_{2.5}$ and PM_{10} pollution levels with high contributions from space heating/biomass burning
3	Spatially disaggregated improved emission datasets for buildings and biomass district heating	8	11/24	06/25	$PM_{2.5}$ and PM_{10} emission dataset for 2022 and 2030 to 2050, Report describing methodology, data used and main results of WP 3

WP No.	Work package title	Duration (month)	Start MM/YY	End MM/YY	Planned result
4	Applying chemistry-transport models for selected scenarios	15	01/25	03/26	Evaluation of CTM performance with different chemical mechanisms. Aggregated CTM outputs (past and future) for synthesis and dissemination activities in WP5
5	Synthesis, dissemination, policy recommendations	4	03/26	06/26	Stakeholder workshops, scientific papers, policy recommendations, CCCA factsheet

Overview of milestones

Table 4: Overview of milestones

Milestone No.	Milestone title	Work packages involved	Expected date	Milestone is achieved when:
1.1	Inception report finalised and approved	All WP	09/24	Inception report has been prepared and approved
1.2	Final report finalised and approved	All WP	06/26	The final report has been published in time and disseminated to relevant stakeholders

Milestone No.	Milestone title	Work packages involved	Expected date	Milestone is achieved when:
2.1	List and maps of regions and municipalites in these regions affected by high $PM_{2.5}$ and PM_{10} pollution levels with high contributions from space heating/biomass burning finalised	WP 2, WP 3	11/24	Regions with existing and possible future air quality problems have been identified and discussed with administration of federal provinces
3.1	Emission dataset finalised	WP 3	02/25	The emission dataset 2022 and 2030 to 2050 for Austria at 5x5 km² raster has been prepared (including preliminary results at 1x1 km² raster for chosen regions).
3.2	Stakeholder consultations finalised	WP 2, 3	04/25	Based on M 2.1, further stakeholder consultation with administration of federal provinces, regions and municipalities has concluded in acquisition of local data on biomass burning appliances, on district heating and information on future development.
3.3	Improved emission dataset prepared	WP 3, 4	05/25	The improved emission dataset 2022 and 2030 to 2050 for Austria at 5x5 km² raster has been prepared (including final results at 1x1 km² for chosen regions).

Milestone No.	Milestone title	Work packages involved	Expected date	Milestone is achieved when:
3.4	Emission and scenario dataset processed for modelling	WP 3, 4	06/25	The emission dataset 2022 and scenarios for emissions dataset 2030 to 2050 for chosen regions (WP 2) at 1x1 km² has been processed for model simulations (WP 4).
4.1	All CTM simulations (hindcast and future) performed	WP 3, 4	01/26	All model simulations have been performed by the CTMs for all selected episodes and domains
4.2	Influence of ambient biomass burning emissions for PM air quality quantified, as well as changes under different biomass burning scenarios and RCPs	WP 2, 3, 4	03/26	All model simulations have been analyzed for all selected episodes and domains, conclusions are summarized and recommendations are given.
5.1	The report on the co-creation workshop is available	All WP	05/25	The first stakeholder workshop was held, relevant stakeholder and experts participated, and the workshop report is available
5.2	The report on the consolidation workshop is available	All WP	04/26	The second stakeholder workshop was held, relevant stakeholder and experts participated, and the workshop report is available

Milestone No.	Milestone title	Work packages involved	Expected date	Milestone is achieved when:
5.3	Policy recommendations are available to policy makers and stakeholders	All WP	05/26	Policy recommendations were prepared, discussed at the workshop and laid down in the final report
5.4	Scientific papers are submitted	All WP	06/26	All scientific papers (target #2) have been submitted to open access scientific journals.
5.5	Draft of the CCCA factsheet is available	All WP	06/26	CCCA factsheet has been drafted and submitted to CCCA

Overview of deliverables

Table 5: Overview of Deliverables

Deliverable No.	Deliverable title	Work packages involved	Expected date
1.1	Inception report	WP 1	09/24
1.2	Final report	WP 1	06/26
2.1	Report describing methodology, data used for WP 2 including delimitation of regions at risk	WP 2	11/24
3.1	Emission dataset for 2022 and scenarios for 2030 to 2050	WP 3, 4	06/25
3.2	Report describing methodology, data used and main results of WP 3	WP 3	06/25

Deliverable No.	Deliverable title	Work packages involved	Expected date
4.1	Aggregated CTM outputs for further community research and policy (CCCA Data Centre)	WP 4	03/26
5.1	Report co-creation workshop	WP 2-5	05/25
5.2	Report consolidation workshop	WP 2-5	04/26
5.3	Scientific papers submitted	WP 2-5	06/26
5.4	Chapter on policy recommendations for final report	WP 2-5	05/26
5.5	Factsheet on project results for CCCA	All WP	06/26

1.6.2 Detailed description of work packages

Description of work package

Table 6: Description of work package - WP number and title

WP No.	1
Title of WP:	Project Management

Table 7: Description of work package - Participating organisation and person months per organisation

WP Leader (written in bold) and participating organisation (A/Pn) and person-months per organisation:
Christian Nagl, Environment Agency Austria (EAA, Umweltbundesamt): 1.5 person-months

Table 8: Description of work package - Goals

Goals:
• Monitoring and controlling the progress of the project • Ensuring an efficient project administration • Setting up of internal and external communication • Ensuring an efficient project progress according to the proposed timeframe and milestones • Coordinating the reporting • Drafting the interim and final report

Table 9: Description of work package - Description of contents

Description of contents:
• Communication with the funding agency • Coordination of internal meetings • Coordination of meetings with stakeholders • Coordination of the quality assurance of results and reports • Provide accounts and reports in accordance with the funding contract

Table 10: Description of work package – Method

Method:

• Coordination and organisation of internal and external communication
  ○ Establishing a secure platform for exchanging documents
  ○ Kick-off meeting
  ○ Internal progress meetings (mainly online) approximately every month, depending on demand
  ○ Meetings with stakeholders
• Management of all legal, contractual and administrative aspects
• Minutes of the project meetings
• Drafting the inception and final report
• Coordination of the quality assurance of the project results

Table 11: Description of work package – Milestones, planned results and deliverables

Milestones (to measure project progress), planned results and deliverables (verifiable results/products of R&D work)
Milestones: • M1.1: Inception report finalised and approved (09/24) • M1.2: Final report finalised and approved (06/26) Deliverables: • D1.1: inception report • D1.2: final report

Table 12: Description of work package - WP number and title

WP No.	2
Title of WP:	Identification of regions at risk of exceeding future AAQD limit values and WHO guideline values

Table 13: Description of work package - Participating organisation and person months per organisation

WP Leader (written in bold) and participating organisation (A/Pn) and person-months per organisation:
Iris Buxbaum, EAA, 2 person-months BOKU: 1 person-month GeoSphere Austria: 0.67 person-months

Table 14: Description of work package - Goals

Goals:
Identify regions in Austria that are at risk of exceeding future AAQD limit values and WHO air quality guideline levels for the air pollutants $PM_{2.5}$ and PM_{10} due to biomass burning from space heating. Regions at risk will be further assessed in more detail in the following work packages.

Table 15: Description of work package - Description of contents

Description of contents:
Regions (and municipalities in these regions) in Austria with high levels of $PM_{2.5,}$ and PM_{10} due to biomass burning: 1. Analysis of air quality monitoring data from recent years 2. Collection of information for the assessment of the contribution of biomass burning: data on chemical composition of PM, spatially disaggregated emission data, spatially disaggregated information on biomass use and heating appliances, existing model results by federal provinces. 3. Preselection of possible regions at risk of exceeding future AAQD limit values and WHO air quality guideline levels.

Table 16: Description of work package – Method

Method:
We will use air quality data from monitoring stations for 2021 to 2023 in Austria. The observed trends since 2013 of $PM_{2.5}$ and PM_{10} will be assessed by the measured B(a)P concentrations (as an indicator for solid fuel burning), by information on the chemical composition of PM (especially organic matter, Levoglucosan), where available, by existing emission data[12] (e.g. from EMIKAT federal states' emission cadasters (described in (Umweltbundesamt 2023d), further readily available data such as Umweltbundesamt (2017), KEM/KLAR!-regions, e7-municipalities), model calculations at federal province, national and European levels as well as source allocation data and studies to estimate the share of emissions from space heating to ambient air pollutant levels. This allows for a preselection of regions (e.g. specific KEM/KLAR!-regions) where $PM_{2.5}$ and PM_{10} concentrations are already above or in the range of future limit values and well above WHO guideline levels due to space heating. This might therefore be regions at risk of exceeding future AAQD limit values in 2030 and WHO air quality guideline levels in the long-term. For these preselected regions, emission datasets will be improved and scenarios will be developed in WP 3.

[12] https://www.ceip.at/the-emep-grid/gridded-emissions

Table 17: Description of work package – Milestones, planned results and deliverables

Milestones (to measure project progress), planned results and deliverables (verifiable results/products of R&D work)
Milestones: • M2.1: List and maps of regions and municipalites in these regions affected by high $PM_{2.5}$ and PM_{10} pollution levels with high contributions from space heating/biomass burning finalised Deliverable and planned results: • D2.1: Report describing methodology, data used for this WP. Delimitation of regions affected by high pollution levels with high contributions from space heating/biomass burning, information about source contribution from space heating/biomass burning, as far as available.

Table 18: Description of work package - WP number and title

WP No.	3
Title of WP:	Spatially disaggregated improved emission datasets for buildings and biomass district heating

Table 19: Description of work package - Participating organisation and person months per organisation

WP Leader (written in bold) and participating organisation (A/Pn) and person-months per organisation:
Wolfgang Schieder, EAA, 5.5 person-months BOKU: 1 person-month GeoSphere Austria: 1 person-month

Table 20: Description of work package - Goals

Goals:
WP 3 aims at providing a 5x5 km² raster dataset of greenhouse gases (GHG: CO_2, CH_4, N_2O) and air pollutant ($PM_{2.5}$, PM_{10}) emissions from heating appliances (stationary sources of CRF/NFR 1.A.4) and biomass district heating (part of CRF/NFR 1.A.1.a Public Electricity and Heat Production) for the actual year 2022 (most recent emission inventory year) as well as for projected years 2030 to 2050 (national GHG reduction scenarios With Additional Measures, WAM, and Transition) covering all of Austria. For the selected regions affected by high concentrations of air pollutants with high contributions from heating appliances (according to WP 2) stakeholder consultation will yield in extended datasets (supported by local data on biomass burning appliances, district heating and future development) provided at higher 1x1 km² resolution. These datasets will be prepared for modelling of pollutant concentrations (WP 4).

Table 21: Description of work package - Description of contents

Description of contents:
WP 3 focuses on spatial disaggregation of greenhouse gases (CO_2, CH_4, N_2O) and air pollutant ($PM_{2.5}$, PM_{10}) emissions from heating appliances and biomass district heating. Therefore, WP 3 involves acquisition, compilation and completion of necessary proxy data and modelling. Stationary sources of CRF/NFR 1.A.4 (in 2021) currently account for about 12% of GHG (predominantly fossil fuel burning), 51% of $PM_{2.5}$, and 27% of PM_{10} (predominantly biomass burning) national total emissions. $PM_{2.5}$ and PM_{10} emissions from 1.A.1.a Public Electricity and Heat Production (predominantly biomass burning) both increase in projected national emission scenarios (WAM, Transition). Health impacts of exposition to $PM_{2.5}$ are potentially severe during winter months. Thus, actual (2022) and future spatial patterns of emissions (2030 to 2050) are provided in WP 3 to allow addressing several conflicting interests to the goal of reducing GHG emissions from fossil fuel burning by the increased (widespread) use of biomass. The Austrian wide emission datasets will be prepared at 5x5 km² resolution. Special emphasis is set on regions highly affected by high concentrations of air pollutants (according to WP 2) during stakeholder consultation to improve the model by use of local data on biomass burning appliances (fuel use, share of technology and building-related data), on district heating and information on future development. The regional emission datasets will be prepared for modelling of pollutant concentrations (WP 4) as 1x1 km² raster datasets (optimized spatial resolution) at hourly time resolution for relevant winter months.

Table 22: Description of work package – Method

Method:
The greenhouse gases (CO_2, CH_4, N_2O) and air pollutant ($PM_{2.5,}$ PM_{10}) emissions from heating appliances (stationary sources of CRF/NFR 1.A.4) and biomass district heating (part of CRF/NFR 1.A.1.a Public Electricity and Heat Production) of federal provinces emission inventory data (Umweltbundesamt 2023d) and projected national emission scenario data for actual year 2022 (WAM, Transition, (e-think 2023; Umweltbundesamt 2023e) will be spatially disaggregated and compiled to a 5x5 km² (for selected regions identified in WP 2: 1x1 km² as required for WP 4) raster using energy demand modelling and proxy data. • Energy demand model for space heating and hot water preparation: Building and dwelling stock, Heating type by energy carrier/technology, Building energy performance, Final energy demand by technology (Umweltbundesamt 2023b) at municipality level (LAU, local administrative units). • Buildings and Dwelling Census 2021 (Statistik Austria 2023g) • Local Units of Employment Census 2021 (Statistik Austria 2023f) • Population Census 2021 (Statistik Austria 2023h) • Address-Buildings and Dwellings Register (ABDR) (Statistik Austria 2021, 2022, 2023a, 2023b) • Federal states' databases on heating stock and energy performance of buildings • Market surveys on national and regional heating stock (BMK 2023a; LKNÖ 2023) • Heating degree days (GeoSphere Austria and Statistik Austria 2023), modelled based on elevation of building sites • Biomass district heating and combined heat and power plants by installed capacity and location (Biomasseverband 2023) • Integrated Administration and Control System (IACS) database[13] on area and animal-based interventions of common agricultural policy (CAP) in Austria[14]

[13] https://agriculture.ec.europa.eu/common-agricultural-policy/financing-cap/assurance-and-audit/managing-payments_en

[14] https://info.bml.gv.at/themen/landwirtschaft/gemeinsame-agrarpolitik-foerderungen/nationaler-strategieplan/direktzahlungen-ab-2023/invekosinvekosgis.html

Method:

Spatial allocation of existing buildings structures and district heating will be supported by additional datasets, tools and study results, such as:

- Wärmezukunft Gebäude 2040 (Umweltbundesamt 2021)
- Austrian Heat Map (TU Wien & e-think 2022): Cooperation with TU Wien, data update pending/ongoing.
- EMIKAT federal states' emission cadasters (described in (Umweltbundesamt 2023d))
- Energiemosaik Austria (Abart-Heriszt and Reichel 2022)
- Allocation of renewable energy potentials by municipality (Schneider et al. 2024)

For spatial disaggregation of national emission scenarios (with additional measures, transition, intermediate), proxy data for projected years 2030 to 2050 will be extrapolated with guiding variables.

- Regional population projections(Statistik Austria and ÖROK 2022)
- Labour force projections (Statistik Austria 2023d)
- Household projections (Statistik Austria 2023e)
- Projected datasets for land use and land cover change, agriculture and forestry (Umweltbundesamt 2023e)

Spatial allocation of new buildings structures and district heating will be supported by additional datasets, tools and study results, such as:

- Austrian Heat Map (TU Wien & e-think 2022): Potential future regions for district heating by scenario.
- Spatial planning instruments (such as zoning, development planning, designation of suitability and priority zones for renewables, etc.)
- Spatial Energy Planning for Energy Transition (SEP[15], GEL – S/E/P II[16])
- Any other regional or local information and local development concepts

Local data on biomass burning appliances (fuel use, share of technology and building-related data), on district heating and information on future development acquired during stakeholder consultation will be incorporated for regions highly affected by high concentrations of air pollutants (according to WP 2).

The regional emission datasets will be prepared for modelling of pollutant concentrations (WP 4) as 1x1 km² raster datasets (optimized spatial resolution) for all days of relevant winter months at hourly time resolution using heating degree days and typical load profiles.

[15] https://projekte.ffg.at/projekt/3093358

[16] https://projekte.ffg.at/projekt/3851883

Table 23: Description of work package – Milestones, planned results and deliverables

Milestones (to measure project progress), planned results and deliverables (verifiable results/products of R&D work)
Milestones • M3.1: Emission dataset 2022 and 2030 to 2050 for Austria at 5x5 km² raster prepared (including preliminary results at 1x1 km² raster for chosen regions) • M3.2: Stakeholder consultations with chosen regions (WP 2) finalised • M3.3: Improved emission dataset 2022 and 2030 to 2050 for Austria at 5x5 km² raster prepared (including final results at 1x1 km² for chosen regions) • M3.4: Emission dataset 2022 and scenarios for emissions dataset 2030 to 2050 for chosen regions (WP 2) at 1x1 km² processed for modelling (WP 4) Deliverables • D3.1: Emission dataset for 2022 and scenarios for 2030 to 2050 • D3.2: Report describing methodology, data used and main results of WP 3

Table 24: Description of work package - WP number and title

WP No.	4
Title of WP:	Applying chemistry-transport models for selected scenarios

Table 25: Description of work package - Participating organisation and person months per organisation

WP Leader (written in bold) and participating organisation (A/Pn) and person-months per organisation:
EAA: 0.6 person-months **Harald Rieder**, BOKU: 10 person-months GeoSphere Austria: 7 person-months

Table 26: Description of work package - Goals

Goals:
Within WP 4 we will produce a set of high resolution (1 km) CTM simulations tailored to quantify the influence of ambient biomass burning on regional/local PM air quality. Furthermore, the influence of ambient emissions, and chemical feedbacks, at different warming levels (represented by the RCPs) will be addressed and quantified. • Providing boundary conditions for local high-resolution models within air quality plans by federal provinces • Providing input for long-term strategic planning for air quality, space heat, and energy spatial planning

Table 27: Description of work package - Description of contents

Description of contents:
WP4 comprises all tasks related to climate and chemistry-transport modelling.

Table 28: Description of work package – Method

Method:
Outcomes for ambient PM air quality will be calculated for the recent past and selected future time slices under low, medium and high emission scenarios (RCP2.6, RCP4.5, RCP8.5) with the state-of-the-art CTMs WRF-Chem and CAMx. To address uncertainties in chemical mechanisms included in the CTMs we will consider two different mechanisms for each model. WRF-Chem simulations will be performed applying the MADE/SORGAM and MOSAIC chemistry schemes. Along with WRF-Chem a secondary CTM, CAMx, will be applied using the ISSORPIA and EQSAM chemical mechanisms. CAMx simulations will be performed by the subcontractors from Charles University. All CTM simulations will be performed for the case study regions selected in WP1. Historic simulations will be performed for selected winter seasons (JFM) in the recent past (last 15 years), and future time slices will be performed, selected based on climate outputs from a series of simulations performed by the consortium in previous ACRP research (ATtain-O3, Future_Capacity), that did not include PM chemistry. From the climate data available for the decadal time slices for the 2030 and 2050s the coldest and warmest winter as well the winter closest to the mean, to address for interannual meteorological variability. To address changes under different warming levels we will perform the analysis under 3 climate pathways (RCP2.6, 4.5 and 8.5). In contrast our own and previous community research all CTM simulations will be performed at 1 km resolution. This high-resolution CTM ensemble is breaking new ground, given that CTMs are usually applied on scales of > 10 km, which prove to be problematic in adequately representing PM burdens, and especially address the contribution of local emissions to PM loading. The consideration of multiple CTMs, different chemical mechanisms and different boundary conditions will allow quantifying uncertainties in the modelling chain.

Table 29: Description of work package – Milestones, planned results and deliverables

Milestones (to measure project progress), planned results and deliverables (verifiable results/products of R&D work)
Milestones • M4.1: All CTM simulations (hindcast and future) performed • M4.2: Influence of ambient biomass burning emissions for PM air quality quantified, as well as changes under different biomass burning scenarios and RCPs Deliverables • D4.1: Aggregated CTM outputs for further community research and policy (CCCA Data Centre)

Table 30: Description of work package - WP number and title

WP No.	5
Title of WP:	Synthesis, dissemination, policy recommendations

Table 31: Description of work package - Participating organisation and person months per organisation

WP Leader (written in bold) and participating organisation (A/Pn) and person-months per organisation:
Siegmund Böhmer, EAA: 2 person months BOKU: 2 person-months GeoSphere Austria: 1.3 person-months

Table 32: Description of work package - Goals

Goals:
Involve relevant stakeholders at federal province and regional levels to improve the emissions datasets and develop scenarios for climate friendly and sustainable space heating. Develop policy recommendations for the regions dealt with in WP 2 to 4 for how to implement space heating technologies avoiding conflicts between climate and air quality / health objectives. Disseminate project results in reports and scientific papers. Summarise the results for a CCCA factsheet.

Table 33: Description of work package - Description of contents

Description of contents:
WP 5 focuses in the first phase on engaging and involving stakeholders and experts at federal province and regional level, which have been identified in WP 2. The results of the WP 4 (modelling) and the overall project results will be presented and discussed at a stakeholder workshop and at regular meetings with BMK and federal provinces within two respective platforms on head of department levels. Policy recommendations will be developed and discussed with stakeholders. Next to the final report and a stakeholder workshop, scientific papers will present the overall outcome of the results.

Table 34: Description of work package – Method

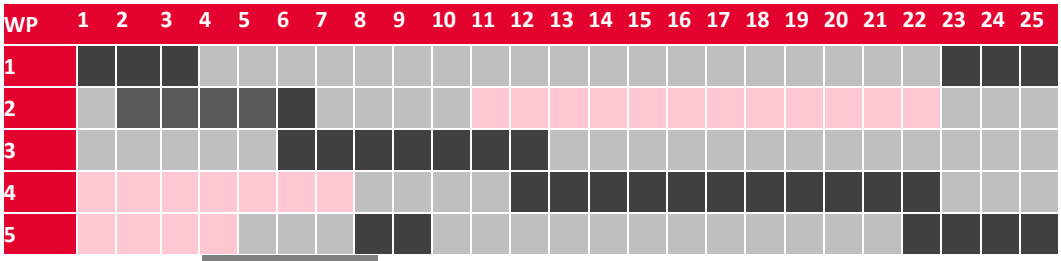
Method:
Individual meetings will be conducted with experts from federal provinces and regions identified in WP 2 to discuss possible improvements of emission datasets. Two stakeholder workshops are planned to support the development of strategies and recommendations related to improving datasets and scenarios. The first workshop (co-creation WS) will present the project concept, will discuss datasets and possible improvements. Stakeholders (with competencies in the thematic fields energy, spatial planning and air quality) will come from municipal, provincial and federal level. The second stakeholder (consolidation) workshop aims at presenting and discussing project results from WP 2, 3, and 4. For the regions where model simulations show a risk of exceedance of future AQ limit values and / or WHO guideline levels, policy recommendations for selection of appropriate measures (e.g. on energy efficiency, heating appliance technologies, district heating) that considers both climate change and air quality / health objectives will be compiled and finalised in WP 5 with inputs from WP 2, 3, and 4. One major focus will be the presentation of the policy recommendation. Participants will be experts/scientists and stakeholders from municipal, provincial and federal level – a suitable mix of competencies in energy and climate issues, spatial planning, emission inventories and air quality is envisaged. Both workshops will be organised in an engaging and interactive way to maximize gains in terms of insights, inputs, and feedback complementing WP 2, 3 and 4. This will foster the drafting of policy recommendations. We will also use workshops to identify suitable ways of disseminating project results together with participating stakeholders. Two presentations at the Austrian Climate Days (2025, 2026) are planned. Further bilateral or multilateral exchanges are foreseen, if necessary. The dissemination of project outputs will build upon available and well-established communication channels of EAA such as social media accounts, press-releases, and websites. The decision on which channels to use and potential additional channels of stakeholders will be taken after the first workshop. EAA will also present the results of this project at regular meetings with federal provinces and BMK on both expert and head of department levels. Scientific papers: BOKU The final project results will be summarised for a CCCA factsheet.

Table 35: Description of work package – Milestones, planned results and deliverables

Milestones (to measure project progress), planned results and deliverables (verifiable results/products of R&D work)
Milestones: • M5.1: The report on the co-creation workshop is available • M5.2: The report on the consolidation workshop is available • M5.3: Policy recommendations are available to policy makers and stakeholders • M5.4: Scientific papers submitted • M5.5: Draft CCCA factsheet is available Deliverables: • D5.1: Report co-creation workshop • D5.2: Report consolidation workshop • D5.3: Scientific papers submitted • D5.4: Chapter on policy recommendations for final report • D5.5: Draft of factsheet on project results for CCCA

1.6.3 Work and time schedule (Gantt chart)

The Gantt chart below presents intensive and supportive work periods per work package on a monthly basis.



Dark grey areas: Intensive work
Light grey areas. Supportive work

1.6.4 Description of cost plan

Environment Agency Austria offers the services described at the following costs:

€ 348 572,00

A detailed cost plan can be found in FFG eCall.

Personnel costs:

Costs are used for employed project staff. The staff involved in the project will feed their expertise into the project for answering to its objectives, thus building on the state-of-the-art scientific knowledge in the respective research area.

2 SUITABILITY OF APPLICANT / PROJECT PARTNERS

2.1 Description of the expertise of project partners

2.1.1 Applicant (A)

- **Environment Agency Austria**, EAA (Umweltbundesamt)
- EAA is a top provider of environmental services in various areas, including AQ monitoring, AQ assessment, emission calculations, scenario development, data reporting, etc. The agency makes use of its experience from environmental research projects, carried out in collaboration with research institutes and universities, and provides consultancy services in large areas of expertise including assessment of EU policy implementation across EU Member States, provision of recommendations to policy makers, capacity building, environmental data management and reporting. Authorship of many project reports in German language indicates experience in providing tailor-suited policy advice for Austrian authorities.
- Infrastructure: EAA hosts the database for air quality monitoring in Austria, which includes data on hourly and daily basis since 1990 for all continuously operating air quality stations according to the Austrian Ambient Air Quality Act. Data is routinely assessed and reported on daily, monthly and annual basis by EAA.[17] In addition, EAA is responsible for national air pollutant and GHG emission reporting.[18]
- **Dr. Christian Nagl** from EAA will be project manager. He has gained several years of experience in conducting and managing studies and projects concerning air quality problems on local, regional and national scale. His work covers technical, legislative, health impacts and political issues of air quality management in national and international projects. He has gained extensive knowledge of implementing EU directives and transposing them into national legislation. On a national level, he is project leader of several air quality related projects on behalf of BMK, which includes aspects of air quality monitoring and assessment, health impacts, and air quality management. Christian is a certified project management associate (IPMA Level D). A detailed CV is uploaded to eCall.
- Publications of Christian Nagl relevant for the project: (Umweltbundesamt 2023g; Haas et al. 2018; European Commission, Directorate-General for Environment 2022; Umweltbundesamt 2018b, 2017)
- **DI Dr. Siegmund Böhmer** is head of the department of Air Pollution Control & Buildings at the Umweltbundesamt. He is responsible for the national background monitoring network on Air Quality and the operation of the National

[17] https://www.umweltbundesamt.at/umweltthemen/luft/daten-luft

[18] https://www.umweltbundesamt.at/emiberichte

EU Reference Laboratory for ambient air quality, as well as for providing support in implementing EU-environmental legislation (e.g. Energy performance of Buildings Directive). He advises authorities on policies and measures regarding transition of the energy system – switch to renewable electricity generation, energy and spatial planning, the concept of smart cities, decarbonisation of space heating and alleviation of energy poverty. He has longstanding experience in collecting data and processing key figures for the spatially high-resolution location of renewable energy sources and in balancing interests in stakeholder processes.

- Publications of Siegmund Böhmer relevant for this project: (Umweltbundesamt 2017, 2021, 2023g, 2023h; BMK 2022)
- **Mag.a Iris Buxbaum**, Msc holds Master's degrees in Environmental Management and Geology. She has been working for Umweltbundesamt since 2012 in the area of air quality assessment and monitoring. Her work covers technical and legislative issues of air quality management in national and international projects. As project leader, Iris is responsible for the Austrian air quality background monitoring network. Since 2012, she has managed service contracts for the European Commission, DG Environment in the area of air quality. She has taken part as expert for air quality assessment in a number of projects abroad on behalf of the European Commission, the United Nations Development Programme and the World Bank.
- Publications of Iris Buxbaum relevant for the project: (Umweltbundesamt 2018a, 2018c, 2023i, 2023a)
- **Mag. Wolfgang Schieder** works as an expert on air pollution control and climate protection in the building sector since 2011. The modelling and analysis of energy use and emissions for conditioning (space heating and hot water supply, cooling and cooling, dehumidification) in private households and service buildings in a national, regional and city-specific context represent the focus of his work (including scenarios, evaluation and assessment of policies and measures in climate protection and air pollution control). Further topics cover the development of indicators for buildings, for cooling performance of green and blue areas as well as for the risk of urban overheating and their implementation through data integration and model-based approaches using modern, geodata-based analysis tools.
- Publications of Wolfgang Schieder relevant for the project: (Umweltbundesamt 2023b, 2023e, 2023d, 2017; BMK 2022; Umweltbundesamt 2021)
- **DI.in Dr.in Astrid Buchmayr, MSc** holds a Ph.D. in Bioscience Engineering and Economics, complemented by Master's Degrees in Natural Resources Management and Renewable Urban Energy Systems. Specializing in the holistic assessment of energy systems, her expertise extends to the development of assessment models focused on life cycle emissions and their impacts on the environment and society. Her work centers on achieving a balance between global and local benefits and impacts associated with (renewable) energy generation. She is experienced with collaborating with diverse stakeholders to create local energy roadmaps, taking into account the unique conditions of the local population.

2.1.2 Project partners (Pn)

- Name of institution: **University of Natural Resources and Life Sciences, Vienna (BOKU)**
- Relevant expertise of organisation and staff involved in the project. The Institute of Meteorology and Climatology (BOKU-MET) is an international research center in atmospheric and climate science. BOKU-MET comprises about 35 scientists focusing on climate processes and climate change, environmental and urban meteorology and chemistry-climate connections. Description of know-how relevant to the project.
  The BOKU team has rich experience in the application of chemistry-transport models and the analysis of changes in ambient emission and climate on air quality on regional and local scale. The team has expertise in nested chemistry-transport model simulations, bias-correction and sensitivity simulations. BOKU has led and contributed to national and international research projects with focus on chemistry-climate connections and has an established track record in informing air quality and climate policy in Austria. Prof. Rieder is experienced in project management, policy dialogues and the supervision and training of early career scientists.
- Description of existing infrastructure: The BOKU team operates the WRF-Chem model and associated analysis frameworks on regular basis and has access to high performance computing (HPC) environments at the Vienna Scientific Cluster and locally at BOKU''s Vienna campus. Furthermore, the BOKU team has rich experience in large-scale global chemistry-climate modelling with SOCOL, a state-of-the-art chemistry-climate model required to provide chemical boundary conditions for CTM analyses.
  Prof. Dr. Harald Rieder is Chair for Meteorology and Climatology at BOKU-MET. He is an expert in chemistry-climate connections and chemistry-climate and chemistry-transport modeling. He is acting among others as Chairman of the Climate Change Centre Austria, Vice President of the Austrian Meteorological Society and Co-Chair of the forthcoming 2nd Austrian Climate Assessment Report.
- Publications of Harald Rieder relevant for the project: (Liu et al. 2023; Schneidemesser et al. 2020; Staehle et al. 2022; Mayer et al. 2022; Trimmel et al. 2023)
- **Dr. Monika Mayer** is a senior scientist at BOKU-MET. She will contribute to chemistry-transport modeling and statistical analyses and provide training together with Prof. Rieder to the PhD student involved that will be trained in Biomass_CC_AQ.
- Publications of Monika Mayer relevant for the project: (Liu et al. 2023; Staehle et al. 2022; Trimmel et al. 2023; Mayer et al. 2022)
- **A PhD student** with background in environmental meteorology will be recruited within Biomass_CC_AQ and trained in chemistry-transport modelling. The student will be responsible for the set of WRF-Chem simulations performed by BOKU and provide input fields to the partners of Charles University and GeoSphere Austria. If international partners are involved, please indicate how they will contribute to building and intensifying Austrian research competence.

- With the project, the BOKU team will closely collaborate with colleagues from **Charles University, Czech Republic. Prof. Peter Huszar** and his team will contribute CAMx chemistry-transport model simulations, which will be driven with meteorological fields, provided by the BOKU team. Within the project, the BOKU PhD student will receive training in CAMx applications and subsequent analyses of CAMx output fields. Thereby the transfer of knowledge will increase the modeling capacities of BOKU and contribute to the overall expansion of the chemistry-climate modelling toolbox available for air quality research in Austria.

- Name of institution: **GeoSphere Austria**
- Relevant expertise of organisation and staff involved in the project. The GeoSphere Austria team has many years of expertise in air quality modelling and dispersion modelling. The team will consist of **Barbara Scherllin-Pirscher** and **Antje Hoheisel** (senior scientists) and **Marcus Hirtl** (head of the competence unit Chemical Weather Forecasts), who has experience in scientific coordination and international project management.
- Publications of GeoSphere Austria project team: (Hirtl et al. 2014; Hirtl et al. 2011; Hirtl et al. 2019; Baklanov 2011; Baklanov et al. 2014)
- Description of know-how relevant to the project. The responsibilities of GeoSphere Austria include the support of the federal provinces and the public, providing advice and counselling services, as well as expert opinions, in areas related to the protection of the environment. GeoSphere Austria operates the WRF-Chem (Grell et al., 2005) chemical transport model system to conduct operational air quality forecasts covering the Alpine region. GeoSphere Austria (formerly as ZAMG) has successfully participated in air quality related projects within the last years. The most relevant ones are:
- FFG project:
  - APP4AQ (ZAMG Prime, 2017 to 2018, ASAP13): Requirements analysis and definition: technical reports on currently available data sets (satellite, emissions, model,, …) that can be used for APP4AQ-p2, comprehensive end user survey to define requirements and priorities for services.
  - AQA-PM (ZAMG Prime, 2011 to 2013, ASAP 7): Implementation of a geostatistical data fusion system (satellite data, numerical model data and ground measurements) to support the assimilation of satellite-based pollution information to improve pollution forecasts.
- H2020 Projects (ZAMG lead):
  - EUNADICS-AV “European Natural Airborne Disaster Information and Coordination System for Aviation”. The project undertakes to develop and test a unique system to provide consistent and coherent information to aviation authorities, airlines and pilots in the event of a natural disaster affecting the airspace.
- Description of existing infrastructure: GeoSphere Austria provides various daily forecast products of different atmospheric parameters (meteorology and air

quality). Numerical models run on an in-house High Performance Computing Facility (HPCF) and a strong expertise in handling big data and in implementing operational modelling chains are available at GeoSphere Austria.

2.2 Capacity to achieve the project goals

BOKU, GeoSphere Austria and subcontractor Charles University are experienced in chemistry-transport modeling and tailored analyses of ambient air quality. The necessary chemistry-transport models and chemical mechanisms are installed at the individual HPC resources of the modeling teams, and the consortium has emission preprocessors and postprocessing scripts readily available for a seamless project implementation. Prof. Rieder, Dr. Hirtl and Prof. Huszar are experts ambient air quality and chemistry-transport modeling and bring together with their teams the necessary expertise to the table required to reach the project goals.

2.2.1 Completeness and coordination of required expertise (if applicable)

Main tasks of all project partners

Table 36: Main tasks of all project partners

Work package	Key expertise required for the work package	Name of partner contributing key expertise
1	Project management, project administration, reporting	EAA
2	Assessment of air quality; source apportionment of main sources for PM, PAH in selected regions	EAA
3	Development of spatially disaggregated, consistent, quality assured and improved emission datasets for buildings	EAA
4	Applying chemistry-transport models for selected scenarios	BOKU, GeoSphere Austria
5	Dissemination of results within the scientific community and the administration	BOKU, EAA

2.2.2 Third-party expertise required

The CAMx chemistry-transport model is not operated by BOKU or GeoSphere Austria. Therefore Prof. Peter Huszar and his team from Charles University will contribute as subcontractors to BOKU in Biomass_CC_AQ. CAMx is required as

secondary CTM for sensitivity studies (role of model configuration and chemical mechanism) for ambient PM air quality outcomes. Prof. Huszar and his team have successfully collaborated with Prof. Rieder and his team in recent years, and the subcontractor has all resources available required for a seamless implementation of the subcontracted task.

General information about subcontractor

Table 37: General information about subcontractor

Relevant WP(s)	WP4 Applying chemistry-transport models for selected scenarios
Subcontractor of A/Pn	BOKU
Name of subcontractor	Charles University, Prague
Content of subcontract	Prof. Peter Huszar and his team will perform CAMx chemistry-transport model integrations based on emission data provided by EEA and driving WRF-Chem meteorological fields provided by BOKU.
Costs of the subcontract [EUR]	30.000

2.3 Composition of project team with regard to gender balance (gender mainstreaming)

Equal opportunities are a central goal of the Environment Agency Austria' s personnel policy. To promote female leadership, innovative models such as part-time leadership, leadership collectives or shared leadership have been implemented for several years. The proportion of women at management level has increased by 7.5% compared to 2020, and in 2021 the ratio of women to men was 45.2%. Income differences have been reduced in recent years. The gender pay gap was 8.3% in 2021 and thus below the income gap in the federal civil service (8.6%). Against this background, a diversity statement was drawn up in 2021, which is published in the various communication channels and in all job advertisements: '*The Environment Agency Austria values the diversity of all employees and sees the different characteristics of people such as age, gender, origin, ethnicity, sexual orientation or disability as a strength and enrichment for the company. This strength supports us in achieving the global sustainability goals. Diverse perspectives, respectful interaction and non-discriminatory cooperation promote cohesion, creativity and innovation*.' In

addition to the commitment to diversity, job advertisements are made even more inclusive by naming a non-binary gender. In addition, the rules of the gender guideline developed by the Ministry of Climate Protection are applied in all EAA texts.

The extended project team of Biomass_CC_AQ, which was responsible for the preparation of the proposal and will be in charge of its subsequent implementation consists of 7 women and 9 men. At BOKU, a PhD student will be hired for the project. Gender balance of the team and scientific expertise will be core hiring criteria for the PhD student selection.

3 CLIMATE FRIENDLY RESEARCH ACTIVITIES

EAA works for a transformation of the economy and society to ensure sustainable living conditions, also for future generations. EAA is committed to transparency and impartiality in its work and is engaged in dialogue with politics, administration, business, science and civil society. The quality and sustainability policy of EAA supports the strategic direction and provides a framework for the setting of quality and environmental objectives. EAA is committed to reducing the negative environmental impact of its activities and to the implementation of its sustainability goals, and thus aim to continually improve its environmental performance.

As a contracting authority, EAA makes procurements based on the principles of equal treatment, proportionality, transparency and cost-effectiveness. Quality and environmental criteria have priority; EAA has therefore implemented environment management systems according to EMAS and ISO 14000 since 2005. EAA uses at its premises electricity certified according to UZ46 and relies on regional and sustainable providers for catering of events.

The three project partners are located in Vienna; therefore, meetings will mainly take place in Vienna at locations easily accessible by public transport. Meetings with the subcontractor Charles University, Prague, will either be virtual or by train from Prague to Vienna in case of in-person meetings. Meetings with stakeholders will either take place in Vienna, Graz, Linz, Salzburg, which allow for travelling by train, or virtual.

4 BENEFIT AND EXPLOITATION

4.1 User benefit and exploitation potential

The project “Biomass_CC_AQ” will provide data for policy makers supporting a sustainable transformation and decarbonisation of the space heating sector, thereby allowing to consider conflicting interests between reducing GHG emissions and the impact of biomass use on air pollutant emissions and on air quality, and by this on human health.

The project will provide knowledge on emissions from biomass burning for space heating (including data on fuel use and heating appliances), and on specific regions affected by high levels of pollution by $PM_{2.5}$ and PM_{10}. It will further provide knowledge on the future developments of emissions of these pollutants from biomass burning in space heating and estimations of future air quality by $PM_{2.5}$ and PM_{10}, particularly in relation to limit values of the revised EU Air quality directive as well as WHO guidelines.

The results will be relevant for administration on national, federal province and regional level to decide on sustainable pathways for transforming the space heating sector both for decreasing GHG emissions as well as decreasing air pollution by $PM_{2.5}$ and PM_{10}. Thereby, the Austrian population will benefit from reduced health impacts of air pollutants when decarbonising space heating.

Unique Selling Propositions of this project are high resolution, consistent, quality assured, and annually updated emission datasets for space heating for both GHG and air pollutants. This includes regional differentiated scenarios for activities, technologies and emission for space heating up to 2050.

The simulation of different scenarios with respect to emissions as well as the change of environmental conditions (e.g. meteorology) due to climate change requires the application of complex numerical meteorological transport and air chemistry models. These have to be provided with appropriate input data (e.g. anthropogenic and biogenic emissions, land use data, topography, initial- and boundary conditions of air quality and meteorology ...), setup (e.g. for the selected grids with a defined resolution and respective parametrizations) and run for the chosen episodes, and the results have to interpreted by experts. The expertise gained in this complex process, and also its application to a very practically oriented research question, is very valuable for the contributing partners. The knowledge gained in this project will strengthen the Austrian research landscape by expanding the national chemistry-transport modelling capacities and expertise with focus on PM. Expertise gained on similarities and differences between individual CTMs and chemical mechanisms will aid air quality forecasts for Austria, routinely provided by GeoSphere Austria, as well as the capacity for future projections and tailored sensitivity analyses to inform air

quality policy. Thereby outcomes of Biomass_CC_AQ will benefit the research, air quality management and policy communities as well as well as broader audiences across the private sector as all project findings will be summarized in open access publications and data sets for PM projections emerging from the project will be provided open source via the CCCA data portal.

4.2 Impact and significance of the project results for the organisations involved in the project

EAA (Umweltbundesamt)

The foreseen revised AAQD will lay down limit values which likely will not be attained in whole Austria in the near future. Achieving attainment requires improved data to allow for identifying the regions at risk to exceed the future air quality limit values and to allow for preparing air quality plans to ensure compliance with the legally binding limit values. Currently, the available data for air quality and especially for emissions from space heating by biomass burning as a major source is too uncertain to allow for identifying these regions and for developing air quality plans. The proposed approach will improve overall data quality of gridded emissions and create new spatially disaggregated scenario datasets. Therefore, the results of this project will enable EAA together with the stakeholders to identify regions where emissions from biomass burning are relevant for attainment/exceedance of limit values, and to develop scenarios and air quality plans and policies for these regions. It will also allow creating a strategy for long-term compliance with WHO guideline levels. The resulting datasets on emissions and air quality and the methodologies will be the basis for further long-term involvement of EAA in questions regarding climate change, air quality and sustainable use of biomass. The EAA's methodologies on spatial energy planning, GHG and air pollutant inventory as well as scenario modelling and emission data gridding will benefit from the project.

BOKU

The proposed research will strengthen BOKU's position as leading research institution in environmental meteorology and climate impact research. Biomass_CC_AQ will expand BOKU's track record in ambient air quality in a changing climate and open a new research stream on high-resolution projections for PM. The project will expand the BOKU modelling toolbox and the team's technical and scientific expertise and provide relevant outputs for interaction with stakeholders and practitioners. Furthermore, novel data sets and further insights in the performance of individual CTMs and their chemical mechanisms of varying complexity will emerge, pathing the way for future research of the team beyond the project duration.

GeoSphere Austria

Up to now GeoSphere Austria was mainly involved in air pollution modelling applications with the emphasis on operational forecasts and to run the model for past events e.g. with different setups/emissions. The simulation of air chemistry in future climate scenarios is a new application at GeoSphere Austria and is therefore an important extension of its services. The topic we address in the project has furthermore a very relevant impact on climate mitigation strategy as well as human health aspects and strengthens the future role of GeoSphere Austria in the field of atmospheric modelling on national level.

4.3 Dissemination and Exploitation strategy

Dissemination of the results of this project is of high importance to inform policy decisions on future pathways for heating systems. Therefore, several different dissemination channels are foreseen to ensure widespread consideration of these results.

Planned number of diploma and doctoral theses: Results of Biomass_CC_AQ will contribute directly to a doctoral thesis at BOKU. Involvement of master students in the project is also foreseen.

Planned number of publications in national and international journals (with or without review process) (BOKU, GeoSphere Austria): At least two scientific publications are foreseen to emerge from the project. One publication will focus on the comparison of individual CTMs and chemical mechanisms in reproducing regional/local PM burdens. Another paper will focus on projections of future PM burdens following changes in climate and emissions. These papers will be submitted for publication to open-access peer-reviewed journals (potential journals are e.g. Atmospheric Chemistry and Physics, Atmospheric Environment).

Planned number of workshops: two stakeholder workshops are foreseen in WP 5 to improve dataset, discuss results and policy recommendations. In addition, EAA will distribute and discuss the results of the project at regular meetings with federal provinces and BMK on head of department and expert level.

Specific exploitation expertise: EAA has a long-term expertise in communicating environmental issues in general and air quality, climate and energy issues in particular to multiple audiences, addressing the scientific community as well as stakeholder, multiplicators (e.g. journalists) and decision makers on a regional, national and EU level. To address Austrian citizen's air quality information generated by the Agency has been continuously disseminated to public audiences using easily accessible channels, above all web and social media.

Furthermore, for selected national and international projects addressing air quality, climate change and energy issues the Agency's staff members developed and

implemented communication strategies and measures to meet the specific information needs of the project's target audiences.

Specific exploitation expertise: The BOKU team is experienced in exploiting model developments and modeling outputs in fundamental and applied research and policy consultancy.

Specific exploitation expertise GeoSphere Austria: Scientific community: presentation of project results at scientific conferences and national/international workshops in the field of air quality modelling.

Authorities and stakeholders: presentation at regular workshops organised by the regional governments.

4.4 Open-access approach

Open access is a key interest of the applicant and all the project partners and subcontractors. We aim for free availability of all aggregated datasets, reports, and papers produced in the frame of the project. GIS data sets will be made available on appropriate portals in the form of open government data as far as technically and legally possible (e.g. open data platforms data.gv.at and opendataportal.at). Scientific papers will be published in open access journals and CTM outputs will be provide open-access via the CCCA data portal.

We are fully aware of that according to Art. 20 Para. 5 of the Austrian Federal Constitutional Law (B-VG), from January 1, 2023, all bodies entrusted with tasks of the federal, state and municipal administration must carry out all commissioned studies, opinions and surveys, including their costs, in a way that is accessible to everyone, as long as and insofar as their confidentiality is not required for reasons of official secrecy.

5 RELEVANCE OF THE PROJECT

5.1 Relevance to the Call

This proposal addresses the following thematic area as described in the "*Guide for the Submission of Proposals*":

Thematic area 2: Specific support for Austria's policymakers

In particular, the proposal addresses the following objective:

Conflicting targets: "*Another conflicting area in this context addresses the health/mitigation nexus: clean air for human health vs. biomass burning as promoted in order to cut down CO_2 emission.*"

As described in detail in sections 1.3 and 1.6, the proposal addresses exactly this conflict by improving the data quality for activity data, emissions and regionally differentiated air quality impacts of space heating and especially of biomass burning. This allows for developing scenarios of both emissions and air quality to avoid this conflict for informed decision-making.

5.2 Incentive effect of funding (additionality)

From the viewpoint of the Biomass_CC_AQ consortium, funding would allow to complete the organizations' ambitious efforts to fulfill the proposed activities. The possible ACRP funding enables interdisciplinary work by the organisations involved in the project within a reasonable timeframe. Without funding, such applied research would not be possible for either of the project partners. In addition, central funding enables involvement of stakeholders and concerned federal provinces. Therefore, without funding, the project could not be undertaken due to the large effort required for setting up such activities, aligning expectations and getting financing from different institutions.

In addition, it is crucial that scenarios regarding impacts of space heating are developed to allow for informed policy decisions for air quality and climate change policies at the same time. Due to the long-term planning and inertness of the building sector on the one hand, and the foreseen deadlines for compliance with future AAQD limit values on the other hand, it is crucial to lay the foundation for evidence as soon as possible.

From the viewpoint of the Biomass_CC_AQ consortium, funding would allow to complete the organizations' ambitious efforts to fulfill the proposed activities.

Without additional funding, the developments planned in this project would not be possible in the considered partnership and timeframe.

In general, **GeoSphere Austria** has the opportunity to develop important methods/applications through internal scientific projects. The budget and the time frame of these projects are limited as well as the cooperation with external organisations. Those two circumstances have a direct influence on the size and the time frame of the projects, which can be increased by the opportunity of external funding as it is foreseen this project.

For **BOKU** funding through Biomass_CC_AQ will provide a unique opportunity to expand the inhouse chemistry-climate modeling expertise with focus on PM and allow the team to provide for the first time, high-resolution PM projections under different climate and emission scenarios to policymakers and practitioners. The project will also help BOKU to strengthen its collaboration with key neighboring institutions in Austria (EEA and GeoSphere Austria). Paving the way for future collaborative research. The BOKU activities (in size, scope and duration) foreseen in Biomass_CC_AQ could not be performed without funding within the ACRP framework.

5.3 Response to reviewers

Not applicable

6 LIST OF REFERENCES

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7 SUGGESTION OF EVALUATORS (OPTIONAL)

None

Title	Name	Enterprise /institute	E-Mail	Field of Expertise

8 CALL-SPECIFIC SUPPLEMENTARY INFORMATION

Letters of intent and CVs have been uploaded to eCall.