

MEMO<sup>2</sup>: MEthane goes MOBILE – MEasurements and MOdelling

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## Data Management and Dissemination & Exploitation Plan

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### Deliverable 5.3

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Delivery month Annex I 6

Actual delivery month 6

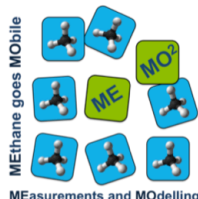
Lead participant: UU      Work package: 5      Nature: ORDP      Dissemination level: PU

Version: 1

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 722479.



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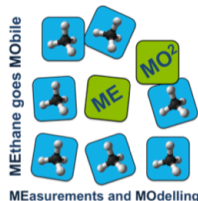
## Data Management and Dissemination & Exploitation Plan

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## MEMO<sup>2</sup>: MEthane goes MOBILE – MEasurements and MOdelling

### Data Management and Dissemination & Exploitation Plan

## Purpose of the Deliverable

This deliverable (D5.3) is the initial draft of the Data Management and Dissemination & Exploitation Plan (DMDE Plan), as MEMO<sup>2</sup> takes part in the Open Research Data Pilot (ORD pilot). The DMDE Plan is a living document and a “prototype” version is due within the first 6 months. At the 1<sup>st</sup> Annual Meeting the plan will be discussed in detail within the consortium to decide whether and which adjustments are necessary ensuring a sustainable data management as well as dissemination and exploitation of results over the course of the project. The DMDE plan will be updated after the 1<sup>st</sup> Annual Meeting and will be adjusted over the course of the project whenever significant changes arise.

MEMO<sup>2</sup> aims at a long-term impact by making its data available to future projects, in particular to use them for objective verifications of CH<sub>4</sub> emissions. The DMDE Plan implements the procedures for this, to improve and maximise access to and re-use of research data generated by MEMO<sup>2</sup> as a Horizon 2020 project. As the DMDE Plan is a key element of project management, it describes preparation, handling, preservation and storage of data collected and generated by MEMO<sup>2</sup>, as well as the dissemination and exploitation of them. First details were already part of the proposal (Annex I, Part B, Chapter 3.2.6) and the Consortium Agreement (Chapter4, Chapter 8-10).

The consortium of MEMO<sup>2</sup> consists of academic and non-academic participants, and the amount of data generated, exchanged and used differs depending on the tasks of the participants. This first DMDE plan focuses on the academic partners, as most of the non-academic partners do not generate data. They mainly contribute by hosting secondments, mentoring ESRs and giving lectures during the training events. Usage and exchange of data by and with the non-academic partners will be discussed during the 1<sup>st</sup> Annual Meeting and the DMDE plan will be updated accordingly.

The DMDE Plan will follow the **FAIR** rules to ensure data are **F**indable, **A**ccessible, **I**nteroperable and **R**e-usable. The proposed DMDE Plan assures

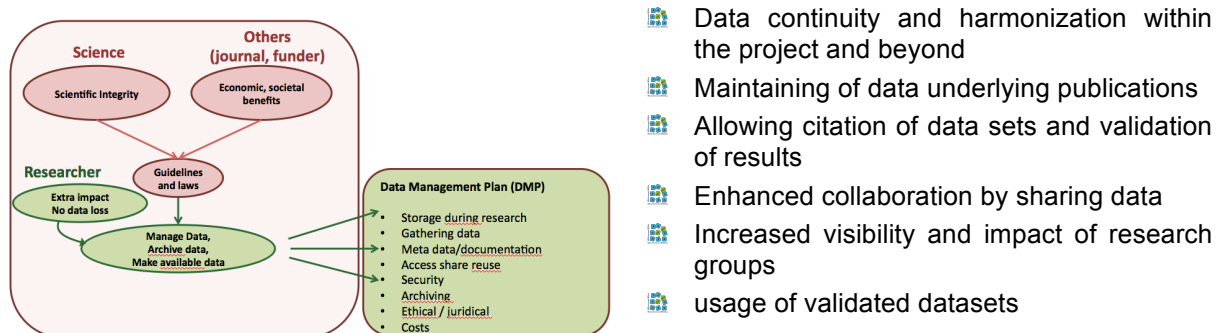
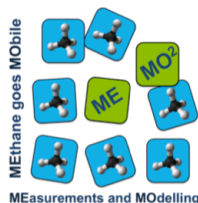


Fig. 1: UU RDM support, T. Pronk

(<https://www.uu.nl/en/research/research-data-management/rdm-support>)

The DMDE Plan is a public document and an approved copy – by the EU and the consortium - will be available on the website to ensure FAIR data.



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Data Management and Dissemination & Exploitation Plan

# A – DATA MANAGEMENT PLAN

## 1. Executive Summary

### 1.1 Purpose of data collection / generation, its relation to the objectives of the project and utility

MEMO<sup>2</sup> is a European Training Network with 22 academic and non-academic partners from 7 European countries. MEMO<sup>2</sup> focuses on measurement and modelling of methane (CH<sub>4</sub>) within Europe and aims to identify and quantify CH<sub>4</sub> emissions by implementing mobile measurements and modelling systems for policy-relevant emission estimates and verification. As Europe's CH<sub>4</sub> emissions are not well quantified, there are significant discrepancies between official inventories of emissions and estimates derived from direct atmospheric measurements. Measurement and modelling data will be collected and generated by the individual research groups of the consortium, and provided to the consortium and beyond to the scientific community for further usage.

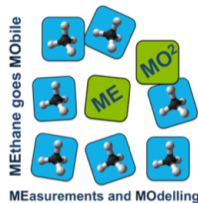
MEMO<sup>2</sup> as an international collaboration will produce a variety of research data, including measurement data (raw data) as well as final data products (calibrated data), modelling data, methodologies, and further analyses of data. This will increase knowledge about CH<sub>4</sub> emissions at the European scale and MEMO<sup>2</sup> will bridge the gap between large-scale scientific estimates from in situ monitoring programs and the "bottom-up" estimates of emissions from local sources that are used in the national reporting. All research data collected and generated in the project need to be shared within and outside the consortium to increase usability of the results and therefore the impact of the project. Data and generated outcome will be useful for a broad audience including scientists in and outside the consortium, policy makers, stakeholders, and the public to better understand processes that drive European CH<sub>4</sub> emissions.

Therefore collected and generated data will be made accessible for different audiences, e.g. as raw data, original calibrated measurement data and model outputs, as further processed and interpreted data, or as summarizing overviews of results. For this purpose MEMO<sup>2</sup> will follow passive and active dissemination approaches by using different media, e.g. data repositories, publications and presentations, the project website or newsletters and factsheets.

### 1.2 Types, formats and size of data collected / generated

As the research includes a variety of disciplines, the generated and collected data are diverse. For the measurement part raw data will be collected in diverse formats specific to the instruments and stored as ASCII files, for the modelling part of the project data will be generated as binary output files, stored in NetCDF format with meta-data, typically sized less than 1Gb. Using ASCII and netCDF ensures, that data are widely readable. Combined data generation, e.g. as publications or presentations, will produce files by using textual and illustration programs such as MS Office, Adobe, LaTeX, or Python.

Most of the non-academic partners involved in MEMO<sup>2</sup> will not generate data. TNO as co-supervisor of ESR10, hosted by UU, will adapt the data management of UU. Usage and exchange of data by and with the non-academic partners will be discussed during the 1<sup>st</sup> Annual Meeting and the DMDE plan will be updated accordingly.



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### Data Management and Dissemination & Exploitation Plan

**Table 1:** Overview of expected file types, formats, and sizes

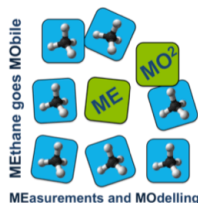
Name participant	File type of raw data	File size of raw data	Data analysis program	Textual / illustration program
UU	.txt or NetCDF	20 MB	Excel, Matlab, Python	MS Office, LaTeX, Adobe Illustrator, IGOR
RUG	.txt	30 MB per measurement day	R, python	MS Office, Adobe Illustrator, IGOR
UHEI	ASCII, .klm	30 MB per campaign day	R	R, LaTeX, MS Office
UVSQ	.txt	3 MB for one hour raw data	R	R, LaTeX
EMPA	TDMS format from QCL laser instrument in National Instruments Raw spectra in binary format Model outputs in NetCDF format, following the CF conventions as much as possible. This includes footprints generated with FLEXPART-COSMO backward simulations and GRAMM/GRAL dispersion simulation	1-10 GB/campaign for TDMS data files 100 GB/campaign for raw spectra FLEXPART: 50 MB per day of simulation per station GRAMM/GRAL: variable size depending on the size of the target area, probably of the order of 5 GB per day of simulation.	IGOR, Excel, R, python, QGIS.	Adobe Illustrator
RHUL	.dat, .csv	20 MB	Excel, Matlab, ArcGIS	MS Office, LaTeX, Adobe Illustrator, IGOR
LU	NetCDF, .dat, .csv, .kml	20 MB	MatLab (WURFMPF Suite), Excel	MS Office, LaTeX
WU	Binary output files, stored in NetCDF format with metadata High-resolution modelling with Micro-HH output	NetCDF: typically sized less than 1Gb Micro-HH output: size becomes prohibitively large.	Mirco-HH: Git (version-control software) to create a hash for the code used to produce MEMO <sup>2</sup> output, which ensures repeatability of the numerical experiment.	Jupyter Notebooks, open-source web application that allows creation and sharing documents that contain live code, equations, visualizations and explanatory text. GitHub repositories will be used to ensure proper version control of post-processing software, based on languages like Python and R.
AGH-UST	ASCII, .klm, .xml, netCDF	10MB / 2MB	Excel, MatLab, R, Earth	R, MS Office

### 1.3 Origin of data and possible re-use of existing data

Data will be generated and collected by all research groups, using different approaches and instruments. The experimental part of the project will measure environmental samples and will create data as given in Table 1.3. Several groups already have performed measurements and modelling and those data will be implemented if possible and useful. Data will be publicly provided within and outside the consortium, to researchers of related disciplines and policy makers.

**Table 2:** Overview of data origin and data re-use

Name participant	Instrumentation used	Data bases and models	Disciplines using the data
UU	Cavity enhanced absorption spectroscopy, Isotope Ratio Mass Spectrometry (IRMS)	t.b.d.	Greenhouse gas regional / global modelling, industrial partners
RUG	Cavity Ring-Down Spectroscopy (CRDS), radiosonde (windsound)	OPS model	Atmospheric Research
UHEI	Cavity Ring-Down Spectroscopy (CRDS)		Atmospheric Research, CH <sub>4</sub> emission estimates
UVSQ	Cavity Ring-Down Spectroscopy (CRDS)	IER, EDGAR	
EMPA	Laser spectrometer (QCLAS)	Lagrangian Particle Dispersion Model FLEXPART-COSMO (subset of simulations will be shared with other projects), high-resolution dispersion simulation system GRAMM/GRAL (simulations will be exclusively produced for MEMO <sup>2</sup> ). Both models require a number of input data sets including static (e.g. topography) and time-varying inputs. In particular, FLEXPART-COSMO is driven by operational COSMO-7 weather forecast simulations of MeteoSwiss.	Atmospheric Research
RHUL	Cavity enhanced absorption spectroscopy, Isotope Ratio Mass Spectrometry (IRMS)	-	Greenhouse gas regional and global modelling, industrial partners
LU	Mobile flux platform, BAT-probe, G2301-m flight-ready analyser for CO <sub>2</sub> /H <sub>2</sub> O/CH <sub>4</sub>	-	Greenhouse gas regional modelling
WU	-	Version-controlled computer code (typically C++). Input data / data to initialise the model will come from global and/or mesoscale models (IFS, WRF). First guess source strength will be based on close interaction with the measurement community.	Atmospheric research, campaign planning, analysis of source dispersion
AGH-UST	Cavity Ring-Down Spectroscopy (CRDS)	NAME, WRF, R, HySplit, SCREEN	Mining Industry, Geophysics, Meteorology, Environmental Science, Biophysics



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### Data Management and Dissemination & Exploitation Plan

## 2. FAIR data

### 2.1 Findability of data

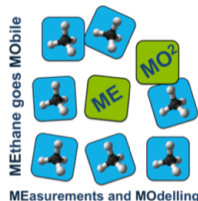
Making data findable requires that they are well described and identified. This includes appropriate definition of metadata and keywords, as well as standard identification mechanisms and naming conventions.

#### 2.1.1 Discoverability of data

Final calibrated data will be submitted with associated keywords and metadata, and with unique file identifiers including e.g. name of the data originator/institute, instrument, parameter, date of measurement, and version number. It will be determined, whether community-based metadata schema or standards are available and if they can be adopted. As different scientific communities are involved in the project, metadata will differ between the experimental measurement community and the modelling community. At the 1<sup>st</sup> Annual Meeting the consortium will define, which keywords and metadata are necessary and useful for the scientific communities in the consortium, the DMDE plan will be updated to describe what type of metadata will be created and how.

**Table 3:** Overview of metadata and keywords actually used by the partners

Name participant	Adopted metadata	Community-based metadata scheme / standard	Keywords for data sets
UU	Metadata will be provided for output data files of cavity-enhanced spectroscopy and measurements of discrete air samples.	t.b.d.	CH <sub>4</sub> , δ <sup>13</sup> C, δD
RUG	NASA Ames ( <a href="https://badc.nerc.ac.uk/help/formats/NASA-Ames/G-and-H-June-1998.html">https://badc.nerc.ac.uk/help/formats/NASA-Ames/G-and-H-June-1998.html</a> )	ICOS or NOAA / ESRL metadata	CH <sub>4</sub> , CO <sub>2</sub> , CO, UAV
UHEI	Standard metadata with GPS information, instrument, unit, calibration, uncertainties, ect.	ICOS or InGOS metadata	CH <sub>4</sub> , <sup>13</sup> CH <sub>4</sub> , meteo
UVSQ		Suggestion: follow ICOS metadata standards for measurements	
EMPA	Necessary meta information for both measurement and model data should include: <ul style="list-style-type: none"> <li>• Originator (e.g. measurement person): Name and email address</li> <li>• Organization of originator: name and address</li> <li>• Data source, e.g. name of instrument, measurement platform, model, including more specific information such as instrument ID, model version, etc.</li> <li>• Mission name, e.g. the name of a measurement campaign or project</li> </ul>	Final data products (calibrated measurement data and model outputs) will be provided in the following standardized formats: NI-TDMS for measurement data ( <a href="http://www.ni.com/white-paper/3727/de/">http://www.ni.com/white-paper/3727/de/</a> ) NetCDF with CF conventions for model output ( <a href="http://cfconventions.org/">http://cfconventions.org/</a> ) Both data formats allow including the metadata information directly into the data file.	
RHUL	Metadata will be provided for output data files of cavity-enhanced spectroscopy and measurements of discrete air samples.		methane, CH <sub>4</sub> , C <sub>2</sub> H <sub>6</sub> , δ <sup>13</sup> C, carbon isotopes
LU	Metadata will provided for all output data files of aircraft and ground-based measurements		
WU	Model meta-data will be compliant with CF conventions ( <a href="http://cfconventions.org">http://cfconventions.org</a> ). For micro-HH not all model data will be stored, but rather sampling according to different measurement strategies through the spatio-temporal model domain. Dataset will be tagged according to model hash (Git) so that exact reproducibility is guaranteed		
AGH-UST	Standard procedure: information about place, instrument, unit, corrections, uncertainties etc.	InGOS standard is available	Silesia, Krakow, Methane concentration, Methane isotopic composition, Stable Isotopes, Methane balance, Methane, Industrial emission, Mining industry, Gas industry



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#### 2.1.2 Identifiability of data

Data must be easily identifiable to ensure, that users will find and use them. One option is to determine naming conventions within the consortium. Besides this, data sets will be hallmarked by persistent and unique identifiers such as Digital Object Identifiers (DOI). By this data sets will also be citable, which increases not only the identifiability but also the visibility and therefore the impact of MEMO<sup>2</sup>.

**Table 4:** Overview of possible naming and identification of data sets




Name participant	Naming conventions	Standard identification mechanisms
UU	NASA Ames, e.g. MEMO2_UU_20170807_1_v1.0.naf	DOI, or published with papers
RUG	NASA Ames, e.g. uav_gro_20170807_1_v1.0.naf	DOI, or published with papers
UHEI		
UVSQ		
EMPA	<p>General naming convention (to be agreed):            MISSION_ORIG_PLATFORM_INSTR_PARAM_DATE_VERSION.EXT            with            MISSION: The campaign, e.g. CAMP1, or if general for the project, just MEMO2.            ORIG: Institute responsible, e.g. EMPA            PLATFORM: measurement platform, e.g. GROUND, or UAV, or CAR            INSTR: the instrument, e.g. PICARRO-G2401            PARAM: Parameters measured, e.g. CH4 or ALL or MULTI if multiple parameters            DATE: ISO8601 compliant date of the measurement, or range of dates, e.g. 2018-04-18-to-2018-04-24            EXT: File extension identifying the type of file</p>	Datasets (or dataset collections) should receive a DOI
RHUL	e.g. RHUL-PIC-Location-DDMMYY; RHUL-ISO-Location-DDMMYY	
LU	e.g. LU-aircraft-Location-YYMMDDHH, LU-ground-Location-YYMMDDHH	
WU	Datasets will be named MicroHH_###_yyymmdd.nc, with ### the hash of the model on git. Will be further discussed in the modeller community of MEMO <sup>2</sup> .	Upon publication, we will request a DOI for the dataset on which papers are based
AGH-UST	Gas, Isotope, Geographical region, type of environment, date of campaign, hour of campaign, version	DOI, Scientific Data or any other open data publication journal

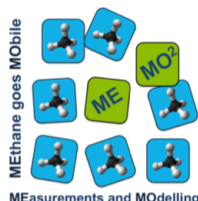
## 2.2 Availability of data

Intercommunication and interdependence are essential for MEMO<sup>2</sup>, as ESRs will have joint campaigns and exchange data with the other ESRs of the network. This close collaboration, which is implemented in the structure of the research program, mediates the risk of individual projects because individual failures (e.g. instrument failures) can be covered by a certain degree of redundancy in the project (e.g. by exchanging instruments, data or data evaluation tools). The interdependence of ESRs requires a clear data sharing policy. MEMO<sup>2</sup> will produce a large amount of data, which will usually involve several steps of data treatment before reaching a final form that is of direct use to the stakeholders and project partners. In the case of measurements, this will be final calibrated data and in the case of model simulations, it may be a modified version of the raw output, e.g. converted to a standard format or remapped to a different projection. Storing and documenting raw data in the various processing steps (called raw data in the following sections) is the responsibility of each partner and should follow good scientific practice. The final, calibrated data (called “calibrated data” in the following sections) will be made available as described below.

#### 2.2.2 Accessibility of data

Data produced within MEMO<sup>2</sup> are in general open access, and will be made available not only for the consortium but also outside the consortium. This will follow in principle the data sharing policy implemented in the Grant Agreement (GA section 3, part B section 3.2.6) and the Consortium Agreement (CA, section 8, 9 and 10). On a day-to-day basis this means:

-  Final experimental or model data generated within the project will be available on a dedicated project website (see section 2.2.2.2) within 3 months of data collection / production.
-  Results are owned by the party that generates them. Parties from WP1 are the “data owners” of their mobile instruments. They have the right and the obligation to evaluate these data in “their” region / environment. They have to share data on individual source types within the consortium.
-  ESRs from WP1 have to provide samples to ESRs from WP2. ESRs from WP2 are requested to carry out isotope measurements on these samples (min. 30 samples per year and ESR). ESRs



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from both WPs may use the common data for interpretation of their measurements on the local scale, respectively for interpretation of the isotope signatures on the European scale.

- ESRs will make calibrated data respectively model results available within 3 months after data collection or after model runs have been produced.
- High-resolution simulations will be made available for ESRs to optimize sampling strategy.
- When the results (samples, measurement data, model data, methods, analyses) of a certain ESR contribute significantly to a manuscript of another ESR, the former will be offered co-authorship. Co-authorship can be extended to the contributing ESR's supervisor when she / he contributes to scientific analysis or writing.
- Six months after the end of MEMO<sup>2</sup>, all data will be made publically available.
- All data marked as confidential will be treated confidential by the beneficiaries and partners, up to 4 years after the end of the project.
- Confidential data are available on a confidential level to the European Commission and the external Scientific Advisory Board.
- Background is included as defined in Annex I of the Consortium Agreement.

#### 2.2.2.1 Software tools

Most data are readable with common software tools such as MS Office, R, Python, LaTeX, IGOR, or Adobe. So no special software tools are necessary and data can easily be shared and converted.

A MEMO<sup>2</sup> GitHub repository will be discussed for code sharing and if accepted, all groups will be encouraged to share code that could be useful for other partners. Common modelling or data processing tools used by several groups will be shared through this repository or, when already available and accessible, through the standard code repository of the tool.

Beside GitHub, also GRAMM/GRAL and FLEXPART are possible options. Both are open source and can easily be shared with others.

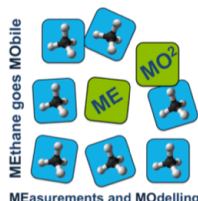
#### 2.2.2.2 Deposition of data

**Table 5:** Overview of used software tools and documentation for data deposition

Name participant	Methods / software tools to access data sets	Documentation about software needed to access data sets?	Include relevant software in open source codes, e.g. GitHub?
UU	Txt, csv or dat files created with MS office software, R, python Google earth	N/A	N/A
RUG	R, python, google earth	N/A	N/A
UHEI	R, Google Earth, excel	No	No
UVSQ			
EMPA			
RHUL	Files will be .csv or .dat so can be opened in MS Excel or by other widely used software.	N/A	N/A
LU			
WU	MicroHH, which is open source software developed and maintained at WU ( <a href="https://github.com/microhh">https://github.com/microhh</a> )	Analysis software will be written as Jupyter Notebooks (self-explaining documents), which will be accessible to MEMO <sup>2</sup> partners.	MicroHH and associated analysis tools are version-controlled at GitHub
AGH-UST	Internet browser program, excel, Open R, Google Earth – depending on data type	No	No

All data will be deposited on a dedicated repository. The suggested platform is B2SHARE, a service of the EUDAT Collaborative Data Infrastructure. The data on B2SHARE will be linked to the MEMO<sup>2</sup> website. It is the responsibility of each beneficiary to share the data and update the repository as agreed (see also 2.2.2). It is also their responsibility to provide and update on a regular basis for each data set a description of data and metadata which will be available on the MEMO<sup>2</sup> website. Suitable naming conventions and templates for the data sets will be discussed at the 1<sup>st</sup> Annual Meeting. A short workshop about how to use and upload data into B2SHARE will be given by Jutta Holst (LU) at this meeting to ensure that all participants do have the basics to work with the repository.





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#### 2.2.2.3 Restrictions of access

Data produced within MEMO<sup>2</sup> are in general open access and will be made available not only for the consortium but also outside the consortium, latest 6 months after project end. In case data cannot be shared (or need to be shared under restrictions), this will be stated in writing to the consortium, clearly separating legal and contractual reasons from voluntary restrictions.

### 2.3 Interoperability of data

As MEMO<sup>2</sup> aims to provide measurement results to an international scientific community, MEMO<sup>2</sup> will use international calibration standards and SI units for measurements and commonly accepted data standards such as the CF convention for NetCDF files for model results. This will ensure a maximum of data interoperability.

#### 2.3.1 Data and metadata vocabularies

Based on the scientific topics the groups will adopt metadata vocabularies and standards. At the 1<sup>st</sup> Annual Meeting the scheme for the consortium will be fixed. A metadata vocabulary will then be available on the project website.

**Table 6:** Overview of actually used metadata vocabularies, standards, and methodologies

**Name participant      Metadata vocabularies, standards and methodologies to make data interoperable**

UU	WMO mole fraction scales and WMO recommendations for mole fraction and isotope calibration. Format will be NASA Ames, txt or netcdf
RUG	NASA Ames, kml
UHEI	
UVSQ	
EMPA	CF convention for NetCDF files
RHUL	WMO scales / recommendations for mole fraction & isotope calibration will be followed. Isotope data will be in ‰ on the VPDB scale.
LU	
WU	CF conventions ( <a href="http://cfconventions.org">http://cfconventions.org</a> )
AGH-UST	netCDF, kml, xml, txt

#### 2.3.2 Standards

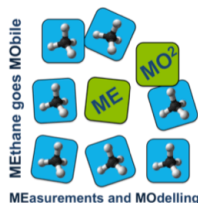
The use of calibration standards on an international scale ensures quality and comparability of data within the project. The most common used within MEMO<sup>2</sup> are scales from WMO and NOAA as well as from MPI Jena. These scales are also used in other projects in atmospheric research, e.g. ICOS.

**Table 7:** Overview of used calibration standards

**Name participant      (Calibration) standards used on an international scale**

UU	Calibrated cylinders of air from NOAA and MPI Jena.
RUG	Calibrated cylinders of air from NOAA and MPI Jena within ICOS
UHEI	WMO scale provided by NOAA and MPI Jena
UVSQ	Standards on NOAA scale
EMPA	will be element of metadata, pragmatic approach, only where suitable.
RHUL	Calibrated cylinders of air from NOAA and MPI-Jena are used to calibrate mole fraction measurements.
LU	
WU	All model output will be available as CF-compliant NetCDF4 output
AGH-UST	WMO respective scale, VPDB scale

Partners are not adhering using standards for formats compliant with available (open) software applications, and in particular facilitating re-combinations with different data sets from different origins. It has been proposed for modelling purposes to use CF-compliant NetCDF4.



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#### 2.3.3 Methodologies

A brief description of most common standards methodologies will be provided on the project website.

**Table 8:** Overview of used methodologies and protocols on an international scale

Name participant	Methodologies / protocols (international scale)
UU	WMO recommendation discussed at GGMT-2015 or GGMT 2017
RUG	The calibration gas will be prepared and calibrated in our laboratory against MPI-Jena standards with ICOS.
UHEI	WMO recommendation discussed at GGMT-2015 or GGMT 2017
UVSQ	Calibration cylinders for the mobile instrument will be calibrated at LSCE against NOAA cylinders. Instrument will be calibrated regularly and target gas will be use during campaign.
EMPA	As this is a research project that will evolve, this cannot be defined yet. Provide with metadata and references therein if suitable/necessary
RHUL	Using recommendations provided by WMO ( <a href="#">18th WMO/IAEA Meeting on Carbon Dioxide, Other Greenhouse Gases and Related Tracers Measurement Techniques (GGMT-2015), La Jolla, CA, USA, 13-17 September 2015, 150 pp. 2016</a> ). Participation in WMO round robin ( <a href="https://www.esrl.noaa.gov/gmd/ccgg/wmorr/">https://www.esrl.noaa.gov/gmd/ccgg/wmorr/</a> ) and cucumber cylinder intercomparison measurements ( <a href="http://cucumbers.uea.ac.uk/">http://cucumbers.uea.ac.uk/</a> ).
LU	
WU	
AGH-UST	WMO strategy

#### 2.3.4 Inter-disciplinary interoperability

MEMO<sup>2</sup> data will be on international measurement scales and given in SI units - or transferable to SI units – and therefore the data are inter-disciplinary interoperable. No uncommon or project specific ontologies or vocabularies are expected.

### 2.4 Re-use of data

The re-use of data is an essential target of MEMO<sup>2</sup> to encourage scientific enquiry and discussions, promote innovation and potentially lead to the production of new data. The re-use of data will increase the impact and visibility of the research and provide not only credits for the involved researchers e.g. by scientific output, but will also provide resources for training and education, and reduce the costs of duplicating data. As data will be re-used in- but also outside the consortium, an agreement on licensing and timeline of use is needed. It is also necessary to define quality standards and describe a data quality assurance processes.

#### 2.4.1 Data licences

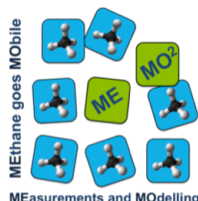
Results are owned by the party that generates them, but each beneficiary must ensure open access and free of charge online access for any use. Each beneficiary may transfer ownership of results and grant licences to its results in agreement with the conditions given in the Grant Agreement and the Consortium agreement (GA article 30, CA section 8, 9). As data will be stored in B2SHARE, the B2SHARE tool “built-in license wizard” can be used to facilitate the selection of an adequate license for research data if necessary. At the moment no transfer of ownership or licensing are planned. AGH-UST will use a NAME license for the Gaussian model.

#### 2.4.2 Timeline of data use

Data generation within the project and sharing them are requirements for all participants, therefore data will be available for the consortium at least 3 months after generation on a dedicated project website (B2SHARE). Six months after the end of MEMO<sup>2</sup> all data will be publically available. Both have been agreed on in the Grant Agreement (GA section 3, part B section 3.2.6) and the Consortium Agreement (CA, section 8, 9 and 10). In principle data will remain indefinitely re-usable, but depending on the availability of repositories and websites respectively the resources of maintenance.

#### 2.4.3 Data use by third parties

Although data are publically available after the end of the project, the consortium might agree on an embargo to use them. Third parties may be allowed to use the data in agreement with the data owner



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and have the possibilities to either cite data and publications or offer co-authorships to the owner of the data. The re-use has to be in agreement with the GA and CA.

#### 2.4.4 Data quality assurance

The quality of data is a critical issue as all data are shared within the consortium and are used for different purposes. Each partner has established quality assurance procedures, including calibration with international standards. At the 1<sup>st</sup> Annual Meeting the consortium will discuss a general data quality assurance procedure to provide a project based quality standard.

**Table 9:** Overview of used data quality assurance processes

Name participant	Used QC / QA process
UU	Data reported on international scales, problematic data will be flagged
RUG	Data reported on the WMO scales, problematic data will be flagged
UHEI	Calibration to international scales
UVSQ	Calibration and target gases will be used. Data will be QC after each day of campaign.
EMPA	
RHUL	Calibration to international scales, consistency in full metadata.
LU	
WU	Proposal: ESRs will be responsible for tested their own and other ESR data and software, reading data using tools provided by the data provider (e.g. script). So, data are provided with script that produces e.g. output (plot, statistics) that should be reproduced by the "receiving" party.
AGH-UST	InGOS standard procedure.

## 3 Allocation of resources

### 3.1 Costs

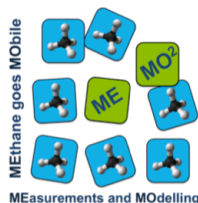
The generation, use and storage of data request the allocation of resources, not only monetary but also men power. This could include server costs, repository costs, or human resources for the generation, quality assurance and maintenance of data. Within the project those costs are covered by the EU funding and will be paid individually by the data generating parties. Costs beyond the project are not eligible.

### 3.2 Data management responsibilities

Each partner who generates data is the owner of the data and responsible for storage and accessibility as described in the Grant Agreement and the Consortium Agreement. Data will be available on the EU repository B2SHARE, it is the responsibility of the data generating parties to upload and update them in time and according to agreed quality standards. The coordinator will monitor the data management of the partners and remind on a regular basis to update the repository.

**Table 10:** Overview of used methodologies and protocols on an international scale

Name participant	Internal responsibilities for data generation, storage, backups, repository updates
UU	Thomas Röckmann, and PhD students,
RUG	Katarina Vinkovic (PhD), and Huilin Chen (PI), Marcel de Vries (technician), IT support
UHEI	ESR, Martina Schmidt (PI)
UVSQ	Sara Defratyka (PhD), Camille Yver Kwok for measurements
EMPA	
RHUL	Data to be backed up on RHUL server as soon as possible after data collection by appointed PhD students and staff.
LU	
WU	ERSs are responsible for the upload of data, and their supervisors should make sure all data is backed up and safeguarded for future use. Model MicroHH this means the ERS is obliged to work with Git and to generate CF-compliant datasets to be shared with the other ERSs.
AGH-UST	PI of project, ESR



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### 3.3 Long term preservation

As costs after the end of the project are not eligible and most partner do not have an available funding for this, the long-term preservation of data is an issue and will be discussed at the 1<sup>st</sup> Annual Meeting.

## 4. Data recovery and secure storage

MEMO<sup>2</sup> aims on a long-term input of generated data to future projects and usage for objective verifications of CH<sub>4</sub> emissions. This requests an effective and efficient data recovery and security procedure. The certified EU data repository B2SHARE, where all relevant MEMO<sup>2</sup> data will be uploaded, will back-up automatically and data can be recovered in case of local loss.

**Table 11:** Overview of planned backup strategy

Name participant	Local backup strategy
UU	All data is backed up on a designated server for the Atmospheric Physics and Chemistry Group at UU.
RUG	Raw data is archived on a local server in our laboratory, calibrated data is shared on dropbox
UHEI	Data backup on the institute server
UVSQ	Data will be uploaded onto the ICOS database as well as saved on the PhD and supervisor computers.
EMPA	
RHUL	All data is backed up on a designated server for the Greenhouse Gas Research Group at RHUL.
LU	
WU	Local analysis software will be backed-up on (i) local back-up system (ii) facilities like <a href="https://beehub.nl">https://beehub.nl</a>
AGH-UST	Data stored immediately after the collection on disk of instrument. After campaign (usually 24hours – copy is made on external mass storage disk. Copies done every 12 months of all raw data and reproduced data on mass storage disk.

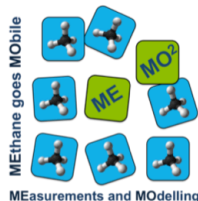
## 5. Ethical and legal issues

Except for data generation by drones there are no ethical issues related to MEMO<sup>2</sup> data. Legal issues regarding to data generation might be territorial flight permissions. This will be discussed with the relevant partners as necessary.

The frame conditions for data sharing have been agreed on by signing the Grant Agreement and the Consortium Agreement. The non-academic partners will be involved as described there and in the DMDE Plan.

## 6. OTHERS

MEMO<sup>2</sup> participants are not using other procedures for data management, except RHUL that is using the CEDA database (UK national database).



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Data Management and Dissemination & Exploitation Plan

# B – DISSEMINATION AND EXPLOITATION PLAN

## 7. Executive summary

An important goal of MEMO<sup>2</sup> is to ensure the far-reaching dissemination and exploitation of the project's results and outcomes. Dissemination and exploitation activities will be carried out throughout the project and will continue beyond to facilitate sustainability. The DMDE Plan is a living document and information and results will be updated on a yearly basis.

MEMO<sup>2</sup> aims on valorisation, i.e. to maximise the impact of the project by dissemination and exploitation. As the Technology Readiness Level (TRL) is low in this project, no commercial technical developments are expected. So exploitation will mainly mean the re-use of data as well as of developed and improved methodologies and methods. The main focus lays on dissemination of results and will include a wide range of activities to reach a broad audience as described in Section 9. Several activities already started before the project and will continue, e.g. setup of the website and its maintenance, presentation of the project at conferences and trade shows.

Several partners within the consortium already have collaborated in other projects, so MEMO<sup>2</sup> is imbedded in an established network of academic and non-academic partners, which is advantageous for dissemination and exploitation activities.

## 8. General dissemination and exploitation management

The general rights and obligations related to background and results are described and agreed on in the Terms and Conditions, Section 3 of the Grant Agreement as well as in Section 8 of the Consortium Agreement.

The dissemination and exploitation management is imbedded in the project management in WP5. WP5 is lead by the Project Coordinator, compulsory supported by input from all beneficiaries and non-academic partners. The dissemination and exploitation activities of all project participants will be monitored on a regular basis and reported towards the EU.

Regarding to the communication to stakeholders and local governments a Strategic Advisory Board (SAB) will be convened during the 1<sup>st</sup> Annual Meeting, consisting of key stakeholders and project partners to facilitate knowledge exchange with the non-academic sector beyond the consortium partners, and with local governments. The SAB will identify the most suitable communication channels to interact with such stakeholders. The culmination of this activity will be the production of a policy brief at the end of the project, facilitated by partner organizations.

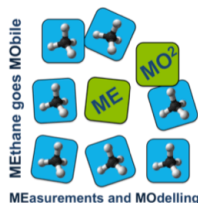
## 9. MEMO<sup>2</sup> dissemination plan

In general dissemination is the public disclosure of results, aiming on maximization of visibility. The obligations of dissemination are given in the Grant Agreement (Article 29 and related) and include that each beneficiary must generally disseminate its results as soon as possible.

### 9.1 Goals and visibility of the project

The Regulation (EU) No 1290/2013 of the European Parliament and of the Council states:

*The EU funding programmes support research and development activities resulting in new knowledge, new products and services, and also in non-technological and social innovation. EU projects are aiming on innovation and increasing benefits to the EU economy and citizens by converting the public investment. **Participants are obliged to exploit and disseminate the outcome of their projects, which means to use and communicate results and multiply the benefit of investments.***



## MEMO<sup>2</sup>: MEthane goes MOBILE – MEasurements and MOdelling

### Data Management and Dissemination & Exploitation Plan

The data and methods gathered and developed within MEMO<sup>2</sup> will provide important information on actual (and potential future) CH<sub>4</sub> emissions in Europe and provide new approaches for the evaluation of emission reduction policies. Besides others MEMO<sup>2</sup> aims on valorization, i.e. to maximise the impact of the project by dissemination and exploitation.

**Dissemination is the public disclosure of the results** by any appropriate means (other than resulting from protecting or exploiting the results), including by scientific publications in any medium.

**Exploitation is the use of results** in further research activities other than those covered by the action concerned, or in developing, creating and marketing a product or process, or in creating and providing a service, or in standardisation activities.

The obligations of the consortium regarding dissemination and exploitation are part of the GA, Section 3. The consortium has not only the obligation to disclose and use the results, but also the responsibility to ensure visibility of EU funding for the project. So any dissemination of results, including electronic dissemination must display the EU emblem and the following text:

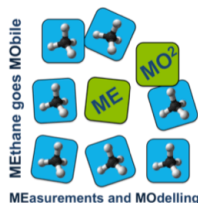
*This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 722479.*

The MEMO<sup>2</sup> DMDE Plan comprise the necessary and likely key points in the dissemination and exploitation of the project to ensure that institutions, companies, authorities and people with potential interest in the project are continuously informed about MEMO<sup>2</sup>, its content, goals and consortium partners. As MEMO<sup>2</sup> aims to extend its data dissemination and exploitation beyond the project-funding period; i.e. the project's results and products are further used and marketed, the DMDE Plan will provide the frame conditions and will be adjusted and updated in the lifetime of the project.

## 9.2 Target groups

The main target group for dissemination and exploitation are scientific communities of related disciplines, but MEMO<sup>2</sup> also aims on different stakeholder groups for communication and public engagement such as regional and national authorities and policy makers, EU authorities, and the general public including media, schools, businesses and local governments.

Various activities and channels (see also Chapter 9.3) target different user groups with different benefits, e.g. dissemination during project meetings, data repositories and network schools will target project partners, stakeholders and the EU, as well as international collaborators of the project and representatives of other networks. This will provide the most direct and detailed access to the project results for users with immediate interest. Dissemination during national and international conferences will target scientific communities related to the objectives of the project, but also stakeholders. Together with dissemination by peer-reviewed publications and reports to the EU this is the traditional pathway providing the most rigorous dissemination. Dissemination via the media will reach stakeholders, regional, national, and EU authorities, as well as the general public. All avenues of social, news and science media, popular science press, and peer-reviewed publications will be used to disseminate the project results to a wider audience. This will provide the major highlights of the project results. Measurement data generated by MEMO<sup>2</sup> will be archived in the EUDAT data repository B2SHARE (<https://b2share.eudat.eu/>) to reach users, following the data management plan and the IP rules as specified in Part A of the DMDE Plan. The project website will play a central role for wide dissemination of all the activities and to reach all target groups.



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### 9.3 Channels

The dissemination channels such as conferences, trade shows, journals, or potential collaborating projects will be further discussed and probably extended throughout the project.

#### 9.3.1 Website and online media

MEMO<sup>2</sup> actively utilizes different online media. The development of the project website (<http://h2020-memo2.eu>) started in November 2016 and was launched beginning of February 2017. It represents the main interface for the dissemination of MEMO<sup>2</sup> objectives, progress and results. The website will provide access for the wider public and experts in the field, key information on the project aims, including project summary, project components, and a detailed description of every work package. Several of the MEMO<sup>2</sup> school lectures will be recorded and made available via the website.

The website will thus provide the most comprehensive access to the project results and to all other dissemination activities of the project. The website is mostly public available, a few password-protected parts of the website will be used to facilitate internal communication among the consortium partners. It will provide a platform for internal exchange of information, documents and data files and for documentation of the MEMO<sup>2</sup> meeting and project progress. The management of the MEMO<sup>2</sup> website is provided by Utrecht University.

Also, a Twitter, Facebook, ResearchGate and LinkedIn account will be used for dissemination purposes. These will be set-up and implemented in the second half of the first year. Social media are an excellent platform to spread information and visual documentation of scientific work performed during measurement campaigns. A campaign blog on the project website will be maintained by the ESRs and established as soon as all ESRs have been appointed, but at latest at the beginning of the 2<sup>nd</sup> reporting period when the first MEMO<sup>2</sup> campaign is planned. We will also record videos during field campaigns, including short video diaries and acquire footage to edit into short online videos and for use in outreach projects. Some of these items will appear on university and research center web sites. The organization of such activities will be part of the campaign planning and organization.

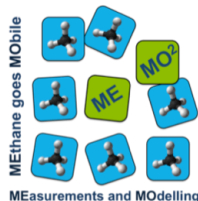
#### 9.3.2 Materials

Many aspects of CH<sub>4</sub> as a relevant greenhouse gas are of interest to the wider press, for example the methods and impacts of its extraction from underground (e.g. shale gas), how our diet might affect greenhouse gas emissions (e.g. by farming and animal breeding) or mitigation of climate change in general. Media coverage of MEMO<sup>2</sup> will be actively promoted by using existing press and outreach offices at the academic and non-academic partner organizations, which will issue press releases and raise awareness of the MEMO<sup>2</sup> project. Articles will be written for popular science media both printed (e.g. New Scientist) and web based (e.g. Science Daily, Wired:Science). The authors of articles and press releases will inform the management and provide it with copies and links.

The ESRs will be trained in presentation and media skills through a “Science and the Media” workshop given at one of the MEMO<sup>2</sup> schools. In the course of the project the management will publish regular newsletters at least twice a year, which will target the wider public and in collaboration with the partner also fact sheets about the project and its results. Both will be available in digital form on the website but also distributed as hand-outs by the consortium during suitable public events, e.g. open days, conferences, workshops or tradeshow. A logo was designed by the coordinator before the project started and is available on the website. This will be used for MEMO<sup>2</sup> dissemination activities to ensure corporate identity. Templates for presentations and poster will also be provided, but are not compulsory.

#### 9.3.3 Scientific conferences and tradeshow

Scientific conferences and tradeshow are a traditional dissemination channel for presenting project results to a broad audience. This channel is planned to be extensively used, and is also compulsory for the ESRs, as each of them has to visit at least two conferences and present her/his project results.



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Several scientific conferences and tradeshow are planned for dissemination activities, as well as for exploitation activities, e.g. by ESR training and workshops.

The following table lists possible events, but is not limited.

**Table 12:** Overview of appropriate conferences and trade shows to present MEMO<sup>2</sup>

Name conference		Next location	Time	Website
AGU	American Geophysical Union Fall Meeting	New Orleans, USA	Yearly, December	<a href="http://fallmeeting.agu.org/2017/welcome/">http://fallmeeting.agu.org/2017/welcome/</a>
EGU	European Geosciences Union General Assembly	Vienna, Austria	Yearly, April / May	<a href="https://www.egu2018.eu">https://www.egu2018.eu</a>
ACPM				
GGMT	Meeting on CO <sub>2</sub> , other greenhouse gases and related measurement techniques	Dübendorf, Switzerland	Biannual, August	<a href="https://www.empa.ch/web/ggamt2017">https://www.empa.ch/web/ggamt2017</a>
PEFTEC	Industrial Methane measurement conference	Antwerp, Belgium	Yearly, November	<a href="https://www.ilmexhibitions.com/peftec/imm-conference/">https://www.ilmexhibitions.com/peftec/imm-conference/</a>
	Intercontinental Landfill Research Symposium	Sweden	Biannual, August	<a href="http://lst.sb.ltu.se/iclrs/web/symposia.html">http://lst.sb.ltu.se/iclrs/web/symposia.html</a>
Sardinia Symposium	International waste management and landfill symposium	Sardinia, Italie	Biannual, October	<a href="http://www.sardiniasymposium.it/">http://www.sardiniasymposium.it/</a>
ICOS	Monitoring Station Assembly Atmosphere Fall Meeting	Groningen, The Netherlands	November	<a href="http://www.rug.nl/research/centre-for-isotope-research/icos-msa-groningen/">http://www.rug.nl/research/centre-for-isotope-research/icos-msa-groningen/</a>

### 9.3.4 Scientific journals

As several disciplines are involved in the project, the results of MEMO<sup>2</sup> will be published in a broad scientific range of different journals and thematic fields. Suitable journals are ACP (incl. special issues), AMT, ES+T, GRL, Atmospheric Environment, JGR, BGC, Chemia Analityczna, PJoES, Waste Management Research.

### 9.3.5 Data repositories

The consortium decided to disseminate data via the EUDAT repository B2SHARE. As part of the EUDAT Collaborative Data Infrastructure (EUDAT CDI), European researchers and practitioners from any research discipline can preserve, find, access, and process data in a trusted environment. The EUDAT CDI is a network of collaborating and cooperating centers, combining sufficient facilities with permanence and persistence of scientific data centers, including e.g. the data centers of Lund University. B2SHARE is a public data repository, available to researchers and communities in order to publish and preserve research data. B2SHARE guarantees long-term persistence of data and allows them to be published. The service is free of charge and data assigned a persistent identifier, which allows retracing the data owner and citing data sets. The management of data generated within MEMO<sup>2</sup> is described in more detail in Part A – Data Management Plan.

A short workshop about B2SHARE will be given at the 1<sup>st</sup> MEMO<sup>2</sup> school by Jutta Holst (LU) ensuring that all ESRs have the basic knowledge to work with this repository and share the data properly within in the consortium.

### 9.3.6 Project deliverables and milestones

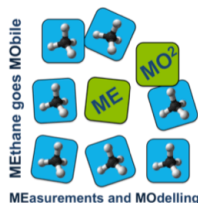
Projects aim to create knowledge and to share it. Elaborated and prepositioned deliverables can help to maximize the impact of a project in an effective and efficient way.

MEMO<sup>2</sup> - as a Horizon 2020 project - will demonstrate progress and impact by submission of in total 32 deliverables. The deliverables defined in the Grant Agreement are mostly public and will be used to disseminate data and results to the scientific community. Each deliverable is defined as a report, for which a general template will be available. The template can be modified regarding to the content of a deliverable,



**Fig. 2:** overview of submission timeline for deliverables





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e.g. reporting a methodology requires different information than reporting results of measurement campaigns. To ensure high quality of the deliverables and convincing presentation of the project to the public, a general timeline and review procedure has been agreed on by the consortium (see Figure 2).

#### 9.3.7 Societies and organizations

Selected societies and organisations, which might be interesting to collaborate with MEMO<sup>2</sup> are the Royal Society, Environment Agency-UK, NPL, AEA-Ricardo, WMO, IGAC, or Dutch emission administration.

#### 9.3.8 Collaborations and synergy with other projects

Collaborations and synergies might be possible with projects such as the MOYA Global methane project (UK NERC funded project led by RHUL) or ICOS. MEMO<sup>2</sup> could be represented by sharing data products, at meetings and conferences, or by providing protocols.

#### 9.3.9 MEMO<sup>2</sup> schools, workshops, courses

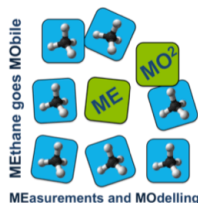
MEMO<sup>2</sup> will offer different training events embedded in the training of the ESRs such as two MEMO<sup>2</sup> schools, local workshops and skill courses. It depends on the needs of the ESRs and requests of the consortium. If possible, the MEMO<sup>2</sup> training events will be open to participants from outside the consortium. This depends on budget and facilities. Those training events will be used to present and disseminate project results.

## 9.4 Dissemination timeline

Dissemination is an ongoing process during and beyond the project. All channels will follow their own timelines and most depend on e.g. time of recruitment and progress of ESR projects. A preliminary planning is given in the following table:

**Table 13:** Preliminary dissemination timeline, responsibilities and target audience

Channel	Nature	Main goal	Responsibilities	Main audience	General timeline
Website	Digital	Internal exchange, general public information	Coordinator	Public, scientific community, stakeholders	Project lifetime and beyond
Online media	Digital	General public information	Coordinator	Public, scientific community, stakeholders	Project lifetime and beyond
Articles/press releases	Print / digital	General publication	All	Public, scientific community, stakeholders	Project lifetime and beyond
Newsletters	Print / digital	General publication	Coordinator	Public, scientific community, stakeholders	Project lifetime, approximately twice a year
Fact sheets	Print / digital	General publication	Coordinator	Public, scientific community, stakeholders, policy makers	Project lifetime, depending on the audience (e.g. for policy makers end of the project, for scientific community as soon as the first results are available)
Conferences/tradeshows	Oral / print	Presentation of the project and results	All	Scientific community, stakeholders	Project lifetime and beyond
Scientific journals	Print / digital	Publication of results	All	Scientific community	Project lifetime and beyond, increasing output expected towards the end of the project
Data repositories	Digital	Data sharing	All	Scientific community	Project lifetime and beyond, start with generating first data, availability of data at least 3 months after generating them
Deliverables/milestones	Digital	Publication of project results	All	Scientific community, EU, policy makers	Project lifetime and beyond
Collaborations	Networking	Networking	All	Public, scientific community, stakeholders, policy makers	Project lifetime and beyond
schools/workshop/courses	Education	Education	All	Scientific community, stakeholders	Project lifetime, as soon as all ESRs are recruited



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### 10. MEMO<sup>2</sup> exploitation plan

In general exploitation is the use of results, aiming on maximization of impact and valorisation of results. The obligations of exploitation are given in the Grant Agreement (Article 28 and related) and include that each beneficiary must take measures aiming to ensure exploitation of its results – up to four years after the project.

The exploitation of data and results - in- and outside the consortium - requires agreements and procedures on Intellectual Property Rights, licenses, and exploitation strategies.

#### 10.1 Intellectual Property Rights

The frame conditions are defined in the Grant Agreement (Terms and Conditions, Section 3 and related; Part B, Section 3.2.4) and the Consortium Agreement (Section 8-10 and related). The consortium will follow the Commission Recommendation C(2008)1329 on the management of intellectual property. The recommendations will be available on the website. RHUL has established and publicised policies and procedures for the management of IP in line with the code of practice (<https://www.royalholloway.ac.uk/iquad/collegepolicies/documents/pdf/research/intellectualpropertypolicy2014.pdf>).

#### 10.2 Exploitation strategy

The exploitation strategy is based on user requirements and objectives of the project. As MEMO<sup>2</sup> aims on I) training of ESRs and II) a long-term input of generated data to future projects and usage for objective verifications of CH<sub>4</sub> emissions, the focus of the exploitation strategy will lay on the utilization of data and knowledge transfer.

The data management has been described in Part A – Data Management Plan. The transfer of knowledge will be based on I) the training elements as described in Section 1.2.1 “Overview and content structure of the training” in Part B of the Grant Agreement, and on II) the project deliverables.

The exploitation strategy will be discussed in detail during the 1<sup>st</sup> Annual Meeting and closely involve the Strategic Advisory Board (SAB).

#### 10.3 Market analysis

MEMO<sup>2</sup> is a scientifically focused project with only low TRLs. Therefore market potential and analyses are not relevant within the project.

### 11. History of the document

**Table 14:** History of the document

Version	Author(s)	Date	Changes
1	Sylvia	9 May 2017	Set-up first draft DMDE plan
1	Sylvia	14 June 2017	First draft sent to consortium
1		5 July 2017	Deadline requested input from each beneficiary and partner to the coordinator (reminder sent 4 July 2017)
1	Sylvia	26 July 2017	First draft re-circulated to consortium for comments and additional request of information
1		9 August 2017	Deadline requested input from each beneficiary and partner to the coordinator
1	Sylvia	23 August 2017	Pre-final version sent to coordinator
1		31 August 2017	Submitted to EU