DELIVERABLE 7.3

Data Management Plan

Main Authors

Volker Krey and Jennifer MacDonald

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Lead author(s):	Volker Krey, Jennifer MacDonald
Contributors:	Christina Cattaneo, Eoin Grealis, Philip Hackstock, Florian Nachtigall, Dominik Wiedenhofer, Ellen van der Werff, Elena Verdolini

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Executive Summary

The CircEUlar project will produce a number of data sets for internal and public use. This Data Management Plan describes these data sets, including information regarding standards and metadata, data sharing and archiving and preservation. The aim of the plan is to ensure that data produced by the project will satisfy Horizon Europe data management guidelines. Care has been taken in the plan to describe how the data will be FAIR — Findable, Accessible, Interoperable and Re-usable. The plan also describes the data that will be generated by the CircEUlar project, whether and how they will be made accessible for verification and re-use, and how they will be curated and preserved.

Keywords

Data sets, database, scenario, inventory

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Abbreviations

BOKU	University of Natural Resources and Life Sciences
CC-BY-NC	Creative Commons Non-Commercial license
CC-BY-SA	Creative Commons Attribution Share-Alike
CD-Links	Linking Climate and Development Policies – Leveraging International Networks and Knowledge Sharing
CircEUlar	Developing circular pathways for a EU low-carbon transition
DOIs	Digital Object Identifiers
ECEMF	European Climate and Energy Modelling Forum
ENGAGE	Exploring National and Global Actions to reduce Greenhouse gas Emissions
EUBUCCO	EUropean BUilding stock Characteristics in a Common and Open database for 200+ million individual buildings
EU	European Union
LMU	Ludwig Maximilian University of Munich
MCC	Mercator Research Institute on Global Commons and Climate Change
NAVIGATE	Next Generation Of Advanced Integrated Assessment Modelling To Support Climate Policy Making
IIASA	International Institute for Applied Systems Analysis
IPCC	The Intergovernmental Panel on Climate Change
IPCC AR 6	IPCC Sixth Assessment Report
IPCC WG 3	IPCC Working Group 3
openENTRANCE	open ENergy TRansition ANalyses for a low-Carbon Economy
SET-Nav	Navigating the Roadmap for Clean, Secure and Efficient Energy Innovation
WP	Work Package

Data Management Plan

Introduction

The CircEUlar project will produce a number of data sets for internal and public use. The list below provides an overview of the data sets to be generated within the project, along with the work packages that are responsible for these data sets (in parentheses):

- Material stock, flow and intensity data sets (WP2)
- Online tool with data, information, and evidence of business models for the circular provision of goods and services (WP3)
- Open-access provision of empirical data on acceptance and adoption of circular consumption practices (including survey data with documentation and descriptive analysis) (WP4)
- Open-access dataset of model-based scenarios/pathways (CircEUlar Scenario Explorer) (WP6)

Care has been taken in the Data Management Plan to describe how the data will be FAIR—findable, accessible, interoperable and re-usable. The plan also describes the data that will be generated by the CircEUlar project, whether and how they will be made accessible for verification and re-use, and how they will be curated and preserved.

Each data set is described in detail further in the report, including information regarding standards and metadata, data sharing and archiving and preservation. The aim of the plan is to ensure that data produced by the project will satisfy the Horizon data management guidelines. The data plan will be updated periodically, and additional details for each data set will be added as the project advances.

To the degree it is compliant with data protection regulations, all research data sets produced in CircEUlar are also intended to be used outside of the project. Experience in particular with existing scenario databases has shown that re-analysis and use of the data beyond the original purpose is pursued heavily if provided on-line (e.g., as in Horizon 2020 projects CD-LINKS and ENGAGE). The scenario data for the CircEUlar project will be hosted in a CircEUlar Scenario Explorer and remain hosted there beyond the end of the project.

Guiding Principles

Discoverability

To aid the discoverability of data sets, digital object identifiers (DOIs) will be obtained for each data set when adequate. As a general rule, Zenodo is used for registering datasets and providing metadata. To make the CircEUlar products more easily findable, a~~n~~ CircEUlar Zenodo community has been registered that links the datasets and other products from CircEUlar. In addition, the underlying scientific publications (reports and peer-reviewed journal articles) will cross-reference these datasets (using metadata).

Accessibility

To ensure accessibility beyond the duration of the project, the use of proprietary data formats will be avoided. In addition, when web-based interfaces are used to display and visualize, the underlying data will also be made accessible in numerical form to ensure accessibility and encourage re-use.

Accessibility and intelligibility

Data sets will be made available to reviewers of scientific publications to aid transparency in the review process. Access will be provided through open data repositories such as Zenodo or ReShare. In addition, dedicated online tools will be developed to provide more convenient, user-friendly access to some of the data sets (e.g., business mode survey data in WP3 and scenario data in WP6). As an example, access to scenario data will be granted via the CircEUlar Scenario Explorer, which is hosted by IIASA and will remain active after the project's end.

Usability beyond the original purpose for which the data was collected

The majority of data sets produced in CircEUlar are intended for use both within the project and external to the project. To foster re-analysis and use of the scenario data beyond the project, data will be made available online including documentation.

Interoperability to specific quality standards

Following the completion of investigative analysis by the various partners, the scenario data produced in the CircEUlar project will use data formats and metadata standards established by the Integrated Assessment Modeling Consortium (IAMC). Applying community standards will allow easy combination with data sets from other European or international projects that rely on energy-economy and integrated assessment models.

Data sets

Each data set is described in greater detail in the following sections.

Material stock, flow and intensity data sets (WP2)

Data Summary

Work by BOKU in Task 2.1 will update, re-use and expand upon ongoing research conducted in the ERC-AdG project MAT_STOCKS, which follows open access guidelines. Specifically, BOKU is going to develop a novel energy and GHG emissions module for the stock-flow consistent modelling framework developed in the ERC AdG project, updating and refining other model input data developed in the previous project, which will be published open access alongside a GitHub repository with all code, documentation including Jupyter notebook examples.

Work by MCC, EUBUCCO, as a main deliverable of Task 2.3, is a scientific database of individual building footprints for 200+ million buildings across the 27 European Union countries and Switzerland. Additionally, building type, height and construction year are included for respectively 45%, 74%, 24% of the buildings. EUBUCCO is composed of 50 open government datasets and OpenStreetMap that have been collected, harmonized and partly validated. It provides the basis for high-resolution urban sustainability studies across scales – continental, comparative or local studies – using a centralized source and is relevant for a variety of use cases, e.g., for energy system analysis or natural hazard risk assessments.

FAIR Data

Making data findable, including provisions for metadata

A DOI is registered for the EUBUCCO dataset through Zenodo. A description of the data format and included attributes is available at https://docs.eubucco.com/data/. Further metadata are provided for download as supplementary files in machine-readable formats.

Metadata on source datasets are provided including dataset name, version, resource URL, access date, license and data owner. Further, an overview of existing datasets that were not included is provided, and a rationale is given as to why. For categorical data such as building type that was harmonized across the source datasets, a mapping between source and harmonized values is provided. Metadata on the administrative boundaries used are provided.

Making data accessible

All publications produced by Task 2.1 will be made open access, either directly via the journals or in the form of pre-prints on Zenodo, including DOIs. Similarly, program code and data are going to be published open access and machine-readable via GitHub and Zenodo, including documentation and rich meta-data for optimized discovery, re-usability and indexing/archiving.

EUBUCCO dataset is publicly available for bulk download from Zenodo. The download of a subset of the EUBUCCO data for specific regions or countries is supported by a dedicated website (https://docs.eubucco.com/data/) maintained by the research group. The EUBUCCO data is downloaded via HTTPS.

Around 95% of the EUBUCCO data are subject to restrictions of use according to the Open Data Commons Open Database License (ODbL) v1.0. The only exceptions are building stock data from Prague which are licensed under CC-BY-SA and data from Abruzzo which are licensed under CC-

BY-NC. The EUBUCCO dataset is publicly available without access restrictions nor the need for access requests.

The EUBUCCO metadata is also hosted on Zenodo and will be available as long as Zenodo provides this service. No software is needed for accessing EUBUCCO dataset, though data access via a Python pip package is planned, with source code available on GitHub under an MIT license.

Making data interoperable

The EUBUCCO dataset is available as a GeoPackage, an open, standards-based, platform-independent file format for both raster and vector data. Additionally, the building attributes can be downloaded as a CSV (Comma Separated Values) file.

Increase data re-use

For the final BOKU deliverables and publications, all copyright issues are going to be considered and published data will be aggregated in a manner, that they can become open access.

Additional EUBUCCO documentation and use-case examples in the form of Jupyter notebooks are made available on GitHub. These examples provide insight into how to visualize the data and process it further for geospatial analysis.

Other research outputs

BOKU plans to substantially expand upon the European Commission's Circular Economy Monitoring Framework implemented by EUROSTAT, which was originally developed by BOKU and which has already been published fully open access (Mayer et al., 2019, *Journal of Industrial Ecology*). Work by BOKU will be useful for practitioners and researchers working on resource use and climate change mitigation in general, as well as those working on the circular economy, resource efficiency and climate change mitigation specifically.

In addition to the EUBUCCO dataset, the Mercator Research Institute on Global Commons and Climate Change (MCC) team has open-sourced the source code of the data pre-processing and harmonization pipeline (https://github.com/ai4up/eubucco) to make the dataset reproducible by others and facilitate integration of new source datasets in the future.

Allocation of resources

To feed into Task 2.1, publicly available databases from Eurostat, IEA, and others are going to be used, to some extent paywalled industry statistics are going to become necessary also, whose costs are budgeted for.

Currently, the data-related costs of the EUBCCO project are covered by MCC and the AI4UP research group collectively maintains the data. Though, the MCC team are exploring further mid-term options for managing and maintaining the data to ensure continued currency, ease of access and high reuse aligned with the public interest. As of now, long term preservation of the dataset is ensured by Zenodo.

Data Security

To ensure high availability, the EUBUCCO data is available via a redundant setup on Zenodo and on MCC's own dedicated server. Additionally, Zenodo has committed to ensure long term preservation of the data. If all safety mechanisms fail, the dataset can be regenerated with a high

degree of automation based on the open-sourced data preprocessing and harmonization pipeline on GitHub.

Ethics

The EUBUCCO dataset does not contain any personally identifiable information.

Other issues

N/A

Online tool with data, information, and evidence of business models for the circular provision of goods and services (WP 3)

Data Summary

Within WP3, a database of available circular approaches in the provision of goods and services will be built using systematic literature review and stakeholder engagement. The database will be openly accessible as an online tool. The tool will allow a user-friendly consultation of data, information, and evidence of business models for the circular provision of goods and services.

For stakeholder engagement, survey data on producers' perceptions of consumer preferences will be collected. No existing data will be reused, as to the best of our knowledge, no data set that encompasses the necessary data for our analyses exists. The format of the data will be responses on survey items. Conclusions on the research questions will be drawn based on the sample results. The data might also be useful for projects that want to examine relationships between the collected variables (looking at relations within the sample), too, or that aim to collect similar data at a later point in time and would like to see changes over time.

FAIR Data

Making data findable and accessible

In order to make the online tool findable, we will create a document, that describes the functionality of the tool, the procedures that we employed to generate the dataset and the link to the online tool. The document will contain keywords. The descriptive document will be uploaded in Zenodo which will generate a DOI. The link to the tool will also be provided in a report and the published scientific article with results of the systematic literature review.

For the survey data, DOIs will be obtained to aid their discoverability. The acquired datasets will be added to the CircEUlar Zenodo community. Furthermore, the resulting scientific publications will cross-reference these datasets. Metadata will include the questionnaire scales, code of analysis and keywords will be provided to optimise the possibility for discovery and potential reuse. Access will be provided through open data repositories such as Zenodo. Any embargo placed on data accessibility will be limited to the duration of the CircEUlar project. Any embargo for data publication will only be employed for the duration of the CircEUlar project. If a publication is pending at the end of the project, the embargo will be prolonged until the publication process is completed.

Making data interoperable

The tool is an online interface for data consultation. A tutorial using tips will guide the users to the different functionalities of the tool.

In order to ensure that survey data collected will be interoperable to the greatest extent possible, data made available will be in simplified non-proprietary (.csv) format.

Increase data re-use

To increase the re-use of the data on business models and practices for the circular provision of goods and services, which are used to build the tool, the source dataset will be freely available upon request. A link for setting the request of the data will be provided in the web page hosting the tool. The descriptive document, uploaded in Zenodo, will contain information on methodology, data cleaning, analyses, variable definitions, to increase re-use.

Other research outputs

N/A

Allocation of resources

N/A

Data Security

N/A

Ethics

N/A

Other issues

N/A

Open-access provision of empirical data on acceptance and adoption of circular consumption practices (including survey data with documentation and descriptive analysis) (WP 4)

Data Summary

For WP4, primary data will be collected in two phases. The first phase will consist of the collection of consumption biographies concentrating on the three focus areas of Digitalisation, Mobility and Household and Building services (Tasks 4.2-4.4). These will be collected by participating partners through interviews with at least 60 households across the Netherlands, Germany and Italy with potential contributions from other European partners. These qualitative consumption biographies will provide the basis for an extensive national representative survey, to be administered to representative samples in participating countries.

The format of the data will be (i) biographical interview and (ii) survey responses on circular consumption practices. These will be stored as CSV files and made available in other common formats where practical to increase accessibility. The purpose of the data generation is to test the research questions on promising circular consumption practices through examining relationships in the collected sample.

The collected data may be useful for projects that want to re-examine relationships between the collected variables and to compare results with similar data collected at a later point in time.

FAIR Data

Making data findable, including provisions for metadata

Data, in so far as is practically possibly, given confidentiality and data protection obligations, will be FAIR following the conclusion of the project in accordance with the guiding principles outlined in the CircEUlar Data Management plan. To aid the discoverability of data sets, DOIs will be obtained for each data set released. The acquired data sets will be added to the CircEUlar Zenodo community. Furthermore, the resulting scientific publications will reference these datasets. Metadata will include the questionnaire scales, method of analysis, and keywords will be provided to optimise the possibility for discovery and potential reuse. Codebook(s) detailing the nature and justification for each variable collected will be made available for each data set.

Data sets will be collected independently. Persistent anonymised identifiers will be used with any identifying information held only by the collecting partner in order to facilitate compliance with data protection and privacy obligations.

Making data accessible

Data sets with accompanying metadata will be made available to reviewers of scientific publications to aid transparency in the review process. Access will be provided through open data repositories such as the CircEUlar Zenodo community or ReShare. Any embargo place on data accessibility will be limited to the duration of the CircEUlar project or if a publication is pending at the end of the project, be prolonged until the publication process is completed.

The data will be made available in accordance with Open science principles. Before data is shared, data will be assessed in order to ensure that no personal or sensitive data is made public and that anonymised participants are not identifiable. Only fully anonymized data and in certain cases, aggregated results may be made publicly available. In the event that participants no longer wish for their data to be openly accessible or re-used, procedures to ensure the removal of such data from the data set will be implemented where possible.

Metadata

Metadata will be made openly available on the CircEUlar Zenodo community, including all necessary information to enable the user to access the data. This entails the questionnaire and method of analysis. Necessary documentation and referencing of software to access or read the data will be given.

Making data interoperable

In order to ensure that data collected will be interoperable to the greatest extent possible, data made available will be in simplified non-proprietary (.csv) format.

It is not intended to include qualified references to previous research. In the case of collected biographical interview data, some qualifications will likely be necessary in order to protect the confidentiality and privacy of participants e.g., the removal of data which objectively could potentially identify participants.

Datasets, questionnaire formats and methods of analysis will be shared openly and in case of use of uncommon ontologies or vocabularies for the project, these will be explained in the published method of analysis.

Increase data re-use

In order to increase data re-use, data will be published in a cleaned format with the cleaning code accessible for examination. The data that is being made available will be usable by third parties as soon as they are made public following any embargo period. The provenance of the data can be extracted from papers based on the referenced data set (i.e., methods section).

To ensure data quality, quality checks appropriate to the nature of the collected data will be deployed (e.g., checking for the time spent on the questionnaire, repeated answering patterns and overall response completeness. Responses that do not meet basic requirements will be excluded from the cleaned data. For individual analysis specific requirements for in/exclusion should be reported in the methods section of papers using the data as well as the code of analysis.

Other research outputs

N/A

Allocation of resources

N/A

Data Security

WP4 data gathered and analysed for the purposes of research carried out by staff and students at the LMU Munich will be stored on secured LMU hardware and LRZ servers in such manner that allows compliance with applicable data protection and privacy legislation.

WP4 Data handled by RUG will be deposited in the university-internal Y-drive that can only be accessed by RUG staff.

Participating partners involved in data collection will be individually responsible for maintaining and observing agreed data collection and security protocols including the preservation of the anonymity of participants.

Ethics

Data gathering, analysis and storage at LMU for the purposes of research will be conducted in accordance with the Bavarian Data Protection Act (BDPA) and the General Data Protection Regulation (EU) 2016/679. The BDPA complies with national and EU legislation and privacy/ confidentiality measures (European Directive 95/46/EC, covering collection and processing of personal data for scientific purposes)

Informed consent will be sought from each participant for the long-term preservation and sharing of anonymised respondent data with the respondents right to withdraw clearly outlined.

Other issues

N/A

Open-access dataset of model-based scenarios/ pathways (CircEUlar Scenario Explorer, WP 6)

Data Summary

Within WP6 of CircEUlar, a set of net-zero GHG emission pathways that explore the climate, economic, environmental, and social consequences of different circular economy strategies will be co-developed with stakeholders. This includes both the development of narrative elements as well as fully quantified pathways based on a suite of linked modelling tools. Insights generated by empirical analyses in the three focus areas will be integrated into the pathways analysis based on the new model developments on scaling up circular economy. Additional insights into the effectiveness of circular economy strategies to reduce GHG emissions will be created by generating a large ensemble of pathways that implement individual and combined circular economy strategies as well as uncertainties related to their parameterization.

This pathway information will be shared with scenario users via the widely adopted Scenario Explorer infrastructure[1].

FAIR Data

Making data findable, including provisions for metadata

In order to make the scenario and pathway data findable, a DOI will be registered for all CircEUlar scenario datasets through Zenodo which integrates well with the OpenAIRE infrastructure that supports the adoption of open science practices in Europe. To further improve the visibility of the CircEUlar scenario datasets, they will be added to relevant Zenodo communities (e.g., IAMC community[2], industrial ecology community[3]).

Metadata about the scenarios and models used in CircEUlar will also be collected, using the data standards developed by the Integrated Assessment Modeling Consortium (IAMC) which have also been adopted in recent IPCC reports (see 'Making data interoperable').

Making data accessible

In general, scenario and pathway data will initially only be available to consortium members, selected collaborators and reviewers. Once the corresponding scientific articles are published, a public version of the Scenario Explorer will be set up with a suitable set of scenarios and variables. Links to this instance of the Scenario Explorer will been included on the CircEUlar website.
Data snapshots of the pathways data that relate to final products of the project will be deposited on Zenodo, DOIs will be issued, and annotated with appropriate metadata. The DOI metadata will contain all relevant information on licensing, versioning and related publications and, if applicable, previous data sets. Any upgraded or newer versions of data will be issued with a new DOI that includes information on any previous versions. The scenario data itself will be made available under the CC-BY licence, the metadata will be released under CC0 license.

[1] https://iiasa.ac.at/scenario-ensembles-and-database-resources
[2] https://zenodo.org/communities/iamconsortium/
[3] https://zenodo.org/communities/indecol/

Making data interoperable

Data will be collected using the data template defined by the IAMC[4] which is widely used in the modeling community, including by the IPCC (e.g., in IPCC 5th and 6th Assessment Reports and Special Report on 1.5C). Metadata about the scenarios and models used in CircEUlar will also be collected, using the same format as the IPCC AR6 Scenario Explorer. Modeling protocols are to be stored alongside the scenario data and metadata. For the purpose of analysis, consolidated data snapshots of scenario data in .csv file format will be generated and made available for download via a public Scenario Explorer instance. Metadata for the datasets is provided via Zenodo[5] through which a DOI will be registered.

Increase data re-use

Beyond the use of community data standards for scenarios, the submission of pathway information to meta repositories, such as IPCC scenario databases, has been proven an effective measure to encourage reuse of scenario data. The CircEUlar consortium will therefore submit scenario datasets to such data collection and assessment efforts.

Other research outputs

The Scenario Explorer infrastructure is currently the most widely used data hub for global integrated assessment modelling comparisons and the IPCC WG3 scenario assessment. It has also been applied in several projects with a global (e.g., Horizon2020 projects CD-LINKS, ENGAGE, NAVIGATE) and European focus (e.g., SET-Nav, ECEMF, ARIADNE and openENTRANCE). It serves as a central destination for modellers, facilitating cooperation and exchange across countries and modelling groups. The main feature is an intuitive web user interface that enables not just experts but a wider audience to visualize and compare scenario results and input data. The infrastructure also supports automated validation steps to ensure consistency and completeness of scenarios submitted to the database by modelling teams, and it provides several possibilities to efficiently retrieve data for subsequent use by modelling.

Allocation of resources

IIASA has appointed Institutional Data Stewards and an Institutional Data Coordinator, who are overlooking and developing data management practices and retention requirements to ensure compliance with funders and legal requirements. IIASA has allocated four person months in connection with this activity over the course of the project.

Data Security

Data Archiving and Availability

All working and development copies of model registration forms and scenario data templates submitted to the scenario database are stored temporarily on GitHub. Upon finalization and completion, they are stored on Zenodo for long-term storage and access. In addition, the imported data in the underlying ORACLE database will be backed up on a daily basis in the form of database dumps. The database snapshots are also archived using a suitable publication and data repository for which Zenodo has been used so far that allows issuing metadata and, where appropriate, a DOI with the data (see above). The DOI metadata contains all relevant licensing, versioning and related publications or previous data sets. Any upgraded or newer versions of data will be issued with a new DOI that includes information on any previous versions. Within the

[4] https://github.com/openENTRANCE/nomenclature

[5] https://zenodo.org/communities/engage-climate

repository, older versions will be marked, and users will be directed to the updated information. Access to this data will be maintained for a minimum of 10 years.

Ethics

N/A

Other issues

N/A

For more information:

http://circeular.eu

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