



DELIVERABLE

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Title	Converting <u>WASTE</u> to offer flexible <u>GRID</u> balancing <u>Services</u> with highly-integrated, efficient solid-oxide plants
Duration	18 months
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Lead beneficiary	DTU
Authors (beneficiary)	Mar Pérez-Fortes (EPFL), Ligang Wang (EPFL)
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Disse. level (PU/CO/CI)	PU
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Comments	Revised version according to mid-term review report

Summary

The purpose of this deliverable is to describe the way how the W2G project manages the data: data creation, use, analysis, storage, sharing and reuse. This document includes as well the intellectual property agreement.



1. Data summary

The overall objective of the Waste2GridS (W2G) project is to identify the most promising industrial pathways of waste gasification and solid-oxide cell (SOC) integrated power-balancing plants. W2G project performs in essence conceptual design work, a theoretical investigation of waste-based grid-balancing plants. As such, data collection / generation are crucial. The project has the actions below with a large amount of data to be managed:

- (1) *Data collection and analysis.* Identification of grid-balancing needs of renewable energy sources (RES)-dominated power-generation zones with the historic data (local power generation and consumption) from grid operators and their prediction for 2030. This allows to find the zones with different scales of grid-balancing needs in the future.
- (2) *Data collection and analysis.* Identification of available wastes in a larger zone covering the identified zone and its prediction for 2030, as the waste supply chain can be critical for the feasibility of waste-based plant's applications.
- (3) *Data collection and analysis and data generation.* Identification of preferred (current and future) balancing scenarios. By analysing various historical balancing needs and future predictions, a pool with a variety of balancing scenarios can be generated. A balancing scenario is defined as the ratios of up-/down-regulating hours and average up-/down-regulating loads of the electric grid, which correspond to the ratios of the operating hours and average loads of power generation or storage modes of the balancing plant. The balancing scenario sets the most important constraint to the conceptual plant design.
- (4) *Data generation.* Generation of the pool of optimal plant designs covering all balancing scenarios with the superstructure-based process design platform (OSMOSE). For each balancing scenario (even not existing in the scenario pool), there will be several available optimal plant designs generated based on a database of components to be integrated.
- (5) *Data generation.* Design selection, plant sizing and scheduling to meet the specific grid-balancing need. This identifies the plant design and size, which best match the grid-balancing needs.
- (6) *Data generation.* Proposal of case studies, based on supply chain optimization. A W2G case study is defined as a specific, existing RES-dominated power-generation zone with identified grid-balancing need and available waste in and around the zone itself, a specific plant design with corresponding size (which can be supported by the identified available wastes) and operating strategy to meet the grid-balancing need.
- (7) *Data generation.* Description of the development path and upscale strategy, technical bottlenecks of the technology and promising business cases.

Each one of the partners has a different area of expertise and experience concerning the different objectives of the project; therefore, the project will use, adapt and update already existing models, tools and data. See below, between brackets, the partners that have previously worked, and will work, into each one of the previously mentioned objectives.

- (1) Identification of long-term RES dominated power generation zones and of grid balancing needs (DTU and ENEA) for the identified zones in Denmark and Italy. Different scales of power capacity will be collected from their respective national transmission system operators or local distribution system operators (in *csv* or *xlsx* format).
- (2) Identification of long-term available organic waste streams (ENEA and DTU) for the identified zones in Denmark and Italy. The biomass source dataset will be built in the geodatabase format, Lambert equal area projections, the formats to be used in GIS software and convertible to raster or ASCII file.



The spatial resolution will be the EU NUT3 level and major cities. The geodatabase will also include additional attributes, e.g., price and current use of biomass feedstocks, when available. Final data will be available in *csv* or *xlsx* format. Customized thematic maps representing biomass sources will be provided with biomass availability and streams.

- (3) Matching points (1) and (2), a preselection of potential zones will be completed based on the biomass waste availability ratio and the RES dominated zones (ENEA). Gathered biomass data envisages moisture content, lower heating value (LHV), bulk density and seasonality, if relevant (MJ/selected timescale). Biomass transport (mainly trucks), storage and pre-treatment (if needed) means will be characterized by their investment cost, operating and maintenance costs, scale and biomass properties change. Power balancing needs (energy profiles) at different timescales (MWh hourly / daily / weekly / monthly) will be identified. Both sources will be geo-located based on their UTM coordinates, and characterized as well by their estimated price (EUR/t and/or EUR/MWh). Data will be available in *csv* or *xlsx* format.
- (4) W2G plant modelling, including (i) biomass handling and pre-treatment, (ii) biomass gasification, (iii) syngas cleaning and conditioning, (iv) solid oxide reversible stack and (v) methane synthesis and purification. The models already developed (EPFL) for points (i), (ii), (iii) and (v) will be further adapted for wastes (EPFL) and validated with first hand expertise and back-of-envelope modelling results, or literature (ENEA). Economic and performance data of the considered technologies will be collected in a *csv* or *xlsx* file. The software Aspen Plus will be used for process modelling. The Aspen Plus files will be in *apw* or *bkp* format. Matlab (file extension *m*) and/or Lua (file extension *lua*) will be used for design optimization based on efficiency and/or cost. The output data will be preferably converted to *csv/xlsx* and *txt/docx* for further use.
- (5) Together with point (6), conclusions about optimum plant sizes, plant scheduling and possible supply chains will be drawn based on system optimization and supply chain optimization (EPFL). The software Aspen Plus will be used for process modelling. The software GAMS and/or AMPL will be used for supply chain optimization (matches between biomass sources - biomass transport detail, electricity generators, W2G location, size and scheduling), customizing the already developed tool in GAMS; format *gms* for GAMS and *txt* for AMPL. For the identified promising case studies, the flexibility of plant scheduling for grid integration is investigated with different assumptions of time requirement of plant-mode switch (DTU). The output data will be converted to *csv/xlsx* and *txt/docx* for further use and dissemination.
- (7) SORC development path and upscale strategy, technological bottlenecks and business cases (SP, all). Results, based on bibliographic data, industrial experience, previous results (optimizations) and economic calculations in Matlab (*m* file), Lua (*lua* file) and/or Excel (*xlsx* file) will be preferably reported in *csv/xlsx* and *txt/docx* for further use and dissemination.

W2G project will collect and generate an important amount of data, know-how and knowledge (i.e. the results of the project). There will be two categories of data:

1. The input data required for the various optimizations.
2. The output data from optimization(s) and further studies.

The existing models, as well as the new adapted models for the purposes of the W2G project, will remain with the organizations. We anticipate that the data produced in category 1 can go up to several tens of MB. The model files are between 1 to 10 MB / each. Several hundreds of MB are required to perform the optimizations. The total volume needed may go up to 1 TB. The members of the consortium will be free to use the knowledge and tools generated by them during the project for other projects or actions. Ideally, further work in the field



to W2G will imply the study of further European areas or countries, and/or the inclusion and study of other waste-treatment technologies.

In general, the data and results generated from this project will be useful to other organizations that are interested in energy storage, biomass sources quantification and location, particularly in Denmark and Italy. Also for possible technology investors. Particularly important for W2G project are (i) the bioenergy community, regarding the best way of using biowaste, and (ii) the transmission system operator's, regarding the accommodation of electricity storage plants in their electricity grid planning. The data management of this project is supported by the Research Data Library Team of the EPFL. The potential intellectual property (IP) generated from this project will be fully discussed and exploited with help from the institutional Technology Transfer Office (TTO) from the EPFL.

2. Fair data

2.1. Making data findable, including provision of metadata

We propose a folder structure allocated to the project. The W2G folder will contain subfolders for reports, presentations etc. (templates), written deliverables, publications, and one for 'Data'. The latter, in turn, is attributed to a particular Work Package (WP). Within a WP, data may be either of the category 1 or category 2. Folders will be named according to the WP Task to which they belong. See as example Figure 1.

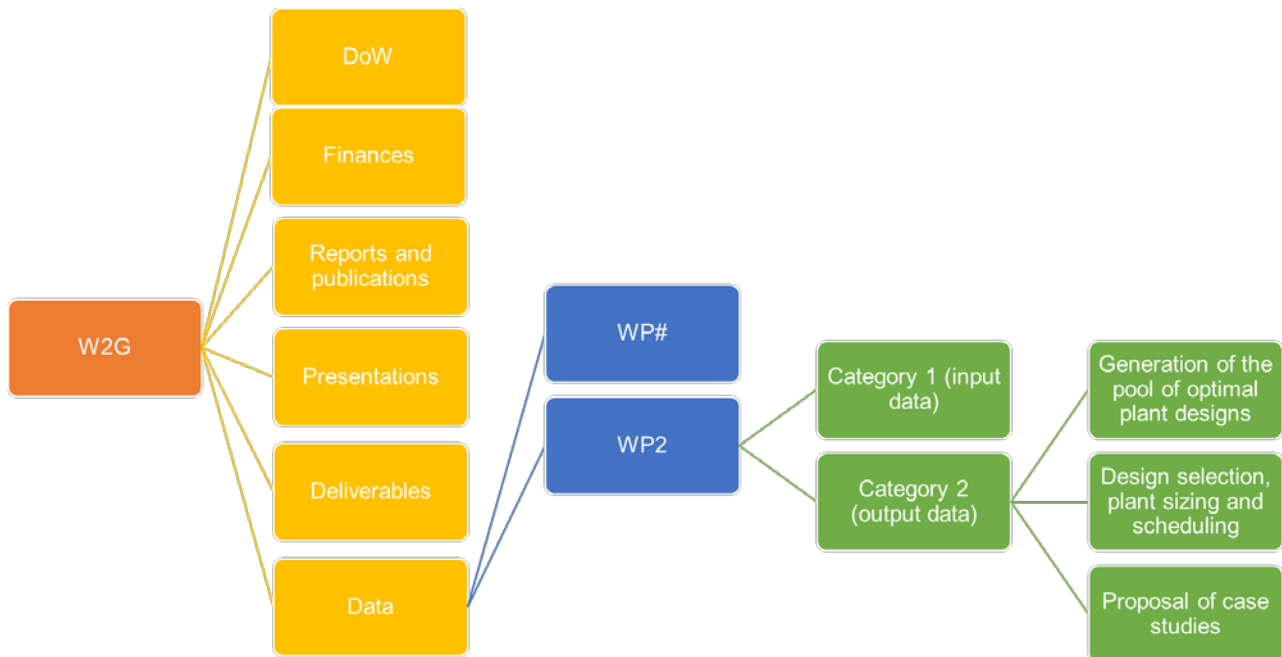
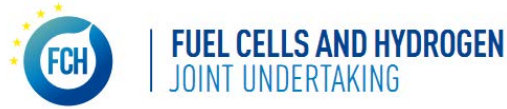


Figure 1. Common folder structure for W2G project.

Files will be named according to *YYYY_MM_DD_Institution_Deliverable_Category of data_Type of data*. Type of data refer to: For Category 1: (i) balancing scenarios of zone X of country Y, (ii) balancing profiles of zone X of country Y, (iii) type of waste of zone X of country Y, (iv) economic and performance indicators of the different units modelled A,B,C; for Category 2: (v) sets of configurations of optimum plant's layouts M,N,O, (vi) sets of sizes, scheduling and storage strategies of the different plants M,N,O, (vii) supply chain(s) proposed for the different plants M,N,O, and difference case studies P,Q,R, and (viii) SORC development path and upscale strategy, technological bottlenecks and business cases.



Data and documents sharing, and collaborative documents among the members of the consortium will be stored in the project Google Drive (Google Apps for Education from EPFL) (cloud-based storage system) and sent via, SWITCHfilesender or email, depending on the size (see Figure 2). Particularly, EPFL will use the Secure File Server (NAS) (the server name is *stisrv.epfl.ch*) for its active files storage; a project folder will be placed in `\\sti1files.epfl.ch\sci-sti-jvh\scistijvh-commun`.

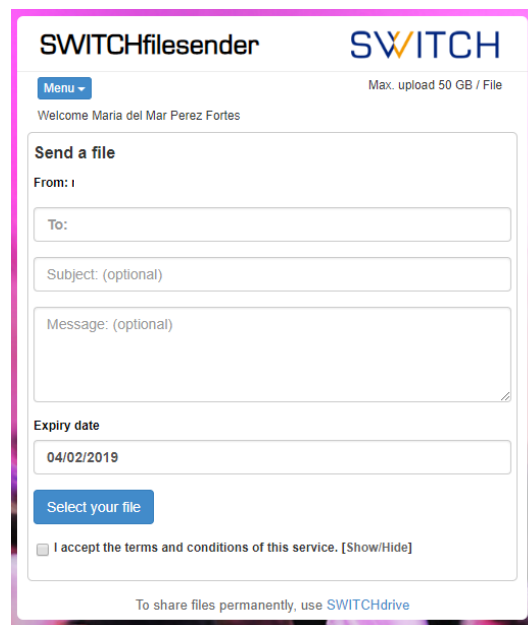
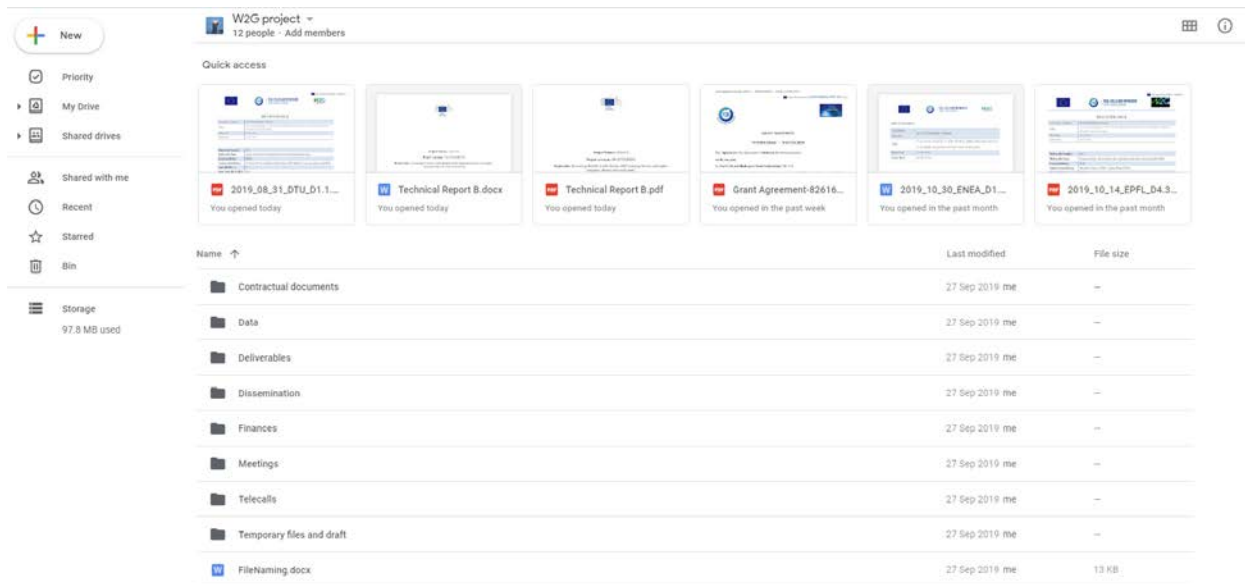


Figure 2. Snapshots of Google Drive and SWITCHfilesender.

The final dataset(s) and publications as deposited (archived) in the chosen data repository (for “our own use”, in EPFL servers; a minimum of 3 years) will be accompanied by a *README.txt* file listing the contents of the other files and outlining the file-naming convention used. Each final modelling file will be accompanied as



well by a *README.txt* file, listing the main features considered, and the main inputs modified / outputs obtained. It will also be linked to the output files generated.

Both, active and archived data will follow the same folder and file naming protocol.

2.2. Making data openly accessible

Publishable data (i.e. selected data collected for the project, and the agreed results within the IPR, considering the possibility of patenting) will be available on Zenodo (see Figure 3), within the specific EPFL community. **Note that the DSO-Bornholm island data cannot be published due to confidentiality. An NDA will be signed between EPFL and DTU on the use of this data.** Files will be available in open archival formats, e.g., *docx*, *txt*, *xlsx*, *csv*. Modelling codes will be appropriately described in the scientific papers. Zenodo will be used as well to share our (gold or green) open access (OA) publications. Most of project reports are intended to be public and linked to the project CORDIS webpage (as well as all the OA publications). If inventions or new technologies are made, access to data will be restricted until the invention disclosures and/or provisional patent filings are made with the institutional Technology Transfer Office.

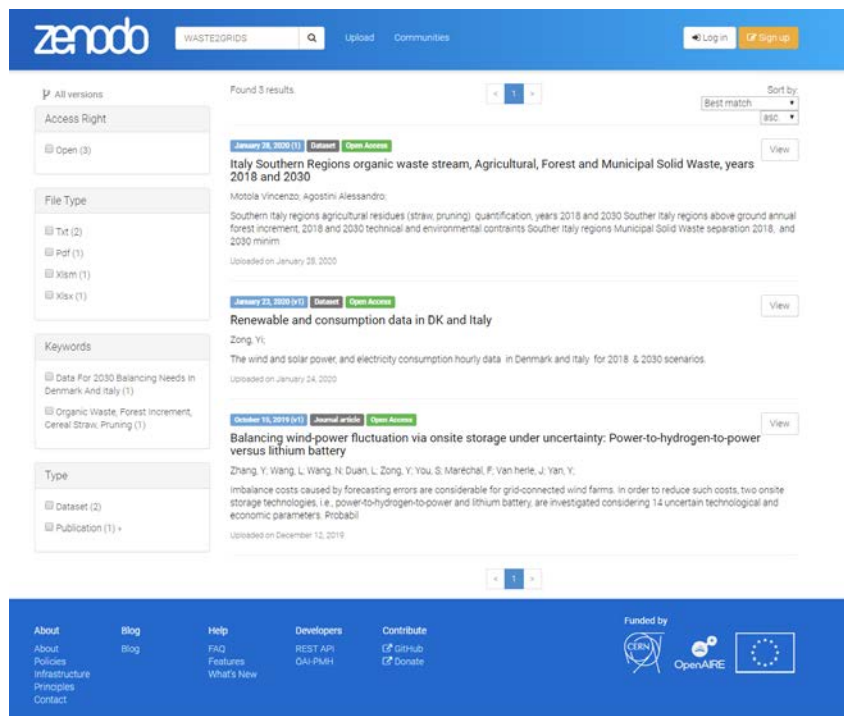


Figure 3. Snapshot of the project linked items uploaded in ZENODO by February 2020.

2.3. Making data openly interoperable

Collected and generated data (publications and research data; refer to Section 1) and metadata (describing the main features of the archived data; see Section 2.1) will be considered in the framework of W2G project. The *README.txt* files in the data repository will explain the purpose, creator, origin, time reference, description, time reference, access conditions and terms of use of each particular data set and resulting article and report. The *README.txt* file related to modelling work, will summarize as well how the different inlet and outlet data files are related among them. The metadata schema used in Zenodo includes title, creator, date, subject,



description, format, resource type, identifier and access rights (closed access, embargoed access, restricted access, open access).

2.4. Increase data re-use

Data used and produced in the project W2G can be reusable by third parties, after the end of the project. However, the project is being carried out with an industrial partner, and results may be patented. Thus, only after discussion with the TTO, data will be shared under Creative Commons CC-BY-NC-ND 4.0 license. The modelling approach will be published in research journals, and the data associated to it appropriately described. We acknowledge the fact that data gathered and used as model input can have an associated uncertainty. The “degree of confidence” of the data will be presented qualitatively via the well-known Pedigree Analysis. Data will remain re-usable 3 years.

3. Allocation of resources

Data will be stored on the centralized file storage system managed by the EPFL IT department, for 3 years. The EPFL is in charge of proposing and disseminating the DMP among the consortium partners, and is the responsibility of each partner to follow the specific guidelines. W2G project has allocated EUR 12 000 for open publications, among other concepts.

4. Data security

Google Drive runs in the Google cloud. Switchfilesender runs in the SWITCH cloud. It is connected to the academic network, and access is protected by Authentication and Authorization Infrastructure (AAI). Files are stored exclusively at SWITCH's data center in Switzerland and deleted after 20 days. Zenodo implements long-term preservation features, notably bitstream preservation.

The access to the EPFL servers is managed through the EPFL identity management system, following the best practices in terms of identity management. EPFL central storage facility has redundancy, mirroring and is monitored.

5. Ethical aspects

W2G project is a theoretical investigation of waste-based grid-balancing plants; there is no plan for materials or sensitive data exchange between the members of the consortium. For non-EU partners (EPFL and SP):

- they will ensure compliance with Horizon 2020 ethics rules and in particular, but not limited to “Art. 34 of the Grant Agreement”. that activities in the project will be compatible with EU and international law,
- they will provide an updated list on the material which will be imported to/exported from EU and will provide the adequate authorizations if this was finally necessary,
- for any import/export activities: “The consortium will obtain and comply with licenses for import/export while performing activities outside EU Member States before starting any activities requiring them. Any such licenses and/or supporting documentation will be made available to the JU upon its request”.

The project does not involve security issues and has non EU-classified information as background or results.



6. Other

7. Intellectual Property Agreement

The following principles apply to all results stemming from the W2G project, unless otherwise agreed between the parties in the Grant Agreement and the Consortium Agreement (dated 17 December 2018), in particular in its Sections 8 and 9.

In the following agreement, the expression Party means either each partner in W2G project.

All intellectual property held by a Party prior to entering into this Agreement or disclosed or introduced in connection with this Agreement and all materials in which such intellectual property is held, disclosed or introduced, shall remain the property of the Party introducing or disclosing it.

All rights, titles and interests in any studies, reports or materials, graphic or otherwise, prepared by either Party will belong to that Party and may not be made use of except with that Party's prior written consent. The provisions of this clause will survive till the termination of the W2G project.

When the Parties jointly develop intellectual property, inventions and innovations as a result of the work of the personnel involved in W2G project with respect to title and exploitation of such intellectual property, inventions and innovations (including but not limited to trademarks and service marks copyright, patents, know-how designs and confidential information on the subject of such intellectual property, inventions and innovations) will be negotiated on a case-by-case basis having due regard for each Party's policies and governance requirements and the terms and conditions imposed by any individual funding agencies or grant-making organization.

Save as aforesaid, nothing in this agreement shall be construed as a license or transfer or an obligation to enter into any further agreement with respect to intellectual property currently licensed to or belonging to either Party.



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