4.2 Subproject 2: Computation & Assessment Toolbox

Please summarise the objectives, planned results and contribution to the overall systemic innovation of this subproject:

(Max. 2000 characters, incl. blanks)

SP2 Objective

OSP2.1: Creation of a free flexible calculation toolbox, which will provide GHG assessment for multiple standards (including ISO 14067, PAS2050, and the GHG protocol (scope 1, 2 and 3)).

These tools will integrate directly with the other WS developed in SP3, SP4 and the databases in SP1. They will be flexible, providing results at different scales, running on multiple platforms and cloud systems, and easily configurable for different business needs. They will be open source with a business-friendly license, allowing for business confidence in integrating the tools, and available as source code and a docker container for direct business uses, and as WS.

The tool will be state-of-the-art, including both complete uncertainty analysis and global sensitivity analysis, allowing for much more effective decision support. It will also provide multiple algorithms to adapt the databases from SP1 for specific user cases, such as specifying the origin or manufacture of materials deep within supply chains for scope 3 assessments.

Planned results

- Open and transparent implementation of multiple GHG standards, referenced against multiple nomenclature conventions
- Toolbox of computation algorithms that can assess GHG emissions with diverse scopes and evaluation standards, while using all SP1 data sources & user data
- State-of-the-art implementation of uncertainty and sensitivity analysis and programmatic, dynamic supply chain adaptation
- Make the toolbox and its computational algorithms available to WIDS users by creating different WS
- Ensure the developed tools and associated WS can meet the needs of the implementation partners in collaboration with SP5, SP6 and SP7

Contribution to the flagship

- Enabling the rich calculations and interpretation routines required for the GHG assessments that are provided by the WIDS
- Creating transparent and traceable calculation methods for GHG assessment to increase trust among users & stakeholders

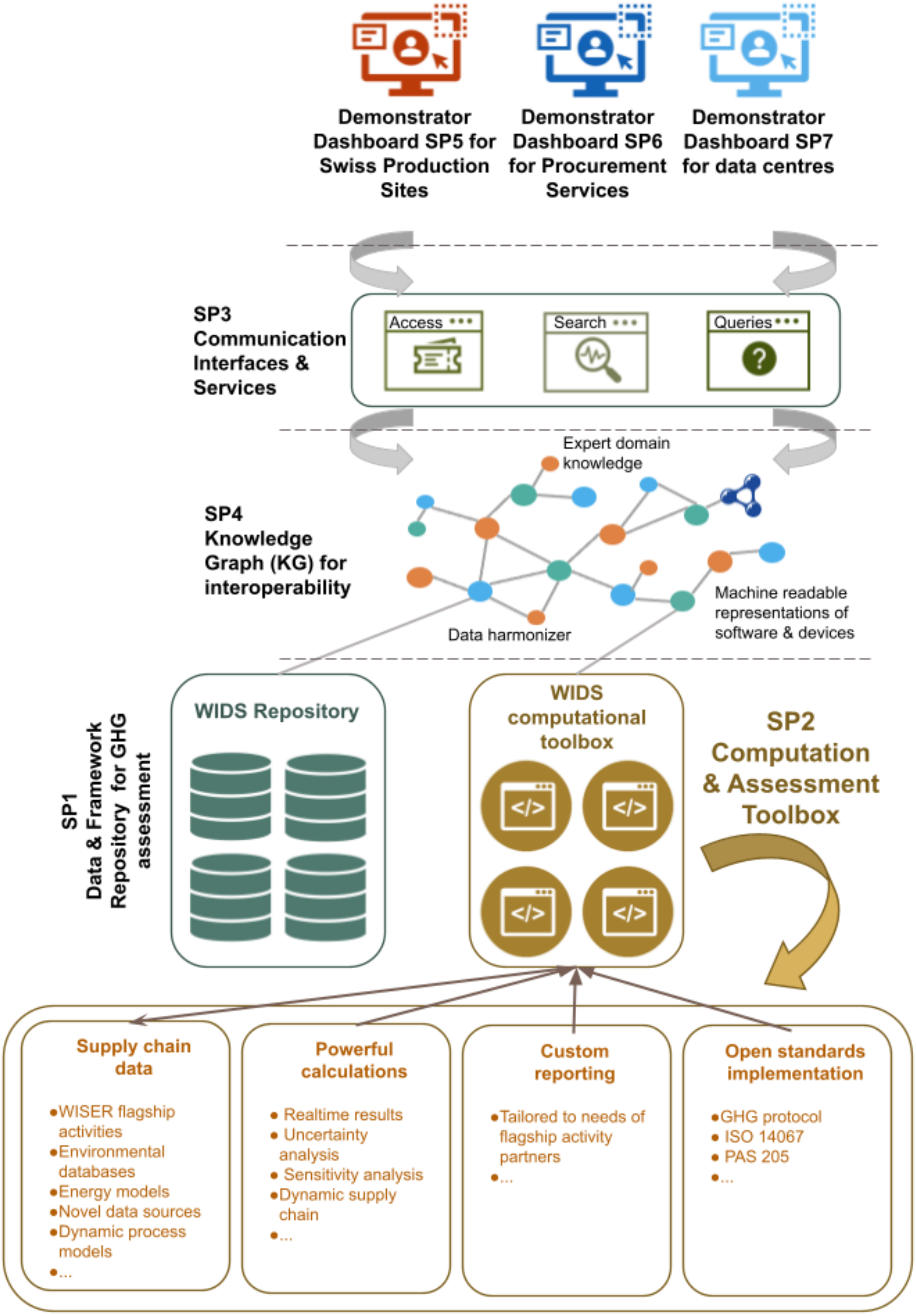

Fig 4.4: Key aspects of SP2

4.2.1 Business targets, business model and/or social value creation

Please describe for subprojects

with economic value creation	with social or environmental value creation
- Business model, target value chain position - Competitive situation, USP (unique selling proposition - Customer model: B2B/B2C/C2C and market size - Planned revenue and profitability development, e.g. net present value (NPV) scenarios with/without subproject	- The problem to be solved; Need of target groups/beneficiaries to be addressed - The other existing actors in the field - The target groups and beneficiaries of the innovation (include quantification) - A cost-benefit analysis for the subproject including qualitative and quantitative components) - Cost structure and revenue streams (scenarios with/without subproject)

For subprojects with economic as well as social and/or environmental value creation, both aspects have to be addressed.

(Max. 4000 characters incl. blanks)

SP2 is not expected to bring economic value creation by itself, though its outputs are critical for the viability of the WIDS and the WISER flagship. We present the aspects related to social & environmental value creation from SP2.

The problem to be solved

Calculations of environmental impact of goods and services are currently extremely expensive, and require substantial expert advice. This cost prevents the widespread application of such footprint calculations, leading to incomplete information for decision makers across society. Moreover, many CF standards lack reference implementations, and there is a lack of agreement on common nomenclature for products and environmental flows, leading to inconsistent calculations with the same input data.

Existing actors in the field

There are currently three broad sets of companies providing corporate footprinting. Consultants can conduct LCAs, but this approach is too expensive to scale. The second provides a web or spreadsheet interface for entering data; firms include MyClimate, Climate partner, and CFt. This type of data input cannot easily be adapted for customers, and does not scale to large numbers of products or constant data entry. The final set of firms allows for data entry through APIs, and some offer integration with ERP or design software; firms include Carbon Trust, One-click LCA, C-Level, Cloverly, and Cooler. While this group has real advantages over the others, they still require harmonisation to their nomenclature, and dependency on their calculations and data sources.

Target groups & beneficiaries of the innovation

The first target group of SP2 are the case studies participants. At a secondary level, the inclusion of large firms in WISER will allow for the inclusion of the toolbox in multiple commercial offerings provided both on the Swiss and international markets. Similar to how Google is building internal tools based on results from electricityMap by Tomorrow, our toolbox, based on open standards and data interfaces, could become the reference implementation of both calculation methods and multiple carbon foot printing standards. A rapidly growing marketplace means that new and better methods, such as our toolbox, could capture 25-50% of the total market within 5 years.

An additional target group is smaller Swiss firms. While these firms will probably not develop WIDS services, our approach can dramatically lower the cost of consulting firms providing turnkey solutions (no commercial software license is required, data inputs and calculation results can be standardised, calculation and interpretation of result cost become minimal), including annual updates. We also anticipate substantial community-based open source development in web-based user interfaces; when combined with existing free background data, the cost of a screening footprint calculation could drop by an order of magnitude.

Value creation

Costs	Benefits
Maintenance of toolbox (calculation software and packaging)	State-of-the-art open toolbox with free access, including analysis functions far beyond existing alternatives
Maintenance of toolbox (nomenclature matching to new or updated metadata)	Increased trust via transparent toolbox
Further development of tools	Community-based standards implementations for adaptation of new approaches and updates
Remote or local storage of WS	Adaptable & flexible solutions
Human resource to help users/developers	Potential for automation of GHG assessments when new data is made available

Cost structure

- ICT infrastructure and usage charges
- Licensing of proprietary databases (when necessary)

Revenue streams

- WISER will fund a complete and working toolbox. Afterwards, opportunities will be developed in collaboration with SP8, such as:
- WS SLA and support contracts; from WIDS access, if it has a fee over a certain resource limit or for certain commercial use cases
- Corporate sponsorship or in-kind contributions (as in many open source software frameworks).
- A comprehensive BMs exploration

4.2.2 Novelty of the solution

Please describe:
- the concrete solution(s) and results to be achieved
- Own position vs. international state of the art
- Uniqueness created with respect to science, economy, society, environment, technology, etc.
- Intended advancement of the status of science and technology
- Scientific/technological/societal/environmental ambition and risk, e.g. technology readiness level (TRL) and/or levels according theory of inventive problem solving (TIPS), if applicable
- Primary applicability of research results
- Wider interest in/applicability of research results

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Concrete solution(s) and results to be achieved

SP2 will produce a reference implementation of GHG standards and a reproducible, open, and state-of-the-art calculation engine, which will interface seamlessly with the WS of SP1/3/4. This toolbox will be available as a service, in accordance with the BMs defined in WISER, but also as open source libraries and containers.

Own position vs international state of the art

In contrast to actors listed in 4.2.1, our approach offers a number of substantial innovations:

- Free choice of background databases, including the ability to switch
- Control over all customer data and calculations, including custom analysis
- Provision of input data from WS allows for easy integration of diverse data sources
- Transparency and reproducibility in all calculations and implementation of standards
- No dependency on continued existence of start-ups or their specific APIs technologies
- Uncertainty analysis to support robust decision-making
- Advanced and transparent methods to account for uncertainties and to provide forecasts in GHG assessments
- Global sensitivity analysis to identify areas for improvement
- Programmatic, dynamic supply chain substitution to reflect specific supply chains

Our approach will substantially advance the state-of-the-art in LCA calculation methods. By building on Brightway2, we inherit a large existing community, and the fastest calculation speed of any LCA software. To this foundation we will add cloud computing capabilities, as well as parallelised uncertainty analysis and global sensitivity assessment (GSA).

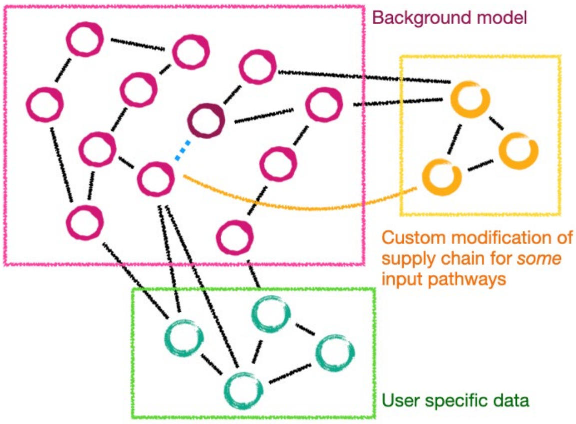

Fig 4.5: Visualisation of deep dynamic supply chain

We will also add functionality that allows for dynamic modification of background databases (e.g. EIA) to better reflect the individual supply chains of toolbox users. For example, an electric mobility firm might have specific contracts or performance data for the metals and energy efficiency of their battery manufacturers. As this data is deep in the supply chain (and hence drawn from background databases), it is difficult to modify, and currently impossible to modify in real-time. We will develop an existing prototype for patches to background databases building on work in Brightway funded by C-Change labs to make such patches usable by the entire user base, and interoperable with the WIDS.

The connection with SP1 and SP3 will also address a current significant cost in foot printing calculations. The use of firm-specific nomenclature lists leads to inconsistent results, as these lists do not perfectly match each other. By using semantic concepts, supply chain data can be linked based on the underlying concepts, and subjective judgments will be clearly identified.

Finally, we will develop transparent implementations of the various assessment standards. The existing documents must be interpreted when applied to actual data and process models, and this means that each practitioner has slightly different implementations. Our approach will include provenance data and explicit references for each numeric value, as well as implementations using the major nomenclature lists (e.g. EIA, US EPA, ILCD). By providing both the code used in the implementation, as well as the final numerical results, we make it easier for the community to build upon and sensibly debate our implementation.

TRL levels for the toolbox components (existing → WISER)

- Brightway foundational code: 9
- Parallel cloud-enabled uncertainty analysis: 4→8
- Cluster-based sensitivity assessment: 4→8
- Dynamic supply-chain patch workflow: 3→8
- Interface with semantic WIDS: 2→7
- Open implementation of foot printing standards: 4→8

SP2 will allow for a standard, open, and powerful calculation toolbox for carbon foot printing, serving as a common standard on which custom interpretation, visualisation, and graphical interfaces can be built. As such, SP2 will provide value to both end users and sustainability service providers, similar to other open source computing utilities.

4.2.3 Goals of the subproject

Please describe and quantify if possible:
- Scientific goals
- Economic goals
- Societal goals
- Environmental goals
- Technological goals, if applicable

(Max. 4000 characters incl. blanks)

Scientific goals:

- Research, develop, and test high-performance distributed uncertainty and sensitivity analysis techniques, taking into account system nonlinearities and parametric models. This research will be documented in a scientific publication.
- Research and explore the ability to modify background databases using "patch" data to allow for dynamic background modification, and analyse the potential of such approaches to improve the realism of existing background databases such as EIA. This research will be documented in a technical report.
- Research how existing standards are inconsistently implemented by different actors, and investigate the most important sources for such differences, and their effects on aggregated LCA results. This research will be documented in a scientific publication, a research report for the LCA community in Switzerland, and will be presented at practitioner workshops such as the LCA discussion forum.

Economic goals:

- Make the computational services self-sustainable from an economic point of view while considering costs for use, maintenance, and development. The evaluation of the SP2 assessment toolbox shall demonstrate the economic viability of the approach. Work with SP8 shall integrate these results with potential BMs.
- Demonstrate the value of a community-driven consensus implementation of footprinting standards such that users maintain these implementations for future revisions or new standards (similar to how software companies fund contributions to open source projects).

Societal goals:

- Provide the foundation for a community-based development of computational services to assess GHG emissions and CF. The demonstrated advantages of the assessment toolbox will be integrated in the GHG emission and computation pipeline of at least 1 Swiss City (SP6). The toolbox will also be presented to Swiss actors in environmental accounting.

Environmental goals:

- Enable GHG-efficient actions in society by simplifying access to GHG knowledge (indirect). The usage of the assessment toolbox in 3 different sectors (SP5, 6, 7) will demonstrate its potential benefits in those scenarios.

Technological goals:

- Develop and document open data implementations of carbon footprinting standards such as ISO 4067, PAS2050, and the GHG protocol for use in LCA. Such implementations will be provided as git repositories, allowing for anyone to examine their history and to suggest changes or fix errors.
- Develop a complete, well-documented, open source toolbox for sustainability footprint calculations, including interfaces using WS. This toolbox should include the novel computational aspects described in 4.2.2.
- Develop well-documented interfaces inside the toolbox to allow for the inclusion of data from the WIDS services in calculations. The toolbox will be able to manage at least the data sources supported by Brightway, and those required by the implementation SPs (SP5, 6, 7).

4.2.4 Preliminary work

Please describe the preliminary work already performed.
(Max. 2000 characters incl. blanks)

Brightway is a complete open source framework for LCA calculations on local computers. It includes modules for data storage in a SQLite3 database, data input and output (including data transformation and normalisation), calculations, and analysis. However, this foundation will need to be substantially adapted to support cloud computing using input data provided by WS. Some of this adaptation is already underway with clean separation of these individual modules with standardised and documented APIs, and the specification of a numerical data transfer format.

Implementations of some initial approaches for uncertainty and sensitivity analysis have been developed as research software. This work will need to be improved for use in customer-facing WS in the context of WISER.

Initial work has been done on linking Brightway with semantic data using the BONSAI ontology through SPARQL queries. As such, Brightway has basic facilities for parsing and using data provided as TTL (a semantic web data format). However, this functionality will be completely rewritten in WISER.

PSI has implemented multiple LCA methods as open code and metadata, including LC-IMPACT, AWARE, ReCiPe 2016, and basic characterisation factors including uncertainties from IPCC AR5. We have also developed a software- and OS-agnostic format for specifying implementations of footprinting standards.

4.2.5 Implementation plan

Please describe and explain for subprojects

with economic value creation:

- Market access and marketing approach
- Concrete plan to implement the business model (incl. specific measures, deadlines and responsibilities)

with social value creation:

- How will you reach the target groups
- How you plan (incl. specific measures, deadlines and responsibilities) to implement the social innovation

- Growth plan (if no growth partner is involved yet, please describe how the results will be scaled in favour of the Swiss society)

For subprojects with economic and social value creation, all aspects are applicable.

(Max. 4000 characters incl. blanks)

Market access & marketing approach to reach the target groups

The digital services business community will learn of SP2 results through content marketing through the DS platform, industry events within DS network, and referral programs and conversational marketing. We also anticipate that WISER project partners will independently disseminate SP2 outputs internally and with their business partners based on the outcomes of the case studies.

The LCA practitioner community will learn of SP2 results through presentations at industry events, such as the LCA discussion forum, and community email lists.

Academic researchers will learn of SP2 results through academic publications, the online documentation and examples, and presentations at research conferences and workshops. PSI will also hold a series of online webinars demonstrating and providing technical support on the toolbox.

Concrete plan to implement the innovation

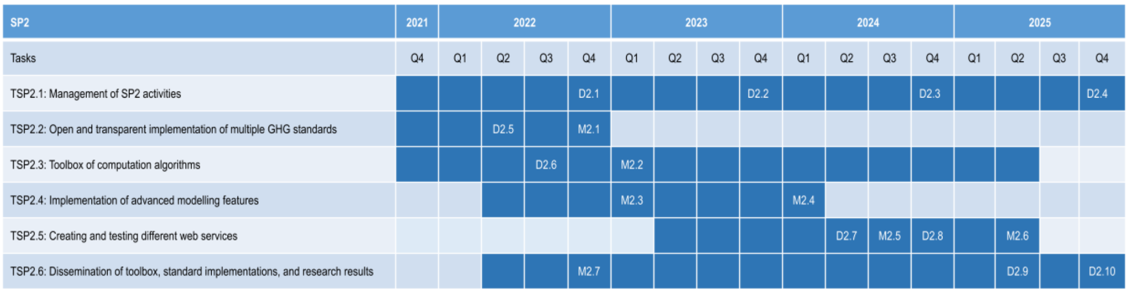

Fig 4.6: Gantt chart of SP2

TSP2.1 Management of SP2 activities

D2.1-4: Annual progress reports

TSP2.2: Open and transparent implementation of multiple GHG standards, referenced against multiple nomenclature conventions

D2.5: Implementation of GHG standards in toolbox
M2.1: Publication analysing impact of multiple standards and standards implementations in LCA

TSP2.3: Toolbox of computation algorithms with diverse scopes and evaluation standards

D2.6: Toolbox technical implementation manual released for comment to stakeholders
M2.2: Initial toolbox release

TSP2.4: State-of-the-art public implementation of advanced modelling features, including uncertainty and sensitivity analysis, programmatic, dynamic supply chain adaptation, and prospective assessment

M2.3: Initial toolbox release with uncertainty and sensitivity analysis
M2.4: Integration of prospective assessment & dynamic supply chains into toolbox

TSP2.5: Make the toolbox and its computational algorithms available to WIDS users by creating and testing different WS

D2.7: Adaptation of toolbox to use finalised WIDS API conventions and data structures
M2.5: Use of SP1 WIDS APIs to calculate results
D2.8: Release of WIDS WS providing different aspects of toolbox to 3 partners
M2.6: Public release of self-sustainable WIDS WS using SP8 business plan

TSP2.6: Dissemination of toolbox, standard implementations, and research results

M2.7: Stakeholder workshop on practical differences in GHG standards and implementations
D2.9: Final complete toolbox release to project partners
D2.10: Report demonstrating and analysing usage of toolbox with 3 partners

Growth plan:

SP2 has a two-track program for growth. First, we will ensure that the toolbox and the standards implementations are extensively tested, documented, and provided with examples and user guides. We will also host all code and data on an open platform, such as Github, which allows for anyone to suggest edits, updates, and to discuss issues or enhancements. This will allow a community of both volunteers and professionals to adopt SP2 outputs as common, standardised technologies, similar to mathematics or scientific libraries. Our experience in building the Brightway community, which now has multiple paid developers outside the original PSI team, has shown this model can work.

Second, during WISER we will use the lessons learned during the case study implementations to provide comprehensive guidelines for the inclusion of new computational WS in the WIDS will be created, in collaboration with SP4. This documentation will reduce barriers for new users and developers to adapt the SP2 toolbox for their IT infrastructure and business needs.

This two-track program will allow for Swiss service providers, both small and large, to build new tools and services on top of the WISER ecosystem. By providing best-practice implementations of footprinting standards, powerful calculation capabilities, and flexible interface standards (SP1/3/4), WISER allows for a new class for cost-efficient carbon footprinting products targeting different business types and industry sectors to evolve.

4.2.6 Partners of the subproject

Please indicate which of the research and implementation partners mentioned in chapter 1 are involved in this subproject and describe why they are suited for the planned activities. Please specify:

- Capability of the partners to foster and realise value creation in Switzerland
- Scientific/technical competences of partners
- Track record of partners
- Necessary infrastructure available
- Planned interactions of the partners in the subproject (in particular if transdisciplinary)

(Max. 2000 characters incl. blanks)

The technology assessment group (TAG) at PSI has extensive experience in methodological research in LCA, including multiple publications each on uncertainty analysis, global sensitivity analysis, supply chain traversal, and prospective LCA. Chris Mutel, a senior scientist at PSI, is the primary author of the Brightway open source LCA framework, and has grown the Brightway community to hundreds of users at tens of academic and research institutions worldwide. Brightway is also used in international firms such as Alstom and Airbus. Chris is also the chair of the board of BONSAI, a non-profit organisation advocating for the development of open LCA databases using semantic web technologies, and has experience integrating LCA software with semantic interfaces and data formats.

TAG also has a track record in value creation in Switzerland; they have cooperated in numerous projects for cantonal and federal authorities, as well as providing LCA expertise to smaller Swiss consultancies and start-ups. TAG has also successfully completed an Innosuisse project with the EIA centre (OCELOT) on improving the transparency and reproducibility of activity modelling in EIA.

PSI has the necessary computational infrastructure for SP2, including access to a cluster for development and testing of distributed parallel approaches and the containerised toolbox.

Empa and ZHAW provide internationally recognised expertise on environmental databases, GHG assessment frameworks, and communication options for decarbonisation.

HESSOV has extensive expertise in heterogeneous data integration and usage of ontology-based approaches for interlinking information in different domains. UNISG has extensive expertise in Web and Semantic Technologies, focusing on creating interoperable and contextualised autonomous systems. Together they bring expertise on digital solutions, interoperability, and knowledge graph data exchange.