e-shape

EuroGEO Showcases: Applications Powered by Europe

e-shape-WP2-D2.5 (Report on the cases requiring specific co-design update)

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ABSTRACT

This deliverable complements D2.4 deliverable by compiling the outcomes of the co-design actions experimented with e-shape pilots. It especially highlights the outcomes following 'organizational' KPI and 'cognitive' KPI, and presents the frameworks proposed by WP2 to synthesize these outcomes.

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1 INTRODUCTION

A validated model of co-design adapted to the Earth observation (EO) context is presented in D2.4 deliverable (Barbier et al. 2021). Such a co-design approach involves a long-term and continuous effort of connecting heterogeneous and evolving fields: the field of EO data and the various fields of potential usages. In this perspective, we have highlighted that co-design should not be restricted to the adjustment between users and service designers, but should be considered as a way of **growing an ecosystem of efficient EO-based service designers able to sustain this long-term effort**.

To take into account the specificities of the EO context, the co-design approach built within e-shape includes two phases: (1) a critical "diagnosis process" to identify the co-design needs, i.e. the different blocking points occurring in the growth of the ecosystem over time, that are classified in four main types; (2) the implementation of co-design actions to unlock these blocking points, that aim at creating a 'resilient fit' between stakeholders.

Regarding the co-design actions, WP2 is progressively designing and experimenting a specific protocol for each type of action. D2.4 deliverable presents an overview of these different protocols. The present deliverable complements D2.4 deliverable by reporting on the different co-design actions experimented with e-shape pilots, that are:

- Co-design type 1 experimented with S2-P3 *Health Surveillance & air quality (NOA sub-pilot)*
- Co-design type 2 experimented with S3-P3 *Offshore wind resources*
- Co-design type 3 experimented with S3-P2 *High PV penetration at urban scale (O.I.E sub-pilot)*

The document is organized as follows. A first part gives an overview of the outcomes of each co-design type action, precising the KPI following two dimensions: organizational improvements and cognitive improvements. It is then followed by three annexes, compiling the reports made respectively for co-design type 1, 2 and 3 experimented with e-shape pilots.

2 KPI OF CO-DESIGN ACTIONS: IMPROVEMENTS ON THE ORGANIZATIONAL AND COGNITIVE ASPECTS

The ambition of co-design is to foster the use of EO in a long-term perspective. Each workshop is thus designed to **progressively shape and consolidate 'building blocks' of the long-term development of the pilot's strategy, intertwined with the evolution of both EO and usage fields.** The following two key insights, common to all types of actions, have been highlighted in D2.4 deliverable:

- *Key insight 1:* it is crucial that the co-design actions do not only focus on the design of the service, but also on the design of the relationships, i.e. **'co-design' has to design the 'co'**. The protocols of the workshops integrate this aspect by always organizing a final phase dedicated to building agreements for future cooperation between participants.
- *Key insight 2:* the co-design actions developed by WP2 aim at **establishing a 'resilient fit' between participants, rather than a 'quick fit'**:
    - *'Quick-fit'* actions would focus on finding one type of interaction between data and usages ecosystems (single list of requirements with one user, in a punctual relationship).
    - Whereas, *'resilient-fit'* actions aim at generating a range of alternatives (regarding the lists of requirements, the stakeholders involved, the types of partnerships), allowing a better adaptation to future surprises or unexpected constraints. The difference between these two types of actions can be illustrated by the metaphor of a plant that is all the more resilient as its roots' network is expanded, allowing the plant to adapt to various types of water conditions (see *Table 3*).

	"Quick-fit" actions	"Resilient-fit" actions
General description	 Focus on finding ONE type of interaction with the ecosystem (single list of requirements with one user, in a punctual relationship) *If roots only at surface level: plant only grows if water is easily accessible*	 Generating a range of alternatives (regarding the lists of requirements, the stakeholders involved, the types of partnerships) for a better adaptation to future surprises *Expanded root network: plant more resistant to various water conditions*
Type 1	Finding ONE satisfying list of requirements with one specific user	In order to end up with a robust list of requirements, exploring a range of potential services at different time horizons and related cooperation modalities
Type 2	Finding ONE relevant user to interact with	Progressively building a better understanding of the usage ecosystem and cooperation agreements with a portfolio of relevant actors
Type 3	Building the engineering for the operationalization of one service	Building relationships with relevant partners to ensure a continuous investigation on modules to be operationalized/to be explored
Type 4	Merely asking existing users what they would dream of	Setting-up a joint program for long-term exploration of new usages with existing and new actors (identification of obstacles, research efforts to be made, 'stimulating' proofs-of-concept, etc.)

Table 1: Distinction between 'quick-fit' and 'resilient-fit' perspectives for the 4 types of co-design

These two key insights suggest that the **KPI of co-design actions should always include two aspects**:

- Improvements on the **organizational** aspect, as highlighted by *key message 1*, involving the design and consolidation of adapted relationships with relevant stakeholders;
- Improvements on the **cognitive** aspect, as highlighted by *key message 2*, involving the progressive enhancement of a "T-shaped" project portfolio, i.e. identifying a range of perspectives for future developments with a balance between advanced projects with development efforts at short-term time horizon and more exploratory projects to be carried out at mid-term or long-term.

To take into account these two dimensions, specific protocols have been designed by WP2 and are detailed in D2.4 deliverable. Different reports were written to synthesize the outcomes of each co-design action experimented with e-shape pilots and are compiled in *Annex* of this document. *Table 2* gives a brief overview of the outcomes of each co-design action following the two KPI aspects.

	Organizational KPI	Cognitive KPI
Type 1 *S2-P3 pilot*	Validation and clarification of the different users' interests to further cooperate with NOA. Identification of the general form of such a cooperation for each actor (*at least type of service at which time horizon*). One-to-one meetings were later organized by NOA to further set up the cooperation modalities.	Overview of the different expectations of the participants regarding the type of services to be developed by NOA, at different time horizons.
Type 2 *S3-P3 pilot*	Different forms of cooperation envisaged with the participants of the workshop, and identification of new relevant actors to interact with.	Identification of a range of potential development perspectives, thanks to a better understanding of the users' ecosystems and the usefulness dimensions of DTU's service.
Type 3 *S3-P2 pilot*	Agreement between the pilot's partners on specific cooperation modalities to further work on the different modules of the service (either to be operationalized, to be explored, or still undetermined)	Clarification of the development perspectives, defining concrete actions at different time horizons related to modules to be operationalized, to be explored and still undetermined.

Table 2: Table synthesizing the outcomes of the experimented co-design actions

Feedbacks of the different pilots that experimented these co-design actions were also very positive, as illustrated by the following verbatims (coming from questions asked to the pilots to get their feedbacks, or during WP2 steering committee presenting the co-design advances):

- **Feedbacks from S2-P3 pilot:** "The initial co-design workshop proved to be an immense success […]. Beyond providing a forum for this initial discussion of the list of requirements from these users and an introduction to the HSAQ Pilot and co-design process, the workshop served as a means to formalize relationships and find synergies between workflows and users, propelling us to officially pursue partnering with National Public Health Organization and the Ministry of Energy and the Environment to discuss and share data, and contribute to the development of a national health observatory." *(Evangelos Gerasopoulos, NOA, pilot leader)*
- **Feedbacks from S3-P3 pilot**: "For me it was really eye opening that we could use it in such a broad way to look at all sort of possibilities rather than trying to narrow down what we wanted to do. It was more about broadening out and gathering lots of ideas and inputs." "In particular, it was beneficial to understand that co-design is not just about convincing a user to adopt a product or service. The main purpose is to get a better understanding of the ecosystem." *(Merete Badger, DTU, pilot leader)*
- **Feedbacks from S3-P2 pilot:** "This exercise has proved to be useful as in 3h we have structured our working plan for the next 6 months in a clear way." *(Etienne Wey, Transvalor, member of S3-P2 pilot)* "We learnt a lot definitely. It's something which dealt with some tremendous unknown things that we learnt by talking to you [i.e. WP2 team] through this process" *(Lionel Ménard, O.I.E., member of S3-P2 pilot)*

As explained in D2.4 deliverable, **WP2 proposed specific graphs and tables in order to synthetically capture the outcomes of each co-design actions, including both organizational and cognitive aspects.** Each framework indicates the different development perspectives, precising: a specific aspect of the service to work on and its associated time horizon (*cognitive* dimension) and the related actors involved (*organizational* dimension). General templates of these frameworks are given in *Figure 1* for

co-design type 1, *Figure 2* for co-design type 2, and *Table 3* for co-design type 3. The completed frameworks are detailed in the respective reports of the co-design actions (see *Annexes*).

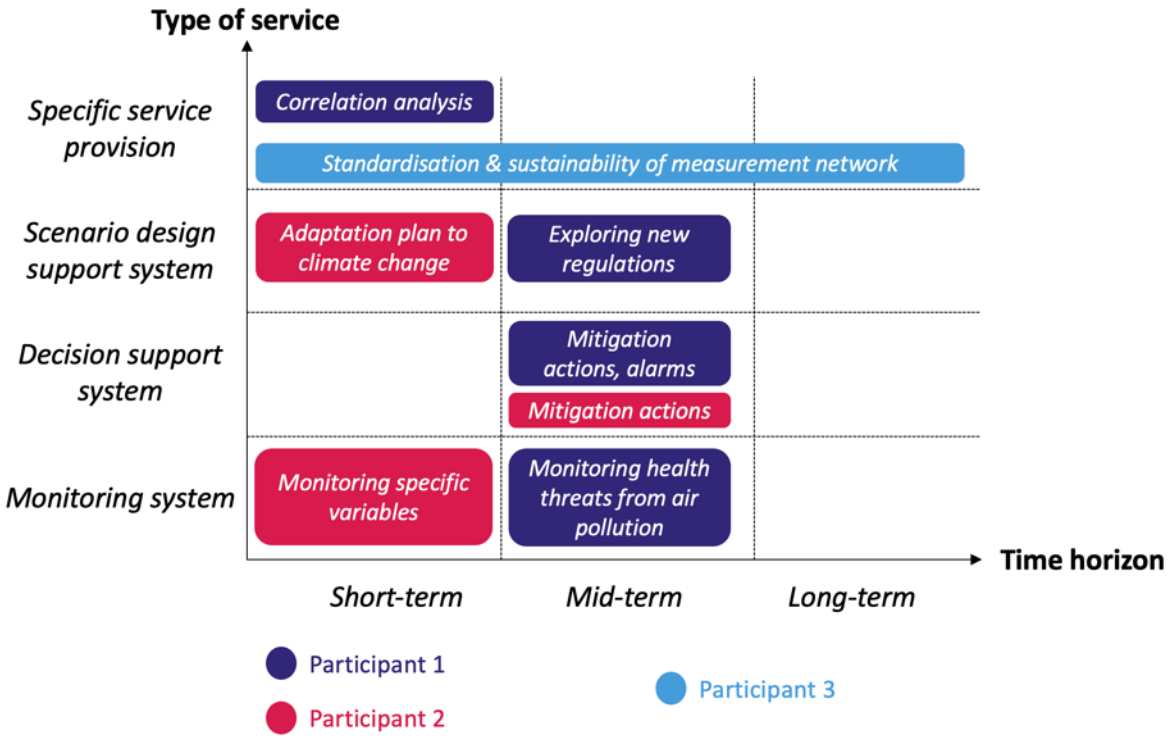

Figure 1: Graph synthesizing co-design type 1 outcomes in a 'resilient-fit' perspective

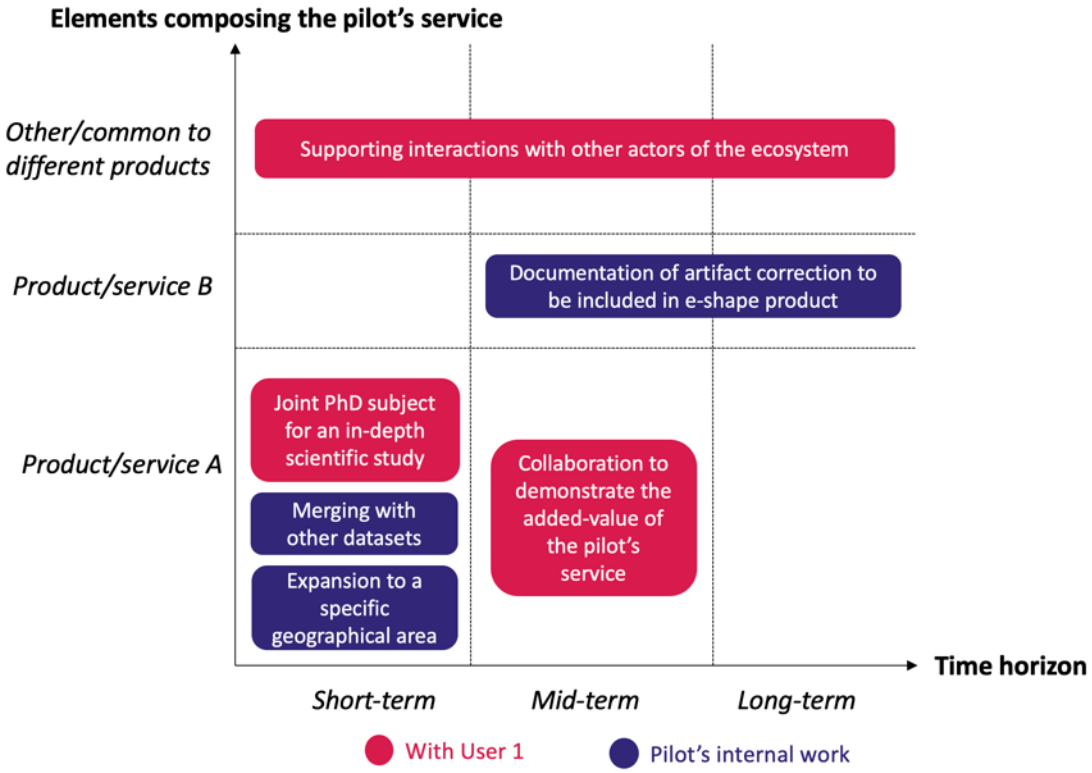

Figure 2: Graph synthesizing co-design type 2 outcomes in a 'resilient-fit' perspective

	Short-term	Mid-term	Long-term	Cooperation modalities
Modules to be operationalized	Product based on *method a,* limited to a a certain geographical area	Product based on *method a*, with additional functionality		March 2021: kick-off and working sessions to define inputs & outputs and development planning.
Modules to be explored	Product based on *method b*, limited to a certain geographical area	Processing transferred to operationalization entity	Product based on *method b,* with additional functionality	March 2021: technical working session with on python code developed by research entity
Undetermined	Collaboration for exploration of new deep learning methods		Commercial service for forecasting at different time horizons	R&D collaboration (joint PhD & internships, specific interest group)

Table 3: Table synthesizing co-design type 3 outcomes in a 'resilient-fit' perspective

3 ANNEX 1 - REPORT FOR CO-DESIGN TYPE 1 EXPERIMENTED WITH S2-P3 PILOT

3.1 Introduction

3.1.1 Context of the workshop

The present document summarizes the outcomes of the co-design workshop, organized within the e-shape project for S2-P3 pilot (*Health Surveillance Air Quality* within the *Health Surveillance Showcase*) on July 1st. The workshop is a focused part of the co-design approach that is developed and implemented in e-shape, to support the development of the pilots taking into account the specific issues related to the EO field. Based on the analysis of the different e-shape pilots, four main co-design types have been identified, each one corresponding to a specific design issue related to the service itself or to the relationship with users. In the case of Athens, it seems that the relationships with the different potential users are favorable, but there is still a need to further define the list of requirements of the service developed by the National Observatory of Athens (NOA, pilot lead) and the coordination modalities between NOA and the different users. This situation corresponds to a co-design type 1, leading us to organize this 3 hour workshop with the following subject, objectives, expected outcomes and participants:

- Subject: ***Building a health surveillance & air quality platform for current and future operations of Athens' actors***
- Overall objectives: (1) assessing and enhancing the list of requirements of the service for the different potential users, (2) setting-up the future relationships with the users.
- Expected outcomes:
    - **« Building blocks »** for further development of the service (knowledge shared by participants, identification of missing knowledge/competencies)
    - **Broader range of potential lists of requirements** (related to different types of data-driven actions, with their respective timeline - from short-term to long-term)
    - **Cooperation modalities** between NOA and participants for further development of the service
- Participants:
    - NOA as provider of a future health surveillance & air quality platform
    - A panel of different potential users, that are:
        - National Public Health Organization (NPHO)
        - Region of Attica (Environment Division)
        - Municipality of Athens (DAEM)
        - Sustainable City Network (includes 40 Greek mayors)
        - PANACEA Research Infrastructure
    - ARMINES – CGS to support the co-design process

To be noted, that other users are also considered by NOA, but could not be present at the workshop:

- Hellenic Statistical Authority
- Ministry of Environment (operates the Greek air quality regulatory network)
- Ministry of Health
- Private companies: Karavias Insurance Company & Openhouse Real Estate

3.1.2 Workshop agenda

The idea of the workshop is to explore the topic mentioned above ("*Building a health surveillance & air quality platform for current and future operations of Athens' actors*), by organizing the dialogue between the pilot and the users, and especially by slowing down the dialogue. From a theoretical point of view, in design processes, there is a tendency to try to solve problems with quick solutions (so-called

"fixation effects") that might result in overlooking some important elements. To overcome fixation effects, the workshop was organized in three distinct phases aiming at slowing down the dialogue.

- **9h - 9h15** – **Introduction**
- **9h15 – 9h30 - Phase 1**: presentation of Health Surveillance Air Quality Pilot
    - NOA: presenting
    - Participants: active listening - *to what extent might the service be useful for me? Any issue raised?*
- **9h30 – 10h45 – Phase 2**: Knowledge exchange by each participant
    - Participants: speaking
    - NOA: active listening - *Would my service be able to address the expressed use cases? What functions could be added?*
- **10h45 – 10h55** - **Break**
- **10h55 – 11h45 - Phase 3:** Enriching the lists of requirements based on participants' inputs and assessing potential users' involvements:
    - NOA: suggesting
    - Participants: reacting
- **11h45 – 12h** - Wrap up and next steps

For the knowledge exchange phase, the following questions were addressed to the different participants (also sent prior to the workshop):

- **Overall usefulness of the service:** What are your current operations that would potentially benefit from the Athens service?
- **Detailed use case of the service (1/2):** According to what was presented by NOA, what would you do with this service? Which division would be concerned? To what extent would you be able to use the provided service on your own?
    - If you use the service for monitoring purposes, what information would you like to monitor? *Ex: pollutant concentrations*
    - What types of actions in your operations would it potentially support? *Ex: triggering certain actions when threshold exceeded*
    - Beyond using the service for your current workflows, how could the service help you to develop new operations or services on a longer-term perspective? *Ex: exploring new mitigation actions, regulations*
- **Detailed use case of the service (2/2):** What would be the constraints, drawbacks and risks of using the Athens service?
- **Dream of future EO services:** If you forget the current technological/resource constraints, what EO applications would you dream of?

3.2 Workshop outcomes

This workshop has confirmed the interest of the different participants in further collaborating with NOA to build its service. It has also highlighted the need of formalizing the cooperation modalities between NOA and users, taking into account participants' specific interests. The outcomes of the workshop are detailed below, following the three main elements mentioned above:

- **« Building blocks »** for further development of the service (knowledge shared by participants, identification of missing knowledge/competencies)
- **Broader range of potential lists of requirements** (related to different types of data-driven actions, with their respective timeline - from short-term to long-term)
- **Coordination modalities** between NOA and participants for further development of the service

3.2.1 "Building blocks" for further development of the service

The knowledge exchanged by each participant during phase 2 and phase 3 is summarized below. It should be noted that the summary is mainly related to the characterization of each participant's context.

3.2.1.1 National Observatory of Athens (NOA)

The National Observatory of Athens (NOA) is a major research center in Athens organized into 3 institutes: the Institute of Astronomy, Astrophysics, Space Applications and Remote Sensing, the Institute of Environmental Research and Sustainable Development, and the Geodynamics Institute. NOA's team working on the S2-P3 pilot is part of the Institute for Environmental Research and Sustainable Development, and more specifically within the Atmospheric Physics and Chemistry Group.

This pilot includes both a global component and local components. The global service is mainly developed by DLR, the German Space Agency, and aims at blending existing platforms using satellite data to monitor air quality (such as the Urban Thematic Exploitation Platform, NextGEOSS and BioClis). This global component is complemented with local components in different cities (Athens, Helsinki (along with Porvoo and Turku), Vienna, Munich), each one addressing specific issues of relevance.

Regarding the Athens component, NOA has developed a robust high-resolution air quality (AQ) model system, providing pollutant concentrations at a resolution of 100mx100m. The model involves a downscaling methodology called Urbem, resulting in an urban emissions inventory derived from regional emissions and disaggregated through Copernicus high resolution proxies to produce emissions at a 1kmx1km resolution. The latter then allows for the running of the city-scale chemical transport model (Episode-Citychem) to finally end up with 100m resolution concentration fields of pollutants, all available as web-based spatial maps.

Building off this application of the model, a range of added-value products can also be produced in order to build a multi-faceted health surveillance service for Athens, including:

- Pollutants not included in the model through the use of in-situ measurements (for ex black carbon using carbon monoxide from the model and its correlation with black carbon measurements)
- Population exposure information for all pollutants by relating the concentration fields with population characteristics - not only static population exposure, but also dynamic population exposure (taking into account movement of people in time and space on a microenvironmental scale, thus providing a more realistic view on the health risks to air quality)
- Other relevant information (depending on users' needs) by integrating other health and socio-economic data (for ex a health index tool (health impact related to AQ over time, looking at past AQ information)

Overall objective:

- Building an air quality health surveillance platform, providing a snapshot of relevant primary information and secondary, tailored indicators, on an open access basis
- Long-term perspective (besides e-shape timeline): different modules and new city components to be developed with different time horizons

Type of "EO" data that are included in the Athens component:

- Satellites (Copernicus programme)
- In-situ (Regulatory network of the Ministry of the Environment along with NOA supersite and monitoring)

- Information from AQ and exposure models
- Citizen observatory
- IoT network & smart sensors

Expectations related to the interactions with participants:

- Feedbacks on the following elements:
    - Specific indicators of interest (e.g. what type of data they would like to include and combine)
    - Specific processes needed to handle them (visualization, other tools)
    - Temporal scale of the information:
        - Snapshot of the situation on a yearly/daily basis
        - Data from the past for trend analysis
        - In a more mature implementation, could have a forecasting and alarm systems in real time
    - Resolution: 100m resolution → is it enough, too much? Where should we stop? Does it make sense to have information at building level, street level? It is an important point to discuss as sometimes huge efforts are needed to reach such high resolution, whereas there is no real need for it.
    - Different aggregation/disaggregation levels (at prefecture level/municipality level/regional level, etc.)
    - Relevance of providing a ranking of municipalities (based on a composite index including air quality, health, socio-economic information) for hot spots identification and policy prioritization purposes
- Specific expertise and data (socio-economic, health) that could be potentially shared by participants. Regarding data, data that has not been aggregated yet (for ex at municipality level) would be of particular interest for NOA

3.2.1.2 NPHO

The National Public Health Organization (NPHO) in Greece, former Center for Diseases Control and Prevention, constitutes the operational center for the planning and implementation of public health protection actions in the country and is responsible for the surveillance and control of diseases in Greece.

NPHO's is developing an Environment Office. Its main goal is to set up an environmental data observatory/database on a national scale, gathering all potential data on parameters that could affect health (not only focused on air quality) for all of Greece. NPHO is potentially interested in different types of systems, as they would like to create their own database, in collaboration with NOA and this pilot, and alert system with the capability to explore mitigation measures, systematically and permanently monitor air pollution and give guidelines, etc.

Potential interest in NOA's service:

- Monitoring of health threats from air pollution
- Also interested for action-taking support, and setting up guidelines and regulations

Specific requirements:

- Forecasting and early alerts would be of high interest
- Dynamic exposure interesting as well to monitor health threats
- Identification of hotspots could support dedicated health campaigns: identification of factors playing a role, kind of actions to take to mitigate impacts
- Proposition for short-term focus: correlating daily existing air quality data with visits to emergency departments

- If correlation exists, working on alert system to inform citizens (in order to prevent severe asthma events for example)

Contribution to NOA's service:

- Relevant and primary health data: cardio-vascular, respiratory diseases
- Potentially data at hospitals and emergency department levels
- Bring their expertise on health aspect of the platform to make it scientifically more robust and relevant

3.2.1.3 Region of Attica

Attica Region is an administrative region of Greece that encompasses the entire metropolitan area of Athens, the country's capital and largest city. This area represents the main experimental zone where actions based on this pilot's results will take place. More specifically, participants of the workshop belong to the General Directorate for the Environment and Climate Change.

The Region of Attica is interested in air quality data gathering, to use the data in future projects and for decision and policy making in the context of climate change and urban planning. To be noted that the region has also some specific legal obligations, especially it is responsible for developing the regional plan for adaptation to climate change, where health issues related to atmospheric quality will play a part.

Potential interest in NOA's service:

- Specialized air quality monitoring
- Decision support and design support for mitigation actions (environmental regulations for factories for ex)
- Identification of hotspots and ranking of municipalities: to justify prioritisation of actions on behalf of the region

Specific requirements:

- Pollutants to monitor: $PM_{2.5}$, Black carbon (for which the national regulatory framework is not very extensive), and if possible for other pollutants such as Volatile Organic Compounds (VOCs), benzene
- 100m resolution is indeed of interest
- Potentially to be combined with other types of data: other factors that are also taken into account for action prioritization (e.g. land use)
- Aggregation/disaggregation level of data: both local and regional levels are important. Indeed, there is a need to identify regional problems, and to take coordinated action between municipalities that are close to each other
- Question to be discussed next meeting: define priorities at different time horizons (short-term, mid-term and long-term)

Contribution to NOA's service:

- Socio-economic data

3.2.1.4 Municipality of Athens - DAEM

DAEM is an IT company within the municipality of Athens. It aims at providing Cloud based multiplatform e-Governance to local government organizations, public administration and other authorities and organisations. The development and promotion of new innovative services which are fundamental to the smart and sustainable city idea, is a strategic objective at the city level.

DAEM is involved in the project DUET, developing digital twins for European cities. It uses AI as a decision-making support for cities, potentially helping to set new strategic goals. In Athens, the objective is to exploit air quality data (but not related to health issues), and to correlate it with new ways of getting around the city.

Potential interest in NOA's service:

- Linking of air pollution data with traffic data
- Dynamic air quality data on a municipality scale
- Socioeconomic data to develop urban parking management service
- Other synergies related to NOA's expertise (involving an academic partner to deploy a sensor network would be helpful)

Contribution to NOA's service:

- Being an agency of the city, the municipality can bring other agencies into the pilot such as the municipal medical center of Athens as well as other organizations involved in the resilience of the city.
- Possibly sets of data at a municipality level

3.2.1.5 PANACEA Research Infrastructure

PANhellenic infrastructure for Atmospheric Composition and climatE chAnge (PANACEA) is envisioned to become the high-class, integrated Research Infrastructure for atmospheric composition and climate change not only for Greece, but also for southern Europe and eastern Mediterranean, an area that is acknowledged as a hot spot for climate change. It is part of international networks: ACTRIS for aerosol and optical parameters and ICOS for greenhouse gases.

PANACEA's main purpose is to bring all the air pollution monitoring facilities to work together to apply a protocolary observation on atmospheric parameters. Among its priorities, the organization is trying to answer these questions: what are the atmospheric pollution sources? What is the impact they have on health? Two major campaigns in several Greek cities recently took place to measure some air pollution parameters, specifically a new parameter (Reactive Oxygen Species (ROS)). Regarding this parameter, the question of integrating it in ACTRIS is currently discussed. This would require specific efforts on how to routinely measure this parameter (homogenisation, standardisation issues).

Potential interest in NOA's service:

- Further study on the impact of air pollution on health
- Collaboration to improve and standardise measurements for a range of specific pollutants (PM1 for ex) or specific parameters (ROS) and working on the future sustainability of the measurement network

Contribution to NOA's service:

- Share air quality data
- See what parameters could be incorporated in their future operations

3.2.1.6 Sustainable City Network

The City Network "Sustainable City" was established as a civil, non-profit organization with the intention to provide substantial technical support in informing, networking and managing the Municipalities that partake in it, enabling them to prepare and submit proposals to European Programs and utilize the available funding.

Potential interest in NOA's service:

- Air pollution monitoring, as a support of some of the projects followed by SCN, especially to assess the relevance/effectiveness of some measures such as:
    - Stopping traffic on certain roads (by seeing how the pollution indicators will evolve as a result).
    - Energy upgrades of buildings (what impact on air pollution)

Contribution to NOA's service:

- Potential role of interfacing with other municipalities (organizing specific events for diffusion, gathering specific data from municipalities)

3.2.2 Range of lists of requirements for NOA's service

The second objective of the workshop was to further **clarify the range of potential lists of requirements for NOA's service, according to different time horizons**. Given the limited amount of time of the workshop, it was not expected to result in a fully established list of requirements for each participant, but rather to start formalizing each participant's expectations by categorizing them in different types of services, at different time horizons (part 2.2.1). Based on this better understanding of each participant's expectations, some first elements on a development strategy for NOA's service can be inferred (part 2.2.2).

3.2.2.1 Characterization of participants' expectations

It was initially expected to classify participants' expectations according to three different types of systems, integrated EO-based information but also other elements (such as visualization or editing tools) enabling this information to be effectively integrated into user's actions and workflows. The type of system depends on the type of support that is needed by the user to transform EO-based information into action:

- **Monitoring system** when the user only needs to monitor a certain variable or phenomenon - information is then complemented with visualization tools and other customized tools depending on user's operations. *Ex: monitoring pollutant concentrations.*
- **Decision support system:** monitoring system complemented with other customized tools based on specific decision rules, helping the user to choose between a certain set of predetermined alternatives. *Ex: system that integrates some functionalities to help trigger certain actions when threshold is exceeded.* To be noted that building such a system requires to make explicit these decision rules, the level of precision expected and the underlying risks (for ex false alarm).
- **Scenario design support system:** monitoring system complemented with other customized tools helping the user to design new alternatives or operations, for example by the exploration of specific scenarios. Ex: *system that integrates some functionalities to help explore new mitigation actions, regulations, etc.* To be noted that it differs from the decision support system as the latter only helps to choose between existing alternatives.

It is worth highlighting that it is crucial to clarify the type of system that is needed by the user, as these different systems do not have the same requirements in terms of technical development.

However, this typology of systems proved to be not sufficient to describe all types of expectations from users. Indeed, **these three systems describe the targeted service, once it is stabilized (not necessarily all within the project lifetime). But other types of specific service provision appeared to be also needed** (e.g. punctual advisory service, specific preliminary study). Therefore, the participants' expectations are categorized in four categories:

- **Monitoring system**

- **Decision support system**
- **Scenario design support system**
- **Specific service provision (punctual advisory service, specific preliminary study)**

These different expectations could also be distinguished according to different time scales, defined as follows:

- **Short-term:** when the expectations related to a specific type of service are already clear enough to initiate the cooperation and move towards the development phase;
- **Mid-term:** when there is an expressed interest and some expectations have been mentioned, but a certain part of the expectations remains to be clarified before being able to move towards the development phase;
- **Long-term:** when there is a general interest or need expressed, but expectations remain to be clearly specified.

To be noted that **these different time scales do not account for the technical feasibility** and the level of technical development that might be required. Indeed, even expectations referred as *short-term* could require large development efforts: this *short-term* time scale only indicates that these expectations are clear enough to start these development efforts. In conclusion, regardless of time scale and clarity of expectations, development effort and time needed will be evaluated in parallel to decide whether they can fit into the available resources and within the project lifetime, or if additional resources would need to be pursued.

Based on these definitions, the main elements that came through the discussions can be summarized as follows:

- **NPHO** appeared to be interested in all types of systems but the priorities related to each type of system still need to be clarified (*monitoring, decision support, scenario design support systems at mid-term).* NPHO also suggested to start the collaboration by doing a preliminary study on the possible correlation between air pollution episodes and visits to emergency departments (*specific service provision at short-term*). Based on the results of this study, it could potentially lead to designing a specific decision support system (e.g. tools to issue alarms to stakeholders and the public).
- **Region of Attica** appeared to be also interested in all three systems, however probably with different time horizons. It appeared that there are priorities on a specific species monitoring system, including enhanced mobility and operational capacities (*monitoring system at short-term)* and a design support system to support the design of the climate adaptation plan, for which Region of Attica is responsible (*scenario design support system at short-term)*. Region of Attica is also interested in decision support for mitigation actions (for example triggering environmental regulations for factories), but this latter aspect will need further examination (*decision support system at mid-term).*
- **Municipality of Athens – DAEM** was only present until Phase 2 of the workshop. Therefore, they expressed their interest in collaborating with NOA in the future. However, the type of expectations and their respective time horizon could not be clarified through Phase 3 (*possibly monitoring, decision support and scenario design support systems, at mid-term or long-term)*. Further discussions would be needed to agree on these points.
- **PANACEA RI** expressed an interest in working on specific measurement and standardization protocols for specific pollutants that would be of interest for the users, and working on the long-term sustainability of the measurement network. This could take the form of a targeted scientific partnership within the existing RI (*specific service provision from short-term to long-term).*
- **Sustainable City Network** would be keen on building a kind of advisory interaction with NOA, where SCN would present their different projects and NOA could advise on some topics related to their expertise (*specific service provision at short-term*). They also expressed their interest

in a monitoring system, especially to support some of their projects, but the expectations related to this system remain to be clarified (*monitoring system at long-term)*.

To summarize these elements, the following diagram representing each participant's expectations at the different time scales can be drafted:

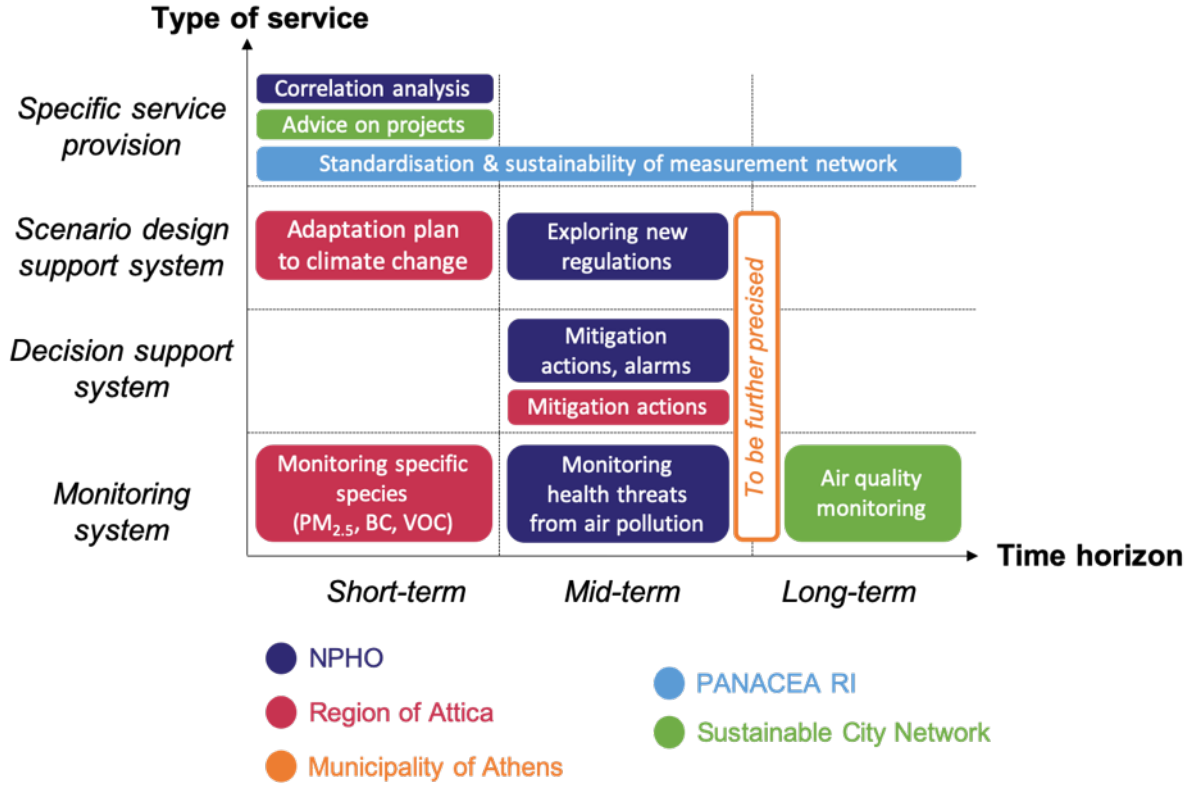

Figure 3: Characterization of participants' expectations, according to the expected types of service and their respective time horizon

3.2.2.2 Lessons for the platform developed by NOA

The following conclusions can be deduced from this characterization of participants' expectations:

- **At mid-term and long-term**, the interest of **building a platform with a common core and addressing the different users' contexts** is confirmed. This will be done by setting up a common database, complemented with specific modules. However, some uncertainties are remaining regarding the features of the common core of the platform (e.g. questions of resolution, temporal scale, data to be combined, other building blocks), and these questions are difficult to answer before starting working with the users.
- **At short-term**, it seems that **rapid explorations** could be put in place as first steps. In this perspective, a possible strategy would be to build quick & smart proofs-of-concept in response to the specific demands of participants, that would both aim at addressing the immediate issues raised by participants, and also to progressively design the common core of the platform.

3.2.3 Cooperation modalities between NOA and participants

As mentioned above, the workshop highlighted (1) the need of putting in place future interactions with the different participants in order to further learn and work on their demands, (2) the variety of forms that this cooperation could take. Thus, **for each participant, cooperation modalities should be formalized, as far as possible through a written agreement**, precising:

- The common interest in cooperating
- The expected exchanges (especially features of the common database, and respective contributions of the partners to the platform)
- Timeline and milestones of the interactions

In some cases, this agreement could come under the umbrella of a memorandum of understanding. Implementing such cooperation will need to be further discussed with each participant. However, it is already possible to draw some first conclusions on the type of cooperation that would be relevant for each participant:

- **NPHO:** strong interactions seem to be envisioned, including a rapid preliminary study phase, followed by frequent interaction loops to progressively refine the service to be developed and for NOA to also contribute to their workflows. As important design efforts could be foreseen, formalizing this cooperation through a general MoU and a complementary agreement related to the pilot development appears to be particularly relevant.
- **Region of Attica:** a strong cooperation is also foreseen, with a particular need in further defining the different time horizons for the expected developments. A MoU is already in process between the two organizations under broad terms. It seems to be relevant to complement this MoU with an agreement related to this specific pilot development.
- **Municipality of Athens – DAEM:** an interest in collaborating is clearly expressed, but the type of cooperation cannot be specified at this stage. Next steps would be to set up a meeting to further clarify the types of expectations and the form of a possible cooperation.
- **PANACEA RI:** as mentioned above, a specific scientific partnership within the RI could be put in place, facilitated by the fact that NOA is already a leading part of this network.
- **Sustainable City Network:** there seems to be an interest in putting in place a kind of advisory cooperation, that could involve regular meetings where SCN presents its projects and NOA reacts based on its expertise. This could be formalized through a specific agreement, precising the overall purposes of this cooperation, the frequency of meetings, the other possible forms of interactions.

3.3 Conclusion and possible follow-up

This workshop could be followed by different types of actions:

- **Operational next steps:**
    - First stage: meetings to be set up with participants to discuss the modalities of cooperation, and implement the rapid preliminary actions aforementioned for the concerned participants.
        - NPHO: meeting to design the MoU and preliminary studies
        - Region of Attica: meeting to discuss the existing MoU draft (extending beyond the project)
        - Municipality of Athens – DAEM: meeting to clarify expectations
        - PANACEA RI: meeting to put in place the specific scientific partnership
        - Sustainable City Network: meeting to design the MoU for an advisory cooperation
        - Informing users that were not present in this first workshop, but have expressed their interest in learning of the outcomes and providing further contribution in co-designing the service and/or establishing a long term collaboration
    - Following stage: based on the cooperation modalities agreed with each participant, further interact to progressively finetune the list of requirements for NOA's service.

- **More exploratory follow-up:** in this workshop, the exchanged knowledge only came from the different participants. This was a first step to initialize the interaction, however some interesting paths might have been overlooked as no external knowledge was brought in the design process. In this perspective, it could be interesting to broaden the exploration in order to make emerge other dimensions of interest for the service. This larger exploration could be done through additional workshops, by involving actors in other countries that would have built similar platforms (for ex leveraging the other pilot's cities: Helsinki, Munich, Vienna). Different formats could be considered: diffusion of knowledge through a dedicated website or oral presentations, reactions through the website, working sessions, etc.

4 ANNEX 2 - REPORT FOR CO-DESIGN TYPE 2 EXPERIMENTED WITH S3-P3 PILOT

4.1 Introduction

The present document summarizes the outcomes of the co-design type 2 process, organized within the e-shape project for S3-P3 pilot (*Offshore wind resources* within the *Renewable Energy showcase*). Co-design type 2 process organizes the exploration of usages in a specific way by confronting the service to different contexts (known contexts, contexts with unmet needs, unknown contexts). This involves running a cycle of different workshops: a first internal workshop (only involving DTU's team) is then followed by workshops with external stakeholders (beginning with existing contact points, and later on with actors identified as relevant during the process). The following workshops were carried out:

- First internal workshop on September 17th 2020
- First workshop with an external stakeholder (C2Wind) on October 28th 2020
- 2nd workshop with an external stakeholder (Equinor) on November 23th 2020
- 3rd workshop with an external stakeholder (VORTEX) on November 26th 2020

4.2 Conclusions of the first internal workshop

The first internal workshop is part of the preliminary phase and aims at helping the pilot to better define the scope of the exploration that is expected within this type 2. The agenda was the following:

- 14:00-14:05 - Introduction (WP2)
- 14:05-14:15 - Presentation of prototype (DTU)
- 14:15-14:45 - Exercise 1: imagining the use of DTU's service in **known contexts**
- 14:45-15:15 - Exercise 2: imagining the use of DTU's service in **contexts with unmet needs**
- 15:15-15:45 - Exercise 3: imagining the use of DTU's service in **unknown contexts**
- 15:45-16:00 - Wrap-up: discussion of next steps and to what extent the exercises were useful to DTU

Guiding questions were used for each exercise:

- **Guiding questions for exercise 1 – known contexts:** confronting the service to known contexts as a substitute of existing tools + analyzing the related stakeholders

How is the offshore wind sector organized? What are the different actors involved in all phases of wind farm development and use (tendering, construction, operation, electricity distribution…)? How do these actors interact?
To what extent do these actors already measure wind resources? What tools are they already using?
As a thought exercise, think of the integration of your service as a substitute of the existing ones:

  - *What would be the effects of such integration? What functions would the service need to include?*
  - *Exercise to be repeated for each actor involved in the different phases of wind farm development & use (tendering, construction,…).*

- **Guiding questions for exercise 2 – unmet needs:** confronting the service to contexts with unmet needs + analyzing the related stakeholders

For each actor, have you already identified some of their unmet needs (well-identified problem but with no existing solution)?
To what extent the EO-based solution developed by DTU would contribute to address these unmet needs? What would be the functions of the service?

- **Guiding question for exercise 3 – unknown contexts:** confronting the service to unknown contexts + analyzing the related stakeholders → characterization of offshore wind resources to be thought in other contexts:

Still for off-shore wind industry but in other countries?

- *Potential usefulness? Specific constraints?*
- *Need of complementing wind resource information with additional elements? (for ex there might be a need to strengthen means of intermittency management depending on the country context)*

In contexts other than off-shore wind industry but that would benefit from the advantages of your specific wind characterization? Marine activities?...

In a larger audience perspective, different means of promoting the specificities of the characterization proposed by DTU?

The exercises enabled DTU to understand the different alternatives for its exploration and their respective consequences:

- Going further on exercise 1 would involve **exploring what would be the convincing strategies for these specific users.** To be noted that "demonstration" needs to be considered in the sense of "scientific demonstration" and not only marketing action. It would more specifically involve exploring **other dimensions as the accuracy of wind**.
- Going further on exercise 2 would involve **making a deeper analysis on the current situation of these « unmet needs »,** especially examining the following elements: *are there already existing alternatives? What are the potential competitors already dealing with this question?* This would imply **interacting with new stakeholders for DTU** (for ex O&M actors, or other actors involved in the other stages of a wind offshore project)
- Going further on exercise 3 would involve **exploring the demonstration strategies that would encourage unknown people to interact with DTU** → how to make DTU's service surprising/fascinating so that it could attract a broader audience. A first step would be to have a **look at the existing demonstration strategies done by others, that seem to work well on this fascinating aspect.** Some examples:
  - Demonstrations that look like "magic tricks": NASA shuttle thermal tile → handling a 1100°C tile! https://www.youtube.com/watch?v=Pp9Yax8UNoM
  - Polymagnet: http://www.polymagnet.com → demonstration playing on several dimensions:
    - Kit of magnets sold in the perspective of being used as a starting point of new designs
    - Largely diffused video highlighting the "magic" aspect (https://www.youtube.com/watch?v=IANBoybVApQ&feature=youtu.be&t=2m1s),
    - Completed with webinars for more expert people willing to understand the underlying physical process.
  - Boston Dynamics → range of very impressive videos

Following this preliminary session, DTU chose to more specifically **focus on known contexts and contexts with unmet needs** (corresponding to exercises 1 & 2). A cycle of workshops with external stakeholders was then built to further support DTU's exploration.

4.3 Protocol for the different stakeholder workshops

Each workshop followed the same structure: it lasted 1 hour and a half and had the following subject, expected outcomes and participants:

- Subject: ***Exploring the range of usefulness of DTU's service and related actors of the ecosystem by leveraging C2Wind/Equinor/VORTEX knowledge & experience***
- Expected outcomes:
  - **Expanded usefulness of the developed service:** unveiling new generic functions of the service, resulting in new dimensions of usefulness for the service;
  - **Expanded pool of stakeholders** that would benefit from the developed service, based on the existing network of the pilot and on the identified generic features of the service.
  - **Identification of potential users** that could move towards a **co-design type 1**.
- Participants:
  - DTU as provider of a future wind information web-application
  - C2Wind/Equinor/VORTEX as a potential user and for its expertise and knowledge
  - ARMINES – CGS to support the co-design process

The idea of the workshop is to explore the topic mentioned above (i.e. *exploring the range of usefulness of DTU's service and related actors of the ecosystem by leveraging C2Wind/Equinor/VORTEX knowledge & experience*), by organizing the dialogue between the pilot and a specific stakeholder to unveil the potential usefulness dimensions of the service. From a theoretical point of view, in design processes, there is a tendency to try to solve problems with quick solutions (so-called "fixation effects") that might result in overlooking some important elements. To overcome fixation effects, the workshop was organized in three distinct phases aiming at structuring this dialogue.

- **10h30 - 10h35** – **Introduction**
- **10h35 – 10h45 - Phase 1**: demonstration by DTU
- **10h30 – 11h45 – Phase 2**: exploration of the range of usefulness of DTU's service with C2Wind/Equinor/VORTEX support
- **11h45 – 11h55** - **Break**
- **10h55 – 11h45 - Phase 3:** building-up relationships with the ecosystem (C2Wind/Equinor/VORTEX and other potential actors)
- **11h55 – 12h** - Wrap up and next steps

For the *Phase 2 - exploration of the usefulness of the service phase*, the following questions were addressed to C2Wind/Equinor/VORTEX:

- **Opening question:** What potential do you see in DTU's products and services?
- **Guided exploration** by asking 3 questions for each type of information included in DTU's service:
  - Could you detail a **potential use case** for this information: for which use? **Added-value** of this information? What would be the **constraints** of using it?
  - Same questions for **other actors** (wind farm developers, large utility companies, investors, foundation designers/fabricators, wind turbine manufacturers, others…)
  - If you forget the current technological/resource constraints, what EO services would you/other actors **dream of?**

For the *Phase 3 – building-up relationships with the ecosystem*, two other questions were asked to C2Wind/Equinor/VORTEX:

- According to you, **which stakeholders of the ecosystem** would it be interesting to work with to continue the exploration & development of the service?
- **Regarding C2Wind/Equinor/VORTEX,** to what extent would you like to continue working with DTU? In which form?

4.4 Co-design type 2 outcomes

First, it is worth **highlighting an important element of the co-design type 2 process that proved to be crucial but not evident for the pilot in the first place**: in order to maximize the exploration, users do not have to be considered only as future potential clients but rather as **knowledge providers**. In practice, this resulted in favoring questions asking for the potential seen by the user in a certain feature, rather than merely asking for validation or invalidation of this feature.

Second, co-design type 2 could be materialized by **concrete advances on the three following elements:**

1. Shift in DTU's representation of the users' ecosystem
2. Shift in DTU's perception of its own service and its different usefulness dimensions
3. Identification of a range of alternatives for future development efforts at different time scales and launch of first actions with some of the users involved in the workshops.

4.4.1 Shift in DTU's representation of the users' ecosystem

The different workshops have progressively helped DTU to **build an enriched representation of its external ecosystem,** namely the offshore wind industry, including (1) mapping the landscape of actors, (2) how they interact with each other (value chain), (3) and where DTU could possibly integrate in this landscape (i.e. what could be the different interests in the field). This representation of the ecosystem can be summarized as follows:

A wind farm project cycle consists of four stages (Figure 4): Pre-construction, construction, operation and maintenance, and decommissioning. From the beginning, it was clear to the project team that DTU's EO-based service is mostly relevant in the pre-construction phase where a number of site analyses are required. New insights, gained by researchers at DTU through the co-design workshops, lead to a much better understanding of the actors and processes, which form the pre-construction. Through the workshops, we explored especially the need for spatial data and the requirements for accurate wind information. It became clear how these requirements change as a wind farm project gets closer to the investment decision and the actual wind farm construction. The workshops also lead to valuable insights in how wind analysts work in practice and how they need to have data and clear documentation readily available. There is little time to explore and understand new data types in their daily work, or to work with data conversion. As part of our future co-design cycles, we might explore the actors of the three other phases in the project cycle and also look beyond offshore wind energy e.g. towards hybrid power plants or fish farming.

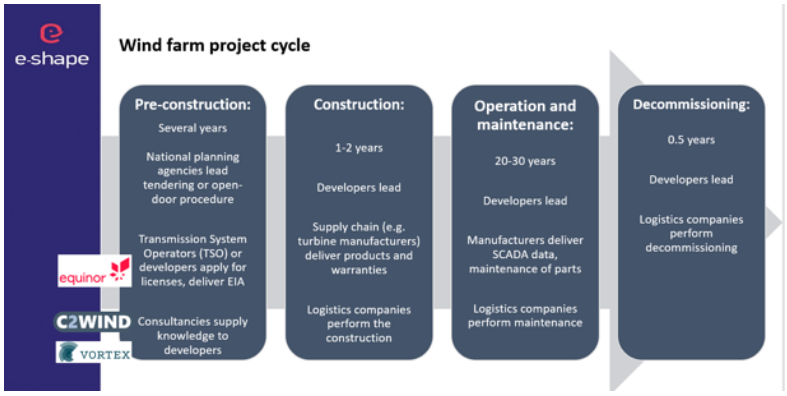

Figure 4. Overview of a typical wind farm project cycle and the actors addressed so far.

4.4.2 Shift in DTU's perception of its own service and its usefulness dimensions

The different workshops have also allowed DTU to better understand the different usefulness dimensions of the service, resulting in a shift of how DTU previously imagined its service. It especially appeared that DTU should not only focus on delivering turn-key wind resource products, but should rather **provide users with the means of calculating these wind resources on their own**. This especially requires building a stronger documentation on the products (helping users to understand their validity domain and the underlying processing chains), and providing products in a specific format so that they could be transformed into wind resources by the users themselves. These elements have been thus identified as priorities for next sprints in e-shape.

4.4.3 Range of alternatives for future developments and concrete actions for each user

It is important to highlight that the objective of this cycle of workshops was not to merely select one of these alternatives but rather to **generate an overview of the different potential alternatives regarding DTU's development efforts, that could be considered at different time scales**. These elements were represented in the following diagrams (one diagram made for each user), mapping the efforts to be made on DTU's side and efforts that could be made in collaboration with the user.

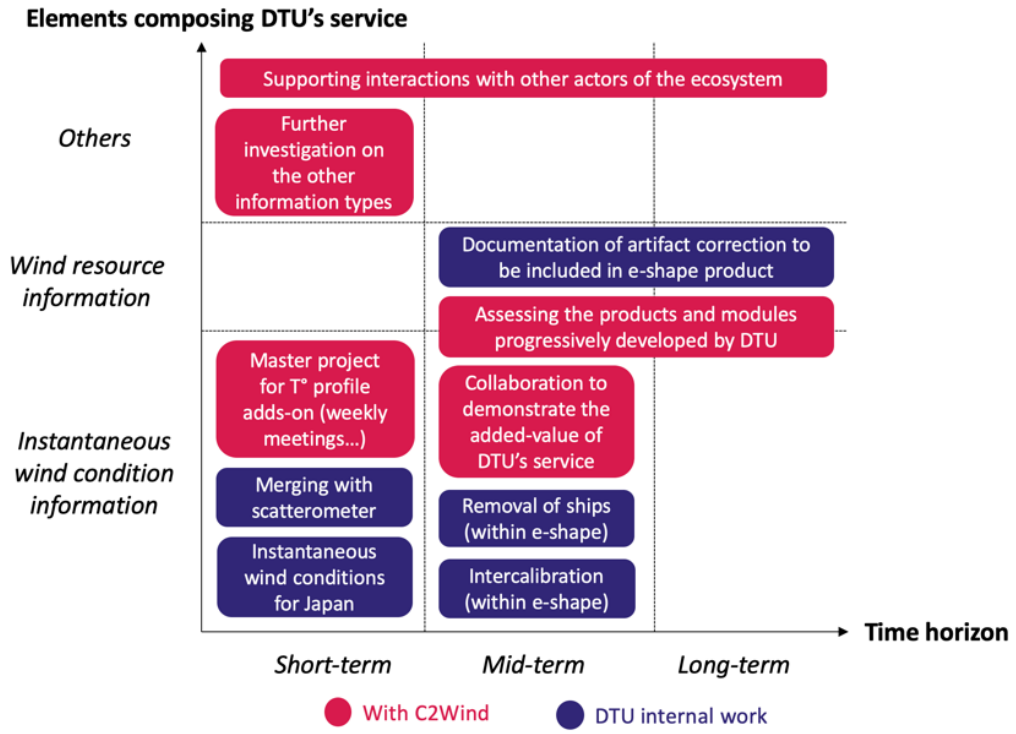

Figure 5: Overview of the development alternatives at different time scales for C2Wind

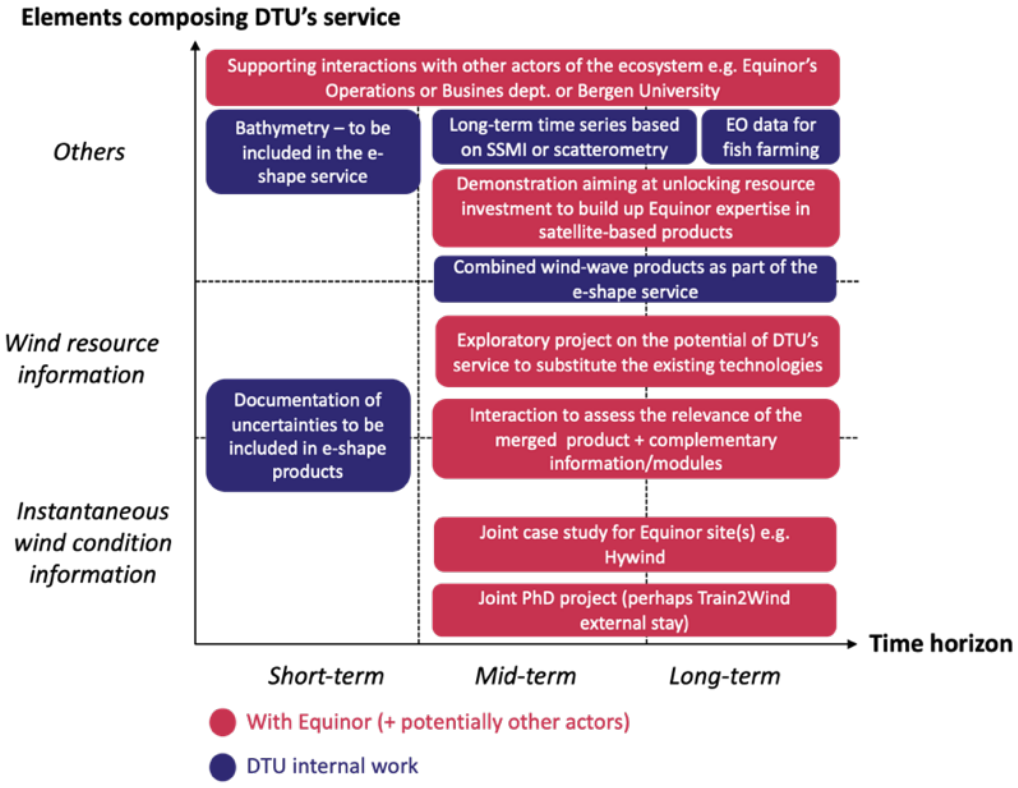

Figure 6: Overview of the development alternatives at different time scales for Equinor

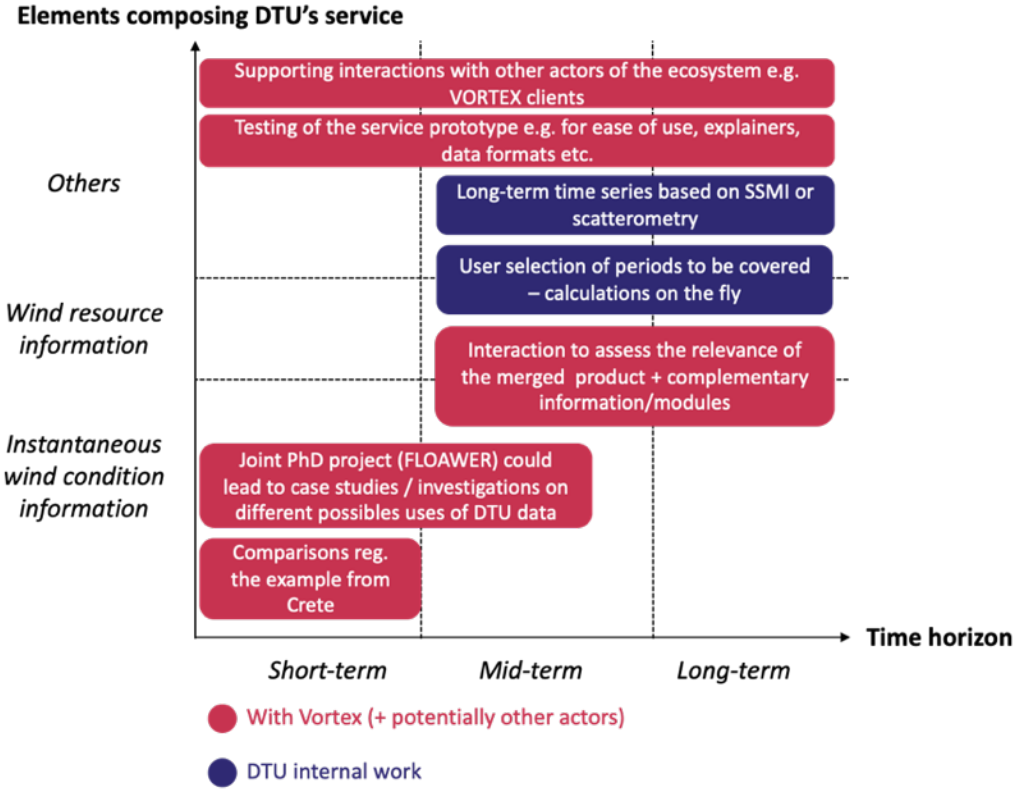

Figure 7: Overview of the development alternatives at different time scales for VORTEX

Besides the overview given by these different diagrams, concrete actions were already launched by DTU following the different workshops, especially:

- With VORTEX, study of hurricane and extreme events through a joint PhD project
- With C2Wind, exploration of future partnerships within different calls for proposals (e.g. ESA)

4.5 Next steps

DTU has formulated several perspectives for the future:

- Routinize this co-design type 2 process to continue exploring both the ecosystem of actors and usefulness of DTU's service (for example through a certain number of interviews to be carried out each year)
- Move towards co-design type 1 for some of the actors identified as relevant: co-design type 1 aiming at better formalizing and scheduling the development plan with these actors.
- DTU might also be confronted to co-design type 3 in the future: for the moment, development is made internally but might be transferred to an external company.

WP2 will at least provide DTU with materials on the other co-design types (when ready) and give additional support if needed. The final objective is that DTU could autonomously implement these different co-design actions in the future, even after e-shape timeline.

5 ANNEX 3 - REPORT FOR CO-DESIGN TYPE 3 EXPERIMENTED WITH S3-P2 PILOT

5.1 Introduction

5.1.1 Context of the workshop

The present document summarizes the outcomes of the co-design workshop, organized within the e-shape project for S3-P2 pilot (*High PV penetration at urban scale*). The workshop is a focused part of the co-design approach that is developed and implemented in e-shape, to support the development of the pilots considering the specific issues related to the EO field. Based on the analysis of the different e-shape pilots in e-shape, four main co-design types have been identified, each one corresponding to a specific design issue related to the service itself or to the relationship with users.

Several co-design types were identified as relevant for S3-P2 pilot, however the workshop documented in this report was dedicated to co-design type 3 corresponding to the following situation:

- Context: in cases where the usefulness or the relationship with the user is already clearly established, but there is a need to implement it and make the service operational and robust in compliance with the established requirements.
- Objective: establishing the engineering needed to further operationalize and scale-up existing and future services
- Expected outcomes:
    1. **Clarification of the service structure**: distinction between two categories of modules - the modules that can be operationalized, and the modules that need further exploration
    2. **Establishing relationships** with the relevant actors to deal with each category of modules

In the context of S3-P2 pilot, operationalizing services is done in collaboration between O.I.E. (research lab) and Transvalor, also referred as TSV, (commercial entity in charge of engineering and commercialization of services). However, some issues appeared in establishing adapted relationships between these two entities, especially on some specific cases.

Indeed, the operationalization of the service is **not only a question of transferring modules to be operationalized** to the entity in charge of operationalization as some **parts of the service might still need further exploration**. Neglecting this distinction between the two types of modules might result in difficulties establishing the relevant relationships with entities in charge of operationalizing the service. Co-design type 3 thus acts as a **revealing chamber, eliciting each category of modules (see *Figure 1)***. This clarification also allows to better specify the type of cooperation modalities needed to deal with each type of modules. Given these considerations, the co-design type 3 is organized as follows:

- Preliminary session to identify several concrete cases (at least one or two) where the relationship between the service developer and the operationalization entity has proved difficult to be defined *(carried out on January 15th 2021)*
- A sequence of workshop sessions (number depending on the pilot's objectives and constraints) to progressively refine and update a common understanding of the service structure (modules to be operationalized/to be further explored) and the related cooperation modalities on each type of modules: *the present document reports on a first workshop gathering O.I.E. (research lab) and Transvalor (commercial entity in charge of engineering and commercialization of services)*

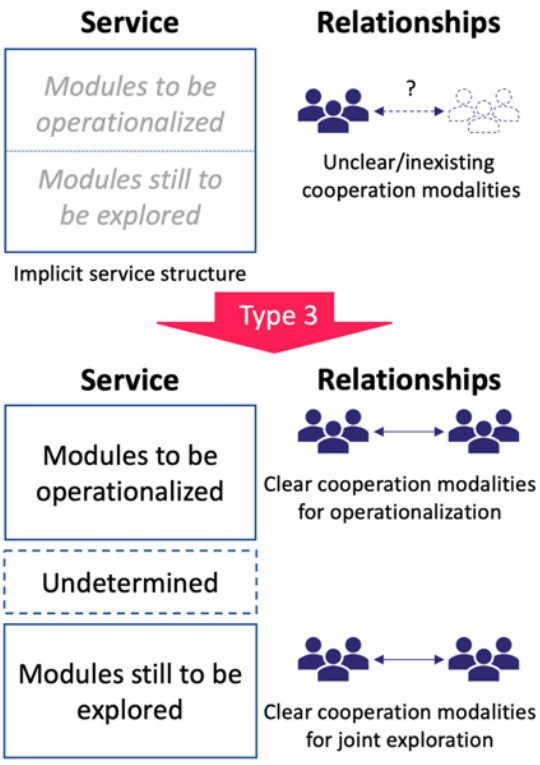

Figure 8: Co-design type 3 acting as an eliciting chamber

5.1.2 Workshop agenda

The workshop objective was the following: *based on the concrete cases identified in the preliminary phase, clarifying the parts of the service* ***to be operationalized/to be explored*** *& the associated* ***cooperation modalities*** *between O.I.E. and TSV.*

From a theoretical point of view, in design processes, there is a tendency to try to solve problems with quick solutions (so-called "fixation effects") that might result in overlooking some important elements. To overcome fixation effects, the workshop was organized in three distinct phases aiming at structuring this dialogue.

- **9:00 – 9:15 – Introduction:** e-shape & co-design
- **9:15 – 10:00 – Quick investigation on a case study (Cloud Motion Vector)**
  - **Phase 1:** case study seen from O.I.E.
  - **Phase 2:** case study seen from TSV
  - **Phase 3:** clarification with WP2 support of the two types of modules (to be operationalized/to be explored) and the associated cooperation modalities to be put in place
- **10:00 – 10:15 – Wrap-up**
- **10:15 – 12:00 – Deeper investigation** on specific elements

O.I.E. and TSV agreed in the preliminary phase to work on the case of a *CMV (cloud motion vector) service*, that was initially described by O.I.E. as follows. This service would:

- *Give access to solar radiation data in all-sky or clear-sky conditions in a gridded mode around an area of interest (with a 50km radius)*
- *Calculate the motion vectors of clouds based on two consecutive images*
- *Include two modes:*

- *Hindcast (to stimulate forecasts in the past (for demonstration purposes of the forecasting algorithm performances)*
- *Nowcast for a real-trim application (within a day)*

Phase 1 and Phase 2 consisting in asking each party to **share certain critical knowledge bases** (identified prior to the meeting), and **expose different concepts of the service that might be envisaged,** including the ideal version, a minimal quick & smart version and in-between versions.

Phase 3 then aimed at creating connections between both O.I.E. and TSV visions, leading to a shared understanding of the modules to be operationalized and to be explored, and the associated cooperation modalities.

5.2 Workshop outcomes

5.2.1 Synthesis of Phase 1 – O.I.E. vision of the CMV service

A framework was used as a support of the discussion, representing in a synthetic way the knowledge bases to be elucidated and the range of alternatives that might be envisaged for the CMV service, from O.I.E. perspective (the ideal version, the minimal quick & smart version, and the range of alternatives in-between). The content of the exchanges has been synthesized in this framework (*Figure 2*):

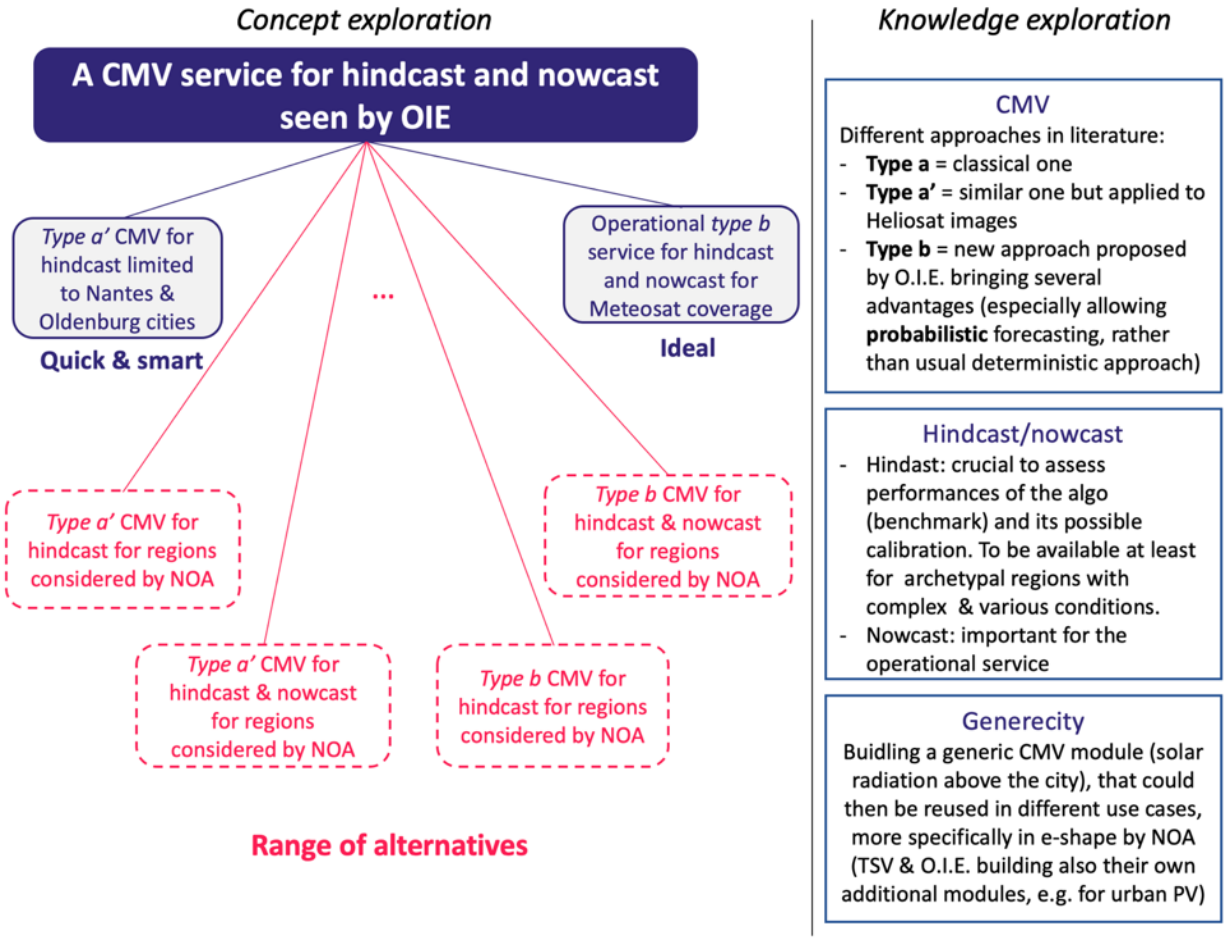

Figure 9: Framework synthesizing the CMV service seen by O.I.E.

To complement this synthetic overview, some details can be added on the different CMV approaches in literature:

- The *type a* approach can be described as follows: from a sequence of two Meteosat images, the cloud motion vectors are derived and applied to the last image to generate the forecasted image. The latter can then be used as an input of the Heliosat method without changing the usual processing chain.
- The *type a'* corresponds to the same approach but using Heliosat outputs directly (sequence of clearness index) rather than satellite images.
- Type *type b* corresponds to a new approach developed by O.I.E., using clearness index maps and cloud motion vectors to deduce the estimated time when different clouds will converge to a certain point. The advantages of this method are twofold: first it allows tot take into account several clouds converging to the same point, second and most importantly it allows making probabilistic forecasts

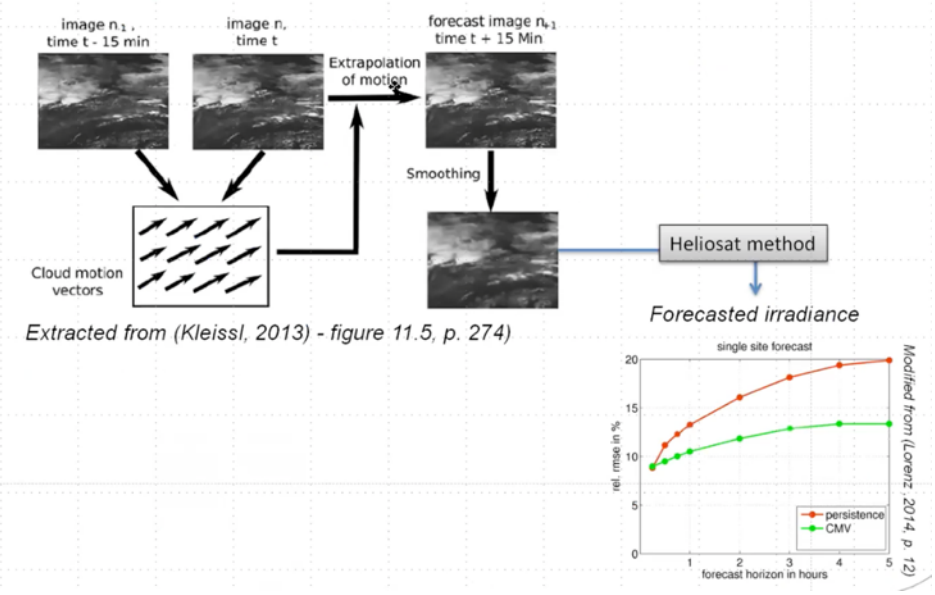

Figure 10: Classical CMV approach (type a)

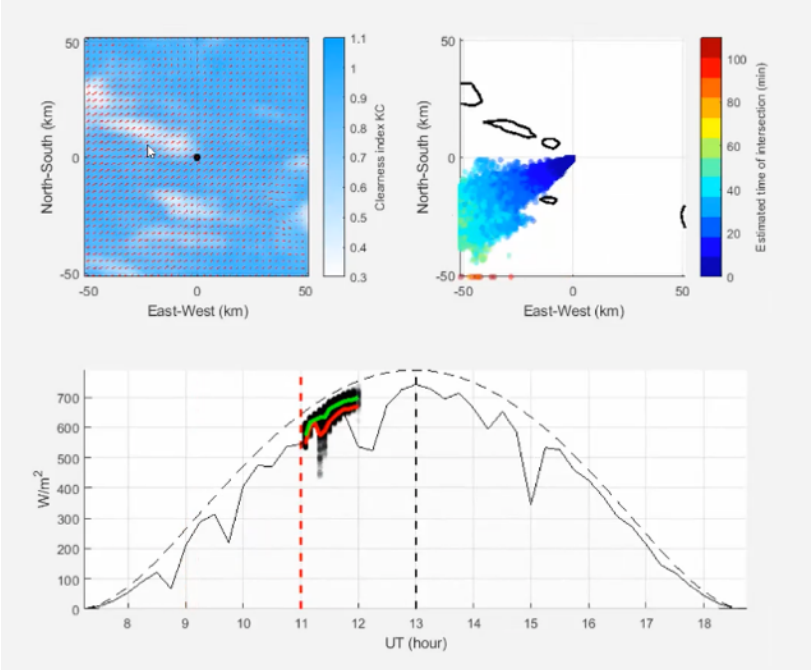

Figure 11: Approach developed by O.I.E. (type b)

5.2.2 Synthesis of Phase 2 – TSV vision of the CMV service

The same framework was used for TSV, and is synthetically represented below (*Figure 5*).

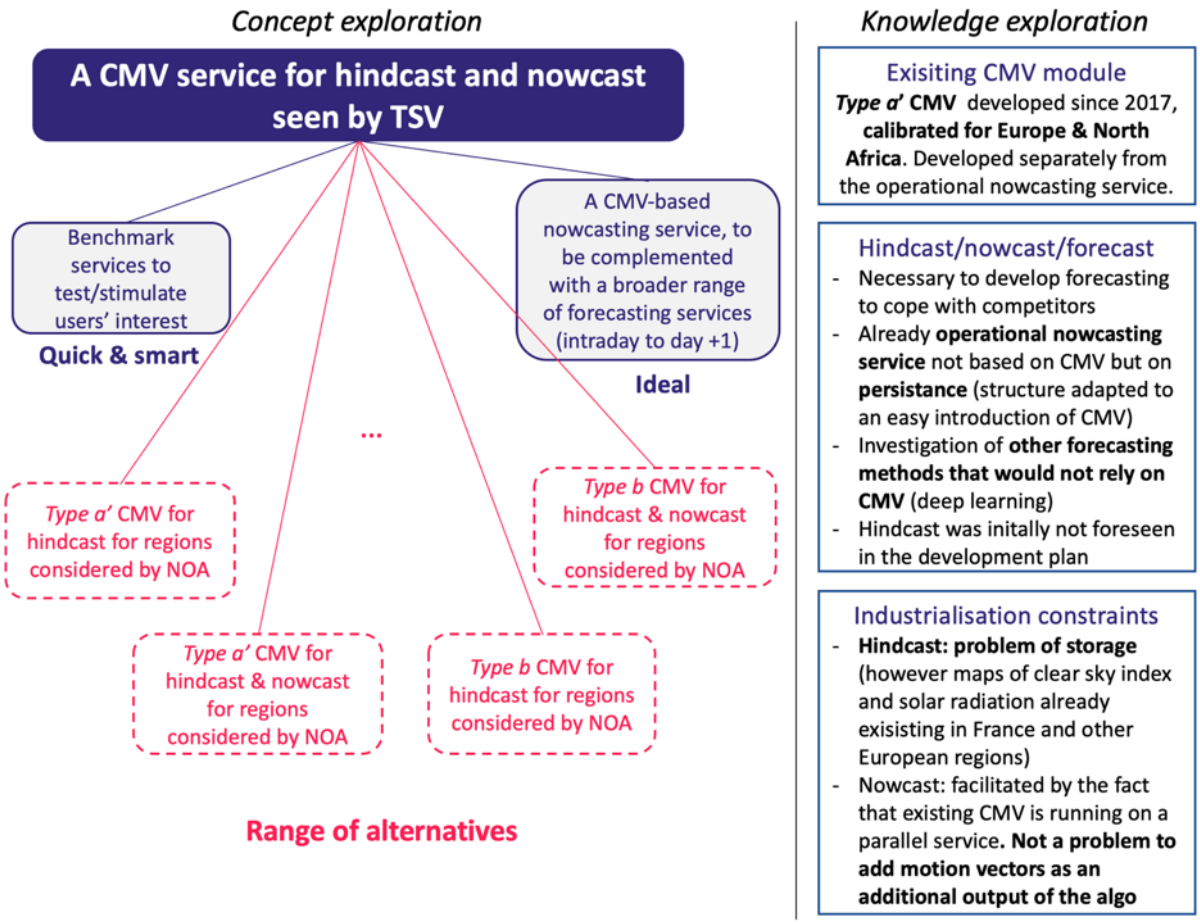

Figure 12: Framework synthesizing the CMV service seen by TSV

5.2.3 Clarification of the service structure and associated cooperation modalities

Some common interests were already identified during phases 1 and 2. Phase 3 was dedicated to clearly formalize these common interests by filling-up a synthesis table, differentiating between modules to be operationalized, modules to be explored and undetermined modules, and agreeing on the types of interactions to put in place between O.I.E. and TSV (cooperation modalities). This resulted in building a concrete action plan for the coming months, including different time horizons.

	Short-term	Mid-term	Long-term	Cooperation modalities
Modules to be operationalized	*Type a'* CMV for hindcast - Gridded maps of clear sky index & cloud motion vectors). - Area: starting with Nantes & Oldenburg. Enlarging to Europe & Mediterranean basin	*Type a'* for nowcast		March 2021: kick-off and working sessions to define inputs & outputs and development planning. TSV: involving Stéphane OIE: beta-testing Milestones for e-shape sprint 2
Modules to be explored	*Type b* CMV for hindcast with partial processing from O.I.E. (TSV providing maps; O.I.E. processing the algorithm). Same area	*Type b* CMV for hindcast with processing transferred to TSV	*Type b* CMV for nowcast	March 2021: technical working session with TSV (Alexandre Boilley) on python code developed by O.I.E.
Undetermined	TSV-OIE collaboration for GAN methods	Collaboration on other deep learning methods for long-term forecasting	Commercial service for forecasting at different time horizons	R&D collaboration (joint PhD & internships, specific interest group on forecast between O.I.E. and TSV)

Table 4: Shared vision on the service structure (modules to be operationalized / to be explored / undetermined) and cooperation modalities between O.I.E. and TSV

5.3 Conclusion and next steps

5.3.1 Feedbacks on the co-design type 3 process

At the end of the workshop, some time was spent to discuss about the co-design process itself and get first feedbacks from the pilot. The approach proved to be useful for the pilot as it brought a specific structure to the interactions, resulting in a clearly formalized work plan for the next months.

The discussion also suggested an interesting source of improvement, that is **starting the workshop by formulating explicitly the assumptions of the pilot regarding the usefulness of the service** (thus introducing a first step of 'usefulness check'), and **regularly revise these assumptions**. Indeed, the co-design type 3 process starts with a certain usefulness of the service already identified, and then focuses on building the engineering resources given this usefulness. It was also highlighted that the assumptions on usefulness might not necessarily come from a thorough client prospection effort, but can also come from other elements perceived as strategic by the pilot that might not be explicitly formulated by clients.

In the case of this workshop, although the usefulness of the CMV service was not explicitly checked at the beginning of the workshop, it was however mentioned along its different phases in the following ways:

- Overall usefulness of CMV: it is considered as strategic for the foreseen evolution of the energy sector, especially through the emergence of energy trading activities with a portfolio of PV systems. In this model, these energy trading companies have to make commitments on how much electricity they would sell on the SPOT market, a day-ahead and intraday. Forecasting PV production is thus of paramount importance to make adapted commitments. CMV would serve as a crucial building block of intraday forecasting techniques (day-ahead forecasts would have to be addressed through other techniques).
- For TSV, competitors are already doing CMV, so they do not have the choice of also working on this topic.
- Having an interoperable CMV module could also be of interest for scientific benchmark, and more specifically in e-shape for building synergies with NOA's pilot.

To be noted that this 'usefulness check' has to be done regularly as the usefulness perceived by the pilot might evolve overtime (depending on new interactions with clients or new research directions), at least at the beginning of each new meeting within co-design type 3.

5.3.2 Next steps

Co-design type 3 process will continue for TSV and O.I.E., through different potential types of actions:

- For the CMV service, actions are to be taken following the agreement made in phase 3 (see *Table 1*)
- Revision on a regular basis of the perceived usefulness and the next modules to be operationalized (regular meetings between O.I.E. and TSV to be dedicated to this question)
- In addition to the topic on CMV service, the same kind of workshop could be organized to address other topics, proposed either by O.I.E. or TSV

On WP2 side, the co-design type 3 protocol will be enriched thanks to this first workshop, especially integrating an initial step of 'usefulness check'.