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| WEATHER CLIMATE WATER | **World Meteorological Organization**  **COMMISSION FOR WEATHER, CLIMATE, WATER AND RELATED ENVIRONMENTAL SERVICES AND APPLICATIONS**  **Second Session** 17 to 21 October 2022, Geneva | **SERCOM-2/Doc. 5.9** |
| Submitted by: Chair  17.X.2022  **APPROVED** |

***[All changes to the document have been made by the United Kingdom]***

**AGENDA ITEM 5: TECHNICAL REGULATIONS AND OTHER TECHNICAL MATTERS**

**AGENDA ITEM 5.9: Integrated energy services**

# Integrated Energy Services



# DRAFT DECISION

## Draft Decision 5.9/1 (SERCOM-2)

### Best Practices for Integrated Weather and Climate Services in support of Net Zero Energy Transition

**The Commission for Weather, Climate, Water and Related Environmental Services and Applications,**

**Recognizing** the pressing challenges by governments to reduce Green House Gas (GHG) emissions and to implement net zero strategies across all sectors, including energy,

**Noting** the important role that National Meteorological and Hydrological Services (NMHSs), as government bodies at the vanguard of weather and climate services, will play in providing technical support and services in the transition to reliable clean and net zero national energy systems,

**Further noting** the information contained in the [annex](#_Annex_to_draft_1) to the present decision,

**Decides:**

(1) To support the publication by the most efficient means of the best practices on integrated weather and climate services in support to net zero energy transition developed by the Study Group on Integrated Energy Services. Including the 10 recommendations for further develop collaborative approaches between weather, climate and energy, and embed them in long-term collaboration frameworks;

(2) To encourage Members of the Commission to take note of the 2022 State of Climate Services Energy report developed by WMO and 26 partners representing climate finance institutions and key energy stakeholders, including members from the Study Group on Integrated Energy Services and the private sector, as a useful guidance for actions towards net zero, including strengthening climate services for energy;

(3) To invite the Members of the Commission to apply the best practices for developing user-driven weather and climate services for the energy sector to support resilience, renewable energy development and energy efficiency, and report to the Commission on their experience.

See [SERCOM-2/INF. 5.9(1)](https://meetings.wmo.int/SERCOM-2/InformationDocuments/Forms/AllItems.aspx) for the complete document of Best Practices

See [SERCOM-2/INF. 5.9(2)](https://meetings.wmo.int/SERCOM-2/InformationDocuments/Forms/AllItems.aspx) for the complete 2022 State of Climate Services: Energy report

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Decision justification:

[Resolution 1 (SERCOM 1)](https://library.wmo.int/doc_num.php?explnum_id=10767#page=14) – Establishment of Standing Committees and Study Groups of the Commission for Weather, Climate, Water and Related Environmental Services and Applications (Services Commission)

[Resolution 2 (EC-75)](https://meetings.wmo.int/EC-75/_layouts/15/WopiFrame.aspx?sourcedoc=/EC-75/English/2.%20PROVISIONAL%20REPORT%20(Approved%20documents)/EC-75-d03-3-RECOMMENDATIONS-SCIENTIFIC-ADVISORY-PANEL-approved_en.docx&action=default) – Recommendations from the Scientific Advisory Panel, The Scientific Advisory Panel, in their Vision Paper, has urged the WMO and NMHSs to work together in the move towards net zero in the next decade. As energy production shifts more towards renewables, weather, climate and water information will become valuable in siting and operating wind, solar and hydro power

[Resolution 1 (EC-75)](https://meetings.wmo.int/EC-75/_layouts/15/WopiFrame.aspx?sourcedoc=/EC-75/English/2.%20PROVISIONAL%20REPORT%20(Approved%20documents)/EC-75-d03-1(1)-GFCS-STRATEGY-ENHANCED-IMPLEMENTATION-approved_en.docx&action=default) – Global Framework for Climate Services (GFCS) Strategy and Measures for Enhanced Visibility, Effectiveness and Implementation, as a new strategy and measures are considered for enhancing GFCS visibility, effectiveness and implementation, Members are urging SERCOM to review the existing GFCS exemplar on the five priority sectors which include energy.

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[Annex: 1](#Annex)

## Annex to draft Decision 5.9/1 (SERCOM-2)

## Summary of the Best Practices on Integrated weather and climate services for net zero energy transition

### 1. Background and Structure

In 2017, the Global Framework for Climate Services (GFCS) published the “Energy Exemplar to the User Interface Platform of the GFCS”. The Exemplar served to guide the World Meteorological Organization (WMO) Members and partners in identifying key climate data and products, as well as mechanisms needed to develop user-driven climate services for the energy sector[[1]](#footnote-2) to support increasing resilience, a faster renewable energy deployment and energy efficiency measures. Since then, there has been an acceleration of the race to achieve net zero carbon emissions by the middle of the twenty-first century, in order to meet the international goals, particularly those set with the Conferences of the Parties (COPs) under the United Nations Framework Convention on Climate Change (UNFCCC) auspices.

The document is an update of the GFCS “Energy Exemplar” and was compiled under the aegis of the WMO Study Group for Integrated Energy Services (SG-ENE[[2]](#footnote-3)), part of the Commission for weather, climate, water and related environmental services and applications (SERCOM), with contributions from some of the leading experts in the field. The SG-ENE, established in 2020, has as its main purpose to support the WMO Strategic Plan by helping members and relevant stakeholders to create and sustain services delivery for the Energy sector, as well as to develop partnerships for WMO to contribute to the Sustainable Development Goal (SDG)7, Affordable and Clean Energy, and the Paris Agreement.

The publication is structured as follows.

Chapter 1 provides the background and overall motivation for the whole document, starting from the policy drivers;

Chapter 2 continues by discussing the underlying information production of Weather and Climate Services (W&CSs), namely weather and climate data;

Chapter 3 discusses energy conversion models, using the weather and climate data introduced in Chapter 2, to meet the industry needs;

Chapter 4 looks into co-production approaches;

Chapter 5 looks at enabling uptake of W&CSs through realizing socio-economic benefits, harnessing business models, identifying key policies and creating partnerships and collaborations;

Chapter 6 discusses capacity development;

Chapter 7 provides concluding thoughts and recommendations.

### 2. Objectives

This document provides the background and guidelines required to strengthen the development, and enable a widespread uptake, of integrated W&CSs for the Energy sector needed to accelerate the transition towards net zero emissions. More specifically the objectives of this document are:

 To review current state of knowledge on weather and climate services value chains in the energy industry

 To benchmark best practice and identify knowledge gaps and barriers to the uptake of these services

 To describe implementation approaches, including business models, public-private-academic partnerships and capacity development programmes to assist with the deployment of these services.

The overall objective of this document is to provide a guide to WMO members, typically NMHSs, but also to other service providers as well as energy sector companies and practitioners, in identifying key weather and climate data and products as well as mechanisms needed to develop user-driven weather and climate services for the energy sector to support resilience, renewable energy development and energy efficiency.

Also, while effort is made to specialize the content of this publication to the energy sector, it is inevitable that some of the components constituting W&CSs for the energy sector are also valid for other sectors (e.g. production of weather and climate data, stakeholder engagement). These will therefore be presented in a rather general way; however, examples are also presented (e.g. via call out boxes) to link them back to the energy sector.

### 3. Scope

From an energy sector user perspective there are several areas served by W&CSs:

 Characterization of past weather/climate events using **historical data**. Perhaps this is the most important element, as it provides a baseline, or first order approximation, of the current risks and opportunities and thus it is key to manage the energy production and distribution at present;

 **Nowcasting/short term weather forecasts** for load balancing by maximizing the usable component of the generated power;

 **Sub-seasonal to seasonal climate forecasting** for maintenance of infrastructure and resource and risk management purposes;

 **Decadal climate forecasting** for multi-year resource risk management; these forecasts effectively extend the seasonal forecast range to typically ten years ahead thus allowing to have a longer risk assessment horizon;

 **Multi-decadal climate projections** for infrastructure risk assessment, planning and design purposes. This includes providing authoritative data on possible evolution of climate considering different GHG emission scenarios, aligned with different climate mitigation policies.

The production of weather and climate information (in the form of data, visualization, briefing documents) that underpins the services for the energy sector (and indeed for other sectors too) is ultimately based on the simulation or observations of the Earth system (or relevant components, depending on the specific problem). Observing and simulating the Earth system involves extremely complex technology, which has been developing over many decades, with huge and long-term investments at the national/international level. This remains the case even when just the atmospheric component is simulated, which is necessary for e.g. the prediction of wind power up to several days ahead.

Energy conversion models are defined as the models which link meteorological and energy variables. These models can be either statistical or physical or a combination of both approaches. Given the focus of this document on weather and climate services, only the effect of weather and climate variations on energy demand and generation is considered. In this context, energy system components are more or less sensitive to weather and climate. On one end of the spectrum, there is thermal energy generation, including nuclear. At the other end of the spectrum, wind and solar PV energy generation are mainly controlled by wind speed, solar radiation and air temperature, even if other factors such as power system failures, maintenance downtime, etc. affect the amount of power generated by these technologies.

### 4. The full value chain of weather and climate services

At the heart of the W&CS co-creation process, lies **actor interactions**. We distinguish among knowledge producers (e.g. national meteorological service), intermediaries (e.g. W&CS providers) and users (e.g. grid operators) that represent the three broad groups of actors involved in this process. The co-production steps for W&CSs are (see Figure 1):

 **Understanding user needs & solutions** – This includes understanding context, building partnerships, common ground and co-exploring needs.

 **Data generation & selection** – The starting point for the development of new services is the systematic collection and analysis of user requirements. The outputs of this initial phase can then be used to inform either the selection of available data or the generation of new data, or both.

 **Service co-production –** This may include co-design of a project or initiative and co-developing the solutions to be applied. This process allows both user needs, and knowledge producers capacities to be considered, taking into account the ability and interest of intermediaries in participating and facilitating this process.

 **Operationalization and Delivery –** A robust and real-time information production workflow is critical to providing a timely and effective service so it can be used for instance to manage predicted extreme events and major disruptions to the grid.

 **User decisions and actions** – Utilizing the information provided by the service, also based on semi-automated decision-making processes (e.g. based on decision trees) and support tools (e.g. interactive visualization platforms), enables users to properly embed weather and/or climate data into their decision-making.

 **Value-add and scalability –** Assessing a value, be it economic, social or environmental ensures the outcome of a service is understood and appreciated by the funders or users. Assigning a value is critical for communicating the benefit of the service, and potentially for scaling it up to other geographies and/or sectors and/or typology of users.

 **Assessment and evaluation of services –** Setting benchmarks and Key Performance Indicators is critical to ensuring services are effective and successful. In this context, evaluation can be understood as having several layers:  
(i) meteorological/climatological evaluation;  
(ii) evaluation of energy-related service components;  
(iii) socio-economic assessment,  
(iv) performance of the delivery of the service, including user support.

 **Capacity development** – This takes place across all stages of the co-creation process and may include individual, procedural, infrastructural and organizational spheres of capacity and targeted activities to build these.

Diagram

Description automatically generated

**Figure 1: Framework for co-developing integrated weather and climate services  
for energy**

*Source*: Figure 1.7, of the “Best Practices for Integrated weather and climate services for net zero energy transition”

### 5. Gaps and Recommendations

Overall, there is a strong need to further develop collaborative approaches between weather, climate and energy, which are still too fragmented. Additional multidisciplinary projects, including effective and well supported networks, are needed. Critically, these should be embedded within long-term collaboration frameworks in order to overcome the issue of the limited lifespan of project and corresponding (intense) collaborations within them. The lack of sustainable collaboration issue is exacerbated by the fact that there are still some critical disconnects between the W&CS community on the one side, and energy system services on the other side, even if more connection efforts are underway, due to the increasing recognition by the latter on the important role of weather and climate data in energy production modelling and energy sector applications.

Accordingly, the following are the ten proposed recommendations:

**R.1. Improve mapping of users’ requirements**Users’ requirements are the foundations for useful and usable W&CSs. Specific requirements from energy sector users globally should be collected in databases and ideally widely shared in order to minimize duplication of effort and at the same time be able to act on them in a timelier way. The collection of user requirements is a continuous process, as production of a W&CS needs to be adapted to the specific user and therefore requirements must be adjusted to the circumstances.

**R.2. Improve the science and technology supporting W&CSs**There should be a close link to entities guiding weather and climate research, e.g. the WMO Research Board, the WMO World Weather Research Programme (WWRP), the World Climate Research Programme (WCRP). In weather forecasts, for instance, work could be done to improve parametrizations relevant for wind and solar power. In seasonal climate forecasts, improvements could come from the dynamics of climate anomalies, which may involve improving model resolution, but also increased observation coverage (particularly in oceans and sea ice) and enhancements in the understanding of physical processes of the different components of the climate system. Limits of predictability and uncertainties should also be better quantified, while clearly stating the limitations of the experimentation adopted to evaluate them.

**R.3. Improve post-processing methods and energy conversion models**Weather and climate data should increasingly be used with energy applications as targets, which means that metrics should measure integrated application performance rather than the quality of weather and climate data themselves, even if the latter typically is a fundamental input in the production chain of the service. Post-processing tasks to be considered include tailoring (e.g. through physical or statistical models to derive variables required for energy applications, such as wind at a specific height), downscaling (dynamical or statistical, e.g. to increase the temporal resolution of timeseries to suit energy models), calibration (e.g. of probabilistic information, by adjusting the reliability of the forecasts).

**R.4. Improve data access, exchange and policy**Incentives to make data available, particularly meteorological and energy measurements, should urgently be explored, tested and implemented. Incentive could, for example, be in the form of economic and/or institutional knowledge-creation. Certified data quality assurance must also be a high priority as data that does not pass quality checks substantially increase inefficiencies in the W&CSs workflows, especially when in the end these data must be discarded. Moreover, despite efforts towards the adoption of common conventions and interoperability of datasets, much work still needs to be done.

**R.5. Refine co-production approaches, including data visualization, support and guidance and use of delivery channels**The dialogue between providers, intermediaries and users of W&CSs should be enhanced through, for instance, novel participatory approaches, both in person and online. More should also be done to improve ways in which users pro-actively interact with the producers to achieve a better weather and/or climate service. One such way could be through effective visualization tools, in the form of standard graphics or online web applications, as they can provide a key common focal point for discussion. Such tools should adopt a user-centred design approach, thereby requesting continuous user feedback, and by keeping the visual aspects and terminology as approachable as possible.

**R.6. Explore new energy sector applications using weather and climate services**An immediate area of extension in the current work is the link with energy modelling, especially in the research community. An increasing number of collaborations are being established in this area, but institutional support, as provided for instance by WMO, would be required to accelerate this important process. In addition, several specific topics, some of which relate to new technology developments, are emerging. Amongst these are: i) the use of weather and climate information in energy storage (electrical, hydro, or even hydrogen) management, ii) the sensitivity of existing or new technologies to weather and climate conditions as in the case of dynamic line rating or bifacial solar PV panels, iii) the computation of climate risk to energy systems by properly accounting for vulnerabilities, exposure and likelihood of impacts.

**R.7. Refine business models for sustainable W&CSs**While there is a strong projected market growth for W&CSs over the next many years, as climate change increasingly affects energy systems operations, management and planning, the W&CS enterprise is not yet taking advantage of the (potential) opportunities. Therefore, a two-pronged approach should be adopted whereby the WMO, or other relevant agency, could on the one hand set up a task force composed of environmental economists, W&CS managers, and energy sector users to provide recommendations for possible business models for sustainable W&CSs; on the other hand, they could assist in identifying appropriate funding bodies and/or investors interested to accelerate the growth of W&CSs, including through public-private partnerships.

**R.8. Implement capacity building activities**It is critical to create a network of producers, intermediaries and users, who have a good understanding of the close interlinks between weather, climate and the renewable energy systems, with a clear idea of the challenges and opportunities of a W&CS. Capacity building can and should be achieved in multiple ways, to allow recipients to choose the learning method most suitable to them. Thus, capacity building should include targeted training courses, summer schools, Masters programmes, webinars, conferences, open discussion fora, etc. Crucially, the learning should be intended as a two-way process, with producers learning from intermediary and users, and vice-versa. This two-way process allows for a more targeted and efficient interaction towards the co-creation of a weather and/or climate service.

**R.9. Enhance communication activities**Communication activities are needed: (i) to inform all community actors about the latest developments and main achievements in the area of W&CSs for the energy sector; (ii) to raise awareness amongst users of the benefits of W&CSs and how they can be used for real-life decision-making and risk management in the energy industry. One of these activities is the set up and maintenance of a portal under the SG-ENE with three main functions: (i) Knowledge gateway, (ii) Action-oriented and (iii) Networking and Connecting. Other communication activities should include standard social media posts, blogs, interviews, etc, in order to inform and raise awareness about W&CSs progress and achievements. Organization of a major conference, also biennially and possibly based on the existing International Conference on Energy & Meteorology, should be another key communication (as well as capacity building) opportunity for the SG-ENE.

**R.10. Strengthen, and create new, collaborations across organizations and sectors**There is a renewed need to increase collaborations with energy sector users. Such a framework should also have as one of its mandates to lobby for sustained support from national and continental funding agencies. It is crucial that the energy sector finds value in these interactions and that they play an active role in formulating an effective network/framework to exchange information. In addition, the increased cross-sectoral socio-economic interplay of the energy sector, especially with the water and agriculture sectors, means that it is becoming crucial to establish and/or strengthen collaborations with an even larger number of organizations, such as UN Water, Food and Agriculture Organization (FAO), etc. Overall, such a framework and/or collaborations should play an important role in facilitating the development of science-based and user-driven solutions, for effective integration of high-quality weather, climate and other environmental information into energy sector policy formulation, planning, risk management and operational activities to better manage power systems on all timescales and strengthen climate change mitigation and adaptation.

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1. In the Energy Exemplar and in this publication, with Energy sector we refer mostly to the Electricity component of the sector. [↑](#footnote-ref-2)
2. <https://community.wmo.int/activity-areas/sercom/SG-Energy> [↑](#footnote-ref-3)