



WORLD
METEOROLOGICAL
ORGANIZATION



ADAPTATION FUND

WMO ENANDES PROJECT

Energy Activities

Main implementation period: September 2025 – September 2026



Advancing Climate Services for a Resilient Energy Transition in South America



RENEWABLE
ENERGY



CLIMATE
INTELLIGENCE



SUSTAINABLE
DEVELOPMENT



STRONGER
TOGETHER

Prepared by Dr. Hamid Bastani

WMO Energy Lead Consultant – ENANDES Project

Regional Office for the Americas | September 2026

World Meteorological Organization (WMO)



List of Deliverables, Products and Resources

Demonstration Products

National Renewable Energy Atlases for Wind, Solar, and Hydropower

- Interactive platform: Explore the results at <https://atlas-energia.ciifen.org/>
- Operational Manual: <https://library.wmo.int/idurl/4/69907>
- Jupyter Notebook Code: <https://github.com/energymeteorology/reatlas>
- Recorded training: <https://vimeo.com/manage/videos/1229797172/77dcae7bd8>
- Third progress report: [Policy Brief, conference paper, and final report](#)
- Second progress report: [Bilateral co-development meetings with the participating countries](#)
- First progress report: [Methodology update, factsheet, HTML and workplan](#)

Evaporation Reduction in Floating Solar Panels (Chile)

- Operational tool integrated into the Chilean Ministry of Energy's Explorador Solar: <https://solar.minenergia.cl/fotovoltaico>
- Operational Manual: [Evaporation Model for Floating Solar Panels \(SOLEVAPP\)](#)
- Jupyter Notebook Code: <https://gitlab.com/rodrigo.caceres1/enandes-solevapp/>
- Recorded training:
 - o Part 1: <https://vimeo.com/1229799333/c77f8ad6b7> ,
 - o Part 2: <https://vimeo.com/manage/videos/1229799677/b56acb14f4>
- Peer-reviewed Article: [10.1016/j.apenergy.2025.125556](#) –
- Second peer-reviewed article: Under submission
- Technical deliverable: [Summary of the calibration and validation of the parameters](#)

NWP Solar Radiation evaluation and correction

- Jupyter Notebook Code: <https://crc-osa.ciifen.org/en/CST/cst/servicios/energia>
- Operational Manual: [AI-based evaluation and correction of WRF solar radiation](#)
- Recorded training:
 - o Part 1: <https://vimeo.com/manage/videos/1229798213/d52855d0ea>
 - o Part 2: <https://vimeo.com/1229798873/e5c23f0c98>
- First Progress report: [Data analysis and model development](#)
- Peer-reviewed Article: under submission

Capacity Development:

- Regional Training Workshop on Energy and Nexus Services, Asunción, November 2025: [Final Report and other documents](#)
- Regional Online workshop on Energy Services, November 2023: [Repository of documents and materials](#)
- Fourth WMO AI Webinar, 30 July 2026: [Energy Services in South America Supported by the ENANDES Project](#)

Other Outputs:

- Regional Plan for Weather, Water and Climate Services for the Energy Sector in Central and South America (2026–2035): [A Framework to Address Gaps, Needs, and Priorities](#)
- Climate Service Toolkit for Energy (CST4E): [Conceptual Framework](#)
- Peer-to-Peer Learning: Cuba–Chile: Report documenting Chile's support, through the ENANDES Project, to Cuba under the CREWS Cuba Project
- Regional Project Concept Proposal: Concept for future resource mobilization to scale up and further develop climate services for the energy sector in the region

Note: Two additional scientific publications are currently under development/submission. These, together with the deliverables and resources listed above, will be made available through the CIIFEN ENANDES Energy webpage: <https://crc-osa.ciifen.org/en/CST/cst/servicios/energia>

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1. Executive Summary

This note summarizes the energy activities undertaken through the WMO ENANDES project during 2021–2026, with the main portfolio of activities implemented from September 2025 to September 2026. The work evolved progressively from regional needs assessment and country consultations to capacity development, demonstration products, regional strategic planning and regional legacy for future scale-up, providing a coherent pathway from identified needs to practical climate-service applications for the energy sector.

A portfolio of activities was designed to strengthen the capacity of participating National Meteorological and Hydrological Services (NMHSs) and energy sector stakeholders to support climate-resilient energy transitions through advanced weather, water and climate information and services. Activities directly supported the ENANDES countries—Chile, Colombia and Peru—and, through synergies with ENANDES+, Argentina, Bolivia and Ecuador, while also facilitating knowledge exchange and engagement with other countries across Central and South America.

The portfolio combined capacity development interventions, science-to-application demonstration products, technical publications and regional coordination. These activities collectively mobilized more than 45 experts, engaged institutions across 12 countries, and generated a diverse portfolio of technical products, publications and strategic outputs.

Key results included four regional workshops and technical webinars, three demonstration products, a regional plan identifying requirements and priorities for climate services for the energy sector and setting out a 2026–2035 pathway, a conceptual framework for the Climate Services Toolkit for Energy (CST4E), and a regional project concept to support the continuation, replication and scaling-up of ENANDES energy activities across the region.

Taken together, these efforts helped lay the foundations for a more structured regional approach to climate services for the energy sector, moving from isolated national applications toward a connected portfolio of capacity development, technical services, reusable tools and strategic planning. ENANDES therefore served not only as an implementation project, but also as an important catalyst for advancing climate services for energy across Central and South America, with partnerships, technical assets and strategic foundations designed to support continued action beyond the project. Figure 1 provides an overview of the evolution, principal outputs and overall scale of the ENANDES energy portfolio, from regional needs assessment and capacity development to demonstration services, strategic planning and future scale-up.

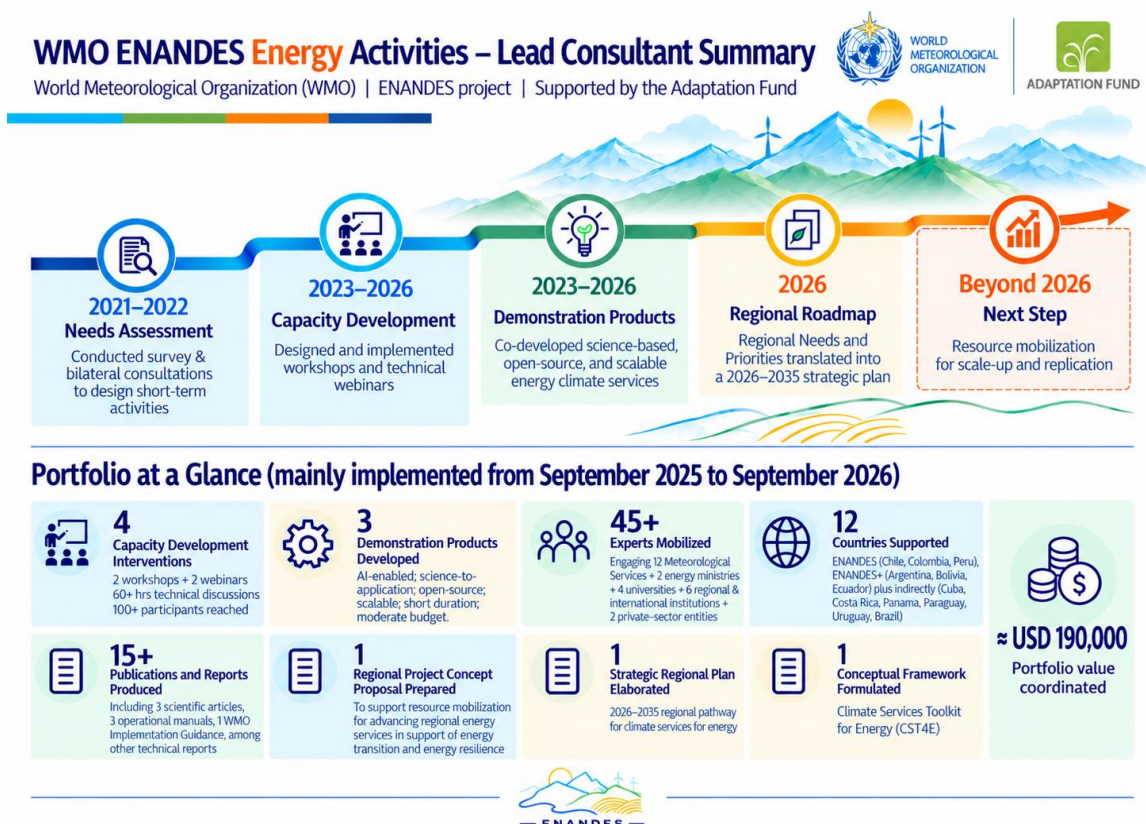


Figure 1: ENANDES Energy Activities Portfolio

2. From regional needs to an energy climate-services portfolio

In 2022, WMO conducted a regional survey on climate services for the energy sector among its Members, including countries participating in ENANDES and ENANDES+, complemented by bilateral consultations with Chile, Colombia, and Peru held before and during the same period. Together, these exchanges provided a clearer picture of existing energy-related climate services, institutional capacities, ongoing and planned initiatives and priority needs across participating countries.

The findings were analysed to identify common and country-specific gaps and priorities, which informed the definition of a targeted portfolio of energy activities. These included capacity development, knowledge exchange and the co-development of demonstrative and scalable climate services, designed both to respond to national needs and to generate approaches, tools and lessons with wider regional applicability.

Particular demand emerged for training and technical capacity development, together with practical services for renewable energy resource assessment in a changing climate, wind and solar forecasting, and longer-term energy planning.

Figure 2 presents the regional dashboard¹ of the WMO energy survey, which provided an overview of existing services, capacities and priority needs across participating countries.



Figure 2: Regional dashboard of the WMO energy survey for South America

¹ https://energymeteorology.info/regional_survey_dashboard/

3. Capacity development and regional knowledge exchange

To address the identified gaps and needs, ENANDES established capacity development as a core component of its energy activities. Table 1 summarizes the main Four capacity-development and knowledge-exchange activities supported through the project. The objective was to facilitate knowledge sharing and peer learning, while strengthening the ability of National Meteorological and Hydrological Services (NMHSs) and energy sector stakeholders to co-develop, apply and sustain climate services for energy, while facilitating the uptake, adaptation and replication of methods and demonstration products across different national contexts.

Capacity development activities were delivered through expert discussions, hands-on technical sessions, webinars and regional knowledge exchange. These activities brought together meteorological services, energy institutions, energy and climate public entities, academia and regional partners, providing a practical mechanism for sharing experience, testing approaches and transferring knowledge across the region. Across the capacity development activities, ENANDES engaged more than 100 participants from 12 countries, generated over 60 hours of technical exchange and included more than 35 technical presentations, contributing to the development of a growing regional community of practice for climate services for energy.

A particularly important milestone was the Regional Energy Services Workshop, held in Asunción, Paraguay, in November 2025. As the first training workshop of its kind in the region dedicated specifically to climate services for the energy sector, it brought together experts from meteorological services, energy institutions, academia and regional organizations for hands-on technical work, exchange of experience and discussion of longer-term priorities. The workshop represented an important step toward a more coordinated regional approach to the development and delivery of climate services for energy in Central and South America.

Another highlighted element was cross-project peer-to-peer learning, through which ENANDES supported knowledge transfer to the CREWS Cuba initiative. In November 2025, the Meteorological Directorate of Chile (DMC) hosted the Institute of Meteorology of Cuba (INSMET) for a technical exchange involving both the DMC and the Ministry of Energy of Chile. The exchange enabled practical knowledge sharing on the development and delivery of climate services for the energy sector and helped identify approaches with potential for adaptation and application in Cuba.

Table 1: ENANDES capacity-development and knowledge-exchange activities

Activity	Date / Format	Reach	Main focus and contribution
Regional Workshop (Online) on Energy and the Water–Energy–Food–Ecosystems Nexus	November 2023 · Online	60+ participants	Identification of national priorities and needs for energy and Water–Energy–Food–Ecosystems climate services; strengthened dialogue among meteorological services, energy stakeholders, academia and public and private actors.
Regional Training Workshop on Climate Services for the Energy Sector and Nexus	24–28 November 2025 · Asunción, Paraguay	25+ experts	Regional knowledge exchange, hands-on application of open-source demonstration products, expert discussions on strategic and long-term priorities, and stronger collaboration among meteorological, energy, academic and regional institutions.
Technical Webinar Series	December 2024 · February 2025 · July 2026 · Online	100+ participants	Technical knowledge sharing and demonstration of renewable-energy atlases, floating-solar evaporation assessment, numerical weather prediction solar-radiation correction and artificial-intelligence-based methods.
Cross-Project Peer-to-Peer Learning: Chile (ENANDES)–Cuba (CREWS Cuba)	18–20 November 2025 · Santiago, Chile	Institute of Meteorology of Cuba; Meteorological Directorate of Chile; Ministry of Energy of Chile	ENANDES-supported knowledge transfer to the CREWS Cuba initiative, sharing Chilean operational and institutional experience in climate services for energy and identifying approaches with potential for adaptation in Cuba.

4. Demonstration Products through Science-to-Application Energy Mini-Projects

In response to priority needs for services, ENANDES supported the development of demonstration products designed to translate country demands and sector-specific challenges into practical climate services for the energy sector. These demonstrations were intended not only to address immediate national needs, but also to generate replicable approaches, methodologies and tools with potential for wider regional application.

Therefore, the ENANDES energy mini-projects were designed as science-based, open-source, moderate-budget, short-duration and scalable demonstration interventions addressing concrete energy-sector needs. Their science-to-application approach progressed from needs assessment through co-design, co-development, testing and validation, and co-delivery, with WMO providing technical preparation and coordination throughout the process (Figure 3).

Beyond the country-specific results, the mini-projects generated reusable methodologies, open-source tools, technical guidance, training resources and implementation lessons that could support replication and broader regional climate-service development. Table X complements Figure X by summarizing the individual demonstration energy mini-projects, including their scope and contribution, implementation period, participating partners and principal reusable outputs.

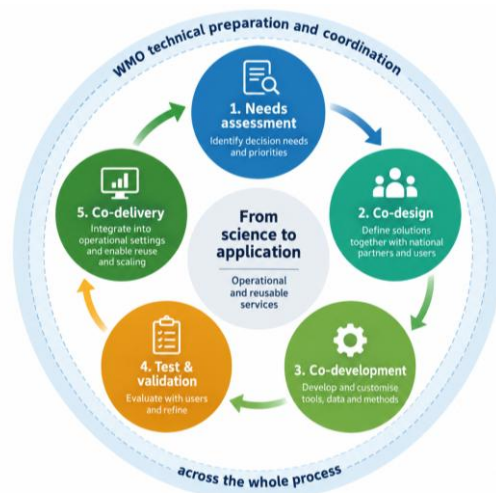


Figure 3: ENANDES Energy Mini-Projects Approach (aligned with WMO GFCS)

Table 2: ENANDES energy mini-projects (September 2025-September 2026)

Demonstration	Scope and contribution	Duration	Partners
Evaporation Reduction in Floating Solar Panels– Chile	Assessed how floating solar PV could reduce reservoir evaporation across Chile, linking energy production and water management. Modelling and observational validation identified evaporation reductions of up to approximately 80% under specific assessed conditions. The developed tool was integrated into the Ministry of Chile’s toolkit.	Jun 2024 – Jun 2026 (2 phases)	Meteorological Directorate of Chile (DMC); Ministry of Energy; Universidad Diego Portales (UDP), WMO Regional Office
NWP Solar Radiation evaluation and correction– Argentina	Combined NWP outputs, statistical correction and AI to improve solar-radiation information and develop short-term prediction approaches for selected locations in Argentina. The work established a reusable evaluation, AI-based correction and prediction adaptable workflow.	Sep 2025 – Jun 2026 (9 months)	National Meteorological Service (SMN); Institute for Research in Non-Conventional Energy; Universidad Nacional de Luján
Renewable Energy Atlases – Chile, Peru, Argentina, Bolivia and Ecuador	Strengthened national capacity to assess wind, solar and hydropower resources, integrating future climate scenarios. The scalable, open source methodology enabled countries to apply common approaches using their own data, teams and priorities.	Feb–Jun 2026 (5 months)	National counterparts in Chile, Peru, Argentina, Bolivia and Ecuador
Conceptualized Climate Services Toolkit for Energy (CST4E) – Regional	Conceptualized an open-access, modular and scalable toolkit for climate services for energy and Nexus, integrating data, analytical tools, decision-support and capacity development.	Apr–Sep 2026 (6 months)	WMO; CIIFEN

5. ENANDES as a Foundation for Regional Energy Climate Services: 2026–2035 Strategic Plan

Building on the regional needs assessment, consultations, capacity-development activities and energy mini-projects, the Regional Plan for Weather, Water and Climate Services for the Energy Sector in Central and South America (2026–2035) was developed by regional experts to translate identified gaps, needs and priorities into a longer-term framework for coordinated regional action.

The Plan calls for a shift from fragmented and project-based activities toward coordinated, operational, scalable and institutionalized climate services for the energy sector. As summarized in Figure 4, it connects identified regional gaps and needs with strategic objectives and lines of action across four main areas: governance, policy and financing; data, infrastructure and digital systems; science, innovation and service development; and capacity development and human capital. Together, these areas provide a pathway toward more resilient, sustainable and climate-informed energy systems across Central and South America.

Aligned with the priorities and implementation pathway of the Regional Plan, a regional project concept proposal was developed to build on the ENANDES legacy and provide a practical basis for continued support to countries across the region through mobilizing resources. The concept is intended to help NMHSs and energy-sector institutions strengthen their support to governments and decision-makers through improved climate-informed planning, operational services and investment-related decision support. It also provides a framework for further operationalizing and scaling proven ENANDES approaches, strengthening national capacities and institutional coordination, and mobilizing future partnerships and resources for wider regional implementation.

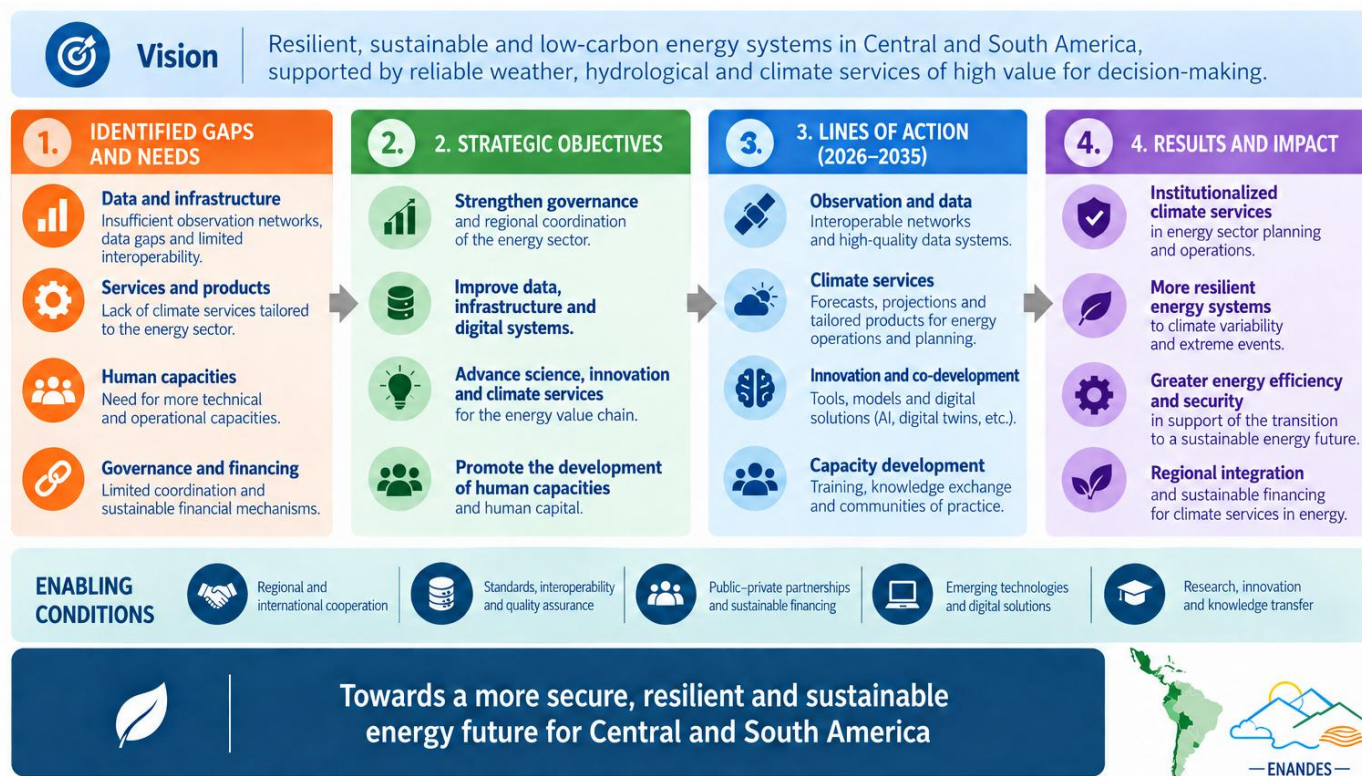


Figure 4: Regional Plan for Weather, Water and Climate Services for the Energy Sector in Central and South America (2026–2035): from identified gaps and needs to strategic action and regional impact.

6. Regional Legacy, Lessons Learned and the Way Forward

The ENANDES energy activities strengthened the interface between climate services and the energy sector in Central and South America, progressing from regional needs assessment and consultation to practical demonstrations, capacity development, institutional strengthening and pathways for regional scale-up. Through regional surveys, bilateral consultations, targeted mini-projects and sustained technical coordination, the portfolio helped establish a practical foundation for more systematic and sustained climate services for energy.

A key strength was the partnership and co-development model, which brought together WMO, NMHSs, energy-sector institutions and users, universities, technical partners and regional centres during different activities. This helped ensure that activities responded to real decision-making needs while combining authoritative climate information, applied research, operational relevance and national ownership. The experience also demonstrated that relatively small and focused demonstration projects can generate wider regional value when designed from the outset for replication, reuse and adaptation, particularly through open methods, reusable workflows, tools, guidance and documentation.

Several key lessons emerged from implementation:

- Co-development increased relevance and ownership, particularly when NMHSs, energy-sector institutions, users and technical partners were engaged from the early stages of service design and development.
- Testing and validation strengthened confidence in the developed products and services and supported their progression from demonstration activities toward practical application.
- Open, reproducible and well-documented methodologies facilitated replication, enabling tools and approaches to be adapted to different national contexts and institutional capacities.
- Capacity development was most effective when directly linked to practical applications, hands-on technical work and real service-development processes rather than delivered as stand-alone training.
- Small, focused demonstration projects can generate wider regional value when scalability, transferability and reuse are considered from the beginning.
- Regional knowledge exchange and peer learning strengthened implementation, helping countries share experience, transfer practical approaches and reduce duplication of effort.
- Long-term sustainability requires clear institutional ownership, continued collaboration between NMHSs and energy-sector institutions, defined operation and maintenance arrangements, sustained technical capacity and financing beyond project closure.

Looking ahead, the ENANDES energy portfolio provides a basis for moving from demonstration to sustained implementation and regional scale-up. Future efforts should focus on operationalizing and replicating proven approaches, strengthening institutionalized climate services for energy through the Regional Plan for Weather, Water and Climate Services for the Energy Sector in Central and South America (2026–2035) and the Climate Services Toolkit for Energy (CST4E), and developing a pipeline of national and regional investments.

The regional legacy of ENANDES therefore extends beyond the individual products delivered. It includes strengthened national capacities, tested climate-to-energy methodologies, reusable technical assets, stronger institutional partnerships and a practical service-development model that can support future climate-informed and resilient energy transitions across the region.

7. Contributing Experts and Institutions

World Meteorological Organization (WMO)

Hamid Bastani (Lead Consultant—ENANDES Energy Activities); Raul Polato (ENANDES Project Officer); Julian Baez Benitez (Director, Regional Office for the Americas); Roberta Boscolo (Climate and Energy Unit Lead); Daniel Vila Espigo (Regional Office); Fabiola Guerrero (Regional Office); Alicia Pavetti Infanzon (Regional Office)

Meteorological Directorate of Chile (DMC)

Juan Crespo Fuentes; Marjorie Alexandra Cataldo Soto; Gaston Torres Aravena; Carmen Vega Riquelme

Institute of Hydrology, Meteorology and Environmental Studies of Colombia (IDEAM)

Henry Benavides; Diana Carolina Rueda; Lina Pico Roa

National Service of Meteorology and Hydrology of Peru (SENAMHI)

Giovanna Egas Tapia; Cristian Montesinos; José Inoue Velarde; Irene Trebejo Varillas; Grinia Avalos Roldán; Elvis Medina Dionicio; Yury Escajadillo

International Research Center on El Niño (CIIFEN)

Pier Maquilón; Felipe Costa; Iliana Salazar; Yania Gómez

Other Hydrological and Meteorological Services

National Meteorological Service of Argentina (SMN): Silvina Righetti; Cynthia Matsudo; Lorena Ferreira

National Service of Meteorology and Hydrology of Bolivia (SENAMHI): Adrian Mamani

National Institute of Meteorology and Hydrology of Ecuador (INAMHI): Cristina Valdivieso; Amparo Condor

National Meteorological and Hydrological Services of Paraguay (SMHN): Violeta Gonzalez; Cintia Espinola

Institute of Meteorology of Cuba (INSMET): Israel Borrajero; Alfredo Roque Rodriguez

Institute of Meteorology and Hydrology of Panama (IMHPA): Luz Graciela de Calzadilla; Maria Belén Rodriguez

Universities and Scientific Institutions

Diego Portales University, Chile: Hernán Alcayaga Sadías; Rodrigo Cáceres González; Andres Diaz Alarcon

National University of Luján, Argentina: Anahí Lanson; Maria Jose Denegri

Research Institute for Non-Conventional Energy (CONICET-UNSa), Argentina: Germán Ariel Salazar; Rubén Darío Ledesma

University of Oxford – School of Geography and the Environment (SoGE): Homero Paltán

University of the Republic, Uruguay: Agustín Laguarda

Public entities and Energy Ministries

Ministry of Energy, Chile: Camila Vasquez

Costa Rican Institute of Electricity (ICE): Berny Fallas López; José Alberto Zúñiga Mora

Other Centres and Institutions

Regional Climate Center for Southern South America, Argentina (CRC-SAS/ RCC-SSA): Fiorela Bertone

Japan International Cooperation Agency (JICA): Juan Carlos Chavez

National Institute for Space Research (INPE): Daniel Vila Espigo

Economic Commission for Latin America and the Caribbean (CEPAL): Naja Vargas, Marina Gil Sevilla

Copernicus Energy Hub: Mark Parrington

Private-Sector

ITAIPU Binacional (Paraguay): Santiago Vera, José Sánchez

AMIGO S.r.l.: Sara Dal Gesso, Alessandro Moser, Marco Venturini