RENEWABLE ENERGY AND CLIMATE CHANGE

Building adaptive capacity through innovative climate services for hydropower and solar facilities

Executive summary

Energy infrastructures resilient to climate change claim for adequate policies, to ensure effective operating conditions for Renewable Energy Sources in the power system, towards EU 2030 climate and energy targets. Climate Services play a key role by providing energy companies required knowledge to support operation and management decisions or wholesale and distribution market strategies. When Developers, Data Purveyors and Users of CS work together to tailor the innovation to users' needs and to depict reliable marketing strategies, a new economic value of climate and seasonal knowledge is discovered, building in the meanwhile new capacity and facilitated access to this knowledge on user's side. The European Commission's Research and Innovation policy and investments will drive the emergence of a climate services market by providing a framework for reliable climate information which provides tangible benefits and solutions, in order to promote an innovation attitude in the energy companies. Governments, businesses, and civil society need to work in partnership to make sustainable energy a reality for all by 2030. This document provides insights and suggestions on successful CS for renewable energies, based on the newly created Copernicus Climate Change Service (C3S), ranging from technical aspects to user engagement and market & business planning.

Introduction

Since the publication of the **Renewable Energy Directive** (2009/28/EC) "RES Directive", there is a global panorama in which renewable energy sources are being encouraged and promoted to meet the objectives of reducing greenhouse gases and fighting climate change. Ambitious renewable energy targets for the EU have been set for 2030 in the "**Clean Energy for All Europeans**" package published in 2016 by the European Commission (EU), revising the RES Directive and aiming the EU to be a global leader in renewable energy. Renewable Energy Sources (RES) have experienced both a relevant growth and a huge cost improvement, becoming increasingly competitive with fossil fuels. Nonetheless **energy transition toward RES**, with changes on how electricity is produced, transported and consumed, poses challenges to power system structures to foster maximum and optimal energy use (such as wholesale market pricing, valuing electricity, retail tariffs, distributed generation). These challenges become even more critical in a climate change (CC) scenario, in which Variable Renewable Energies (VRE) and Distributed Energy Resources are markedly affected by meteorological events.

According to the "**EU Strategy on adaptation to climate change**" (2013), some of the main energy infrastructures affected by CC are hydropower and solar plants. In snow covered mountainous areas (where many hydropower facilities are located), CC is expected to result in a later seasonal snow, less snow coverage, and shorter snow seasons. In addition, the water cycle components are expected to change significantly, i.e. increasing or decreasing water availability for hydropower generators. In the field of solar energy, increasing temperatures will produce the loss in solar cell effectivity, but the potential decrease in cloudiness will increase the solar radiation. On the other hand, the projected increased frequency of extreme weather events or changing water and air temperatures will have effects on the energy transmission, distribution, generation, and demand. Finally, heat waves, cold spells, and droughts will likely produce

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higher electricity demand peaks.

As said by the EU, making energy infrastructures resilient to climate change requires sophisticated decision-making, even at the earliest planning stages. Addressing climate risk in investment, operation and management tasks can avoid later costs, by using new IT-based technology. Thus the **forecast for the next season** by using climate services will be required to avoid a demand-driven overstress of energy infrastructure. EEA describes as a CC adaptation action to build adaptive capacity "collecting and monitoring data, providing climate services, risk assessments, producing guidelines and other measures that facilitate targeted adaptation" to achieve the **Energy Union** by 2015. Consequently, CS can be a key tool, contributing to a mixed energy market dominated by renewables with smart and modern infrastructures and operation systems, stimulating competition, affordable prices for consumers, and increased efficiency of the energy production facilities.

Approach and results

Opportunities for improvement through CS in the renewable energy sector

Climate forecasting is currently being provided as global services developed as major contribution from the European Union to the **WMO Global Framework for Climate Services (GFCS)** such as **Copernicus Climate Change Service (C3S)**. The management and operation of hydropower and solar systems can benefit from these forecasting tools and techniques based on increasingly available climate and seasonal data through innovative CS such as the ones developed in CLARA. These innovative tools can create opportunities in the RES arena. For **long term investments** in new installations, planning either hydropower or solar projections of climate scenarios through devoted CS provide information about potential **areas for higher production** in a future climate. In managing VRE **existing plants**, advanced forecasting helps planning the required additional seasonal flexibility and stability to the grid from storage plants, by taking advantage of times of the year when a high VRE penetration is expected. Under an exclusive **financial** point of view relying on accurate energy forecasts leads to better income prediction and early (and cost effective) adoption of counter measures though the financial market. VRE plants themselves can also provide **flexibility to the system**, if market rules and forecasting quality allow them to be dispatched, for example by Capacity Payment Mechanism (CPM) usually applied to thermal plants, i.e. by saving part of the potential for being ready to generate supply electricity to the grid. Finally, having a reliable and confident prediction of the **water availability** helps managers to conform to the EU environmental laws but also to schedule maintenance tasks during the shutdown periods, otherwise the system will suffer an opportunity cost.

Which are the climate services for renewable energy?

GWh provides projections in the EU about areas of increased or decreased inflow for hydro power production. It produces daily updated inflow forecasts for the 15 coming days, providing the trading team with knowledge of available hydro energy for trading on the European Energy Market. With a special version of the hydrological model E-HYPE (European setup of HYPE), inflow forecasts for all countries of interest can easily be set up and produced.

SCHT gives an estimation of the energy production, which helps managers to tune plant management strategy in order to optimize production. It also allows the financial department to know subsequent cashflow in advance and correct the financial plan and budget dynamically. The service is designed on machine learning algorithms and seasonal forecast data to be replicable virtually worldwide.

SHYMAT provides users with the most up-to-date hydrological combining

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measurements and modelling with seasonal forecast information. It anticipates high production and shutdown periods, for maintenance and repair tasks planning and the possibility of compliance with environmental river flow restrictions. The service also gives predictions of spilling, giving managers the opportunity to quickly tune up additional turbines, and energy production, clearly valuable information for market issues.

SEAP supports solar photovoltaic facilities through accurate weather forecasts on different scale times enabling operators to manage the generation process efficiently, and provide both operator and final consumers with new value-added services. The service improves the optimal balance between generation and demand offering alternatives for photovoltaic plants in which the user can act on, either managing the priority of consumption in autonomous installations or determining the most appropriate solar panel tracking for each day.

Moreover, two horizontal services were developed in CLARA for providing climate forecast data: **CLIME** for climate projections and **PPDP** which provides ready to use decadal predictions as input for operative CS.

Conclusion

Building adaptive capacity in the RES through innovative CS poses undoubtedly challenges to developers, users and the regulatory framework as well.

The structure of the power system and rules governing market access play a fundamental role to drive the deployment of renewable energy.

To ensure effective operating conditions for renewables in energy systems and market, dedicated policies and measures in all sectors (generation, transport demand, efficiency improvements, etc.) are needed to achieve an energy transition that is in alignment with the national and climate objectives.

To exploit the full potential of RES, increase their flexibility, optimize the scheduling of distributed energy resources and reduce costs, energy producers can benefit from advanced forecasting tools and techniques belonging to the broader family of CS, based on increasingly available climate and seasonal data. Such services shall be built in strong cooperation with users, taking care of technical aspects and strong value proposition for business planning and market positioning, as summarized in the following box.

The CS developed in CLARA offer a clear example of integration with the underlying framework, exploiting the value of the public forecasts provided by C3S to create new added value information's for the renewable energy sector.

Implications and recommendations for a successful CS for Renewable Energy and Climate Change

Under a **technical point of view** flexibility and in depth **customization** shall be taken into account in such highly specialized services. For example being able to forecast one specific variable of interest, or tailoring and adapting the service to the geographical area of interest by downscaling the raw forecast data to the local spatial resolution. A specific **timescale** may be required as well (i.e. hydropower managers are traditionally more interested on short term forecast than seasonal forecast, of greatest interest for market departments).

To overcome reluctancy in the renewable energy sector to apply innovative forecasting CS, attention should be paid in creating **confidence** and showing accuracy and skills and uncertainties of the provided forecast. While performance metrics of the output information are well known, they imply presence of local observed data (historical and real-time) sometimes unavailable due to a lack of measuring device in energy facilities. Provided forecasts shall be **reliable** enough to avoid frequent strategy changes in the decision makers, assessing the damages or losses deriving from wrong forecasts. Co-development and interactions with the users in the Energy sector (despite relevant technical background) preference should be given to provide **simple and clear information's** (i.e. correct scale and the right tools to convey

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information, which results in a more effective knowledge system). The human factor shall not be overlooked in this co-development process. This opens an interesting window of opportunity for the consultancy sector actor to promote innovation playing as a **bridge** between "complicated" CS and users "that look for simpler information".

Value for the users is evident when skilful predictions in weather, climate and hydrology are translated in **monetary metrics** (i.e. more revenues, extra profits or avoided costs). Playing with a new CS in what could have happened scenarios (with or without the added climate knowledge) with past data helps disclosing such value. Encouraging innovation starts from a tangible co-developed proof of concept, a basic privacy agreement on exchanged information and (often sensible) data, and training for users (a process to help overcoming tendency to keep "old habits" and support the **innovation adoption** and enhance in house capacity building).

Targeting **Business and economics aspects**, to foster a systemic innovation is needed in the RES sector, national governments should provide energy companies with **guidance**, information about available climate services, shared platforms, which will facilitate energy companies the access to relevant climate information innovation. Unfortunately most of the National Renewable Energy Action Plans (NREAPs) do not provide **incentives** to encourage energy companies and stakeholders to implement climate adaptation actions.

Also introducing new ambitious **regulatory frameworks** to push towards innovative CS adoption (i.e making accurate energy forecast a vehicle for getting **premiums** from the produced energy or facing **penalties** in case of mismatch). The experience of existing EU-funded projects, the know-how and expertise but also the IT-based technology needs to be exported to the rest of Europe, thus contributing to the Energy Union. However, a longer time funding needs to be considered to improve the emerging climate services and ensure their scalability, viability and commercialization involving the private sector.

Access Provision Business Model is preferred in the developed CS, covering new geographical areas and providing new methods to communicate with clients. Users are willing to pay for the implementation and maintenance of a climate service offering clear and reliable information of water availability for the next season and how it affects the operation planning. Cost of the CS depends on the type of service and the level of **public support** to invest in capacity building and education for behaviour changes in the RES sector.

For a successful marketability and commercialization of the climate services, a **European macro framework** with an institution which centralizes the information and links climate services providers with end-users would facilitate the communication and market channels. In addition, the success of the climate services for the energy sector relies on the development of formal partnerships and collaborations with agencies, organizations and bodies working on energy (e.g. WEC, UN Energy, IRENA, IEA), which support **shared platforms** including targeted climate services based on Copernicus dataset and promoting them among business associations in the energy sector in order that they can support their members in building climate resilience. Platforms need to be also promoted by global renewable energy communities of actors from science, governments, NGOs and industry (e.g. REN21), helping to foster a dialog between meteorologists and energy business communities and to identify major challenges which should be addressed in a co-design approach in the coming years.

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