DRAFT VERSION

Collaborative Project

CLIM-RUN

Climate Local Information in the Mediterranean region Responding to User Needs

WP7 – Renewable Energy Case Studies

Deliverable 7.4 Cross-cutting conclusions (Month: 30)

Climate Services for the Renewable Energy Sector

Project No. 265192– CLIM-RUN

7th Framework Programme

Underpinning work to enable provision of local scale

climate information (annual to decadal timescales)

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EXECUTIVE SUMMARY

The Mediterranean region is a climate hot spot with an enormous renewable energy resource potential. The renewable energy case study team of the CLIM-RUN project applied a bottom-up research approach (i.e. directly including stakeholders from four case study regions into the research process) to explore if and how climate data is currently used in the region and to appropriately address wants and needs of renewable energy stakeholders in the light of their climate adaptation actions.

In particular, the following **goals** were pursued throughout the CLIM-RUN project:

- Test components of the CLIM-RUN bottom-up methodology to support the development of a Mediterranean-wide Climate Service.
- Understand how climate data is currently used in the renewable energy sector.
- Develop climate information sheets to support stakeholders' adaptation actions.
- Create linkages between climate scientists and renewable energy stakeholders.

The main **findings and outcomes** from the case study activities are:

- Early-on and continuous involvement of stakeholders is crucial but difficult to achieve.
- Stakeholders do hardly make use of medium- to long-term future climate data.
- Prototypes of climate information products for wind and hydropower are useful but not yet usable by respective stakeholders.
- A large network of renewable energy stakeholders has been created.

Based on these results, we suggest the following **next steps**:

- Revise CLIM-RUN bottom-up engagement methodology.
- Institutionalize individual training sessions for renewable energy stakeholders.
- Further consolidate and extend the stakeholder network.
- Work towards identifying functioning climate services business models.

1. INTRODUCTION

The energy sector is one of the sectors most directly affected by climate variability and change (cf. Ebinger and Vergara 2010, Moomaw et al. 2011). In the past, researchers focused mainly on the traditional energy sector and its mitigation as well as adaptation potential. Yet, more recent initiatives such as the European FP7 project CLIM-RUN (Climate Local Information in the Mediterranean region – Responding to User Needs) aim explicitly at exploring how a changing climate may affect renewable electricity production and how they can support renewable energy stakeholders through so called Climate Services.

The concept of Climate Services (CS) is still very new and only vaguely defined. The National Academy of Science (NAS 2001) considers the CS to be a *"timely production and delivery of useful climate data, information and knowledge to decisions makers"*. In this sense, the goal of a renewable energy CS is to make cutting-edge climate forecast and scenario techniques as well as climate data more easily accessible and directly usable by relevant stakeholders in order to support their climate adaptation actions. In some regions, such as the US, Germany, or the UK, a CS for the energy sector and dedicated climate service agencies already exist. Although the Mediterranean region is a real climate hot spot, a user-oriented CS for the renewable energy sector is still lacking.

The renewable energy case study (WP7) of the FP7 project CLIM-RUN contributes to filling this gap of knowledge and supports the development of a functioning CS for the REN sector of the Mediterranean region. The main goals of WP7 are:

- to test different components of the CLIM-RUN bottom-up methodology, also referred to as the CLIM-RUN protocol;
- to explore if and how climate data is currently used in the sector;
- to develop measures to respond to stakeholders' climate data needs;
- to create linkages between climate scientists and renewable energy stakeholders;
- to give recommendations for the further development of a Mediterranean CS.

Before we look at the current level of usage of climate data, we give a brief description of the energy sector in the four case study regions, the role of renewable energies in the different country contexts, and the CLIM-RUN partner teams in charge of the case study coordination.

1.1. The CLIM-RUN Renewable Energy Case Studies

1.1.1.Croatia

Most electricity in Croatia is coming from thermal (gas, nuclear) and large hydro power plants. The potential for non-conventional renewabels, such as wind, biomass and solar, is promising but still marginal in the current Croatian power mix (Cerjak et al. 2009). Croatia has a goal of sourcing 35% of electricity generation from renewables by 2020. This implies that also a massive share of power

must come from non-conventional REN sources. Throughout the last few years the share of non-conventional renewables has grown gradually, facilitated by a national feed-in tariff for wind and solar PV. While in 2005 just about 21 GWh of electricity from renewable energy sources was produced, in 2011 the number increased to 217 GWh (JR 2013).

Several stakeholders are involved in the Croatian energy case study but the primary stakeholder is the HEP group which is the biggest Croatian power supplier.

Cedo Brankovic (DHMZ) and Robert Pašičko (UNDP) are in charge of developing the Croatian case study. For the development of Climate Services, the Croatian case study team foremost focuses on hydro power and to a minor extent on wind.

1.1.2.Cyprus

The Cyprian power sector is an electricity island with a generation capacity of 1400 MW in 2012. Cyprus doesn't own conventional energy sources, 97% of primary energy use is imported. Electricity production is with 96.5% almost all oil-fired. The remainder is sourced by coal and renewables. A significant switch to renewable power would allow the country to reduce energy import dependence. Cyprus has a high resource potential for the deployment of solar PV and CSP and medium conditions for wind (IRENA 2013). Wind generation capacity increased by 63% during 2011 (REN-21 2013). It is expected to see 16% of final electricity production to be coming from renewables in 2020. A feed-in tariff triggered growth of renewables, but even without state support it is expected to see further increase in renewables deployment (Partasides 2013).

The Electricity Authority of Cyprus is the main stakeholder in the Cyprian power market as it controls more than 90% of the power market.

The Cyprian case study is coordinated by EEWRC (Manfred Lange, Yiota Gregoriou) and focuses primarily on exploring the potential of CS for wind and solar power stakeholders in Cyprus.

1.1.3.Morocco

The current Moroccan power generation capacity consists of 6,337 MW, which is mainly based on coal and gas. It is planed to be increased up to 2020 not least due to very ambitious goals for renewable power production. Morocco has very favourable resource conditions for the deployment of wind, solar PV and CSP, Hydro and Ocean Power and medium potential for Biomass (IRENA 2013)[1]. According to the National energy strategy from 2009, REN technology deployment will be scaled up to 6000 MW of power generation capacity by 2020 (2000 MW wind, 2000 MW solar, 2000 MW hydro), which would make renewables to count for almost half of total electricity generation capacity in Morocco (IRENA 2013). In 2012, the installed capacity of solar PV, CSP, onshore wind, and hydro was 15 MW, 20 MW, 291 MW and 1,745 MW, respectively (Ellenbeck et al. 2013).

[1] For the exact meaning of the resource potential see IRENA's glossary: http://www.irena.org/REmaps/Glossary.pdf

Important stakeholders of the Moroccan REN sector are for instance ONE, who operates and owns more than tow third of the total power generation capacity, the Moroccan Renewable Energy Agency (ADEREE), the Moroccan solar energy agency (MASEN) as well as a number of international stakeholders from financial institutions (e.g. KfW) and renewable energy project developers.

The CLIMRUN team in charge of the Moroccan case study consists of ENEA (Sandro Calmanti), PIK (Peter Schmidt, Antonella Battaglini), and PLAN BLEU (Habib El Andalousi). Within the CLIM-RUN project, we mainly focus on climate services for solar (PV, CSP) and onshore wind technology.

1.1.4. Spain

The Spanish Power Sector consisted of 96000 MW of installed generation capacity in 2010, most of them is thermal generation capacity (nuclear, coal and gas). Spain has a high resource potential[2] for wind, solar PV and CSP, biomass, hydro and wave technology (IRENA 2013). Wind power has gained significant importance in the Spanish power sector, representing already 21,673 MW of the total power generation capacity in 2011 (EvWind 2013). Spain is among the top ten countries for non-hydro renewable electricity generation capacity (REN-21 2013). Despite of the country's economic recession and cut-backs in support for renewable technology deployment, Spain is still on track to match its ambitious renewable electricity goal of 38.1% by 2020.

Important stakeholders of the Spanish renewable power sector are for instance Iberdrola, Abengoa Solar, but also a wide range of international stakeholders (such as international renewable energy financiers or IRENA).

The Spanish case study is coordinated by IC3 (Melanie Davies, Paco Doblas-Reyes, Fabian Linnert). The main technology focus in this case study is on solar PV and onshore wind.

This brief outline indicates the growing role of REN in the power mixes of all case studies. Given the sensitivity of renewable energy production technologies and their energy yield to changes in critical climate parameters the question is raised what data the REN sector in the case study regions currently uses and whether a CS is something that is considered to be useful for the future development of the sector.

1.2. Current Usage of Climate Data in the Mediterranean REN sector

Why should REN stakeholders actually use climate data at all? Climate data can be very useful, for instance, at the early scoping stages of a REN project (e.g. for selecting the optimal REN production site or determining the investment timeframe). A REN project developer requires a detailed understanding of the climate resource availability (e.g. precipitation, solar irradiation and wind speed) and the location specific risk of variability from the current climate at inter-annual and decadal timescales as variations do have a significant impact on the energy yield of a REN plant.

[2] For the exact meaning of the resource potential see IRENA's glossary: http://www.irena.org/REmaps/Glossary.pdf

What type of climate data is currently used in the REN sector? Generally, one may distinguish between recorded past and projected future climate data. Past climate data is available and usually referenced in the planning and operational phases of REN projects. However, this type of information is rarely based on true observations, but instead on "reanalyses" which infer the past climate state at certain spatial and temporal scales. This is the first limitation of climate information currently available to the REN sector.

The second limitation is that there is a hidden assumption very common within the REN sector that the past climate will represent future climate states. However, climate is known to vary considerable over space and time, so with this assumption comes a large uncertainty. CLIM-RUN made the first attempt to introduce for instance climate predictions (i.e. probabilistically predicting the most likely future climate state) for the REN sector in order to minimise this uncertainty and its associated risk to REN planning and operational decision making processes.

The current usage of future climate data is very low in the Mediterranean REN sector. Most of the REN stakeholders are aware of potential sources of climate forecast data (e.g. the IPCC reports) and some of them – in particular public entities (e.g. Green investment banks such as the KfW) - also take them into consideration, for instance, for evaluating the potential long-term climate effects on a REN project. However, the vast majority clearly prefers to use past climate and meteorological data to retrieve site-specific weather information. For instance, in the specific case of a PV or wind power plant a project developer collects the necessary information by setting up a basic weather station at chosen sites and collects information over the course of at least one year. This is usually requested by banks as minimum requirement to get a project bankable (e.g. Zickfeld and Wieland 2012)

Currently, hardly any REN stakeholder considers climate forecast information on e.g. seasonal, decadal or centennial time scales to be useful as this type of data does not suffice to get a project bankable. Indeed, many stakeholders believe that climate forecasts are a 'crystal ball' theory. This, however, does not mean that they completely reject such forecasts and long-term climate scenarios. On the contrary, all stakeholders from the different case study regions regardless of the technology they work with expressed strong interest in learning about the limits and the potential of techniques developed within CLIM-RUN to model long-term changes of critical climate parameters close to REN production sites.

1.3.Structure of the Report

In the next chapters we summarize the main insights and experiences that researchers in WP7 gained during the last two years while continuously interacting with REN stakeholders from the different case study regions. The second chapter describes and discusses the different components of the CLIM-RUN bottom-up methodology. Sections 2.1-2.3 introduce the bottom-up participatory research approach and the methods/tools that were used to select and contact stakeholders. A brief reflection on the results from the questionnaire and the usefulness of the questionnaire as such follows in section 2.4. An essential component of the CLIM-RUN methodology, the division of the research staff into climate and stakeholder expert groups to

structure and facilitate the interaction with stakeholders, will be evaluated in section 2.5. Then we will discuss how an important tool for engaging with stakeholders, the case study workshops, helped us to get insights into the needs and wants of stakeholders. In the final section of the second chapter, 2.7, we will be reflecting upon the development of a number of prototypes of climate information product sheets to serve the demands of the stakeholders. The third chapter then considers in more detail the climate data user needs and their reactions to the disseminated climate information product sheets. The fourth chapter outlines recommendations for the development of a Mediterranean wide CS. Finally, the fifth chapter summarizes the main insights and gives some recommendations for future work.

2. DEVELOPMENT OF THE CLIM-RUN BOTTOM-UP METHODOLOGY

2.1. The CLIM-RUN Bottom-Up Approach

The most important element of the CLIM-RUN project is the bottom-up approach which includes a number of different components outlined below. Experience shows that many projects in research, technology development or resource management can fail because of inadequate attention posed to different stakeholder groups[3]. Developing a CS for the Mediterranean stakeholders in the renewable energy sector therefore requires a very close cooperation with them as they are the target group the CS should be tailored to.

The term stakeholder generally refers to actors (e.g. an individual or an organization) who have an interest in or are affected by the impacts of a specific project (BD 2013). In the context of the REN case study of the CLIM-RUN project, the term stakeholders refers to all actors whose activities are affected by impacts from climate change and/or variability and who request sound climate information to improve their decision-making in the light of private adaptation action. The list of the potential stakeholders as we will see is large and of course differs across case studies. One of the main objectives of WP7 is to help REN stakeholders to improving the effectiveness of their decisions in real-world projects by explicitly including and considering their interests and needs in the production and supply of climate data.

Given the limited resources in a research project, it is impossible to address the interests of all potential stakeholders at case-study level. Hence, it was necessary to conduct a stakeholder analysis first and to identify a number of stakeholders more relevant to the project and a Mediterranean-wide Climate Service (MCS).

2.2. Stakeholder Analysis: Identification and Clustering of Relevant Stakeholders

- *Which methods were used to identify and select relevant stakeholders?*

Ideally, one of the first steps of a bottom-up approach is the identification and classification of the stakeholders who are considered to be the potential target group of a CS. This can be done by for instance consulting expert opinion concerning who should be included in the project. Furthermore, semi-structured interviews with potential stakeholders can also be used to directly find out how well the stakeholder might fit into the project. Once the stakeholders are identified they can be clustered according to common features in cross case-study groups. This may facilitate the definition of common communication strategies (cf. Doguill et al. 2006).

For the identification of potentially relevant stakeholders in the four case studies of WP7 it was basically followed three different lines. Yet not all case studies followed the general procedure in the way it is described here.

[3] For more details, see Deliverable 1.1 of the CLIM-RUN project.

First, expert opinion, second, capitalizing on existing stakeholder contacts, and, third, identification of relevant stakeholders through conference participation. We followed these approaches in a different manner depending on the situation in the case study. Furthermore, it was an ongoing, iterative process wherein these approaches were combined and used in an integrated form. For instance, conference participation and semi-structured interviews to better identify stakeholders.

Most widely applied was the consultation of expert opinion to identify stakeholders. For instance, for the Moroccan case study, colleagues or other scientists who have a certain track-record and expertise on renewable energy and climate issues in Morocco as well as a good knowledge of potentially relevant stakeholders were consulted for the sake of identifying the most relevant stakeholders. Following their recommendations we pragmatically selected those stakeholders who seemed to be most appropriate for the purpose of CLIM-RUN.

A common strategy across all case studies was to build up on pre-existing stakeholder contacts from previous projects. The biggest advantage of this approach is that stakeholders can be easily contacted. Furthermore, there is a higher likelihood that the interaction at later stages of the process (e.g. stakeholder engagement) will not fail because of whatever reasons since the relationship has organically grown over the years and is more robust. Furthermore, stakeholders are more willing to cooperate when they already know someone in the project and there is certain relationship of trust. However, there are also disadvantages. If the relationship with the stakeholder is very much linked to one person in the research project only, there is always the risk that the relationship may fail in case this person is abandoning the research project.

The third approach is about participation in conferences with a large number of potentially relevant stakeholders. This approach was followed primarily by the Spanish as well as the Moroccan case study team. By attending the conferences, CLIM-RUN researcher had a chance to meet personally with renewable energy stakeholders and to engage directly via face-to-face conversations; thereby easily finding out who and how someone could be relevant for the project. This also enabled us to test questions of the questionnaire and thereby find out what worked and what didn't very early in the beginning of the project.

For all the stakeholders identified to be potentially relevant for the purposes of the CLIM-RUN project, a prerequisite to become included in the activities of WP7 was that the activity/business of the stakeholder is in the area of renewable energy in one of the case study areas and is perceived by the stakeholder itself to be vulnerable to climatic changes.

Over the course of the project it turned out that a large number of renewable energy stakeholders are active in several case studies and their interest is not necessarily related to a specific country but rather on how CLIM-RUN can help to generate new knowledge about climate sensitivity of different technologies (e.g. aerosol and CSP). This is particularly true for those stakeholders we call hereafter international stakeholders. A typical example is Abengoasolar who has been active in both the Spanish as well as the Moroccan case study.

After the stakeholder identification process, we grouped stakeholders according to specific organization types in order to harmonize communication strategies.

- International Private Financial Institutions (e.g. Société Générale)
- International Public Financial Institutions (e.g. World Bank, KfW)
- International Agencies (e.g. IRENA)
- National Agencies (e.g. ADEREE, Morocco)
- National Power Companies/TSO (e.g. ONE, Morocco, HEP, Croatia)
- Representatives of Ministries (e.g. Electricity Authority of Cyprus)
- Consultancy (e.g. SIAAH, Croatia; Garrad Hassan, Spain)
- Project Developers (EKONERG, Croatia)
- Technology Companies (e.g. Abengoa Solar, Spain &Morocco)

The clustering of the stakeholder according to type of organization indicates as well that we were able to find a representative team of stakeholders; ranging from renewable energy promoters, over project developers and consultancies, to international financiers and national power companies.

Yet stakeholder clustering across the different case-studies of WP7 did not prove to be very helpful, which is something we did not expect from our methodological approach. We figured out already in the early beginning that the individual organizations did have very different wants and needs which were also very much influenced by the case study context (e.g. electricity demand, resource potential of renewable energy, subsidies for REN, liberalized market or not, regulatory stability) as well as the technology they were focusing on. For instance, stakeholders from the same cluster (e.g., national power companies) do have very different priorities that need to be addressed individually, which complicates the development of a common communication strategy. On the one hand, HEP in Croatia is very much interested in decadal climate forecasting for precipitation due to the high relevance of hydro power in the Croatian power system. On the other hand, ONE from Morocco is more interested on understanding of how aerosols do affect CSP production but not at all in decadal climate forecasting for hydropower.

Not surprisingly, international actors do usually have stakes in several case studies at the same time. Depending on what they are focusing on in these countries they need a differentiated treatment. For instance, Société Générale is an international investor who finances wind power plants in Morocco and PV stations in Spain. Given the different wants and needs the stakeholder has in the country, s/he needs to be approached accordingly. International actors do play a very important role in Morocco – due to the engagement of international donors such as the World Bank - whereas in Croatia and Cyprus it is seem to be foremost national players who are key to involve. So the institutional setting of each country is very unique and therefore each stakeholder needs an individual treatment in the end.

Depending on the case study specific situation, the pre-existing relationships between researchers and stakeholders, and the degree of interest stakeholders expressed toward climate risk issues, the stakeholders were divided into primary and secondary stakeholder groups. For instance, for

the Moroccan case study it was decided to focus foremost on the National Agency for the Development of Renewable Energy and Energy Efficiency (ADEREE) as it turned out early in the beginning that they do have a strong interest in potential wind forecasting tools for the update of their national wind atlas. Similarly, in the Croatian case study the HEP power group was selected as the primary stakeholder due to its strong interest and the strategic position of this company in the Croatian energy system.

Yet this approach was not followed strictly across case studies due to very practical reasons. For instance, for the Spanish case study it proved to be more effective to go to sector specific conferences and to engage with as many stakeholders as possible because all of them delivered very important information. Furthermore, it can be risky to decide too early in the process about whom to consider as primary or secondary stakeholder because relations with new contacts are usually not yet very stable and robust and may therefore easily fail.

Overall, the application of the approaches mentioned before allowed us to reach a wide audience and to identify a representative group of renewable energy stakeholders; from stakeholders involved in the promotion and financing, over consultancy and development of a REN Project to those who design REN plants. In total, more than hundred stakeholders were identified and contacted throughout the project. Depending on the case study specific situation, it was decided independently by the Climate Expert Team (CET) and the Stakeholder Expert Team (SET) of the case studies to continue working with either one or several stakeholders.

2.3.Stakeholder Engagement and Involvement Methods

- *What kind of methods and tools were you used to communicate with stakeholders?*

CLIM-RUN followed a participatory research approach (cf. Sutherland 1998), i.e. we directly included representatives from target groups of the MCS to make sure that research reflects upon the stakeholder-specific requirements of the renewable energy sector. For participatory research it is important to draw on the full set of methods for engagement and communication in order to facilitate stakeholder inclusion.

It was basically decided to follow three generic steps to involve more actively stakeholders in the research process over the course of the three year project: a first workshop in the beginning of the project, a final workshop towards the end of the project, and iterative consultations in between. Throughout this process different methods of engagement were selected to communicate with stakeholders and to engage with them throughout the research project.

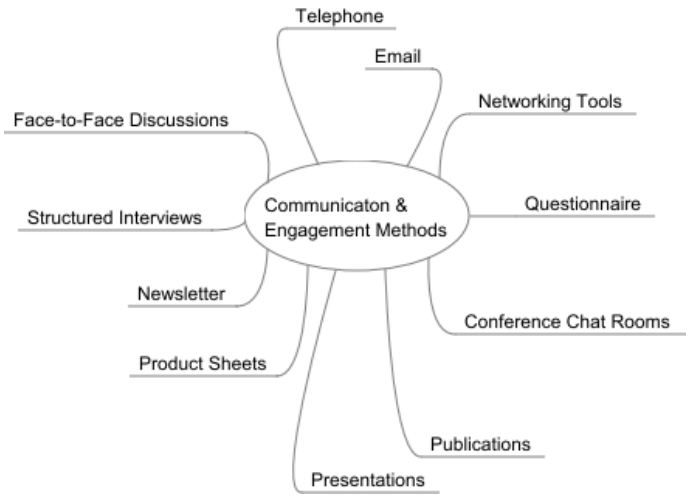

Figure 1: Communication and Engagement Methods

One can group the different engagement methods according to the time they were implemented; though some of them were obviously used at all stages (e.g. e-mail, telephone, presentations) while others (e.g. Climate Information Sheets) only towards the end of the project.

In the very beginning, before the first workshop and throughout the identification process of stakeholders, first contacts were usually established by telephone, email or conference chat rooms. Across the case studies usually a combination of these methods was used. In the case where contacts with e.g. stakeholders from the power sector already existed (e.g. Croatia, Cyprus) personal telephone conversation was utilized to inform stakeholders about the project and to explore their interest in engaging with CLIM-RUN researchers.

In the Spanish and Moroccan case study where communication went foremost through conference participation first contacts were often established through e-mail and conference chat rooms. For instance, in the case of Morocco it proved to be quite effective to use the conference chat rooms and networking tools which are usually offered by the conference organizer and are opened a few days before the official start of the event. As this kind of renewable energy conferences are typically used as networking events it is quite easy and uncomplicated to engage with stakeholders through rather informal communication in the conference chat rooms.

Email communication was probably the most intensively used tool to get in touch and maintain contact with stakeholders. The advantage is that supplementary material (e.g. introduction to the project) can be easily attached to the email. However, the disadvantage of engaging via email is that stakeholders often ignore incoming emails. The experience from the Moroccan case study team prior to and after the Menasol Conference 2011 in Morocco showed that emails should be resubmitted if there is no reaction from the side of the stakeholders within 3-5 days after the first e-mail was sent. Also requesting submission receipt and indicating high priority can increase the pressure on the receiver to respond. Yet, in some cases even this more pro-active communication strategy did not suffice.

At a later stage (during and after the first workshop) other communication methods such as the questionnaire, face-to-face discussions and semi-structured interviews were used.

A common approach in all case studies was to give presentations to relevant stakeholders about the project, the ongoing developments and to ask for direct feedback. This approach allowed us to reach a broader audience and to make communication more effective. Specifically the intensive feedback rounds provided sufficient room for the variety of stakeholders with their very distinct and specific requests.

- *Were different methods used depending on the different stakeholder types?*

The overall experience of WP 7 is that there is no specific communication method that is particularly suited to engage with a particular kind of stakeholder. Generally, any communication and engagement method that facilitates stakeholder participation should be used. A crucial determinant for the choice of a specific engagement and communication method is usually the duration of the relationship and the level of trust between the researchers and stakeholders; the longer the relationship the easier it is to rely on direct, informal communication.

It also turned out that more important than the method and tools as such are often the way how SET and CET communicate to external stakeholders (see below). The most paramount issue to keep in mind here is to be precise, as concise as possible, and clear about the goals of the engagement as well as the potential benefits a stakeholder could reap from a closer involvement.

The questionnaire (section 2.4) is certainly the best option to elicit detailed information in a structured manner from stakeholders of any type. This is also the reason why the questionnaire was foreseen to play the most dominant role in identifying data usage patterns and better understanding the usage of climate data among the stakeholders and their interest in future climate data. For the exploration of the real stakeholder needs and wants and the subsequent development of the product sheets, a semi-structured, quantitative questionnaire therefore might theoretically be the ideal option regardless of the type of the stakeholder.

Yet, practical experience from all case studies indicated that the tool was somewhat cumbersome and not flexible enough to be used for direct, real-world interaction at e.g. conferences or during workshops regardless of the stakeholder type. As the CLIM-RUN project is the first of its kind (i.e. using a participatory approach to identify use of and needs for climate data by RES-E stakeholders in the Mediterranean region) a large number of stakeholders were contacted for the very first time by the CLIM-RUN staff and most of them during conferences. In this context, where it is important to raise the interest of the stakeholder, get in touch with each other and to keep conversations as natural as possible the questionnaire did not prove to be an effective instrument. In the first workshop rounds with a high share of stakeholders from the REN policy and industry (e.g. Croatia, Cyprus, Morocco) more time was available to fill-in the questionnaire. Yet the overall response rate remained low and only a few questionnaires were completely filled out.

- *Did the stakeholder analysis help to define common communication strategies?*

In WP7, none of the case studies did conduct a fully fledged stakeholder analysis. Communication and engagement methods were also not used in the same manner across the case studies. Besides from the individual context each case study is embedded in, which somehow determines the choice of how to communicate and with whom to communicate, this is also due to the fact that there was hardly time to prepare a common, coordinated and thorough stakeholder analysis which would have probably facilitated a common communication strategy. The workshops were conducted within the first six month of the project due to project deadlines. This is quite ambitious considering that most of the stakeholder relationships had to be established from scratch. Furthermore, in two case study regions (Morocco, Spain) workshops had to be held almost right after the beginning of the project (May, June 2011) to benefit from a gathering of potential stakeholders that took place anyway in the case study regions. This however shortened considerably the period to prepare a coordinated cross case study approach.

Nevertheless, the work done on stakeholder identification and in particular the first round of exploring stakeholder climate data usage patterns as well as their interest in climate data contributed to gradually adjusting language and communication strategies along the project to specific stakeholder types. For instance, the preliminary identification of stakeholder characteristics (e.g. low or high awareness of climate issues) and data needs indicated that a better understanding of the climate variability over future timescales could help REN financiers to better manage one of their key risks: the predicted energy yield of a REN power plant and therefore its cash-flow analysis and bankability over the full investment time-frame (between 1-15 years). As CLIM-RUN has focused to a large extent on REN financiers, this finding was taken into consideration while designing presentations, newsletters and product sheets for this kind of stakeholder type. For instance, in the Spanish case study hypothetical examples based on real wind measurement data for a given site in Spain and how a change of the wind resource over the next years could impact up on the average productivity of a REN plant were given to financial stakeholders. The economic impact of a potential greater variation of the wind resource over the life time of a project is certainly of interest to other stakeholder types as well but it should be at the heart of communications with REN financiers as this is on of their key concerns related to climate variability and change. In this context it is more important as well to pay sufficient attention on how to frame the communication (e.g. about the economic value of climate data) than what tool to choose for the communication.

- *Which barriers emerged in the engagement process with stakeholders?*

One of the more implicit assumptions underlying the methodological approach for the stakeholder analysis and engagement, such as described in D 1.1 of the CLIM-RUN project, was that there would be sufficient interest from part of the stakeholders in developing a MCS. While we can certainly say that all of the stakeholders engaged with the WP7 expressed their sincere interest for the project and their concerns about the climate sensitivity of REN plants, a couple of factors complicated the engagement and communication process:

- First, Many REN stakeholders are non-climate experts and do, of course, consider more than purely environmental/climate risks in their risk strategies. Although the climate/resource risk

is one which receives growing interest from all stakeholders, a finding that is also confirmed by an industry poll (The Economist 2011), it is still dwarfed by political, regulatory, technology and market risks. This is particularly true for Morocco but also for Spain where the economic recession and retro-active cuts of feed-in tariffs for wind and solar put the regulatory and market risks at the top of the risk agenda.

- Second, CLIM-RUN is only one of several research projects renewable energy stakeholders are actually involved in. As their resources are limited most attention will be given to where the greatest output can be expected. Even if the added-value of the project may not be disputed among the stakeholders in all case-study regions, the fact that CLIM-RUN could not guarantee a final product or an improved resource assessment with acceptable levels of uncertainty that really suits the request of a stakeholder, adversely impacted stakeholder expectations.
- Third, also language challenges and problems of understanding between CET and SET as well as between the CLIM-RUN staff and the stakeholders with very different backgrounds complicated the engagement process (see below). Especially during the first conferences, the persons representing relevant stakeholders were often not the most appropriate ones because of their educational background (e.g. Communications or Marketing managers). We were very much dependent on the willingness and ability of these first contacts to pass on the information and request by the CLIM-RUN group to the right staff member in the company. If there is nobody working explicitly on this topic in the organization it is even more difficult to build up a relationship because communication and understanding with non-climate experts is a major challenge.
- Finally, REN is only a minor source for power production and its overall relevance in the energy sector therefore relatively low. Many stakeholders we talked to have a different mindset because they grew up in the conventional energy sector. Preconceptions of many of these stakeholders toward climate change prevail and are very hard to overcome which clearly impinges on the chances to make them participate in the project.

2.4.Role of the Perception and Data Need Questionnaire

- *What is the questionnaire about and how was it implemented?*

The CLIM-RUN perception questionnaire was developed by WP4 members and foreseen to be applied in all CLIM-RUN case studies, i.e. the tourism, wild-fire and energy case study. It was considered to be a tool to collect data in a structured manner about, first, the characteristics of the stakeholders (organization type, perceived climate sensitivity of business and current usage of climate data) and, second, their climate data requirements (e.g. what kind of data at which temporal and spatial scale and resolution); thereby providing input to the 'who' and 'what' questions defined in D1.1 of the CLIM-RUN project. In other words, the first section of the questionnaire should generate the information for the stakeholder analysis. The second section should satisfy the requests of WP2 and WP3 where stakeholder tailored climate products were devised (see section 2.7 and chapter 3).

In WP7 case studies, the perception questionnaire was exclusively used in the first period of the project, more precisely during and shortly after the first workshop; except for Croatia where it was already circulated prior to the first workshop. In total, 43 questionnaires were sent out in the four case study regions (Morocco: 20, Spain: 4, Croatia: 16, Cyprus: 3). The response rate remained rather low, with only 15 questionnaires originally completed by stakeholders themselves. In most case studies the questionnaire was circulated during the workshops and received back from the stakeholders a few weeks after the first workshop. After the first round of stakeholder interaction in the CLIM-RUN project the questionnaire was not used anymore. Yet main elements and most of the questions of the questionnaires were somehow incorporated into face-to-face discussions, semi-structured interviews and also later in the guidelines of questions for the second round of workshops.

The process of implementing the questionnaire as a standard tool to collect data and information about stakeholders and their data needs across the different case study regions proved to be challenging in WP7. Even if the thematic area of all case studies in WP7 was the same, i.e. renewable energy production and its climate sensitivity, each case study has its own context and thus is very individual (e.g. due to technology focus of stakeholders, institutional environment). Hence, the questionnaire had to be used in very different manners and was adapted to the local conditions. For instance, in Spain and Morocco where workshops were held and first stakeholder interactions carried out during renewable energy conferences, the questionnaire was substantially shortened and basically used as a guideline for face-to-face discussions and semi-structured interviews with stakeholders. In Cyprus and Croatia, the original questionnaire – or at least parts of them - was sent out prior to the workshop or during the break of the first workshops. Completed questionnaires were then usually received back within a few weeks after the first workshop.

- *How did the questionnaire work?*

The questionnaire as such certainly helped us to get a first overview of the potential renewable energy stakeholders interested in climate services and what data they require. In all case studies – regardless of whether the original questionnaire or a modified version was used – it generated sufficient amount of relevant information to start with developing climate products.

Nevertheless, considering that the questionnaire was regarded as the main tool to gather relevant data and information about stakeholders and their usage of climate data, it was less effective than we had expected. Hardly any questionnaire was filled out completely. Some stakeholders did not return the questionnaires despite of having promised it during the workshop (e.g. Morocco). Due to the overall low response rate and the different ways in which the questionnaire was deployed in the four case study regions, the conclusions drawn from the data always need to be interpreted with certain cautiousness. The data certainly does not allow for generalization.

- *What kind of problems emerged throughout the implementation process?*

There is much room for speculation but there are at least three factors that might help us to understand why the implementation of the questionnaire in the different case studies of WP 7 faced difficulties.

First, most of the renewable energy stakeholders we spoke with – this applies for the case studies in Spain, Morocco and Croatia - come from the private renewable energy industry (including consultants, project developers, technology, energy utilities, and power grid companies). For those working for many years in the field of climate change, this may be a surprise but a wide range of renewable energy stakeholder are not at all familiar with questions concerning their climate risk perception, specific climate modelling techniques, and/or the concept of climate services. Against this background, it was challenging for many stakeholders to respond appropriately to the questionnaire. For instance, the question about the stakeholder's definition of climate sometimes caused surprise and indeed in some occasion triggered rare responses (e.g. "Climate is a situation that is comfortable"). For other questions (e.g. What kind of climate and weather-related events and their impacts do you consider are important for your sector?) the level of detail in the indicated answers was perceived to be too specific. Again other questions (e.g. specification of climate data needs) simply were too difficult to answer for a wide range of stakeholders contacted during renewable energy conferences; though most of them considered themselves to be familiar with climate issues affecting the operations of their organization. Even if they often promised to communicate with climate experts in their organization to complete the more technical questions, this rarely happened.

Second, the questionnaire is too complex for first interactions and time needed to complete the questionnaire is too long. Renewable energy industry conferences were used as a main entry point for communicating with REN stakeholders in the case studies of Spain and Morocco. We found out that a renewable energy industry conference is an appropriate place to make first contacts with potential non-scientific stakeholders because these conferences are usually about networking and building up new relationships. Nevertheless the culture of these renewable energy industry conferences is different to scientific conferences. Whereas during the latter ones most interest is paid to discuss the issues that are not understood, in the first ones priority is given to 'sell' potential solutions. As the stakeholders are usually very busy because they are approached by other participants as well or are themselves searching for new contacts and networking time is limited it is paramount to clearly and convincingly communicate the benefit a stakeholder can have by participating in the project within the first minutes of the conversation. For this, short conference chats are more useful than approaching the stakeholder directly with the questionnaire and a long list of technical questions.

Third, even within the WP7 team the main goal of the questionnaire - answering the 'who' and 'what' question to be addressed for the protocol - was not entirely clear. From a today's perspective the added value of the perception questionnaire – relative to other engagement and communication methods - is much clearer than in the beginning of the project. This is probably also due to the fact that the concept of the CLIM-RUN protocol as it has evolved until today was not that well understood by all project participants in the very beginning of the project. In a project set up by a large consortium with some staff members completely new to the topic of

climate services and coming together for the very first time, a number of the questions were not obvious. Furthermore, there was actually neither sufficient time nor room to discuss and to clarify on potential problems in a coordinated manner and to pilot with the questionnaire and to adapt it accordingly before the first workshop round. Stakeholder identification and workshop organization (in the case of Morocco without a local partner) took substantial time and received in all case studies priority as it was crucial to start working with the stakeholders as early as possible. A lack of understanding between the climate and stakeholder experts about the usefulness of the questionnaire for the overall goal of the project has certainly complicated the implementation process as well.

- *What to learn from the implementation of the standardized questionnaire?*

Based on these mixed experiences we have developed for the second term of the project and in particular for the second workshop a brief guideline with a list of 15 qualitative, open questions for stakeholder interaction. Certainly, the aim here was not a matter of collecting data for cross-case study comparison but rather to trigger structured feedback from stakeholders across case studies. The introductory part with two questions on how the business of the stakeholder is affected by climate change and what kind of climate data would be relevant for her are considered to be an ice-breaker since we also had to engage with new stakeholders during the second workshop period due to the fact that e.g. in the Moroccan case study the main stakeholder left throughout the process.

The results and experiences from the second workshop in Cyprus are pending by the time of writing this report but insights from Spain, Morocco and Croatia indicate that by using the guidelines some common feedback from stakeholders could be retrieved.

Something we can learn from the work with the questionnaire is certainly that it should be used as flexible as possible and probably not as a tool to start interaction with stakeholders. While this may reduce the scientific quality of the results to be derived from stakeholder interactions and probably fail short to satisfy the purposes of comparison and generalizations, in projects like CLIM-RUN where many stakeholder contacts had to be built up from scratch with actors from very different areas most attention should be given first to thoroughly building up a climate of trust and a robust relationship by using other methods of engagement and communication. Once this has been achieved, the questions about willingness to engage and interest in modelling techniques, etc. as well as the technical and difficult to answer questions should be addressed. It could be tested to implement the questionnaire after the first workshop, not before or during the workshops. At a later stage stakeholders may better understand the overall context of the project and also be clearer about their level of engagement with the project team. While this is certainly more time-consuming it could be one way to reduce the drop-out rate of stakeholders and to make sure that also within the project there is a common understanding of the goals of the questionnaire. It could also be helpful to start right from the beginning with an online version of the questionnaire that is adapted to the characteristics of each case study (i.e. wild fire, energy, tourism).

2.5.Interplay between CET and SET

- *How did the interplay of CET, SET and stakeholders look like?*

An innovative element of the CLIM-RUN project is the implementation of a team of Climate Experts (CET) and Stakeholder Experts (SET). The differentiation between both groups was agreed upon early in the project. The main goal was to facilitate the two-way communication and to support the internal and external flow of information between CLIM-RUN researchers and the main stakeholders of WP7. Table 1 gives a brief overview of the teams of each case study. A more comprehensive list can be found in the report of Milestones 8, 9 and 17.

Case Study	Climate Expert Team (CET)	Stakeholder Expert Team (SET)
Spain	Paco Doblas-Reyes, IC3	Melanie Davis, IC3
Morocco	Sandro Calmanti, ENEA	Peter Schmidt, PIK, EL HABIB EL ANDALOUSSI, PLAN BLEU (until 07/2011)
Cyprus	Panos Hadjinicolaou, Manfred Lange, EEWRC	Manfred Lange and Aris Bonanos, EEWRC
Croatia	Cedo Brankovic, DHMZ	Robert Pašičko, UNDP

Table 1: CET and SET of the Case Studies

At the beginning of the CLIM-RUN WP7 project, both the CET and SET were directly involved in the identification of stakeholders and the definition of the relationship with certain stakeholders, e.g. whether a stakeholder is considered to be a primary or secondary stakeholder. Right after the project kick-off meeting in March 2011, it was started with the stakeholder analysis and selection of relevant stakeholders in the four case studies. Both the CET and SET contributed with their knowledge and existing network to the stakeholder selection process. Some basic knowledge on the role of certain climate parameters, modelling capacities of the CLIM-RUN project and the limits of climate forecasting techniques were explained by the CET to the SET. Also, depending on the prior experience in the work with stakeholders from e.g. the private renewable energy industry information was exchanged between SET and CET on how to best approach stakeholders. For instance, the invitation letter and supplementary material was revised together in order to make it more apt to the language of potential stakeholders.

In the light of the first workshop round, the SET and CET usually separated working tasks and focused on their area of knowledge and responsibility. For instance, in the Morocco case study the SET contacted and invited a wide range of potential stakeholders to conduct interviews and/or organized their participation in the workshops. The main introduction of the CLIM-RUN project to the invited stakeholders was divided into two areas. The SET was in charge of introducing the main idea of the CLIM-RUN project and the concept of the bottom-up approach. The CET presented available climate modelling and scenario techniques during the workshops and offered areas for future cooperation with stakeholders (e.g. using long-term climate scenarios to support the

definition of a solar or wind atlas in Morocco). After the workshop, the workshop reports were prepared by both SET and CET in order to make sure all relevant details – viewed from a stakeholder and climate expert perspective - are included in the report.

In the case studies where semi-structured interviews and face-to-face discussion with stakeholders were held (e.g. Morocco, Spain) both CET and SET attended the interviews. This facilitated the conversations with stakeholder and the interpretation of stakeholder requests. The main reason is a practical one. One person (either CET or SET) could concentrate only on the conversation with the stakeholder whereas the other person in the meantime could take notes and record the conversation. Second, with the combined expertise of both SET and CET it was also possible to better engage with the stakeholders as a more comprehensive understanding of the set of challenges a stakeholder is facing while dealing with climate issues can be achieved. Furthermore, the SET was usually the first contact for the stakeholders and a certain kind of trust between SET and stakeholder already existed; thereby facilitating the conversation.

Throughout the project – i.e. particularly during the second stage of the iterative stakeholder consultation - continuous interaction between both CET and SET was key to define and develop climate information, products and tools. Stakeholder experts were generally more focused on the direct interactions with stakeholders after the workshops; though this also differed across the projects depending on whether there was a specific stakeholder selected (e.g. Morocco in the first period of the project) or a broader range of stakeholders was addressed (e.g. Spain). In the Moroccan case study direct interaction between CET and the stakeholder was held whereas in the Spanish case study most of the stakeholder interactions were coordinated via the SET.

Given that in all case studies CET and SET were involved in the identification of user needs, both groups were already aware from the very first stage of the project of the specific requests expressed by the stakeholders. The questionnaires as well as the workshop reports were used to identify the critical variables and the formats (e.g. spatial scale, temporal scale) stakeholders were looking for.

The CLIM-RUN questionnaire did of course play an important role in collecting first sets of data from stakeholder as already described. However, as questions in the questionnaire (e.g. concerning the data specification) were not comprehensively answered by most of the stakeholders, CET showed some dissatisfaction with the data collected via the questionnaire in the first round of stakeholder interactions. Ongoing interactions via face-to-face discussions and interviews as well as conference participations were helpful to consolidate the data and to help better define the specification of the stakeholder needs.

In general, there was little explicit discussion about the concrete definition/format of the climate information sheets, such as described in section 2.7 and chapter 3, between CET and SET. As a first step, WP7 CET and SET developed a full list that contained all relevant climate parameters that were mentioned by external stakeholders to be of potential interest[4]. In addition to the climate

[4] https://docs.google.com/spreadsheet/ccc?key=0Ak-vXfiZiAgwdERYdkFZdFdIdUxKc29aWVBKNHNzclE#gid=0

variables, also the type of renewable energy generation technology, the temporal resolution, as well as the spatial scale in line with stakeholder interests were added to the list. CET evaluated for each climate variable from a seasonal-to-decadal forecasting and climate change modelling perspective what can be done within CLIM-RUN. From the early interactions with stakeholders some coordinates of potentially interesting real-world renewable energy projects were already known and communicated to the climate experts in WP 2 as well (e.g. CSP plan in Quarzazate, Ain Beni Matar, Morocco). In the light of some of the stakeholders' requests for site specific information, it was discussed to use these as potential test cases for CLIM-RUN modelling and forecasting techniques. However, it figured out that many requests could not be addressed directly, among others, due to the limitations of current downscaling methodologies, the low quality of observational data at many renewable energy production sites or simply because it was not possible to do that within the indicated timeframe of the CLIM-RUN project.

In the light of growing stakeholder expectations and the need for the case study teams to get back to stakeholder with a few examples of what can be done in CLIM-RUN, it was agreed upon, for instance, to start generating seasonal and decadal climate forecasts for the whole Mediterranean from which environmental parameters of interest for the wind energy sector could be extracted (e.g. 10 m wind speed). Also, an ensemble of regional climate models was used by ENEA to project long-term changes in 10m wind speed over the Mediterranean for the decade 2040-2050 with respect to 1990-2000 (see also newsletter issue 2, 7/2012). These simulations were used by both SET and CET in presentations given to stakeholders in 2012 and early 2013.

With the lessons-learned from the presentations given at different conferences, the simulation results were further refined and finally converted in to the prototypes of climate information products which were then disseminated from the 2nd round of stakeholder workshops onwards.

The SET was involved in drafting the final product sheets by providing input on how to design the product sheets in order to make them as easily accessible as possible for non-climate experts. Visual elements (e.g. maps, colours used to demonstrate the range of uncertainty, figures) were regarded to be of paramount importance to raise stakeholders' awareness. As most of the stakeholders indicated that they do hardly use climate data from scientific sources because they were too difficult to interpret and not easy to access, the SET input and background in working with stakeholders from the private renewable energy industry proved to be conducive to develop more appropriate formats.

During the second round of stakeholder workshops the SET and CET participated in almost all case studies. Yet, in Spain for instance where both SET and CET came from the same institute only the SET attended the workshop events and conferences. For the Moroccan case study SET and CET decided to organize together the interaction process with stakeholders such as in the first workshop round. Whereas the CET was in charge of explaining the modelling approach as well as interpreting the results, the SET took responsibility of organizing stakeholders' participation in the second workshop round and preparing face-to-face discussions. These were used to introduce the prototypes of climate information products as well as to trigger feedback from old and new stakeholders (e.g. in the case studies of Morocco and Spain).

- *How did the interplay between CET and SET work during the project?*

Overall, the CET and SET cooperated very well in WP7 which was key to deliver a first series of prototypes of climate information products for the case studies in Spain, Morocco and Croatia. After the first round of stakeholder interactions and workshops, communication flow was generally organized through a regular exchange of information via Skype, telephone conferences or the CLIM-RUN project meeting where both CET and SET from all case studies participated. This is true in particular for the first term of the project. It helped to make sure that all partners were up to date concerning stakeholder interactions in all case studies and facilitated the sharing of lessons-learned (e.g. in how to best engage stakeholders with the project). This was also important because a number of stakeholders (e.g. the group of international financiers) were active in several case study regions and hence their demands were not related only to one specific case study. The reason to focus in the climate information products on forecasts and scenarios for wind was first of all a result of the experiences shared between SET and CET of the case studies of Spain and Morocco.

Nevertheless, there were also difficulties and challenges which complicated the interplay between CET, SET and stakeholders.

First of all, it is certainly true that there was a big challenge of understanding and communicating effectively with each other because of the different educational backgrounds, working languages and cultures. The climate expert 'world' is rather technical, characterized by scientific rigidity and abstract language. It is quite different from the world of the SET which is characterized by pragmatic communication (i.e. less can be more) and service-orientation. The SET and CET of WP7 worked together for the very first time in this setting. This implied that both CET and SET basically started from scratch and had to learn a lot about the communities they belong to. This required a considerable amount of time and was difficult to manage within the tight project schedule. Furthermore, in some case studies (e.g. Morocco, Cyprus) SET and CET did not come from the same institute which further complicated regular interaction. Although frequent exchange of information took place (e.g. via Skype and the CLIM-RUN wiki), it did not prove to be very effective in keeping each other updated of ongoing events, etc., specifically during the second term of the CLIM-RUN project. Beyond the CET and SET interactions, also the stakeholders from the private industry do have a different culture and types of communication which was especially in the case study where English was the working language challenging as it further complicated effective communication with local stakeholders.

Second, the SET's work at the intersection of three different areas (energy business, climate modelling, and communication) was a challenge too. For instance, the SET had to acquire a sound understanding of the fundamentals of available climate forecasting techniques and climate models as well as profound knowledge about communication issues because many SET do have a background in the field of energy policy and/or energy industry and were actually not trained for being facilitators or communication experts in a transdisciplinary research project. In the CLIM-RUN project the SET followed by and large a learning-by-doing approach to acquire the required background knowledge. In future projects this challenge must be recognized earlier in the project

phase and a common training (indicated for instance by a milestone in the project description) for all SET would probably facilitate both communications with the CET as well as the stakeholders.

Third, stakeholders faced difficulties in filling-in the questionnaires – especially the data specification needs – and keeping really engaged with the project, as for instance indicated by their low level of participation in the CLIM-RUN training courses. It can be speculated that low level of feedback, low engagement and weak response rate may have been a matter of insufficient communication with the SET or not understanding the rather technical language used by CET. This is certainly true for stakeholders who are not experts in climate issues and thus did not feel sufficiently competent to respond to our demands and engagement calls. Another reason that may have played a role is that there are also strong indications that some stakeholder did not really see the benefits from taking the time to thoroughly specify their needs as they were sceptical about the real added value of the CLIM-RUN project, among other, due to the huge uncertainty or level of skill of climate forecasts for the site specific information they are actually interested in.

2.6.Role of the Workshops

In CLIMRUN's participatory research approach it is decisive to provide stakeholder sufficient room and space for engagement. Hence, a three step consultation approach was suggested to engage with stakeholders (see Deliverable 1.1). First, a workshop with all relevant stakeholders should be organized. Second, an iterative consultation process with stakeholders, SET and CET should be designed to reflect upon the workshop results and to work together towards prototypes of climate information products. Third, a second workshop round should be organized to present the product prototypes to stakeholders and to trigger feedback.

- *What was done in the first workshop and what are the lessons-to-learn?*

After the identification of relevant stakeholders, the next crucial step in the stakeholder consultation approach was the first round of workshops between May and November 2011. The aim of the first workshops was to present the CLIMRUN project to stakeholders in the different regions, to introduce the concept of climate services and to collect data about climate perception of the stakeholders and their climate data needs through the questionnaire. In all case studies formal workshops were organized in Rabat, Barcelona, Zagreb and Nicosia and potentially relevant stakeholders were invited. In addition to these workshops in the Spanish and Moroccan case study it was also engaged with stakeholder during so called 'hosted workshop events' (at e.g. the Menasol conference 2011 or the Genera Renewable Energy Exhibition and Conference) where speaking slots were used and presentations given by CLIM-RUN CET and SET.

More detailed information on the individual workshops can be found in the individual workshop reports and/or Deliverable 7.1. In general, the most important insights derived from these workshops and first round of stakeholder interactions in WP 7 are the following:

- Very few RE stakeholders have considered the use of seasonal to decadal climate information;
- A better understanding of the climate variability could help to facilitate the bankability of RE projects;
- Wind speed and DNI are key parameters for which REN stakeholders would require reliable analyses;
- REN stakeholders consider technological and regulatory risks to be more important than climate risks;
- The questionnaire response rate and quality of the answers as well as participation of external stakeholders in workshops was rather low; ranging between 3 in Cyprus, 11 in Morocco and 16 in Croatia.

Overall, the goals of the first round of interactions with stakeholders in WP 7 have generally been achieved. Information was compiled on climate risk perception of most stakeholders in order to better understand with whom we want to engage. Also, understanding of how stakeholders use climate data as well as their needs could be increased substantially. This helped us to define what to deliver to the stakeholders. In almost all case studies primary stakeholders were identified (e.g. ADEREE Morocco, RE Insurer and Financiers – Morocco, Spain, and Power Companies Croatia) and decisions on future interaction with them were agreed upon. For instance, in the Moroccan case study it was suggested by the CLIM-RUN team to discuss how the data which will be collected in the Africa-CORDEX framework can be used for the purpose of enhancing the current assessment activities in the field of renewable energy in Morocco. Hence, the stakeholder relationships built up throughout the first stage of stakeholder interaction were regarded as generally sufficient to initiate the second step of the participatory research strategy of CLIM-RUN.

However, the level of constructive feedback from participants of the workshops (e.g. by filling-in the questionnaire) remained rather low in all case studies of WP7. Furthermore, it was difficult to motivate some relevant stakeholders to attend the workshops set up in the different locations. E.g. the number of those rejecting the invitation was at least as high as the number of people participating in the workshops in all case study regions.

Most of the data on perception of climate risks and stakeholder want and needs in the Spanish but also in the Moroccan case study were compiled through other forms of interaction, e.g. the hosted workshop events and face-to-face discussions with stakeholders during conferences based on adapted versions of the questionnaire. Yet, as indicated before, exact data specification was a problem here too.

Experience from the first workshop round in Spain and Morocco indicates that a classical workshop format such as initially foreseen by the CLIM-RUN protocol can have some disadvantages over a hosted work shop event at a conference venue.

- The organization of a workshop generally involves higher costs than hosted workshop events; although entrance fee to private renewable energy industry conferences is expensive too.

- The workshop preparation is more time-consuming as it needs to be prepared well in advance and coordinated with a wide range of stakeholders (room booking, transport, etc.).
- The level of participation crucially depends on the location. If no travel budget is available for stakeholders, they are often not willing to join.
- It is challenging to get the 'right people' to attend the workshop – during hosted workshop events it is often easier to get in touch with them.
- It is extremely important to have a local partner with a functioning network involved in the workshop organization.

- *How did the iterative consultation work and what are the lessons learned?*

The main goals of the iterative consultation and collaboration process which started after the first workshop are the following:

- Increase understanding of different types of renewable energy stakeholders needs in terms of climate information to sustain their decision making processes.
- Develop, test and improve data products/tools based on the feedback from different types of renewable energy stakeholders.
- Find a consensus on priorities for development of climate services (e.g., added value of data vs. effort to supply the appropriate data).
- Sustain level of engagement of renewable energy stakeholders with CLIM-RUN

To fulfil the goals of the CLIM-RUN energy case studies, the WP7 project team started engaging again with several renewable energy stakeholders from the different case study regions after the first workshop round was finished in late 2011.

Generally, the stakeholder focus was on both local (Cyprus, Croatia, Morocco) and international stakeholders (Morocco and Spain) from the solar (PV, CSP), wind and hydro energy industry. It depended very much on the case study team whether it was concentrated more on a single stakeholder (e.g. ADEREE, HEP Power Company) or a specific stakeholder type (e.g. international REN financiers/investors) or the REN sector in general.

The tools and methods outlined in section 2.3 were used to engage with stakeholders and to keep engagement going between the first and second workshop round.

Most of the communication right after the first workshop round based on e-mail communications and telephone communication. Material was sent out with examples of what could be done in CLIM-RUN or potential cooperation was discussed. Questionnaires were received back from workshop participants.

Representatives of the stakeholders we have been engaging with were also tried to meet in other contexts in order to keep in touch with them as much as possible. For instance, the Berlin Renewable Energy Academy Conference was attended by delegates from primary stakeholder

ADEREE as well as secondary stakeholder Rechtsanwaltskanzlei Löscher. Such events were used to consolidate existing relationships and contacts and further expand the network.

The most common way of communication with stakeholders was through conference visits and presentations given by CLIM-RUN staff at REN industry, policy and academic conferences (e.g. Climate Services conference Brussels, EGU 2012).

An element that emerged throughout the project and was used in an increasing manner by all case studies of keeping stakeholders up to date of what is going on in WP7 was the CLIMRUN newsletter which started in early 2012 and was sent to all stakeholders who participated in the first CLIMRUN stakeholder workshop round. WP7 used very actively the newsletter to communicate and update stakeholders of recent results and developments of our work. This was also used to make stakeholders aware of new publications, such as for instance the article of the Croatian case study team on climate change and hydro power in Croatia[5].

In the early phase of the project we focused on the climate data wants and needs of several actors in the solar (PV, CSP), wind energy and hydro energy sector. Towards the end of the 2nd step of stakeholder consultation, however, we limited our interactions to stakeholders from the hydro and wind energy industry. Especially in the Moroccan case study it was decided to focus only on wind. This was due to two main reasons. First, it is still very challenging and virtually impossible to address all stakeholder needs in terms of assessing how climate variability does affect power production resources of solar and wind in the mid- to long-term. Such an approach binds too many resources. Hence, it was decided to bundle the limited resources and to focus primarily on wind at this stage of the project. In CLIM-RUN, there was already a good body of knowledge related to wind modelling and seasonal wind speed forecasting capacities. The second reason for the wind focus was the growing stakeholder interest in deploying wind technology in Morocco. This is indicated for instance by a report from the Desertec Industry Initiative (Dii) (cf. Zickfeld and Wieland 2012), who is now paying much more attention to exploring the wind power potential in MENA than in the first assessment of the industry consortium. This decision, however, also implied that interactions towards the end of the project very mainly limited to wind stakeholders in the Moroccan as well as the Spanish case study.

Whereas the Spanish case study team mainly engaged with several and different stakeholders, the Croatian and Moroccan case study team focused on primary stakeholders such as HEP (main power company in Croatia) and ADEREE (Agency for Renewable Energy and Energy Efficiency of Morocco). In the latter case, this has proven to be a failure as it did not work out the way it was expected during the first workshop round. When we started to developing the first scenarios for Morocco, their feedback remained very limited. Several attempts were undertaken to reinitiate detailed discussions such as agreed upon during the stakeholder workshop in Casablanca in 2011, mainly through e-mail and telephone calls, but without success. The reasons for the lack of engagement are unclear but there is some room for speculation. First, between the first gathering

[5] Pašičko, R., Č. Branković, et al. (2012). "Assessment of climate change impacts on energy generation from renewable sources in Croatia." Renewable Energy 46(224-231).

in May 2011 and the dissemination of first simulations almost one year passed. Yet it was extremely important to come up as quickly as possible with first examples that could be understood by stakeholders. Another reason for why ADEREE left the process may be found in the close relationship between ADEREE and a former staff member of CLIM-RUN who left the project after the first workshop round. Here also language issues may have played a role as this staff member used to talk to ADEREE in French or Arabic which the rest of the Moroccan case study team was not able to do. Finally, it is also not clear whether the key contact from the first workshop of the Morocco case study was still working at ADEREE when consultations started as several attempts to contact him failed.

In the Croatian case study, the cooperation with HEP power company seems to allow for future cooperation. Large number of HEP staff participated in the workshops and overall high awareness of climate issues exists. It is not entirely clear why cooperation with energy actors in Croatia went successful. An important issue is of course that energy production in Cyprus is extremely dependent on hydro power. Stakeholders are already today highly aware of the impact of changes in temperature and precipitation on water run off and water availability and thus energy production capacity. The link between changes in wind speed and irradiation on energy output is more complex to identify and far less well understood. It is certain that cooperation between HEP and the Croatian CLIM-RUN team will not cease to exist after the end of the project. Yet, the risks of relying too much on one stakeholder only should also be kept in mind.

In summary, the iterative consultation and engagement period in between the two workshop rounds was quite effective. Although an important stakeholder in the Moroccan case study left along the process, fortunately, this did not substantially affect our activities as product sheets could still be adapted to requests from other primarily international stakeholders.

- *What was achieved in the second workshop and what are the lessons learned?*

The main objectives of the second workshops, which were held between May and July 2013[6], were the following:

- Disseminate climate information research and products to RE stakeholders.
- Test the relevance of the simulations and tools developed in CLIM-RUN.
- Trigger stakeholder feedback on prototypes of climate information products.
- Consolidate existing and enter new stakeholder relationships.

Depending on the stakeholder experiences made during the first round of workshops and the subsequent iterative consultations as well as the specific situation in the case study, different ways to organise the second workshop round were chosen by SET and CET. For instance, the Moroccan and Spanish case study team based on their overall positive experience with hosted workshop events at conferences followed this approach and invited as well new stakeholders to CLIM-RUN.

[6] By the time of writing the Cyprus workshop has not been held yet. The workshop is scheduled for 11/2013.

The Croatian team invited those stakeholders who were present already in the first stakeholder workshop, among them also the primary stakeholder HEP power company.

In the Spanish and Moroccan case study it was followed a two-fold dissemination and communication approach during the hosted workshop events at REN conferences in Rabat, Toulouse and Berlin to maximise the visibility of CLIM-RUN during the conference and to optimise the level of feedback on the developed product sheets. The main focus was on international stakeholders – among them REN insurers, power traders, grid operators, and financiers - during these events as it turned out that these do have the strongest interest in s2d as well long-term climate forecasts. The language spoken at these events was English.

The first strand of the approach concentrated on the results of the CLIM-RUN project that were presented in detail during speaker sessions of all energy events. Speaking slots were usually provided for the CLIM-RUN team free of charge after having introduced the topic of the project and its relevance to the organizer of the conference.

In the speaker sessions, the CLIM-RUN team introduced the problem of climate variability in the wind energy sector; outlined the potential of scenarios and forecast techniques at the seasonal to decadal to climatic scale; introduced the climate information prototype products for the wind industry prepared by the CLIMRUN Climate Expert Teams at ENEA (Italy) and IC3 (Spain); and pointed to challenges and potential future areas for stakeholder cooperation. In the Spanish case study also a wind forecast newsletter was presented. It aims to demonstrate the value of wind forecasting in practice, and how operational climate forecasting could reduce the uncertainty of seasonal wind variability, and guide decisions within the wind energy sector.

The second strand of our approach focused on intense face-to-face discussions in English with in total 22 stakeholders from the REN policy and wind energy industry (insurers/financiers, power traders, and power plant managers). The individual conversations with stakeholders lasted 20-25 minutes and generally were guided by a list of open questions explicitly developed for the second stakeholder workshop round. The data and perception questionnaire was not used anymore at this stage of interaction. However, some of the questions were derived from the questionnaire. In order to give sufficient leeway for a natural conversation, some questions were skipped, or new ones were added depending on the characteristics and the interest of the stakeholder. Once the main goal of the three different information sheets was introduced and discussed with the stakeholders, the conversation focused usually on the usability of the information in practice. In the light of ongoing or potential future cooperation, the following themes were most commonly discussed:

- Examining the probability of reaching critical thresholds for turbine operation in areas where there is a high frequency of wind extremes.
- Using global climate models to calibrate regional weather models to specific sites for wind energy production.
- Deriving tailored climate indices based on wind forecasts over climate time-scales.

In Croatia, the workshop was divided in two parts. The workshop was attended by 17 stakeholders from consultancy, NGOs, grid and power companies. Workshop language was Croatian. In the first section presentations were given by CLIM-RUN CET and SET to the different stakeholders, among them the primary stakeholder HEP Power Company. The importance of climate information on energy production from hydro power was discussed by showing the case from hydro power plant Senj in Croatia. Furthermore material was presented indicating that by the midcentury a neutral impact is expected of climate variables on generation from PV, positive impact on generation (in terms of higher value) from wind parks and rather negative impact on generation from hydropower because of frequent periods of droughts. The second part of the workshop in Zagreb gave sufficient room for discussions of the presented results. One of the main issues discussed was how CLIMRUN methodologies could be used to improve power production forecasts for hydro or wind in order to decrease the risk of grid instabilities. It was concluded that better information and understanding of climate data could lead to more efficient planning in hydro energy generation as well as the management of the power grid. The discussions between the Croatian Power Company (HEP) and Croatian Meteorological and Hydrological Service (DHMZ) were most fruitful and will be ongoing beyond the end of the CLIM-RUN project.

Generally, the goals of the second stakeholder workshop round have been achieved. In addition to reengaging with previous stakeholders (foremost in Croatia), new stakeholder contacts were made in the Spanish and Moroccan case study (e.g. with IRENA). Climate product prototypes based on state-of-the-art modelling and forecasting techniques in CLIM-RUN were presented in the Spanish, Croatian, and Moroccan cases study and general feedback was received on the usefulness of the results as well as the appropriateness of the format of the product sheets (see chapter 3). An important observation made in the second workshop, and especially in the workshops of the Croatian and Spanish team, is that stakeholders (e.g. traders, power grid companies) do have very limited understanding of probabilistic climate forecasts. It seems that this is an important area for future cooperation.

As a concluding remark, it is important to make sure that all team members are aware of the long-term goals of the workshops, i.e. setting the ground for future engagement of stakeholders. The experience of WP7 indicates that in the preparation towards the first workshop there was actually very little time to explain CLIM-RUN members – especially those who have not been involved in the drafting of the CLIM-RUN project proposal - the importance of a thorough stakeholder analysis and how this is meant to improve the effectiveness of the workshop and subsequent steps of the consultation process. In WP 7, there were only two month between the kick-off meeting of the project and the first workshops in Morocco and Spain. As a thorough preparation of the workshops crucially impinges on the effectiveness of the workshop itself and the further development of the project, in future projects more time should be allocated in the beginning to explain the overall idea of the protocol definition for a MCS and what the role of the workshops is supposed to be in this concept.

2.7.The Prototypes of Climate Information Products

A main goal of the CLIM-RUN WP 7 is to make climate data more suitable for the purposes of renewable energy stakeholders. Currently, the publicly available climate data sources are either not easily accessible or understandable or not really relevant for the decision making processes of stakeholders, for instance, because they are not available in the right format (i.e. spatial and temporal resolution). Hence, there is a large gap between the conventional 'products' that the scientific climate community has already produced and the kind of climate information products that stakeholders are actually looking for.

This section discusses a few products[7] tailored to stakeholder needs that were produced in WP7. The process of developing these products with regular stakeholder feedback rounds was also conceived as an important mechanism to increase the level of interaction between the climate and renewable energy community.

- *What products were delivered and were they sufficiently/appropriately adapted to the stakeholder needs?*

In general, the greatest interest of renewable energy stakeholders concerns the very short term forecasting, i.e. nowcasting. This is particularly true for, for instance, wind and solar energy stakeholders. However, CLIM-RUN stakeholders also requested during the last years a better understanding of existing modelling capacities and forecasting techniques to address the mid- to long-term challenges of climate change. This was explicitly expressed in the Croatian case study where long-term management of hydro power resources is an issue of considerable interest to Croatian energy stakeholders.

The CLIM-RUN WP7 team addressed this demand by developing four different climate information products which were presented and discussed in detail at the renewable energy hosted workshop events of the case study teams of Spain and Morocco as well as a the 2nd Croatian workshop in the 2nd stakeholder workshop round between May and July 2013. In addition to the prototypes of climate information, IC3 also introduced a newsletter focusing on s2d forecast for the wind energy sector. Here, however, only those products are introduced and discussed that were expressed in a commonly agreed upon format by the CLIM-RUN team in the CLIM-RUN project meeting in Rome July 08-10, 2013.

The different prototypes of climate information products were developed by IC3 (Melanie Davis, Fabian Lienert, Francisco J. Doblas-Reyes), ENEA (Sandro Calmanti, Alessandro Dell'Aquila) and DHMZ, UNDP (Ivan Güttler, Čedo Branković, Robert Pašičko). The individual documents can be accessed by following the links under resources (see annex). Hereafter, only a brief outline of their specific features will be given.

[7] We did not define the term product for the purposes of the CLIM-RUN project. In general, however, it can be conceived as a type of information sheet that addresses a specific problem of a renewable energy stakeholder and indicates how this could be dealt with by means of available modelling and/or forecasting approaches in CLIM-RUN.

The information was developed to give different stakeholders from the wind energy as well as hydropower sector an indication of how wind energy and hydro power resource assessments in the Mediterranean region could be improved by different types of climate information services. The prototypes of climate information products explain how the information is produced (i.e. the technique, method) and give examples how this information can support stakeholders with respect to wind energy and hydro power resource assessments. The main difference between these three information packages consists of the techniques deployed to project wind speed changes and the time-frame they focus on.

The product prototype developed by IC3 is based on seasonal forecasting; time-scale is 1 month to 30 years. The seasonal wind speed forecasting approach follows two steps. First, an estimate of the quality of the climate forecast system is made. Second, operational predictions are issued which generate probabilistic future wind information. Results showing seasonal wind speed predictions for Pamplona, Spain indicate the potential for using sub-seasonal wind forecasts to manage the operational risk of wind power generation for a given project site.

In addition to the IC3 climate information product on wind, also the importance of an "operational" wind forecast newsletter was introduced during the 2nd stakeholder workshop round of the Spanish case study team.

In the newsletter, a global forecast is issued for the past season, alongside a global map showing the actual wind speeds that were observed for the same season. The correlation between these two maps aims to demonstrate the value of a forecast in practice. If a true operational product (i.e. future seasonal forecast) would be available to the end users every three months, for use within their decision making processes, the observations would not be available. In this context, the value of the forecast can only be assessed by the overall climate forecast system skill assessment. Such a newsletter is planned to be issued quarterly with seasonal wind speed and solar radiation forecasts for the wind and solar energy sector respectively in the future.

ENEA uses regional climate models (RCMs) to generate wind scenarios for the Mediterranean region and focuses on the longer time scale, which is from now to 2050. Compared to Global Climate Models (GCMs), RCMs enhance the quality of climate projections especially in the presence of complex orography and in the proximity of coastal areas. For wind modelling, today's largest and most consolidated archive of RCM simulations produced during the EU FP6 project ENSEMBLES is used to develop the CLIM-RUN products on wind scenarios. Two products on wind scenarios were developed by ENEA. The first one focuses on the distribution of projected changes in wind speed over the region of Rabat, Morocco during winter and summer. The second product deals with mean changes in surface wind speeds over the Mediterranean region. Such wind scenarios on longer time scales can contribute for instance to site evaluation in the absence of very accurate wind atlases.

DHMZ and UNDP used 18 simulations from 13 regional climate models (RCMs) which participated in the ENSEMBLES project in order to estimate potential climate change and its impact on precipitation patterns over Croatia and the neighbouring countries for the timeframe 2011-2040.

The RCMs horizontal resolution of 25 km enables a reasonably well-defined insight of future change of the seasonally-averaged precipitation climate patterns. Main focus was set on the region of Dalmatia where most of Croatia's hydro power plants are sited and where the primary stakeholder expressed strong interest for.

The stakeholder reactions to the presented prototypes of climate information products indicate that, compared to scientific reports and databases which are often not easily accessible especially for non-climate experts, the concise presentation of climate data (2-pages, different visual elements such as a graph or a figure, general outline of goals, target group, and reasons for usability) is an important step forward to increase the level of usability of future climate data in the sector. Also, the level of awareness of the potential tools available to the climate community and the relevance of future climate data for the purposes of the renewable energy sector in the Mediterranean region may be increased through these kinds of product sheets. Yet, it has to be acknowledged that whether the level and detail of information is regarded to be appropriate is also very much depending on the background of the stakeholder consulted. For instance, in the Moroccan case study, a representative of IRENA considered the climate information products developed by ENEA to be sufficient and potentially relevant to support the further development of wind atlases of the Mediterranean region. On the other hand, a meteorologist of an international power company requested more detailed information and better understanding of the levels of uncertainty associated with these results.

Yet the general positive reaction to the products is also due to the fact that up to now no future climate information for seasonal to decadal timescales, let alone climate timescales, is used within the private RE industry. RE stakeholders primary use of meteorological research is related to site-specific weather information. This information is compiled by setting up a basic weather station at chosen sites and collecting information over the course of approximately 1-2 years. Technology specific energy output models are then used to compare this on-site data to longer timescales, though such models do have considerable limitations (see also Deliverable 7.3). These energy models use climate data from the past. This is the reason why any new information that can provide or at least aims to provide add-on information to the status quo comes closer to fit the stakeholder needs best.

Furthermore, from the ongoing interactions with the RE stakeholders – especially those from the private RE industry (e.g. power companies, project developers) - we became aware of the issue that the format in which the data is presented is as much important as the information itself. As hardly any renewable energy stakeholder really engaged with the WP7 team via dedicated trainings or learning modules, the only chance to catch their attention is during workshops, conferences, short face-to-face discussions and e-mail communication. As a rule of thumb, the main questions (what is the target group? what problem is it for? what is the underlying approach? How reliable are the results?) need to be addressed directly, without much text and in an easily understandable language. Consequently, detailed information concerning e.g. the underlying modelling approach and its scientific backing was left off the sheet.

- *Which data and/or research constraints emerged while developing the products and how did they affect the perceived quality of the products?*

Yet, the usefulness of the products as such was doubted by many stakeholders due to different reasons. A main reason was actually not the product itself but the underlying methodologies and the low skill of the modelling results. A primer concern is the high uncertainty associated with forecasting and mid-to long-term climate scenarios and the limitations this has for the bankability of a project. This was foremost stressed by representatives from the private finance industry.

As discussed, for instance, during the second stakeholder workshop round in the Croatian case study the trade department of the primary stakeholder HEP was expecting more accurate forecasts instead of a range of possibilities regarding the change of e.g. precipitation for which also no ultimate certainty could be given. The information was supposed to help the company to optimize its energy import/export ratio over the next years. Yet, it is clear that such demands are impossible to meet as forecasts will always bear the risk of inaccuracies.

Similarly, in the Moroccan case study, the main reason why people doubted the usefulness of the current products is the huge uncertainty involved in forecasting and mid-to long-term climate scenarios and the limitations this has for the bankability of a project. While this is a general concern shared by all stakeholders, it was frequently stressed by representatives from the private finance industry (e.g. Société Generale). Public banks, such as the German Development Bank for Reconstruction (KfW), were not so strict in this regard as they are requested by law to take into consideration long-term climate data when evaluating the viability of a renewable energy project

Another limitation for developing useful and usable products is, of course, the lack of observational data in almost all case study regions. One way to increase the value of the products and the skill of the forecasts is to focus on those sites where observational data is already available and which can be used for reanalysis purposes. This does however not always work as in the CLIM-RUN project we were bound to specific case study regions and – responding to stakeholder requests – sometimes even to specific sites where the quality of observational data was low. If it is focused in the future on explicitly those sites where sound observational data of sufficient quality is available this can help to further demonstrate the potential value of our work for the REN sector.

Furthermore, is was also a challenge to overcome the very limited understanding of e.g. probabilistic climate forecasting in general in all case studies and among almost all stakeholder groups. A main problem is that there are currently very few references that explain the background of renewable energy production risk due to climate variability and the way that climate forecasting can minimise this risk. As a result, it was necessary to give an overview of the context of climate forecasting as well as the research produced within the context of CLIM-RUN. This was a challenge in 2-pages, but at the same time, it was important that the product sheet was not longer than this. Perhaps a way to overcome this challenge would be to create a page dedicated to the background climate information on the CLIM-RUN website, so that the product sheets could focus on the results only.

Last but not least, a final challenge was to evaluate the best approach of how to communicate the research. This required that the CET and the SET took time to write the most effective copy, and decide on the best visualisation approach of the graphics. Even though the CLIMRUN project methodology suggests that the CET create the product sheet and this was mainly followed in the Moroccan case study, the final version in the Spanish case study was done by the SET. Given the very close interaction of the SET of the Spanish case study team with external stakeholders this was probably the better approach because the SET represents the end –users view more closely.

In a nutshell, the first climate information products raised interest among the stakeholders by aiming at getting as close as possible to fit their needs. The main challenges certainly lie in the provision of the product in the appropriate level of information, language and format that can be easily understood and is yet predominantly visual (without much text). We believe that huge progress was made in this respect, but there is still room for improvements of all products presented so far.

3. CLIMATE DATA USER NEEDS AND PRODUCTS

3.1.Identification of Common Stakeholder Needs

On the one hand, it is quite obvious that each case study is individual and the context wherein climate information is used affects also the demand for climate data. This is very much influenced by for instance the goals of renewable energy expansion plans, national energy policies, and green subsidy mechanisms. Furthermore, WP7 has looked at different technologies in different countries which of course impacts on the request for data as well and even within the same group of stakeholders the needs can be very different. Hence, it is difficult to identify generalized, common data needs across all case studies.

On the other hand, there are some common issues that could be identified and that do not vary much across the case studies.

The first issue is related to the financing risk stakeholders are challenged with. For instance, stakeholders in the wind energy sector mainly use, if available, site-specific historical climate information to assess wind resources at a given project site. The main reason is that renewable energy financiers (e.g. banks) do not accept any other source of information. However, one of the main risks which are shared by these stakeholders is the volatility of earnings from year to year. It is common that many renewable energy projects are financed with high shares of debt (between 60-80%). The interest on the debt remains payable every year—whether there is a good climate resource availability or not. The most significant risk is therefore that not enough megawatt hours can be generated from the project to capture energy sales to pay down the debt. On the longer time scale the risk is that a project's energy yields fall short of their estimated levels, resulting in revenues that consistently come in below their projection over the life of the project. There is a possibility to insure against this risk, but many stakeholders find it too expensive. All stakeholders therefore indicated strong interest in how to reduce risk of energy yield changes by means of e.g. regional climate models and/or seasonal-to-decadal forecasting techniques.

Second, the data requested from WP 7 stakeholders could also be specified in a way that some common demands could be formulated[8]. In general, the individual data demand is usually very specific because it depends on which model is then used to calculate e.g. the energy output of the power plant. We distinguish in the Figures 2-4 between three different categories (climate variable, spatial scale, temporal scale/resolution) for which common demands were identified.

Concerning the climate variables, it can be said that regardless of the case study context there is a common demand from solar stakeholders in Spain, Cyprus and Morocco on Direct Net Irradiance and Global Horizontal Irradiance which do affect both energy production from solar photovoltaic (PV) technology as well as concentrated solar PV and CSP. For wind, most interest was expressed for wind intensity at 80-100 m heights. Also extreme wind speeds and the frequency and duration

[8] For seasonal to decadal timescales, REN stakeholders require the following information: https://docs.google.com/spreadsheet/ccc?key=0Ak-vXfiZiAgwdERYdkFZdFdIdUxKc29aWVBKNHNzclE#gid=0

of them were requested by both solar and wind energy stakeholders. The most crucial variables identified by stakeholders from the Croatian hydro power sector were precipitation as well as frequency and duration of high rainfall events.

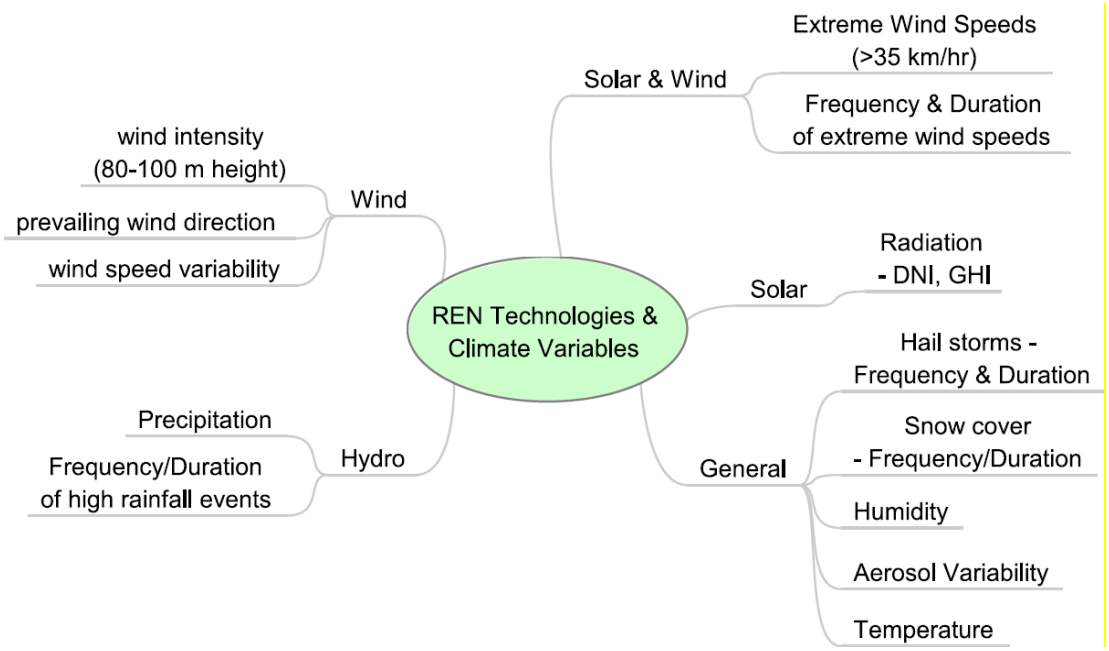

Figure 2: REN Technologies and Climate Variables

Considering the temporal scale of the climate data, historical variability as well as future prediction up to 50 years was requested from all case studies. As mentioned already before, the most interest especially from those stakeholders dealing with REN investments is the very short term and seasonal to decadal statistical forecasting. On the temporal resolution, hourly and sub-hourly data is regarded to be very useful. This is relevant for instance for power traders as well as grid operators who would use this information to optimize their positions on the spot market and for the planning and management of the electricity grid.

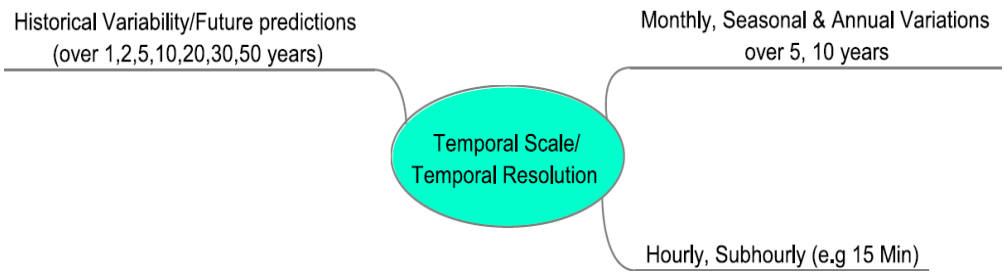

Figure 3: Temporal Scale/Temporal Resolution

Finally, the spatial focus was on four levels: the Mediterranean as a whole, the case study level (i.e. Morocco, Spain, Cyprus and Croatia), geographical regions within the case studies, and specific REN production sites. It is difficult to say which stakeholder is explicitly asking for what kind of information. Nevertheless, it is true that for instance project developers usually look for very site specific information, whereas policy makers in all case studies are usually looking for higher spatial scales, such as for instance for the Mediterranean as a whole, a country (i.e. the case study level here) or a specific region within a case study.

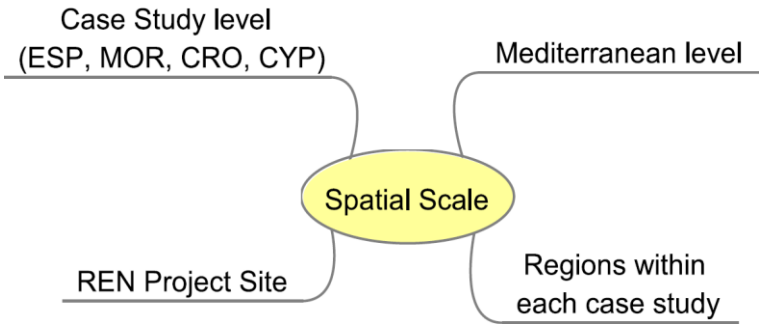

Figure 4: Spatial Scale

Yet, as mentioned earlier, the extent to what common needs can be defined for the stakeholders from the renewable energy sector is very limited. Decision-making processes of different stakeholders require different sorts of information and there is no single information package that suits all.

3.2.Fulfilling the Case Study Needs

Due to the sometimes too unrealistic requests by stakeholders (i.e. exact forecast at a specific hour of a given day at a given site), the limited specification of data needs in all case studies and the difficulties to correctly interpret them, it was evident right after the first workshop sessions in 2011 that needs and wants could not be matched straight forward and not at all sufficiently. They had to be addressed in an iterative manner while always reflecting up on where the limitations are in CLIM-RUN.

A list was developed for WP7 which contained all case study requests and comments from the CET on whether and to what extent the stakeholder requests can be addressed. It turned out that only two case study needs could be immediately addressed as they were already available. These were solar radiation (GHI) on Mediterranean and/or case study level for 1 to 30 years. Also wind intensity at 10m height could be addressed for the same spatial and temporal scale. Data for wind intensity at other heights (e.g. stakeholders indicated that up 80-100 m height would of greatest interest for them) but at the same spatial and temporal scale would require more work and time.

Not available but still producible in CLIM-RUN was data concerning temperature, prevailing wind, and precipitation. Also requested was data for the duration of high rainfall events at case study level at decadal time scale by almost all case studies but foremost Croatia where hydropower played the most significant role.

For the Spanish and Moroccan case study, investment stakeholders have requested data on aerosol variability which however proved to be impossible to by produced by the CET in 2011-2012. In the meantime, colleagues from Meteo France could further improve their climate models and some data related to aerosol variability may be available soon.

Overall, however, it is clear that only a few needs could be directly addressed. Most of the needs expressed by stakeholders of the different case studies require more work and definitely more time to be appropriately addressable.

3.3.Stakeholder Feedback on the Products

Feedback on the products developed up until today and presented to the stakeholders in the different case studies was useful but rather general so far. This is of course owed to the problems described before. Given the difficulties of either too ambitious requests or weakly defined needs products were actually not directly usable by individual stakeholders. Nevertheless, the products are generally considered to be useful. For future research on how to further develop products as well as how to communicate with stakeholders hereafter we come up with some suggestions which emerged from individual stakeholder interactions in different case studies of WP7.

Given the concern about the huge uncertainty involved in the tools used in CLIM-RUN and presented to the stakeholders, it was suggested to use regional climate models for long-term backcasting and to adjust the models correspondingly. This could improve the validity of the results from climate models and help to narrow the gap between P90 and P50 values, the main parameters in wind energy production assessments. More work in this regard would be of interest, for instance, to the risk department of Société Générale. Renováveis, a Portuguese power company, highlighted the added value of a comparison of changes in wind distribution in regional wind scenario maps as devised by ENEA. This could aid to better understand regional patterns of climatic variability which is an important type of information for a company such as ERDP - the group Renováveis belongs to - which deploys wind energy in many different regions across the globe. In this context, their interest is not so much on site specific information but rather on a better understanding of regional patterns of change. Despite of the uncertainties, IRENA also proposed to further discuss the potential usefulness of the wind scenario map in the light of developing more advanced wind atlases for the MENA region. These are areas where both the products as well as the stakeholder oriented research approach in projects like CLIM-RUN can contribute to.

Whatever is developed in the scientific research area, it is of utmost importance to not only deliver the data but also to provide meaning to the data and to describe it in an understandable manner. This has been done especially in the second round of CLIM-RUN workshops. However,

more emphasis should be given to this topic. Even if some stakeholders employ meteorological/climate experts who are familiar with how to use and what to use the climate data for, there is a large number of people with a non-climate background among the stakeholders. Psychological research has shown that the 'unfamiliarity' gap can be a substantial obstacle to implement new practices in day-to-day decision making processes (Dangerman and Schellnhuber 2013). Therefore increasing the stakeholder awareness of the potential that s2d or climate modelling do have is of paramount importance for future interactions with stakeholders. Understanding, interpretation and sense-making precede decision making, strategy definition and real action in the stakeholder world. In other words, if stakeholders do not see how CLIM-Run can help them to improve e.g. their investment risk mitigation strategies or grid planning capacities, it will be extremely difficult to convince them to engage with projects like CLIM-RUN. Therefore it is very important to find ways and further investigate techniques of how to best communicate with stakeholders.

A final remark concerns the observation that stakeholders often mixed up the climate modelling methodologies presented in CLIM-RUN and obviously found it difficult to distinguish their main features. This is not very surprising as they were sometimes confronted with results and methods of both s2d and regional climate modelling and this for various spatial and temporal scale as well as climate variables. As indicated by feedback from the Spanish and Croatian case study it is already complicated for many stakeholders to understand the basics of only one approach (e.g. probabilistic forecasting). Indeed, this needs to be reflected upon in more detail because confusion created by not being as precise or as consistent in using terms as is perhaps needed to reach stakeholders can really convert into a major hindrance for advancing climate services. For future projects, it is recommendable to include expert communicators to overcome this problem, and/or to devise simpler ways to visualise complex climate information.

4. MOVING TOWARDS MEDITERRANEAN-WIDE CLIMATE SERVICES

4.1.Key Aspects for Future Strategy Development

The concept of CS, i.e. the timely production and user-orientated supply of climate information, is still very new and little practical experience exists. CLIM-RUN is the first project trying to develop a bottom-up methodology for how to implement a CS in the Mediterranean region. The practical experiences from renewable energy case studies regarding how the idea of a climate service for the REN sector is actually perceived, how to best approach stakeholders in the region and what data needs to address play an important role in this regard. Based on the lessons we learned throughout the project this section gives a few suggestions on what should be considered in the future interactions with renewable energy stakeholders and in internal and external communication processes so that the main pillars of the CS protocol can be further defined.

Almost contrary to what was suggested in the methodological approach for CLIM-RUN (see D 1.1), WP7 experience indicates that stakeholders should be selected on their willingness to participate regardless of their real influence and importance. Influence and importance are in reality very difficult to explore especially early in the process and when no prior relationship exists between the research team and the stakeholder. For instance, the climate perception questionnaire did not provide the details needed for a thorough understanding of which stakeholder perceives him/herself as particularly susceptible to climate variability.

Concentrating on those most interested (e.g. international stakeholders active in several case studies) can also help to get the project going and to increase the likelihood to receive some feedback on the climate information products. On the one hand, this bears the risk of self-selection and may also adversely impact up on the real concept of a bottom-up engagement where especially local stakeholders play an important role. Yet focusing too much on 'local' stakeholders of the case study regions (e.g. national ministries, local agencies) also bears some risks (e.g. Moroccan case study) and an essential finding from almost all case studies reveals that it is actually not that important to focus on local stakeholders but to rather focus first on those who are most interested in the project. In some cases this can be a real local stakeholder from the specific case study (e.g. HEP Croatia) but it doesn't have to be the case.

Communication strategies with stakeholders need to be further improved. This insight comes from the observation that even after three year project time very little awareness and understanding exits of e.g. probabilistic climate forecasts in all case studies. Despite of the great efforts that were made to introduce the project as well as modelling techniques it is clear that even more emphasis needs to be given to the role of communication with stakeholders. The subject is a very complex one and it will take probably much more time than it was expected to show the benefits of CLIM-RUN modelling approaches to stakeholders.

For the communications part, in addition to the SET which are mainly trained in energy issues, communication experts should be involved in projects to analyse both how to overcome for

instance the 'unfamiliarity gap' (Dangerman and Schellnhuber 2013), which is a significant barrier towards learning and testing of new strategies, and what communication strategies to apply across case studies to make overall stakeholder communication more effective.

The communication issue does not refer to external communication alone but also refers to the internal communication in research projects. For instance, during the CLIM-RUN project meeting most time was usually dedicated to discussions concerning the different modelling techniques, the data specification and how to improve this. While this is indeed crucial for the success of a project like CLIM-RUN, equal relevance must be given to how the stakeholder communication should be carried out best. Internally, mechanisms should be implemented that facilitate the exchange of best practices and knowledge concerning how to best approach stakeholders. Another suggestion is to introduce very early in the project a training for both climate scientists as well as stakeholder experts on climate modelling and on the other hand on communication strategies in order to develop a common understanding of the challenges on both sides.

Evidently CLIM-RUN was an explorative research project that touched upon many issues and gathered experience in different fields. The possibility to come up with a variety of approaches that could be used to respond to stakeholder demands was certainly an enormous strength. However, in order to increase the level of feedback it is important to send out clear messages and transparent results. From the experience of the Spanish case study it seems that a focus on one modelling approach can be more effective than confronting stakeholders with several such as done in the Moroccan case study. Non-climate expert stakeholders can be pushed too hard with too much information. Once the web-portal will be implemented it will probably be much easier to avoid overloading stakeholders with too much information in face-to-face discussions.

A key aspect in communication concerns the issue of uncertainty and how it is communicated. Up to now this was done in each case study in a different manner. In most cases uncertainty was addressed rather implicitly. It could be useful to agree upon on a common communication approach on the uncertainty issue. To better approach the stakeholder's scepticism towards the usefulness of climate predictions in decision making processes it could be worth to allocate more efforts to demonstrate the value of climate predictions of low but still positive skill. This requires time and better coordination but could be a first step towards increased transparency and credibility of the results.

Finally, examples of what can be done by the climate community should be disseminated as early as possible in the process. As people usually think in stories rather than in abstract data it is important to also use impact studies to persuade stakeholders. This is crucial for both the further engagement of current stakeholder and for raising awareness among potentially new stakeholders. This however can also be a problem for a real bottom-up approach since for instance through the examples and pre-defined climate variables the stakeholders may not be free anymore to frame their own needs once they are in touch with the provided material. However, the practical experience from virtually all case studies of WP7 indicates that many stakeholders do not have a climate background and may therefore not really be able to frame their needs anyhow.

4.2. Case-study Contribution to a Mediterranean Climate Service

Three aspects should be mentioned here with regard to the contribution of WP7 to a MCS.

First, the stakeholder wants and needs outlined before (Section 3.1) are cross-case study needs and may represent fairly well the needs of the Mediterranean region as a whole, thanks to the diversity of the case studies. Evidently some are more relevant than others for the different case studies depending for instance on the technology focus of the case study. They need to be further refined and specified as well but the climate data requests give a comprehensive overview of what the renewable energy sector in the Mediterranean region is currently looking for. Nevertheless, it will be necessary to conduct further research to further refine the needs but also to explore whether there are even other data requests that have not been expressed so far.

Second, the WP7 has cooperated with a large number of stakeholders and created a wide network with many contacts from different types of organizations. It is already clear that with some the cooperation will continue beyond the CLIM-RUN project. This is most likely the case for Croatia and Spain. IC3 has already developed a monthly newsletter for Spanish case study stakeholders and will continue interaction via this tool and similar projects. Yet also in the Moroccan case study where cooperation with local stakeholders was a daunting task, a large number of personal contacts with stakeholders from the international wind and solar energy sector were made. For future work and for further developing the concept of climate services for the Mediterranean region this network build up throughout the last years is an essential component where future research projects focusing on climate services may want to capitalize on.

Third, both testing and applying new modelling techniques as well as directly involving stakeholders in the process of supplying climate services for the renewable energy sector in the Mediterranen region has never been done before. Thus, the experiences and insights gained in WP7 are unique and of high relevance and will be essential for the ongoing process of implementing climate services for the REN sector. This refers to different issues. Hereafter only two examples on how and what experiences from WP 7 can be used for the process.

For instance, stakeholder interaction revealed that that examples of what can be done and impact assessments are required to raise awareness and highlight the added value of a climate service for REN. CLIM-RUN has the potential to carry out country-level cost benefits assessments of how climate change may affect renewable energy production (MS 36, Deliverable 4.5). A methodology for such an assessment exists already today and can also be applied. Results from such analysis are essential information for stakeholders, but for the future process these methodologies should be adjusted to be able to address regional and local (i.e. project site specific) assessments as well; although this is a daunting task due to the lack of data required for such assessments.

We also know now that there is very high interest in trainings from side of the renewable energy stakeholders even if their level of engagement in CLIM-RUN trainings remained very low. This can be due to that stakeholders were not convinced by the design and content of the trainings. In general, the summer schools tried to capture many things at the same time and were quite time-

intensive. In the future it can be helpful to think about an institutionalization of trainings specifically for stakeholders from the renewable energy sector through e.g. a climate service academy where trainings and seminars are offered for them.

4.3.Role of External Organizations in Paving the Way for a MCS

The CLIM-RUN WP7 is the first organized attempt to work on the issue of climate services for the REN sector of the Mediterranean as a whole. To further develop the concept, it will be crucial to align strategies with other scientific but even more with non-scientific bodies and organizations that are keen on working on this topic as well.

There are a couple of international organizations that are active on renewable energy and climate issues in the Mediterranean region. This is foremost the International Renewable Energy Agency (IRENA) which has signed among other a Memorandum of Understanding with the WMO[9]. As IRENA is an important international stakeholder of both the Spanish and Moroccan case study it is key to engage with them beyond the sole exchange of data for e.g. further development of the global wind atlas. IRENA consist of a wide ranging network of stakeholder from the renewable energy sector and has agreed upon further developing climate services for the renewable energy sector.

Besides from IRENA, there are other international organizations such as the World Bank or UNEP FI or the GIZ which all do work on financing of renewable energy and climate issues in the Mediterranean region.

[9] http://www.irena.org/News/Description.aspx?NType=NWS&PriMenuID=16&News_ID=163 (Retrieved: 2013.09.02).

5. CONCLUDING REMARKS

The renewable energy case study of the CLIM-RUN project is the very first attempt to explore in a systematic manner the relevance and challenges of an effective climate service for the REN sector in the Mediterranean region. Our experience shows that renewable energy stakeholders are highly interested but far from being able to use climate data due to many different reasons.

The feedback from the 2nd stakeholder round reveals that most of the stakeholders consider the work done so far in WP7 as useful. The examples provided by the climate scientists and the products developed by both CET and SET are very relevant in showing where the added-value of CLIM-RUN actually lies.

However, skepticism towards seasonal forecasting, decadal predictions as well as climate projections remains in all case studies. Even if those who consider the prototypes of climate information products as being useful admit that they are still not usable for their activities (i.e. directly relevant or applicable to their day to day decision making process). Reasons are manifold but an important one is the low confidence they put in the certainty of the results presented in the products and the methodologies behind.

WP7 of the CLIM-RUN project has helped to set the scene for a MCS and gives indication of what needs to be improved in the future application of the bottom-up methodology. We raised awareness of the potential benefit of a MCS by disseminating existing knowledge in new formats more attractive to different stakeholder groups off the scientific community. The climate and the stakeholder community do now have a clearer understanding of the challenges on both sides. This will certainly facilitate future communications and can also contribute to the capacity building of renewable energy stakeholders.

For the future process, the question remains what are the main issues to be addressed in order to help users to build up capacity and what are the priority action areas?

First, it will be crucial to find new, additional formats of how to interact with stakeholders as it has been a major weakness of the CLIM-RUN project to not being able to get stakeholders constantly engaged over a longer period of time. Assuming that regular interaction and engagement is a substantial precondition for further capacity building it could be thought of a more institutionalized way of interaction. One recommendation in this regard can be a climate service academy which develops a program for the main issues of interest to stakeholders and offers a number of seminars and trainings tailored directly to the needs of REN stakeholders. One area is for instance to explain how to understand, interpret and use probabilistic forecasts, which is an area stakeholders often are confused with. This could also be done for the stakeholders from other sectoral case studies (e.g. tourism) of the CLIM-RUN project. In any event, training courses should approach stakeholder groups individually and not all together such as done in the past.

Second, to improve capacity building of stakeholders it is also essential to get more used to stakeholders' communication, habits and language. For instance, the assumption that

stakeholders read climate-related media proved to be wrong. Instead, it is key to communicate with stakeholder media to gradually introduce a climate service to the respective stakeholders. In a similar vein, in the first stakeholder workshop rounds and during the iterative consultation process, stakeholders were sometimes overwhelmed with too much information and confused by in-depth explanations regarding the details of climate models and climate forecasts. While it is paramount to make stakeholders aware of the limitations and challenges faced by the scientific community in providing an appropriate climate service, explanations must also be communicated effectively to be useful. This can be extremely challenging as both the language and the background of climate scientists and renewable energy stakeholders are often very different. Therefore, it may be more effective to give less detail on technical processes of the climate forecasts and more on the meaning and usefulness of the information (e.g. how it translates into mitigating REN investment risk). As this type of information is of most interest to the stakeholders it can also help to trigger his/her interest to build up new capacities.

Based on the direct WP7 case studies experience, here are a few areas where more work needs to be done to facilitate the implementation of a MCS over the years to come.

First, it is extremely important to further consolidate interactions between scientists from both the climate and energy community and renewable energy stakeholders of all WP7 case studies. In the context of CLIM-RUN and other EU research projects dedicated to promote the use of climate services in the Mediterranean region several transdisciplinary initiatives emerged. For instance, the Advancing Renewable Energy with Climate Services (ARECS) initiative. ARECS aims at providing useful and useable seasonal to decadal wind and solar forecasts for the REN sector, to help REN stakeholders understand and manage climate-related risks and opportunities. The overall objective is to develop an operational REN s2d climate service for the REN sector. Some of the CLIM-RUN WP 7 partners participate in the initiative and their work will certainly continue beyond the end of the CLIM-RUN project. As ARECS combines the expertise of both scientists who have set the seeds for the development of a MCS and created a broad trans-national stakeholder network it will be crucial to further support the work of this initiative in order to further progress towards an operational climate service for the renewable energy stakeholders.

Second, it will be crucial to identify CS business models between private and public agents that are marketable and self-sufficient. Potential areas for identifying, discussing and developing business models can be for instance the Adaptation Services Lab of the climate kic-initiative. Within the climate-kic framework cooperation is possible between participating REN stakeholders and research institutions. Proposals can be submitted and if successful will receive funding for a certain period of time to explore the potential of a business model for a CS.

Third, for the communication and the dissemination of climate related information to renewable energy stakeholders it will be necessary to implement a public web portal with all data available. The data needs to be reliable and as easily accessible as possible for renewable energy stakeholders in the Mediterranean region with a non-climate background. For the renewable energy sector, such a web portal is currently not available but there are other examples that could

be helpful and provide guidance in the development process[10]. In the CLIM-RUN project such a portal is about to be developed.

Fourth, in the early stage of the CLIM-RUN project it was decided to implement focal points or climate service agents at the stakeholder side to facilitate communication, e.g. in the Moroccan case study. In the CLIM-RUN project this has been done in the form of the creation of the SET. Yet, on the stakeholder side none of the partners has implemented a focal point. One of the reasons for this behavior can be a lack of resources. Communication requires substantial time and work and some organizations are simply not able to nominate one person who is in charge of climate services at this organization. While it is not necessary to implement a focal point at all stakeholder organizations, it should at least be done for the primary stakeholders. An incentive for stakeholders could be that part of the cost related to the implementation of such a focal point is covered through research project money.

Fifth, main sources of climate information for renewable energy stakeholders should be updated regularly. For instance, the World Climate Service, www.worldclimateservice.com, is a main source of seasonal forecast information for some of the renewable energy stakeholders. One of the main reasons for its sector wide usage is that the GFS model is free of charge. Although concerns exist regarding the validity of 30 year dataset, the GFS system will be upgraded in 2014 and the end-users are hoping that this will bring significant forecast improvement. Such regular updates of data sources and models already used by stakeholders are key to create trust and increase the usability of this kind of information in the sector.

Finally, it is important to better understand the multiple risks related to renewable energy investment and production. The climate risk is only one of many other risks (e.g., regulatory, political, technological) which affect decision making processes of renewable energy stakeholders. For instance, to identify the appropriate stakeholders and to increase the level of stakeholder engagement along a project it can be useful to follow a more integrated perspective, instead of focusing on the climate risk alone. There are always interactions between, for instance, the necessity to use weather and climate information (e.g. for power output control and grid balancing) and country-specific regulations. For example, some renewable energy generators are not interested in using climate information because they are currently not obliged to pay for failures in energy generation forecasts such as discussed during the 2nd workshop in the Croatian case study. However, country's regulatory settings do change frequently and renewables are increasingly exposed to market conditions (i.e. false generation forecast will be penalized as well). When the regulatory risk becomes more prevalent the demand for climate risk mitigation measures may rise as well and thus trigger stakeholders' interest in project participation.

[10] For instance, the portal of the University of South Africa can be helpful in this regard: http://cip.csag.uct.ac.za/webclient2/app/

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