Collaborative Project

CLIM-RUN

Climate Local Information in the Mediterranean region Responding to User Needs

WP7 – Energy Case Studies

D7.2 Workshop Report: MONTH 26

2nd Round Workshops

Reports from individual case study/country partners: Spain, Morocco, Croatia, Cyprus

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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WP7 – Energy Case Studies
Task 7.1 Organisation of periodic meetings and surveys

2nd Round Workshops:

International Conference on Energy & Meteorology (ICEM), Toulouse, France, June 24-28 2013

Weather Risk & Forecasting for the Energy Markets Conference, Berlin, Germany, June 13/14 2013

Weather Intelligence for Renewable Energy (WIRE) COST Action Summer School, Toulouse, France, July 1-5 2013

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1. SUMMARY

Renewable Energy (RE) events have an increasingly European, or even global outreach. Although they take place in one country, they are attended by individuals from within the RE sector at an international level. As the renewable energy sector advances, some events are becoming increasingly focused on a specific area or topic e.g. insurance, operations etc.

The International Conference on Energy & Meteorology (ICEM) is a bi-annual event. It is the only global conference focusing on the link between weather, climate and its impact on the whole energy sector (e.g. demand, supply and distribution). It brings together weather and climate research groups, as well as end users from the energy sector, such as project and grid managers etc. This year was the second ICEM event, and was attended by approximately 200 individuals.

The Weather Risk & Forecasting for the Energy Markets Conference focused on managing the risk of weather and its variability on the price of energy in the European market. Energy traders and the insurance sector were the end users represented. The event was attended by approximately 30 individuals.

The Weather Intelligence for Renewable Energy (WIRE) summer school aimed to provide an overview of the project to Ph.D. students/post-docs in meteorology, energy and related interdisciplinary roles. The project is an EU COST action, and a follow up action is planned for 2014, to include climate forecasting time scales. The event was attended by approximately 90 individuals, including speakers who lead in the field of energy and weather forecasting research.

All energy events included RE topics, and therefore provided us with an ideal opportunity to carry out the second round workshops within the CLIMRUN project, focusing on the latest developments of seasonal forecasts for the wind and solar energy sector, as carried out by the Spanish partners, IC3. A presentation was given at all events and important feedback was received by energy stakeholders. It was also possible to directly discuss with these stakeholders the climate information products produced within the project.

The main objective was therefore to **present and discuss a set of cutting-edge climate information research and products,** which were developed following the CLIMRUN first round workshops when user needs were identified.

The **main outcomes** from this activity are:

- There is a low level of understanding of probabilistic climate forecasts.
- RE insurers, traders and grid operators show the most interest in seasonal forecasting.
- Seasonal forecasts still require considerable development, both in terms of their skill, the information provided, its communication and availability, to be useful within decision-making processes.

Based on these outcomes, the **next steps** in the CLIM-RUN project are:

- Create some basic communications about climate forecasting and its application within the energy sector.

- Further develop the climate information sheets based on the feedback received so far.
- Specify potential areas for future research and collaborations with international stakeholders.

2. BACKGROUND

2.1. International events chosen for the CLIM-RUN 2nd round workshops

International Conference on Energy & Meteorology (ICEM)

Energy & Meteorology 2013 aimed to create an international platform with networking opportunities between the two communities. It provided a source of the state-of-the-art in the science, policy, planning and operations in Energy & Meteorology. The event followed on from the first ICEM 2011, which was convened in Queensland, Australia.

The event brought together weather and climate researchers and service providers, energy specialists such as regulators, planning institutes, financial and insurance services, utilities, transmission and distribution operators (i.e. policy makers, researchers and industry) working in any energy sector (renewables, power, oil and gas, etc) with the goal to:

- Expose research findings relevant for operational activities, long-term investment planning and policy making in the energy industry
- Advance ways to manage weather and climate risk by the energy industry, especially in the face of climate variability and change
- Enhance coordination between experts in weather and climate research and the energy industry to leverage experience and resources
- Explore the possibility to establish an international network for the exchange of information between the weather and climate community and the energy industry

Weather Risk & Forecasting for the Energy Markets Conference

The event aimed to “optimise opportunities and manage risks in Europe’s weather-driven energy markets by providing structured weather solutions for transferring of weather risk”.

This event provided the latest and most valuable information on the many ways to use weather knowledge to your advantage within energy markets. The conference continued the success of previous editions on the energy markets whilst focusing on in-depth analysis on short-term trading based on weather, new technologies for quick and accurate weather information, temperature effects on demand, weather derivatives, and long-term weather-based investment decisions.

WIRE summer school

The aim of the WIRE project is to develop dedicated post-processing algorithms coupled with weather prediction models and measurement data, especially remote sensing observations; secondly the project will investigate the difficult relationship between the highly intermittent weather dependent power production and the energy distribution towards end users related to the management of power plants and electricity grids. The WIRE summer school covered all of these topics, and was attended by a wide range of both academics within the energy and meteorology research and end-users.

2.2. Goals of the second stakeholder workshops

Whereas the first workshop of CLIM-RUN the energy case study team aimed at identifying the wishes and needs of climate information users in the European RE sector, the main aim of the second workshop was 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 climate information products
- Consolidate existing and enter new stakeholder relationships

3. The Stakeholder Interactions

3.1. Lessons learned since the first CLIM-RUN workshop and its implications

To fulfil the goals of CLIM-RUN's energy case study, the Spanish project team has engaged with several RE stakeholders since the start of the project in 2011. Our stakeholder focus was on actors from both the solar and wind energy industry at an international level. Most of the RE stakeholders are related to the supply side of the energy sector, and more specifically, those whose decisions are influenced by the power generation of RE systems. The firstround workshop report listed such stakeholders, who range from RE investors and insurance to RE project managers and energy traders.

The climate information products that were produced so far by ENEA and IC3 are of general interest for all stakeholders of the RE sector in the greater Mediterranean area. At the very beginning of the project we concentrated on identifying the climate data wants and needs of several actors (e.g. project developers, investors, government organisations) of the solar (PV, CSP) and wind energy sector. For the second workshop we focused our presented research and products to the wind energy industry only. This is due to two main reasons. First, it is still very challenging to assess and communicate how climate forecasting can help to predict power production and its variability in the mid- to long-term, and therefore simplifying the message to one technology would make it easier to optimise research resources and focus the messages to make them more understandable. Within CLIM-RUN, there is already a good body of knowledge related to wind modelling and forecasting capacities. The second reason for the wind focus is that the wind energy market continues to be the leading RE technology, and there is growing stakeholder interest in deploying wind technology.

Although the focus was on the wind energy sector, the general forecast methodology and communication would be the same for the solar sector, had solar radiation been used instead. This message was conveyed at the start of all presentations/discussions with stakeholders from other RE technologies.

3.2. The Climate Information Products for the second round workshops

Although the greatest interest of wind energy stakeholders still concerns very short term wind forecasting, i.e. minutes to days, CLIM-RUN stakeholders also requested during the first-round workshops a better understanding of existing modelling capacities and forecasting techniques for the mid- to long-term. We addressed this demand by developing two different climate information product prototypes and one wind forecast assessment newsletter for the second-round workshops.

The different prototypes were developed and designed by IC3 (Melanie Davis, Fabian Lienert, Francisco J. Doblas-Reyes) and ENEA (Sandro Calmanti, Alessandro Dell'Aquila). The individual documents can be accessed by following the respective links under Resources (see annex). Hereafter, only a brief outline of their specific features will be given.

This information was developed to give different stakeholders from the wind energy sector an indication of how wind energy resource assessments, in the Mediterranean region, could be improved by different types of climate information services. The product prototypes 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 resource assessments. The main difference between these two information packages consists of the techniques deployed to project wind speed changes and the time-frame they focus on. The wind forecast newsletter was a very simple and easy-to-understand information sheet, which 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 product prototype produced by IC3 is based on seasonal forecasting for a time-scale of 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. The accompanying "operational" wind forecast newsletter shows a global forecast issued for the past season (hence why it is not actually an operational product), 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.

ENEA uses Regional Climate Models (RCMs) to generate wind scenarios for the Mediterranean region and focuses on the longer time scale, time scale is 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.

For the CLIM-RUN second-round workshops carried out by IC3, only the seasonal climate forecast product and newsletter was presented, to keep its assessment more focused and, hopefully, more understandable and valuable.

3.3. Two-fold Dissemination Approach

To maximise the visibility of CLIM-RUN during the conference and to optimise the level of feedback, a two-fold dissemination approach was followed.

First, the results of the CLIM-RUN project were presented in detail during the speakers session of all energy events.

At ICEM, this presentation was within the Wind, Solar and Wave Resource Assessment session. In the same session, NCAR professor Sue Ellen Haupt presented on “Quantifying Wind and Solar Resources and their Inter-annual Variability Under Current and Projected Future Climate Conditions” and DTU professor, Sven-Erik Gryning on “Profiles of Weibull Distribution Parameters of Long Term Wind Speed Measurements”. The session was attended by approximately 30 participants.

At the Energy Markets event, the presentation was within the Weather and Climate Effects on New Types of Power Sources session. In the same session, Dr Nenad Keseric, Head of Operational Support at Statoil presented the Hywind experiment, which looks at how weather affects offshore wind farm output. Juan Miguel Morales, Associate Professor of the DTU presented on “Market Aspects of Weather Prediction”. The session was attended by approximately 30 participants.

At the WIRE summer school, the presentation was within Climate Issues session. In the same session, Alberto Trocolli, CSIRO, presented on Weather and Climate Predictions for the Energy Sector. The session was attended by approximately 70 participants.

The CLIM-RUN representative introduced the problem of climate variability in the wind energy sector, outlined the potential of climate forecast techniques at the seasonal time-scale, introduced the above described seasonal wind forecast information prototype product and newsletter for the wind industry, and pointed to challenges and potential future areas for stakeholder cooperation.

During the subsequent discussions, questions were raised regarding how climate forecasts can be used to manage mid-to long-term wind variability in wind energy project

planning and operations. For both cases the relevance of the climate information products was stressed as a potential tool to support risk coming from climate variability.

The second strand of our approach focused on face-to-face discussions with twelve stakeholders from energy trading, power plant management/utilities and energy insurance/derivatives:

Power plant management/utilities:

- Stefan Bünte, Head of Board Project, E.ON Climate and Renewables
- Hans J.H. Tuenter, Senior Model Develop, Ontario Power Generation
- Gianmarco Pizza, Asset Manager, Axpo Power

Energy trading:

- Arman Mohii, Product Director, The NASDAQ OMX
- Gary Dowling, Trader, SIG Susquehanna
- Joe Maisano, Director, Trading Technology Australia

Insurance:

- Ralph Renner, Director European Origination, Eudurance (joined with Galileo)
- Munich RE, Head of Section, Dr. René Mück
- Stephen Doherty, Director, Speedwell Weather Derivatives Limited

Other:

- J.Charles Smith, Executive Director, Utility Variable-Generation Integration Group (UVIG)
- Dusanka Zupanski, VP Meteorology, Precision Wind
- Pierre Pinson, Professor in the Modelling of Electricity Markets, Department of Electrical Engineering, Centre for Electric Power and Energy, Head the Electricity Market group, Technical University of Denmark (DTU).

The final list of all partners engaged with during the events and their contact details can be accessed under resources (see below).

The individual conversations with the stakeholders took about 20-25 minutes and followed the list of guiding questions attached to this report (see ANNEX I). 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. 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.
- The role of climate forecasting using global climate models to improve regional weather models at specific sites for wind energy production.
- Deriving tailored climate indices based on wind forecasts over climate time-scales.

4. Results

4.1. Summary of events

International Conference on Energy & Meteorology (ICEM):

The conference speakers recognised that the area of energy and meteorology is starting to grow considerably and that more events, similar to ICEM, will be likely in the future to strengthen the relationship between the two research areas. An emerging area of interest is in the storage of energy, which was said to be key to the success of renewable energy due to its high volatility in power generation feeding into the energy system. This can be attributed to the direct relationship of renewable power generation with weather and climate variability.

It was also mentioned that there is likely to be growing publications dedicated to both energy and meteorology. Renewable Energy World, which has a dedicated section to energy and meteorology, was one of the only sources mentioned that currently covers this combined subject.

In a speaker panel session about related meteorological services for the energy sector, EDF said that they like case studies which explain the value of the service. They view the role of research to provide the capabilities needed for these services by continuing to develop methodologies. In this context, the current single need from industry is better forecasts.

Weather Risk & Forecasting for the Energy Markets Conference:

The event highlighted that in the past few years, there have been huge reasons to incorporate weather risk and forecasting in trading formulas and models. In Europe renewables have a much larger impact than two years ago, and their output is characterised by being intermittent and volatile due to the unpredictable nature of weather. The overall message of this event was that there is constant need to upgrade and adapt models, and to reflect weather's effects on prices, output, and demand. Neglecting all of weather's indices will result in inaccurate predictions, ineffective decision and loss of profit.

<u>Insurance-sector representatives</u>
There were several request from this sector for temperature thresholds e.g. Cooling Degree Days, CDD (number of days when temperature falls below e.g. 18ºC). There is a linear affect of temperature on energy up to a point, where heating devices cannot increase further. For Heating Degree Days, HDD (number of days when temperature reaches above e.g. 18ºC), higher temperatures affect air conditioning control, although this is less linear because there is a wide range of cooling units and each has its own inefficiencies. The threshold temperature depends on the country.

A presentation was given by Dr René Mück, Head of Entrepreneurial Risk Solutions, Ernst Bedacht, Weather Derivities Director, Munich RE.
MEAG is the asset management branch of Munich RE (the investment division).
They are investigating a product called Wind Excess Capacity Cover (WECC). Wind power production statistics is provided by, for example, Red Electríca Española in Spain. He mentioned that an insurance product protection for high wind events has the most potential in the wind energy market. Munich RE recently made an assessment of seasonal forecasting across Europe, and have drawn the conclusion that there is no skill. He also said that modelled output is not representative of real situations because so many factors can affect the real energy output e.g. regulatory changes/bats.

Energy trading-sector representatives
There was a unanimous request from trading individuals for an index to be made available of past climate forecast information, using monthly means. They stated that this should be provided by a credible source along with clear validations so that it could be referenced within their trading operations.
Seasonal forecasts of the variability of wind speeds at specific times of the day over climate timescales was also requested. The ramp up and ramp down periods, which correspond with the start and the end of the day were specified (e.g. will wind speeds at these specific times be above/below normal for the coming season)

A presentation was given by Eric Stein, Head of Weather Analysis and Trading, RWE Supply and Trading.
He stated that the competitive advantage of an energy trader lies in their knowledge of model characteristics and behaviour, and the best way to interpret this forecast information. The value of an in-house meteorologist was therefore highlighted, because it is not necessarily what they say about a forecast that is important, but how it is said (i.e. the confidence that is given to different forecast interpretations). This demonstrates the subtleties and complexity of interpreting forecasts in decision making processes.

He went on to give feedback on probabilistic forecasting, saying that to demonstrate a value in climate forecasting, a forecast has to be right more often than it is wrong. A probabilistic forecast is often seen as weak because stakeholders want straight answers. They are thought to create many false alarms. It is therefore important for a forecasting service to demonstrate how to understand and use probabilistic forecasts. He stated that, in general, a 66% probability was interpreted as a “yes” and 33% as a “no”. [Comment: A probability must also specifying the event it refers to. 66% is a very high probability for a rare event, such as the occurrence of a tropical cyclone in the next day, and a relatively high one for another event, such as whether the mean wind over a season is above the mean.]
He also said that “quick and strong” forecasts were in demand by the sector (i.e. available at short notice and demonstrating skill), but in reality it was hard to work with weather/climate forecasting. It was unlikely that a decision would be made based on such information at present, but that it could be used as a guidance tool.

A presentation was given by Eric Stein, Head of Weather Analysis and Trading, RWE Supply and Trading: Peter Malsbury, Complex Risk and Hedge Execution, RWE npower.

A Composite Weather Variable (CWV) is issued by the grid operator (example given was npower), which includes information on temperature and wind speeds, the variables linked to energy demand. Such information is issued for the following winter during the summer period.

A presentation was given by Stephen Doherty, CEO, Phil Hayes, head of Data and Forecasts, Speedwell Weather.
A 40-year baseline could give a narrow idea of what is “normal”. It is important to question the reliability of data; some series are incorrect and if bad data is put into a model, bad results will come out. He went on to say that wind data is notorious for having discontinuity, partly because measuring techniques and instrumentation has changed considerably over time. He rhetorically asked whether calibrating and de-trending data was worth the effort. He mentioned that banks want the 50th percentile and the 95th percentile of wind speeds to be able to offer investment loans to a wind energy developer. (Specifically, see their presentation slides 23, 44, 56, which show extreme events, wind speed events, and slide 76 for an index definition).

A presentation was given by Stefan Erath, Powermarket Analyst & Meteorologist, Norsk Hydro ASA. He addressed the following independent points:

- He suggested that for wind resource assessments the median should be used not the mean because it does not have a Gaussian distribution.
- He highlighted that there is a high correlation between wind and solar production in Germany.
- He stated that wind speed data goes straight into the traders models, so there is no need for power information.

A presentation was given by Pablo Bermejo, CSP Engineer, E.ON, where he addressed the following independent points:

- CSP solar collectors switch off when average wind is greater than 10m/s for mechanical reasons.
- NOAA provides weather forecasts to the CSP projects of E.ON.
- High risk events are common in spring when wind speeds are often elevated at around 17.00-18.00.

A presentation was given by Arno J.Brand, Wind Energy Research Scientist, ECN, and its summary/key points follow:

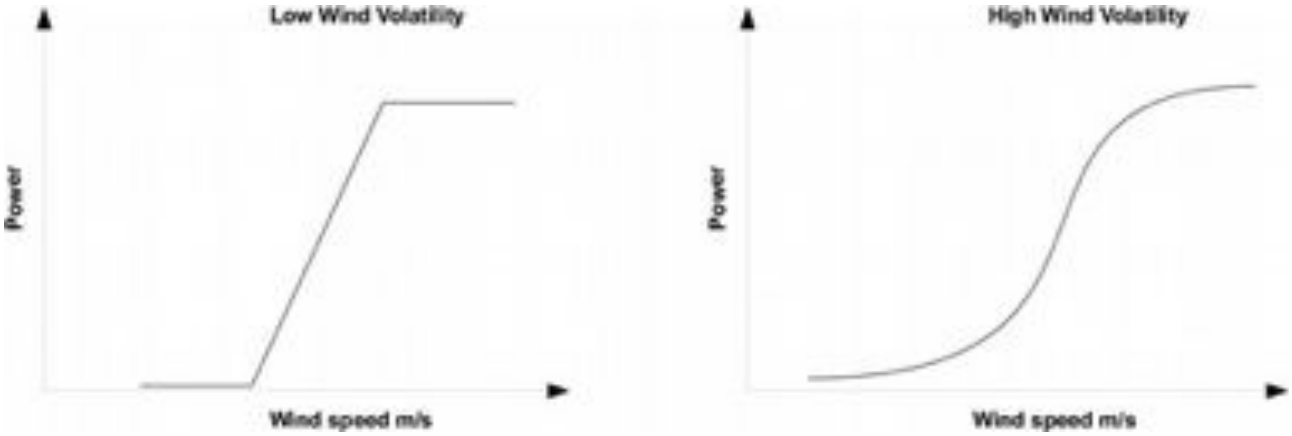
- His presentation has some interesting questions regarding weather/climate forecasting from different end users.
- He highlighted the need to bridge the gap between the next 48 hours forecast and 120 day forecasts.

A presentation was given by Hans Tuenter, Senior Model Developer, Ontario Power Generation, and its summary/key points follow:

- He mentioned that in Ontario, wind farms are paid even if they go offline, which is necessary when there is too much power produced v the demand. A forecast of

what they would have produced is therefore needed to make a payout. The distribution of wind resources is therefore important to minimise such events.

- The volatility of wind speeds re-shapes the effective power curve, which was shown in slide 19 of his presentation, and illustrated here:



- He concluded that understanding wind volatility is key for the future of renewable energy markets.

A presentation was given by Dr Nenad Keseriv, Head of Operational Support, Statoil (nenk@statoil.com), and its summary/key points follow:
He mentioned that a 1m/s error in forecast wind speed can result in an increase or decrease in energy production of approximately 50MW. This risk is very high if put into the context of their 316MW installation, which is driven by average wind speeds of 10m/s.

A presentation was given by Dr Scott Otterson, Research Fellow, Fraunhofer IWES, and its summary/key points follow:

- For day ahead forecasting in Germany, there are 40% forecast errors from wind and 35% from solar.
- He mentioned the EU FP7 DTOC project, which involves assessments of resource variability and predictability: http://www.eera-dtoc.eu/work-packages/wp3-energy-yield-prediction-of-wind-farm-clusters/
- He highlighted that the correlation of wind and PV and is an upcoming topic within the renewable energy sector .

The World Climate Service, www.worldclimateservice.com, was mentioned by a couple of the energy stakeholders as their source of seasonal forecast information. The GFS model is most commonly used by the energy market because it is free. Next year (2014), the GFS system will be upgraded and the end-users are curious whether this will bring significant forecast improvement.

Some of the event participants questioned the validity of a 30 year dataset, which could miss a lot of events that would only be seen if they were consistent or persistent events. [Comment: a reference period from 1981 is the best that is currently available, and is generally considered adequate. Using more years will not necessarily affect the skill of the

forecast. For this, improvements to the forecast system are necessary. Infrequent climate events that may have occurred before 1981 could help to assess how they can be represented in the forecast system, but again, they would not necessarily affect the overall forecast skill. If such an event occurred today, an operational forecast issued following this event may be poorly representative of current climate conditions, and this is an area that climate science could look into further.

WIRE summer school:

Following the IC3 presentation, a few questions were asked. First, it was questioned why we had not used the 100m wind forecasts from ECMWF, developed specifically for the wind energy industry? [Comment: The 100 metre wind is only computed and stored in the medium-range weather forecasts, not on the seasonal forecasts] Alberto Trocolli, CSIRO, stated that seasonal forecasting was shown to have better results using empirical models[1] compared with dynamical models[2]. Elke Lorenz, University of Oldenburg, commented that we could go further and validate the forecasts based on persistence instead of on the climatological means .

Pierre Pinson, DTU (http://pierrepinson.com/) is a Professor in the Modelling of Electricity Markets, and gave a lecture at the WIRE summer school on “Uncertainty in Power Forecasting”. The outline of this lecture is as follows:

- He mentioned that power forecasting is necessary for a wide range of applications within the energy market: reserve requirements, unit commitment and dispatch, combined wind-hydro balancing, storage requirements of e.g. hydro resources, trading strategies, market design etc. If power production is over/under forecast, there is a penalisation. He referred to an example from the Sotavento wind farm data in Galicia, Spain (http://www.sotaventogalicia.com).
- He also stated that optimal decisions need uncertainty (worth reading “Dance with Chance: how to put uncertainty into decision-making processes”.) [Comment: although this is contradictory to previous views, this demonstrates the different perspectives re: using uncertainty in practice]. Uncertainty of wind speed forecasts in a gridded model comes from both the physics of the atmosphere, and from its initial state. This uncertainty is increased when converted to wind power. Nacelle anemometers on the hub of the wind turbines represent the power output most closely.
- End users like to see the band of uncertainty, shown via intervals with bands (like the spread) and PDF's at a specific grid point, however they do not use this information in their decision-making processes. Beyond the ensemble spreads, there is a need to know if the spread comes from highly variable or smoother trajectories.

1 Empirical model: A model represented by simplified processes based on observation, measurements, or practical experience rather than solely on principles or theory.

2 Dynamical model: A model that uses a numerical method to solve a series of equations, as opposed to an analytical model. The results from numerical models are often approximations.

- There are many different forecasts: quantile, interval, density, parametric v non-parametric. Different decision-making processes need different information, there is not a single solution for all. It is important to ask end users how they want their forecast; a more reliable forecast is possible using a calibrated approach, however a sharper outcome may be required to provide more informative forecasts. Ideally, the forecast is both sharp and reliable. In an operational context, end users often go for sharpness without questioning the reliability.

4.2 Climate Forecast Product Feedback

Compared to scientific reports and databases which are often not easily accessible, the concise presentation of seasonal wind forecasts in speaker sessions and the two-page summary document was perceived to be an important step forward to increase the level of awareness and usability of climate forecasts by energy stakeholders. Many of the audience had never heard of climate forecasting, therefore the relevance of climate forecast information for the renewable energy sector may be increased through such climate information products. Communications of climate forecast information should therefore start with the very basics which explains the concept of climate variability and how it can be forecast.

The product sheet contained too much written information for the end user to be able to quickly interpret it. The best approach to disseminate the product sheet is therefore to make them available online so that stakeholders can access and read them at their own pace. The newsletter, however, intended to provide a quick overview of climate forecast potential in decision making without the details of the background methodology. Feedback on whether the newsletter achieved this objective was encouraging, although a few minor changes to its presentation were captured, and has been changed in the version included in this report .

Information was gathered based on the questions asked following the oral presentation, and from the one to one discussions guided by the questionnaire (see annex 1). In general, there was recognition of the risk of climate variability on power generation from wind and solar plants. The wind speed variable chosen for the product sheet was confirmed to be useful to the end-users, although some individuals that were more familiar with meteorology also requested air pressure information (perhaps to calculate wind speeds at different heights). Despite that only seasonal forecasts were shown, as this was identified as the most relevant time-scale for the renewable energy sector, some individuals would also like to have seen longer forecast time-scales. of several years, and shorter time-scales. of weeks to a month.

All end users agreed that information on future wind variability would be interesting to have available within their decision making processes, however, the majority of them questioned the skill and the reliability of the information. The validations that were shown on the seasonal wind forecast product sheet do not show high skill for the Mediterranean region, and it would be useful to use geographical regions where skill is higher for the demonstration purpose. The newsletter is the first step to address this, as it covers the global scales and can therefore indicate regions, beyond the Mediterranean, where there

is reasonable forecast skill. Many stakeholders showed a strong interest and, more specifically a curiosity to receive the quarterly wind forecast newsletter.

The climate forecast information provided by the product sheet and the newsletter was interpreted to be useful to a decision making process in a broad sense (in particular, if there was greater skill). Many end users noted that the forecasts did not provide an indication of how much above or below normal the wind speeds would be, but only the probability for winds to be in one of the three tercile categories. Even if the forecast was skilful, its usefulness was therefore limited for the decision maker, although it was acknowledged that this was still better than no information of future wind resource.

Overall impressions were that the usefulness of the products as such was doubted by many stakeholders, the main reason being the high forecast uncertainty. There was also a specific interest to see the P95 and P50 values, as these are the most common parameters in wind energy production assessments .

However, in general, there is a lack of reliable wind-energy project planning tools which go beyond the short term (i.e. weather time-scale, 1-3 days). Although the perceived uncertainty of climate forecasts is high, there is a growing interest to better understand the research capacities to forecast mid- to long-term climate variability. The level of attention given to long term climate-related risks is still low in the wind energy sector, relative to the weather forecasting time-scales., which itself continues to be an emerging area. The other subject of higher interest to the sector is the perceived political and regulatory risks, which is a recurring problem for the sector as changes to national feed in tariff frequently happens.

The potential of forecasting was perceived by many end users to be greater in the future than at present, due to the current influence of the Feed In Tariff subsidies on energy markets. When this is removed, along with a universal increase in RE installed capacity, forecasting will be of significantly higher importance.

5. Conclusions and Next Steps

The second CLIM-RUN energy case study workshop was held during three, separate energy related events in the summer 2013. Results from the CLIM-RUN project to date were communicated via an oral presentation, and individual discussions which followed a series of questions based on the two-page seasonal wind forecast product sheet and “operational” wind forecast newsletter. The stakeholders expressed a need for tools to better understand changes in temporal and spatial distribution of wind due to climate variability and change. However, the usability of the climate products as such remains a matter for discussion as the uncertainty involved in seasonal-to-decadal forecasts is a main concern by all stakeholders (in terms of reliability, skill and that predictions are not sharp). The current products are also limiting in that they only show the most likely wind speed terciles; for climate forecasts to have significant value, there is a need for more specific information to be made available, such as the upper and lower percentiles of a specific ensemble forecast and the probability of the wind to be above or below given wind

speed thresholds, as well as quantifiable information to show how much, and not just if, wind speeds will vary from the “normal”.

Nevertheless, the feedback also showed that concise climate communications, starting with the basics of climate variability and forecasting, may be helpful to increase the level of awareness of mid- to long-term climate related risks in the wind energy industry. However, compared to the political and regulatory challenges, the climate issue is still perceived to be a minor risk.

By showing the information sheets, it was useful to demonstrate the type of available information from seasonal climate forecasts for wind speed, which was not available in the first-round workshops in 2011. This helped end users to visualise what is possible from a wind energy climate service, and therefore to gain an understanding of the limitation of their requests, which in 2011 workshops was for a forecast at a specific hour of a given day at a given site.

Almost all stakeholders at the events expressed their interest to receive regular forecast updates of wind speed from the CLIM-RUN project. They were particularly interested in the sector-specific newsletter on global seasonal wind forecasts, shown in parallel to the product prototype sheet. All contacts made during the event will be added to the newsletter mailing list.

The next working steps in the CLIM-RUN project will be focusing on the following issues:

- Summarise the lessons-learned from the second round energy workshops and share experiences with colleagues from the tourism and integrated case studies.
- Based on the discussion with CLIM-RUN colleagues and results from the recent stakeholder interactions, we will aim at making the information products to be more in line the stakeholder requests.
- Develop the energy newsletter for seasonal wind forecasts and start to distribute it to all stakeholders asap.
- Interact with IRENA to use their Global Atlas web portal to communicate wind and solar forecast information, explore areas for future cooperation and trigger further feedback on climate forecast products.
- Initiate discussions and research to assess the forecast quality v forecast value by undertaking economic assessments of the climate forecast products for the wind energy sector.

6. Resources

- **Product Wind Forecasting**: http://www.climrun.eu/news_data/108/20120222_climrun_product_wind_forecasting_v1_sml.pdf (Retrieved June 26, 2013).

- **Seasonal Wind Forecast “Operational” Newsletter:**

http://www.climrun.eu/home/melanie.davis/20130621_ARECS_newsletter_winter_2012_13_V4.pdf (Retrieved August 14. 2013).

- Event programmes:
ICEM: http://www.climrun.eu/home/melanie.davis/ICEM 2013 Provisional Programme.pdf

Weather Risk and Forecasting for Energy Markets: http://www.climrun.eu/home/melanie.davis/ME Agenda.pdf

WIRE summer school:
http://www.climrun.eu/home/melanie.davis/WIRE Agenda SS.docx

- **CLIM-RUN Presentation**:
http://www.climrun.eu/home/melanie.davis/20130629_ARECS_WIRE_sml.pdf (Retrieved August 14. 2013).

- **List of stakeholders** met at the workshop events: to be added to online spreadsheet https://docs.google.com/spreadsheet/ccc?key=0AiXD8K8uu4kXdG1SWDI0TkZfWGxRTGEtajJYRnNYNlE&pli=1&hl=en#gid=0

- Access to online presentations from the events:
ICEM: tbc. when presentations are made available online.

Weather Risk and Forecasting for Energy Markets: tbc. when presentations are made available online. (especially Jesper Rasmaussen, Energy Meteorologist, DONG Energy: slide 10 – what to interpret in an energy forecast).

WIRE summer school:
Presentations of the Summer School 2013 on the Action website (www.wire1002.ch).

- Open the section "Summer School 2013"
- Register at the bottom of the page (login: teacher; password: professor) which will open more subsections .
- To access the presentations, please open the sub-section "Program & Presentations" and click on the "program" which will then open up. From there, select the presentation you wish to visit and click on its title to open it.

ANNEX I. Guiding Questions for Face-To-Face Discussions

1) How are your business operations (depending on who you speak to it could be more precise, for instance, how is the mid- to long-term planning of your wind energy projects) affected by climate variability/change?

2) What type of climate information is important for your activity/your organization?

3) Would this type of information (refer to one of the three product sheets) help to improve your decisions with regard to planning your renewable energy project activities?

4) Is the level and detail of the climate information appropriate to support decisions in your business operations?

5) Do you find this climate information as it is presented here useful?

6) Do you have any doubts concerning the reliability of this type of climate information?

7) Is this type of climate information easily understandable for you (or a climate or meteo-expert in your organization) or would you need further explanation?

8) What additional information would you need to improve your decision making with regard to climate variability/change?

9) How would you improve this information or change this product sheet to make it usable in your sector?

10) How could you help us to better tailor these product sheets to the specific needs of the sector you are working in?

Collaborative Project

CLIM-RUN

Climate Local Information in the Mediterranean region Responding to User Needs

WP7 – Energy Case Studies
Task 7.1 Organization of periodic meetings and surveys

Case Study: Morocco
The MAGHREB RENEWABLE ENERGY CONGRESS, Rabat, May 21/22, 2013

Project No. 265192– CLIM-RUN

7th Framework Programme
Underpinning work to enable provision of local scale climate information (annual to decadal timescales)

Authors: Peter Schmidt (PIK), Sandro Calmanti (ENEA), Antonella Battaglini (PIK)

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1. SUMMARY

Morocco is increasingly becoming an attractive place for the development of renewable energy projects (PV, CSP, Wind). In the more recent past, **wind energy has received strong interest** by Moroccan and international stakeholders. The Maghreb Wind Energy Conference is the only wind energy industry-focused event in Morocco in 2013 and provided us with the unique opportunity to present and directly discuss three climate information products with Moroccan wind energy stakeholders.

The main aim of the CLIM-RUN team in participating in this congress was to **re-establish contacts and to enter new relationships** with wind energy stakeholders (e.g., investment, policy makers). The main objective was to **introduce, present, and discuss a set of cutting-edge climate information products** which are as much as possible in line with the up to now identified needs and wants of stakeholders in the Moroccan wind energy sector. We followed a **two step dissemination approach** to maximise the level of feedback to be received from stakeholders on the climate information products. First, the **CLIM-RUN project was presented** during the speaker session of the Maghreb Wind Energy track. Results and challenges were discussed with the audience. Second, **face-to-face conversations** with stakeholders were held.

The **main outcomes** from this activity are:

- 10 face-to-face discussions conducted with REN financiers, local project developers and policy makers.
- Concrete feedback from wind energy stakeholders on three different products.

Based on these outcomes, the **next steps** in the CLIM-RUN project are:

- Discussing experiences of the second round of energy stakeholder workshops with CLIM-RUN colleagues and synthesize main lessons.
- Further developing the climate information sheets based on the feedback received so far.
- Specifying potential areas for future cooperation with international stakeholders.

BACKGROUND

1.1.The Maghreb Renewable Energy Congress

The overall positive experience (e.g. high outreach, lower organisational barriers, and networking possibilities) of our first stakeholder workshop at the MENASOL conference 2011 suggested to follow a similar approach for the 2nd workshop in 2013. Therefore, it was decided to participate in the Maghreb Renewable Energy Congress in Morocco.

The Maghreb Renewable Energy Congress **combines the leading solar and wind power conferences in the Middle East and North Africa (MENA)** region. The event aims at providing business intelligence and contacts to build relationships among a diverse group of small and big market players, investors, and policy makers in the solar and wind energy sphere in MENA. The congress is usually organised by Green Power Conferences, an organisation dedicated to creating business networking events that provide strategic business intelligence and connect industry, government, and investors.

In 2013, the congress took place May 22/23 in Rabat and included the 4th annual Solar Maghreb Congress and the **2nd annual Wind Maghreb Congress**. After four years, The Solar Maghreb Congress is the region's most established conference focusing on development and innovation in the solar industry. The Wind Maghreb Congress is the **only industry focused wind power event in Morocco in 2013** and the most established meeting which concentrates exclusively on the North African wind sector. Given CLIM-RUNs current focus on producing climate information packages specifically for the wind energy sector, the Wind Power Maghreb Congress was the perfect place to be to present and discuss the climate information product sheets with leading wind energy experts.

The congress attracted considerable attention with **around 300 delegates and 65 speakers**. The list of participants ranged from leading experts in the MENA wind energy project planning sector, over MENA-focused investors to a number of Ministries and government agencies from various North African countries. The event was officially supported by Sahara Wind, Dii, RCREE, and RES4MED. High-level delegates from MASEN, IRENA, and the Ministry of Energy, Water, Mines and Environment of Morocco supported the gathering in Rabat too.

1.2.Goals of the second stakeholder workshop in Morocco

Whereas in the first period of CLIM-RUN the energy case study team aimed at identifying the wants and needs of climate information users in the renewable

energy sector in Morocco, the main aim of the second period, and here specifically the stakeholder workshop in Morocco, was the following:

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

2. The Stakeholder Interactions

2.1. Lessons learned since first workshop and implications

To fulfil the goals of CLIM-RUNs energy case study, the Morocco project team has engaged with several renewable energy stakeholders since the start of the project in 2011. Our stakeholder focus was on both actors from the solar and wind energy industry as well as local and international stakeholders.

The original idea to mainly focus on local stakeholders from Morocco itself has proven to be difficult and did not work out the way it was hoped for. At the time of developing the climate information products, their necessary feedback remained very limited. The reasons for the low engagement are unclear. The CLIM-RUN team has undertaken several attempts to reinitiate detailed discussions with Moroccan stakeholders (e.g. ADEREE) – also for the preparation of the second stakeholder workshop in Rabat, but without success.

Nevertheless, the **climate information products that were produced so far by ENEA and IC3 are of general interest** for stakeholders dealing with wind energy issues in Morocco and in the greater Mediterranean area. Thanks to early-on engagement with renewable energy stakeholders from the international community we could capitalize on their feedback to start drafting climate information packages.

In the very beginning of the project we concentrated on identifying the climate data wants and needs of several actors (e.g. project developers, investors, government organisations) of the solar (PV, CSP) and wind energy sector. For the second workshop round in Rabat, we have **limited our interactions to stakeholders from the wind energy industry** only. This is due to two main reasons. First, it is still very challenging to assess how climate variability does affect power production resources of solar and wind in the mid- to long-term and requires a lot of resources. Hence, we decided to bundle our limited resources and to focus primarily on wind at this stage of the project. Within CLIM-RUN, there is already a good body of knowledge

related to wind modelling and forecasting capacities. The second reason for the wind focus is 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 there was no further interaction in Rabat with the stakeholders from the solar industry we have been working with since the start of the CLIM-RUN project. To make sure we get sufficient feedback on the climate products in Rabat, we decided to engage with **new stakeholders from the wind sector** who could have interest in climate information products.

2.2. The Climate Information Products for Maghreb Wind 2013

Whereas the greatest interest of wind energy stakeholders still concerns very short term wind forecasting, i.e. 'nowcasting', CLIM-RUN stakeholders also requested during the last years a better understanding of existing modelling capacities and forecasting techniques for the mid- to long-term. We address this demand by developing **three different climate information products** which we have presented and discussed at the Maghreb Renewable Energy Conference.

The different prototypes were developed and designed by colleagues from IC 3 (Melanie Davis, Fabian Lienert, Francisco J. Doblas-Reyes) and ENEA (Sandro Calmanti, Alessandro Dell'Aquila). The individual documents can be accessed by following the respective links under Resources (see below). Hereafter, only a brief outline of their specific features will be given.

The sheets were developed to give different stakeholders from the wind energy sector a first indication on how wind energy resource assessments in the Mediterranean region could be improved by different types of climate information services provided by the CLIM-RUN project. Generally, the information packages 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 resource assessments. The main difference between the three information packages consist of the techniques deployed to project wind speed changes and in the time-frame they are focusing on.

The climate information produced by IC3 is based on **statistical seasonal to decadal forecasting; time-scale is now to 30 years**. The seasonal to decadal 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 from the climate forecast system for seasonal wind speed projections for Pamplona, Spain indicate, for instance, the potential for using sub-seasonal wind forecast information in wind energy operational risk management for a given project site.

ENEA uses **regional climate models** (RCMs) to generate wind scenarios for the Mediterranean region and focuses on the longer time scale, **time scale is 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.

2.3. Two-fold Dissemination Approach

To maximize the visibility of the CLIM-RUN team during the conference and to optimize the level of feedback we followed a twofold dissemination approach.

First, the **CLIM-RUN project was presented** in detail during the speakers session of the Maghreb Wind Energy track on May 22, 2013. During the same session also representatives from Valorem Energie and Lafarge gave presentations on exploring the complexities of wind farm design, siting, planning, and the procedure to get permits for new wind turbines in the MENA region. The session was chaired by Khalid Benhamour (Project Director, Sahara Wind) and attended by 30 participants.

The CLIM-RUN team introduced the project; outlined the potential of scenarios and forecast techniques at the seasonal to decadal to climatic scale; introduced the above described 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. As an example, the analysis of the uncertainty of future wind speed changes at a test site (Rabat) was presented in detail. For this product, 20 climate simulations from the ENSEMBLES archive (http://ensembles-eu.metoffice.com/) were considered. This example shows a histogram of the simulated winter and summer wind speed changes for the period 2021-2050, with respect to the period 1961-1990, and is further explained by Figure 1.

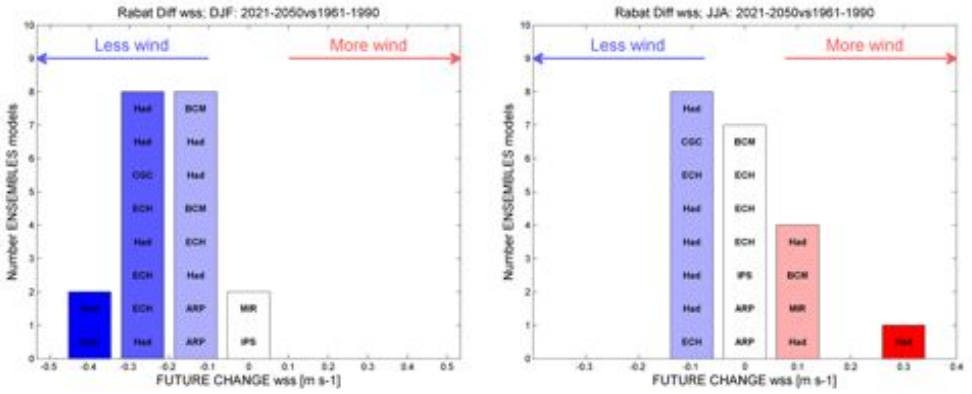


Figure 1. Histogram of the simulated winter (left panel) and summer (right panel) wind speed changes for the period 2021-2050 with respect to 1961-1990 from 20 high-resolution (25 km) regional climate model simulations from the ENSEMBLES archive (ensemblesrt3.dmi.dk). Positive and negative wind speed changes are highlighted with colours: blue for weaker winds and red for stronger winds. The labels inside each bar indicate the global climate model which drives a regional climate model producing the corresponding wind speed change.

During the subsequent discussions, questions were raised regarding how e.g. Valorem Energie deals with mid-to long-term wind variability and climatic changes in wind energy project planning. Furthermore, it was asked how CLIM-RUN results could be used for 10 years planning of wind power plants. For both cases the relevance of the climate information products was stressed as a potential tool to support the mid- to long-term planning in the wind energy industry.

The second strand of our approach focused on **intense face-to-face discussions with ten stakeholders** from policy and the wind energy related investment sector which develop wind energy projects in Morocco. For contacting the stakeholders, we drew on different methods.

The congress internal networking tool was the main approach to contact stakeholders. Basically, this is an online meeting or chat room for all registered conference participants which was set up by the congress organiser. All delegates were listed and information was provided concerning their position, affiliation, and how to contact them. If contacted stakeholders did not respond to the request sent via the platform, e-mail and telephone was used. The following stakeholders were contacted by the CLIM-RUN team prior to and during the conference:

- Khalid, Benhamour, Project Director, Sahara Wind
- Scott, Lawrence, Investment Director, BNP Paribas Clean Energy Partners
- Steve, Ross, Managing Director, 3TIER
- Said, Mouline, ADEERE Morocco.

- Maged Mahmoud, Senior Expert, RCREEE
- Nathalie Lemarcis, Director, Project Finance, Societe generale de financement
- Carlos Martin Rivals, Development Director for Northern Africa EDP Renewables
- Hassan Nadir, General Manager, CME Morrocco
- Nadia Ben Sellam, Representative (Morocco), EcoMENA
- Prud'homme Guido, EIB
- Frank Wouters, IRENA
- Nabil Saimi, Director International Cooperation, MASEN
- Farid Mohamadi, Enercon
- Abdellah Griech, Director of Renewable Energy, ONE Morocco

The final list of all partners we were engaging with during the Maghreb Renewable Energy Congress and their contact details can be accessed under resources (see below).

Generally the stakeholders can be subordinated to the following groups:

- **Wind energy project developers** (e.g., Wind Sahara, Renováveis)
- **Wind energy project financiers** (e.g., World Bank, Société Generale)
- **Public agencies and policy-makers** (e.g., RECREE, IRENA)

The individual conversations with the stakeholders took about 20-25 minutes and followed the list of guiding questions attached to this report (see ANNEX I). However, we did not stick to these questions exclusively. In order to give sufficient leeway for a natural conversation we have skipped questions or added new ones depending on the characteristics and the interest of the stakeholder. After the main goal of the three different product sheets was introduced to and discussed with the stakeholders, the conversation focused usually on the level of detail of the information, appropriateness for usability in the respective sector and the design of the product sheets. In addition to that, the main drawbacks and benefits of this kind of information were discussed as well areas for future cooperation were identified. The following areas for collaboration were suggested by the CLIM-RUN team:

- Examining critical thresholds for turbines in areas with higher frequency of wind extremes
- Calibrating regional climate models to specific sites for wind energy production
- Deriving tailored indices based on wind speed products

3. Results

3.1. General Insights

For those stakeholders who were consulted for the very first time, we asked for some general information again. The parameters of most interest to these stakeholders was on- and offshore wind speed (heights between 80-100 meters), wind speed variations, long-term changes in the spatial distribution of wind in Morocco, the frequency of wind extremes and their duration at specific sites and at the regional level. Most of the stakeholders do currently **focus on nowcasting**. Wind energy productivity assessments are usually outsourced to companies such as Garrad Hassan, Lahmeyer International, or Mott MacDonald.

Compared to scientific reports and databases which are often not easily accessible, 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) was perceived to be an important step forward to increase the level of usability of climate data by energy stakeholders who are non-climate experts. Also, the level of awareness of the relevance of climate data for the purposes of the renewable energy sector in the Mediterranean region may be increased through these kinds of climate information products.

It was very much depending on the background of the stakeholder consulted whether s/he considered the level and detail of information to be appropriate. For instance, whereas Mr Wouters (IRENA) considered it to be sufficient, Mr Rivals (Renováveis) requested more detailed information which is probably due to his educational background in Meteorology.

Overall, the type-specific c**limate information product sheets were perceived as a step forward** towards delivering tailor-made climate information.

3.2. Content-related Feedback and Limitations

The usefulness of the products as such was doubted by many stakeholders. As discussed in the Wind Energy track as well as in the individual face-to-face discussions with stakeholders, the main reason is the **high 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 foremost stressed by representatives from the private finance industry (e.g. Société Generale). 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 direction

would be of interest, for instance, to the risk department of Société Générale. Renováveis highlighted the added value of a comparison of changes in wind distribution in regional wind scenario maps as presented above. 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.

Summarizing the main results from the Maghreb Wind Congress, there are **three striking issues**.

First, the current **lack of reliable wind-energy project planning tools which go beyond the short term** (i.e. weather timescale, 1-3 days). Although the perceived uncertainty of forecast and climate scenarios is high, the interest in better understanding the capacities to model mid- to long-term is growing. This may also be due to the easier to access formats in which our climate information products were presented. Yet, the level of attention given to long term climate-related risks (e.g. variability of the return on investment over the life-time of a project due to changes in the wind resource) is still low in the wind energy sector, relative to the perceived political and regulatory risks which rank highest in Morocco and to an even greater extent in the rest of the MENA region.

Second, the challenge to cope with the **uncertainties of mid-to long-term wind energy planning tools** based on seasonal, decadal, and climate change timescales is probably the largest barrier towards an increased deployment of climate data in the wind energy sector.

Third, although the level of stakeholder feedback remained on a rather general level during the conference, some organisations (e.g. Sociéte Générale, IRENA, Renováveis, Lahmeyer International) expressed their **willingness to distribute the climate information packages** in their organisations and to discuss them with their internal experts.

3.3.Evaluation of Stakeholder Interactions

In terms of evaluating the interactions between CLIM-RUN scientists and external stakeholders, **three important issues** should be highlighted here.

First, the aim of consolidating existing contacts through our participation in the Maghreb Wind conference could only partially be fulfilled. As already discussed above, some of our stakeholders we were working with in the very beginning of

the CLIM-RUN project come from the solar sector and were not consulted again during the congress in Rabat. Other stakeholders such as ONE or ADEREE who also participated in the first workshop in 2011 were contacted several times throughout the last year. Invites for discussing the wind products in Rabat were also sent out via the conference networking tool. Unfortunately, **no feedback was received from them**. It is not clear at all whether representatives from ONE actually participated in the Maghreb Wind Energy conference.

Second, the linking of the CLIM-RUN project to local stakeholders in Morocco was further complicated due to **internal changes in the CLIM-RUN project** (e.g. changes in the staff of consortium partners).

Third, the **strategy to focus also on international players** active in the Moroccan wind energy sector and to engage with new stakeholders potentially interested in climate data was an important one. For instance, a new contact could be established at IRENA. He has expressed substantial interest in examining the potential of climate scenario maps in the light of developing future wind atlases for the MENA region.

4. Conclusion and Next Steps

The second CLIM-RUN energy case study workshop was held during the Maghreb Wind Conference in Rabat in May 2013. Following a **twofold dissemination approach,** the CLIM-RUN team could attain the goal of demonstrating tailor-made climate information in the form of **three climate information packages** to a well-defined number of stakeholders from Morocco and the international wind energy community. Contacts with **new stakeholders from the wind industry** were made and first **feedback on the climate products** was received. The stakeholders expressed a need for tools to better understand changes in temporal and spatial distribution of wind due to climate variability and change. However, the usability of the climate products as such remains a matter for discussion as the **uncertainty involved in seasonal-to-decadal forecasts as well as climate scenario techniques is a main concern by all stakeholders.** Nevertheless, the feedback also showed that a concise climate data package may be helpful to increase the level of awareness of mid- to long-term climate related risks in the wind energy industry. Yet, compared to the political and regulatory challenges, the climate issue is still perceived to be a minor risk.

Almost all stakeholders at the Maghreb Wind Conference have expressed their interest in **getting regular updates from the CLIM-RUN project**. Therefore, we will include them in the emailing list of the newsletter.

The next working steps in the CLIM-RUN project will be focusing on the following issues:

- **Discuss the main insights** from the Rabat conference on the climate products with colleagues from the other CLIM-RUN energy case studies of Spain, Cyprus and Croatia at the annual CLIM-RUN meeting in Rome July 8-10, 2013.
- Summarize the **lessons-learned from the energy workshops** and share experiences with colleagues from the tourism and integrated case study.
- Based on the discussion with CLIM-RUN colleagues and results from the recent stakeholder interactions, we will aim at **making the information products to be more in line the stakeholder requests**.
- Re-engage with relevant stakeholders (e.g. IRENA) to **explore areas for future cooperation and trigger further feedback** on climate information products.
- Discuss how the produced climate data can be used for economic analysis of wind projects and the meaning and relevance of this information for different stakeholders.

5. Resources

- Zickfeld and Wieland (2012): **Desert Power 2050** - Perspectives on a Sustainable Power System for EUMENA, in: http://www.dii-eumena.com/de/dp2050.html, (retrieved July 01, 2013).
- **Product Wind Forecasting**: http://www.climrun.eu/news_data/108/20120222_climrun_product_wind_forecasting_v1_sml.pdf (Retrieved June 26, 2013).
- **Product Wind Scenario Distribution**: http://www.climrun.eu/news_data/109/climrun_wind-scenario_distr.pdf (Retrieved June 26, 2013).
- **Product Wind Scenario Maps:** http://www.climrun.eu/news_data/110/climrun_wind-scenario_maps.pdf (Retrieved June 26. 2013).
- **CLIM-RUN Presentation** at Maghreb Wind Track 2013 May, 22nd: http://www.climrun.eu/products/presentations-and-posters/climrun-at-wind-maghreb-2013 (Retrieved June 26. 2013).
- **Programme Maghreb Renewable Energy Congress** May 21/22, 2013: http://www.greenpowerconferences.com/EF/?sSubSystem=Prospectus&sEventCode=WE1305MA&sSessionID=8f2d8efc566f690a6f8658c3d2e0f4cd-16691990 (Retrieved June 01, 2013).
- The **list of stakeholders** met at the Maghreb Wind Congress:

	Name	Company	Position	e-Contacts	Phone #	Location
01.	Carlos Martín Rivals	Renováveis, www.edpr.com	Director Development Northern Africa	carlos.martin@edpr.com	34 91 399 79 05	Madrid
02.	Kevin J. Sara	NUR ENERGIE www.nurenergie.com	CEO	ks@nurenergie.com	+44 (0)20 3102 5354	London
03.	Frank Wouters	IRENA http://www.irena.org	Deputy Director-General	fwouters@irena.org	+971 2 417 9000	Abu Dhabi
04.	Nathalie Lemarcis	Société Generale www.societegenerale.com	Director, Project Finance, Power	nathalie.lemarcis@sgcib.com	/	London
05.	Louis Bedoucha	World Bank Group France, www.worldbank.org	Senior Business Development Officer	lbedoucha@worldbank.org.	+33 1 40 69 31 59	Paris
06.	Benhamou, Khalid	Sahara Wind www.saharawind.com	Managing Director	kb@saharawind.com	+212 537 74 22 90	Rabat
07.	Mahmoud, Maged K.	RECREEE http://www.rcreee.org/	Program Manager Capacity Development	maged.mahmoud@recreee.org	+20224154755	Cairo
08.	Badis Derradji	Acwa Power www.acwapower.com	Country Manager Morocco	bderradji@acwapower.com	+212537714164	Rabat
09.	Bernhard Menzel	Lahmeyer International www.lahmeyer.de	Rgional Director Business Development	Bernhard.menzel@lahmeyer.de	+496101551455	Bad Vilbel
10.	Robert Serra	Bip www.businessintegrationpartners.com		Roberto.serra@mail-bip.com	+393473712074	Roma

Table 1. Full list of contacts from the MAGHREB RENEWABLE ENERGY CONGRESS

ANNEX I. Guiding Questions for Face-To-Face Discussions

1) How are your business operations (depending on who you speak to it could be more precise, for instance, how is the mid- to long-term planning of your wind energy projects) affected by climate variability/change?

2) What type of climate information is important for your activity/your organization?

3) Would this type of information (refer to one of the three product sheets) help to improve your decisions with regard to planning your renewable energy project activities?

4) Is the level and detail of the climate information appropriate to support decisions in your business operations?

5) Do you find this climate information as it is presented here useful?

6) Do you have any doubts concerning the reliability of this type of climate information?

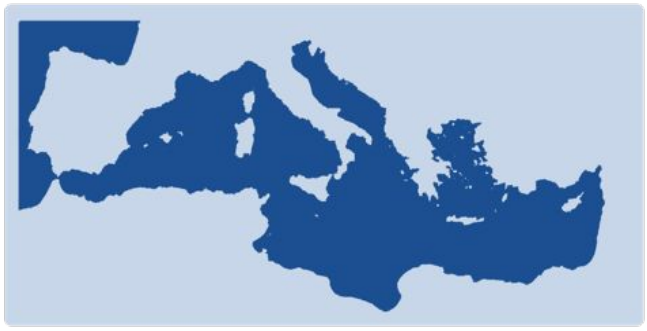
7) Is this type of climate information easily understandable for you (or a climate or meteo-expert in your organization) or would you need further explanation?

8) What additional information would you need to improve your decision making with regard to climate variability/change?

9) How would you improve this information or change this product sheet to make it usable in your sector?

10) How could you help us to better tailor these product sheets to the specific needs of the sector you are working in?

Collaborative Project



CLIM-RUN

Climate Local Information in the Mediterranean region Responding to User Needs

WP7 – Energy Case Studies
Task 7.1 Organization of periodic meetings and surveys

Case Study: CROATIA
CLIMRUN Workshop, Zagreb

Project No. 265192– CLIM-RUN

7th Framework Programme
Underpinning work to enable provision of local scale climate information (annual to decadal timescales)

Authors: Robert Pašičko, Zoran Kordić (UNDP), Čedo Branković (DHMZ)

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Summary

As the nexus between meteorology and energy gets more attention with the growth of investments in renewable energy, it also instigated an increased interest from potential energy stakeholders to participate in the second CLIM-RUN workshop on renewable energy and to discuss both available climate services and the Product Sheets prepared within the project. The second stakeholder workshop in the energy field was co-organized by DHMZ and UNDP Croatia. Local stakeholders were represented from academic, research, business, consultancy and regulator's organizations and companies (all together 28 participants).

In the last few years, the energy policy in Croatia has changed considerably allowing a stronger development of renewable energy sources. There is already a large share of renewables installed (in wind 320 MW in 2013 compared to 6 MW in 2007), but mostly in hydro power – about 50% of total installed energy capacity in Croatia is in hydro. Most of these hydro plants are located in the Mediterranean basin (southern part of Croatia) where climate change is expected to be the most pronounced.

How important are seasonal, decadal and long term forecasts for electricity generation in hydro power plants was discussed during the panel at the end of the workshop. The panel also highlighted the needs of the stakeholders (mainly the Croatian Power Utility HEP) related to existing hydro-climatic data from Croatian Meteorological and Hydrological Service (DHMZ).

1. The CLIMRUN workshop

The workshop in Zagreb was co-organized by DHMZ and UNDP Croatia. Local stakeholders were represented from academic, research, business, consultancy and regulator's organisations and companies, and with the members of the organizers' personnel, the total number of participants was 28. A list of possible participants was first drawn up and most of invitees eventually participated in the workshop. The full list of the workshop participants is attached in chapter 5 (Resources), and a copy of their signatures is in ANNEX III. The workshop programme is attached to this document as ANNEX II.

The opening remarks were given by Cedo Brankovic (DHMZ), the national coordinator of CLIM-RUN project in Croatia, who presented basic information on workshop goals and on the project. It was followed by two presentations, each focusing on one climate variable – wind and

hydro – recognised as important renewable energy sources. Alica Bajic (DHMZ) stated that according to the results from Regional Climate Models, the increase of the mean wind speed in the period 2040-2070 in Croatia in some regions is projected to be significantly higher than today's mean wind speed. According to the well-known rule, the energy yield from a wind generator is directly proportional with the cubic relation of the wind speed. However, a large increase in wind speed will not automatically lead to a possibly high energy generation because it depends on wind distribution. Renata Sokol Jurkovic (DHMZ) focused on the importance of climate information on energy production from hydro power, showing the case from the hydro power plant Senj in Croatia. Robert Pasicko (UNDP) gave presentation on interactions between climate change and energy generation from renewable energy sources. He concluded that by the mid-century in Croatia a neutral impact of climate variables is expected on the energy generation from photovoltaics (PV), a positive impact on generation (in terms of higher value) from wind parks and a rather negative impact on generation from hydropower because of potentially more frequent periods of droughts.

During the animated panel discussion it was emphasized that due to complexity of interactions between climate and renewable energy sources, it is important to have the communication between climate experts and users open, i.e. to combine both the bottom-up approach with the top-down approach, in order to get a better understanding of respective activities. That was most evident in communication between Croatian Power Utility (HEP) and Croatian Meteorological and Hydrological Service (DHMZ).

2. Main Results

In the discussion that followed the value of climate information in planning electricity generation from hydropower plants was addressed and analysed from various points. The potential areas of interaction between CLIM-RUN and stakeholders in the energy sector in Croatia were discussed as well. The overall conclusion was that more cooperation is needed in this area; end users are not aware of all climate services that can be provided, while experts on climate forecasts and modeling need to listen carefully what are the needs from stakeholders from this sector. Renewable energy sources have specifically great need for strengthened climate information as they completely depend on weather conditions.

Because of complexity and uncertainties of both weather and the Earth climate system, the DHMZ forecasts are mostly based on probabilistic approach. The end users, such as HEP Trade, currently do not appreciate such an approach. They do not consider this as being complete climate (weather) information on which they would build agreements for electricity import. However, since the deterministic approach to weather forecasts is becoming increasingly less in use, they will consider integrating the probabilistic approach into their energy planning whereas DHMZ will provide more tangible information on probabilistic forecasts.

All participants, agreed on huge importance in matching energy planning and climate information. In Croatia, DHMZ is the only authorized organization that provides relevant climate information to potential stakeholders. On the other hand, the HEP Trade is in need of various kinds of climate information so that they can plan their trade contracts.. They also questioned why the DHMZ hydro information is not free of charge as it is the case in some other countries.

Responsibility for taking the risks of wrong forecasts was the other question raised during the panel. DHMZ explained that probabilistic forecast means a span of possibilities and that the end user should eventually decide on how to use it. Of course, DHMZ is willing to provide some guidance, but the final decision should be linked to the cost/loss ratio at stake. Furthermore, HEP Trade indicated their need for climate forecasts, such as changes in the level of precipitation, as the major factor in hydro energy planning.

HEP warned on disadvantages in the legislative regulations that are linked with the use of renewable energy; now the investors in renewables in Croatia are not obliged to pay penalties for their possibly wrong forecasts of energy generation. Therefore HEP considers the investors in renewables as “a nuisance” on the national grid. According to the current limits in distribution grid and difficulties in planning electricity generation, Croatia may not fulfil its commitment under the EU RES Directive to achieve a 20% share of renewables in the gross energy consumption by 2020.

It is concluded that a better information and understanding of climate data would lead to a more efficient planning in the hydro energy generation. Close co-operation of all involved parties in the process is critical in order to have climate data that exactly represents users needs. The CLIM-RUN Workshop was also seen as a good step forward to get energy and climate circles together and this opportunity will be further emphasized.

3. Next steps

Based on the discussion on potential interactions between CLIM-RUN and local stakeholders in the energy sector in Croatia, it has been agreed that:

- A better communication between energy and climate circles, bringing experts and stakeholders together, must be attained in order to understand the stakeholders' needs and what kind of climate services could be provided;

- HEP Trade should introduce probabilistic approach to their energy planning – especially this is true for hydro power plants;

- HEP Trade will provide necessary data for a better understanding of the correlation between climate information and power generation from a hydro power plant (such as the research underway for the hydro-power plant Senj);

- Further discussion for using meteorological forecasts in wind energy will be continued at a workshop organized by DHMZ on July 9th (within the EU funded project "Innovative support to wind energy management")

4. Resources

Participants of the CLIM-RUN workshop in the Zagreb, 6 June 2013.

Name	Organization	Contact
Andrea Hublin	Ekonerg	Andrea.hublin@ekonerg.hr
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Zoran Kordić	UNDP	Zoran.kordic@undp.org

ANNEX I. Program for the CLIM-RUN Workshop in Zagreb, June 6th 2013

CLIM-RUN Project (www.climrun.eu)

KLIMATSKE INFORMACIJE I OBNOVLJIVI IZVORI ENERGIJE

Vrijednost modeliranja klimatskih promjena pri planiranju investicija u vodnogospodarskim prognozama pri optimiranju

Datum i mjesto održavanja: 6. lipnja 2013., Zagreb, UNDP Hrvatska, Radnička 41/8

Program

Prvi dio	
8:00	Okupljanje sudionika radionice, kava i keksi
8:30	Otvaranje skupa i pozdravni govor upoznavanje sudionika Projekt CLIM-RUN i modeliranje klimatskih promjena u Hrvatskoj (Željko Branković, DHMZ) Procjena utjecaja klimatskih promjena na proizvodnju iz obnovljivih izvora u Hrvatskoj (Robert Pašičko, UNDP) klima i energija vjetra (Jelica Bajić, DHMZ) korelacija meteoroloških parametara i mjesečne proizvodnje iz HE Senj (Renata Sokol Jurković, DHMZ)
11:00	**Pauza za kavu**
Drugi dio	
11:30	PANEL - vrijednost klimatskih informacija za planiranje proizvodnje iz hidroelektrana – od mjesečne do sezonske prognoze (Dunja Mazzocco Drvar, DHMZ; Vesna Pavičić Filipi, HEP; Davor Bošnjak, HEP Trgovina; Ivan Rajšl, FER)
13:00	**Domjenak**

ANNEX II. Signatures of participants from the CLIM-RUN Workshop in Zagreb, June 6th 2013

Ime i prezime	Ustanova	E-mail adresa	Potpis

CLIM-RUN: Radionica o klimi i obnovljivim izvorima energije, Zagreb, 4 lipnja 2013

Ime i prezime	Ustanova	E-mail adresa	Potpis

CLIM-RUN

CLIM-RUN

Climate Local Information in the Mediterranean region Responding to User Needs

Collaborative Project

WP 5 – Energy case study

REPORT:
Workshop on Climate Services for the Energy Sector of Cyprus
Nicosia, Cyprus, October 14, 2013, 10:00 -13:00

Project No. 265192– CLIM-RUN

Start date of project: 1st March 2011 Duration: 36 months

Author: Manfred A. Lange

C:\Users\malange\Dropbox\EEWRC_~1\EEWRCP~1\EEWRCR~1\RESEAR~4\EU-PRO~1\CLIM-RUN\CLIM-R~1\STAKEH~2\STHWOR~1\ENERGY~1\Report_Workshop on Climate Services for the Energy Sector of Cyprus_22_01_14.docx, 23 January 2014, created: 22 January 2014, MAL

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Agenda

10:00 - 10:30	Welcome Introduction: Climate Services and the CLIM-RUN Project - an update *Manfred A. Lange, EEWRC*
10:30 - 11:00	Climate in Cyprus: Current State and Future Projections *Panos Hadjinicolaou, EEWRC*
11:00 - 11:20	Coffee, refreshments Demonstration of CyI CLIM-RUN portal *Avgoustinos Avgousti, EEWRC*
11:20 - 11:50	Development of detailed climate change projections for Cyprus *Corrado Camera, EEWRC*
11:50 - 12:20	Climate Change and the Energy Sector in Cyprus: Impacts and Adaptation *Aris Bonanos, EEWRC*
12:20 - 12:40	Discussion
12:40 -	Lunch

The workshop "Climate Services for the Energy Sector on Cyprus", a follow-on to the first one in 2011, is being organized in the framework of the Energy, Environment and Water Research Center's (EEWRC, The Cyprus Institute) involvement in the EU-CLIM-RUN project "Climate Local Information in the Mediterranean region: Responding to User Needs" (see http://www.climrun.eu).

CLIM-RUN is a research project funded by the EU Commission under the 7th Framework Programme. The project aims to develop methodologies to provide user-friendly information on current and future climate conditions for a given region and tailored to the needs of a specific (economic) sector. The tourism sector in Cyprus has been selected as one of the case studies in CLIM-RUN, since weather and climate are known to have a strong bearing on the preference of potential customers.

Invitees/Participants[1]

No.	Name	Organization
1	Michalis Chrysaphis (to represent Mr Xichilos)	Energy Service - Ministry of Commerce, Industry and Tourism
2	Ioannis Economides	Electricity Authority of Cyprus
3	Andreas Poullikas	
4	George Kourtis	
6	Stelios Chimonas	Cyprus Institute of Energy
7	George Shammas	Cyprus Energy Regulatory Authority
8	Dr Christos Christodoulides	Transmission System Operator
9	Andreas Yiannakou	
10	Constantinos Varnava	
11	Nicholas Tsioutis	Cyprus Organization for Storage and Management of Oil Stocks
12	Eleni Vassiliadou	Natural Gas Public Company
13	Anthi Charalambous	Cyprus Energy Agency
15	Costas Christofides	Cyprus Employers and Industrialist Federation
16	Michael Pilikos	
17	Theodore Panayotou	CIIM
18	Kyriakos Akritas	Akritas Consulting Engineers
19	George Akritas	
20	Paraskevas Anastasiades	
21	Manfred Lange	Energy, Environment and Water Research Center, The Cyprus Institute
22	Corrado Camera	
23	Panos Hadjinicolaou	
24	Aris Bonanos	
25	Avgoustinos Avgousti	

[1] shaded

Preface

To better prepare for the second meeting with stakeholders, we carried out an extensive survey of the Energy Sector in Cyprus (see Appendix). This survey includes:

- Basic statistics and description of the Energy Sector in Cyprus, both in its current state and its recent history;
- A compilation of main players/stakeholders of the Cyprus Energy Sector and a
- Concise description of relationships and interdependencies between the main players.

This survey was the basis for the selection of invitees to the workshop and proofed most useful in reaching the major institutions involved in the Energy Sector in Cyprus.

Workshop Proceedings

Welcome and Introduction: Climate Services and the CLIM-RUN Project - an update
Manfred A. Lange[2], EEWRC (ML)

Manfred Lange welcomed the meeting participants and gave a brief introduction on the rationale and background of the workshop. He continued by presenting the objectives of the workshop, which comprise:

- present the current knowledge on climate and climate change in Cyprus,
- briefly discuss major impacts of climate change on the tourism sector,
- present various research results relevant to the above topics.

ML started by explaining that the transport and energy/industry sectors represent the largest contributors to Cyprus' CO_2/greenhouse gas (GHG) emissions. By expanding the view to all the countries of the Mediterranean Basin, he demonstrated that these countries have seen a significant increase in energy demand and –use over the recent past and that population growth, changes in lifestyle and climate variability will lead to additional energy/ electricity demand. He showed that the strongest increase in energy/electricity consumption is expected to be seen in the residential sector.

ML explained that the expected climate change in the Mediterranean Basin will have significant impacts on energy demands. In particular, there will be an increase in space cooling and higher energy demands for seawater desalination. Strategic Planning is needed to address these trends. Science can provide valuable support and vital information for such planning. Climate model projections will be particularly important for long-term planning in the energy sector.

Next, he presented some results of regional climate modeling at the Energy, Environment and Water Research Center (EEWRC). ML explained the relationship between temperature changes and changes in the Tourism Comfort Index (TCI), which takes into account several factors (wind, hours of sunshine, precipitation, thermal comfort). He illustrated some results of changes in the TCI for Cyprus and emphasized that relatively modest impacts on tourism comfort are expected for Cyprus.

Results of climate models provide the also the information needed for estimating the amount of additional space-cooling as required to provide indoor comfort of local residents and tourists in Cyprus. For the entire Mediterranean Basin, there are significant changes/increases in future versus the current energy needs for space cooling.

He then introduced a small study on increasing energy needs for space cooling in several Cypriot cities (Kerynia, Famagusta, Larnaca, Nicosia). As was shown, there will be more than twice the energy needed for cooling compared to present cooling levels.

He then presented a case study for the Mediterranean on climate and tourism and introduced the concept of climate services. He explained the current attempts to establish a Global Framework for

[2] see presentation in the Appendix

Climate Services and briefly explained major elements of a link between science and end-users. ML pointed out that modeling and observations comprise essential components of the climate service information system. However, scientists and the scientific community needs to better understand the information needs of the tourism sector.

ML briefly presented The Cyprus Institute's CLIM-RUN Portal (http://climrun.cyi.ac.cy/) and major its capabilities. However, he pointed out that more information and a demonstration would be given during the refreshment-break.

He concluded by emphasizing that climate conditions are expected to change significantly in the Mediterranean Basin in general and the Eastern Mediterranean in particular. This will have significant impacts on the energy needs for space cooling and will ultimately lead to an increase in domestic energy demand that the energy sector has to prepare for.

He finally introduced a simple questionnaire that was distributed and filled in by most of the workshop participants. Results of the survey are given in the Appendix.

Discussions

In the discussions that followed ML's presentations, participants expressed their general appreciation of science aiming to be of service to society in general and the tourism sector, in particular. They also pointed out that the information that is already available through, e.g., the CLIM-RUN web-portal offers most welcome possibilities to gain insight into the role of climate and climate changes on the fate of the tourism industry.

However, it was also pointed out that science will have to continue to make efforts to present its results in a more easily comprehensible way. In particular, the effects of uncertainties and limitations of numerical modeling on the usefulness of such information will have to be clarified more explicitly.

Anthi Charalambous asked if it would be possible to estimate the reduction in heating needs due to milder winters. ML pointed out that this is indeed done, but that it turns out that this reduction does not compensate for the enhanced energy consumption for space cooling during the summer months.

Climate in Cyprus: Current State and Future Projections
Panos Hadjinicolaou[2], EEWRC (PH)

Panos Hadjinicolaou focused on climate science, regional climate modeling and climate projections. He started by showing observations of mean global annual temperatures, which illustrate a steady increase in temperatures over the last appr. 30 years. PH then showed similar observations for selected cities in Cyprus, where he focused on a number of indicators (e.g., hot days with T>35^{o}C and warm nights with T>20^{o}C). While basically showing comparable trends, PH pointed out that there has been an apparent reduction in the rate of warming –that is observed both globally and locally- over the last few years, even though, temperatures are above those of previous years. This change in trend is currently extensively discussed.

PH then introduced global and regional climate modeling methodologies including their strength and weaknesses. One major uncertainty lies in the greenhouse-gas emission scenarios that depend on various poorly definable parameters. PH emphasized the need for regional climate modeling in order

to obtain information on the regional to local scale that is relevant for stakeholders. He also introduced the EEWRC modeling activities and some of the major results. This relates particular to the projections of changes in extreme weather over Cyprus.

PH then discussed new initiatives and methodologies to improve regional climate modeling and explained some of the relationships between climate and air quality/pollution.

Discussion:

A lively discussion followed PH's presentation. The main issues addressed are summarized below:

- Aris Bonanos asked if it is possible to increase the resolution of models in certain areas? Panos Hadjinicolaou responded that this is indeed possible and that Corrado Camera is currently working on this.
- George Akritas: asked if the observational data are verified prior to being used as boundary conditions and/or for model verification?
  Manfred Lange confirmed that researchers do verify observational data and stressed that the quality control of observations is an important component of the work at EEWRC.
- Michalis Chrysaphis suggested that it would be more helpful for the users of climate information, if the cooling degree days and heating degree days will be presented for each location seperately.
- Panos Hadjinicolaou: Noted that the values of acceptable comfort temperatures are available and added that the request by Michalis Chrysaphis can be satisfied.
- Nicolas Tsioutis suggested to consider indoor relative humidity in assessing indoor comfort, as this is known to be affected by humidity.
- George Kourtis requested to clarification on the term "average" (temperature) and inquired, if it will be possible to indicate the highest and lowest temperature for a given day? He pointed out that the duration of continuously high indoor temperature for a given locale is an important characteristic.
- Manfred Lange pointed out that this can be estimated based on current information for specific Cypriot cities.
- In response to the request for extensive data series by some of the participants, he explained that there are limitations due to practical considerations. However, he encouraged participants to express their requests explicatively in order for scientists to assess the feasibility of such requests.

Demonstration of CyI CLIM-RUN portal *Avgoustinos Avgousti,* EEWRC (AA)

During the refreshment break, AA presented the CLIM-RUN web portal that was developed at EEWRC. Figure 1 presents a number of screen-shots of the portal and the kind of graphs that can be obtained by the user of the portal.

Figure 1: Examples of the CLIM-RUN web-portal (*http://climrun.cyi.ac.cy/*); left: Starting page; right: monthly mean temperatures for Athens for 2010-2030

The presentation drew significant attention and participants expressed vital interest to make use of the portal.

Discussion:

The participant showed vital interest in the data portal and confirmed that they will make use of the portal in their daily work.

There were also requests to make a number of additional parameters (e.g., solar irradiance) available on the web-portal. AA confirmed that work is in progress to address this very request.

Development of detailed climate change projections for Cyprus *Corrado Camera*[2], EEWRC (CC)

CC aims to create maps of climate parameters with high spatial resolution of Cyprus. To that end, he has developed advanced interpolation algorithms that allow the transformation of local observational data to a regular grid of 1×1 km^2. The data base and maps thus created enable detailed hydrological and climatological studies. While these methodologies are being applied first to currently available observational data, they can be and are also employed to derive gridded data-sets and maps for climate projections as obtained from EEWRC regional climate models.

Discussion:

Again, the presentation by CC evoked a lively discussion, which is summarized below.

- Andreas Pentaliotis commented that the results represented by CC appear to be contradictory to those of Panos Hadjinicolaou, with the latter's model results implying increasing cloudiness, while CC's model results indicate decreasing rainfall.
  Panos Hadjinicolaou replied that this is due to the fact that these are two distinctly different models. Corrado Camera commented that one obtains a great range of different results depending on the global climate model that is being used.
- Michalis Chrysaphis asked about results for the occupied area of Cyprus.
  Corrado Camera replied that there are difficulties in obtaining data and information in practice due to the lack of collaboration with the occupied area meteorological services.

- Andreas Pentaliotis requested to know if CyI/EEWRC has any model results depicting extreme climate events and their occurrence. He also inquired about the predictability of such events. Corrado Camera explained that such information may be gained by carefully inspecting future rainfall projections.
  Manfred Lange: Noted that an important prerequisite for such an exercise is a precise identification of extreme events.
- Andreas Pentaliotis pointed out that one expects an increase in the failures of major infrastructure installations related to the Energy sector in Cyprus, given the projections in climate change shown here.
- Michalis Chrysaphis requested to know if models used for projecting future precipitation values take into consideration atmospheric composition (air chemistry)? He implied that only a limited set of parameters are taken into account in the modeling.
  Manfred Lange responded by explaining that aerosol and dust concentrations are explicitly taken into account and are seen to play a major role.
  However, Panos Hadjinicolaou stated that the inclusion of aerosol and dust concentrations are still at an exploratory state when it comes to numerical climate modeling and still need to be scrutinized.
- Andreas Pentaliotis noted that the model results presented require more spatial resolution for urban areas. This would be particularly important in the context of urban development plans to be drawn up by the municipalities and the government.

Climate Change and the Energy Sector in Cyprus: Impacts and Adaptation
Aris Bonanos, EEWRC (AB)

AB started his presentation by presenting an overview of the global and –in comparison- the Cypriot energy consumption. He explained the major objectives related to the introduction of renewable energy sources (RES) on a European and Cypriot level and gave an example the output of Cypriot wind energy installations.

He continued by presenting his view on the role of climate services for the energy sector, more specifically the RES-sub-sector. In so doing, he focused on solar energy production in general and concentrating solar power (CSP), in particular. He presented a number of examples of ongoing research at CyI/EEWRC and ended by asking the participants questions about their information needs, specifically:

- How can CyI expertise can help you as a stakeholder?
- What climate services do you request?

Discussion:

The following discussion focused on two issues:

George Kourtis asked, if DNI projections (DNI=direct normal irradiances) are available at the CLIM-RUN website?

Manfred Lange responded by pointing out that information for wind-power are available in the form of Product Sheets (http://www.climrun.eu/frontend/loader?page=1&path[]=products&path[]=information-sheets), but that DNI forcasts are still forthcoming.

Andreas Yiannakou raised the issue of the cost of maintaining the security of the energy system in light of climate change and explained that electricity operators are also responsible for the safety of the system and the reliability of supply.

General Discussions

After the presentations, a more general discussion followed. Below, just a few of the remarks are being presented to provide a flavor of the discussions that took place.

- Andreas Pentaliotis brought up the case of seawater desalination and inquired, why the existing desalination plants and their significant energy losses are not examined more carefully. He indicated that there may be a significant potential for energy recovery that is not utilized at present.
- George Akritas suggested that at least 10% of the current transport sector may be supplied by RES.
- Aris Bonanos agreed and suggested that the use of alternative fuels in the transport sector opf Cyprus be examined more thoroughly.
- Michalis Chrysaphis pointed out that in the context of the current RES target a new government directive addressing alternative fuels and proposals for pilot projects that target such fuels is being issued. Discussions are also taking place with regard to a national energy/electricity plan.
- Manfred Lange requested to know what measures the government proposes in order to address extreme heat events and their possible impacts on human health.
- Michalis Chrysaphis responded by explaining that monitoring these health impacts had been neglected until recently mainly because of a lack of data or studies on this subject. Studies have now being initiated to address this issue.
- Manfred Lange inquired what actions are being taken regarding the integration/enhancement of the stability of RES on Cyprus. He also inquired if an increase in photovoltaic installations is being foreseen?
- Andreas Yiannkou responded by stating that the integration of RES (particularly wind-power) represents a “daily struggle” for the Transmission System Operator (TSO). The TSO is in close contacts with the wind farm operators.
- George Kourtis pointed out that there are significant economic issues to be clarified before a larger number of photovoltaic installations are being implemented. In addition, there are significant distribution network problems to be solved.

APPENDICES

Collaborative Project

WP 7 – Energy case study

The Energy Sector in Cyprus: Economics, Government Support and Main Stakeholders

Project No. 265192– CLIM-RUN

Start date of project: 1st March 2011 Duration: 36 months

Authors: Elena Charalambous and Manfred A. Lange

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An overview of the Cyprus energy sector

(a) Basic characteristics

The sources of electrical energy production in Cyprus are the conventional fuels (petroleum products which are imported) and the domestic renewable energy sources (biomass, photovoltaic systems, and wind farms).

The Electricity Authority of Cyprus (EAC) is the only electricity producer from conventional energy sources, in Cyprus. Due to an unfortunate event on the 11th of July 2011, the main power station producing 60% of the Authority's total electricity production, was damaged in an explosion of 98 gunpowder containers stored at a naval base. This has adversely affected the Cyprus energy sector, as the power station still needs repair before full operation, with many consequences for both the Cyprus economy and the individual consumer, in relation to the efficient power supply and the prices of the electricity which have increased significantly.

Offsetting the above unfortunate event, is the discovery of vast amounts of natural gas in the Cypriot territorial waters, following speculation over many years, as well as the discovery of 453bn cubic metres of useable gas in the Leviathan gas fields in Israel. The Cypriot drilling finally begun by the US-based energy company Nobel Energy in the zone known as Block 12 (Aphrodite field), an 800,000-acre (1,250-square-mile) area in the Cyprus Exclusive Economic Zone (EEZ) southeast of the island and only 34km from the Leviathan gas fields. According to Noble Energy, Block 12 contains an estimated 5 to 8 trillion cubic feet (tcf) (140-230 billion cubic meters) of natural gas. If the prior Tamar and Leviathan discoveries (in Israel) are used as a guide, it is believed that today's initial resource report by Noble is likely to be conservative, and there could be significant upward revisions in the next couple of years as the project nears production. Even with the current estimate of Noble Energy, Cyprus will become self-sufficient in the commodity for decades. Every trillion cubic feet of natural gas covers the Cyprus' electricity production needs for 30 years, meaning the discovery in Block 12 will keep Cyprus satisfied for about 200 years. If one considers that 6,000 cubic feet is equal to one barrel of oil, then approximately 7 tcf is equivalent to one billion barrels, and to give an indicative value of these deposits based on the barrel analogy, the deposits in Block 12 worth today around € 100 billion (US$129 billion). That is 15 times the annual budget of Cyprus.

Furthermore, and in relation to the Renewable Energy Sources (RES), it is noted that the Cyprus Government has adopted the EU Directive on RES, setting a target for Cyprus by 2020, of a 13% production of energy from RES, giving Cyprus an opportunity to promote its own energy production and increase its energy independence with exporting in the near future. With a feed-in tariff for large wind power plants, the Cyprus National Renewable Energy Action Plan, targets the largest renewable electricity share to be from wind power by 2020, reaching a national target of 6.8% of electricity generation. The Cypriot target of solar power both from photovoltaics and concentrated solar power, is the 7% of electricity by 2020, which will be one of the top ones in the European Union markets. It is worth mentioning, that solar heating in 2010 was the highest in Cyprus of all European countries: 611 W per capita.

(b) Cyprus energy policy and targets

The energy policy of Cyprus is fully harmonized with the energy policy of the European Union. The main axis of the energy policy involves the safeguarding of a healthy competition in the market, the security of the supply of energy and the fulfillment of the energy demands

of the country, with the least possible burden on the national economy and the environment. The implementation of the above policy is formulated by:

- The liberalization of the electricity market by abolishing the monopoly of the Electricity Authority of Cyprus (EAC) on the generation and supply of electricity through a 35% market have allowance to free competition.
- The liberalization of the oil sector by abolishing the pricing control system and the cross-subsidization between the different oil products and the adjustment of the prices on the basis of the market events and the excise duty in force.
- The establishment and operation of a strategic oil stock terminal.
- The implementation of development programmes related to the use of energy conservation, technologies, utilization of ingenious RES and the protection of the environment from industrial pollution.
- The promotion of oil products and other sources of energy friendly to the environment, such as natural gas.

(c) Main statistics for the years 2011 and 2012

- The electricity production in 2012 amounted to €343.6 mn, representing the 1.92% of that year's GDP, and recording a 14% increase in comparison to 2011's production.
- 1500 people were employed in the electricity supply sector in 2011, representing 0.38% of the total employed population of that year.
- The electricity consumption for the whole of 2011 amounted to around 4.6 bn kWh's, recording a 3.9% decrease in comparison to the previous year's consumption. In 2012 (January - October for which statistical data are available) the electricity consumption was recorded at around 3.8 bn kWh's, recording a 2.4% decrease in comparison to 2011.
- The biggest portions of the electricity consumption in Cyprus are for domestic, commercial, and industrial purposes, representing 37.4%, 40.3%, and 17.3% respectively, of the total electricity consumption in 2011.
- The imports of petroleum products (including motor gasoline, kerosene, gasoil, light fuel oil, heavy fuel oil, and liquefied petroleum gases) in 2011, amounted to around €1,579 mn, representing 25.2% of that year's total value of imports.
- The volume of sales of petroleum products recorded a 7.2% increase compared to the previous year. The sales in 2011 amounted to 2,132,414 tonnes, equal to a value of around €1.8 bn.
- The total sales of petroleum products in 2012 were decreased by 8.5% compared to the previous year. Large reductions were recorded in the sales of asphalt (-43.4%), light fuel oil (-23.8%), heavy fuel oil (-13.3%), gasoil low sulphur (-11.2%), and gasoil for planes (-10.5%). Sales of unleaded gasoline dropped by 3.3% and of gasoil by 3.1%. Increases occurred in the sales of gasoil for vessels (18.8%) and the sales of kerosene (2.9%).

The closing stock of petroleum products at the end of 2012 dropped by 8.0% compared to the respective figure for the end of 2011.

- In 2011, the production of electricity from RES accounted for 3.62% of that year's total gross electricity production. The production of electricity from RES as a percentage of 2011's total gross electricity production, was the following: 64.34% from wind systems, 29% from biomass systems, and 6.7% from photovoltaic systems. 92.1% of these systems are connected to the EAC grid, whereas the rest of the systems are autonomous.

Support schemes and related policies within the Cyprus energy sector

In Cyprus, electricity from renewable sources is mostly promoted through a combination of a subsidy schemes and premium tariffs. Apart from that, Cyprus has inaugurated a tender for PV installations. Renewable energy sources for heating purposes are eligible for a subsidy and the same applies for transport, mainly through the subsidy of the relevant infrastructure.

With regard to the use of the grid, renewable energy is given priority. Grid development is a matter of central planning based on the Transmission Grid Development Plan 2007-2016 of the Cyprus Transmission System Operator (TSO).

There is number of policies aiming at promoting the development, installation and use of RES installations.

(a) Electricity

Support schemes

Cyprus promotes renewable electricity generation through subsidies and a premium tariff scheme. Apart from that, there are tenders for the installation of PV installations with a capacity of more than 151kW.

(i) Premium tariffs

The Cypriot power company (EAC) purchases electricity from the plant operators at the market price. The Special Fund for RES and Energy Efficiency pays a bonus on top of the market price. The amount of tariff depends on the electricity generation technology employed.

(ii) Subsidies

The scheme applies to natural persons and public entities. The amount of grant is a certain percentage of the amount invested. Grants are awarded by the managing committee of the Special Fund for RES and Energy Efficiency.

(iii) Tenders

The Special Fund for RES and Energy Efficiency invites tenders to allocate 50 MW. Successful tenderers sign contracts with the Cypriot power company (EAC), which purchases electricity from the plant operators at the market price, and with the Special Fund for RES and Energy Efficiency that pays a bonus on top of the market price.

In general, the entitlement of plant operators to the grid connection and development is subject to the general legislation on energy. Plant operators are contractually entitled against the grid operator to the connection of renewable energy plants to the grid. After the conclusion of a connection agreement, a plant operator is contractually entitled to the expansion of the grid by the grid operator, if the expansion is necessary to satisfy his/her claim for connection. Plant operators are contractually entitled against the grid operator to give priority to the dispatch of electricity from renewable sources.

Policies

Cyprus has integrated the European Directives into the national legislation. As Cyprus is a small isolated island, some measures are not feasible.

(i) Exemplary role of public authorities in accordance with Art. 13 Abs, 5 RES Directive

In pursuance of the Energy Performance of Buildings Directive (EPBD), a study has been carried out to design adequate policies and measures to transform public sector buildings into low energy buildings. Apart from that, every public service building must have an energy performance certificate. This obligation applies mainly to newly built and newly rented buildings and public buildings with a floor area of more than 1000 m².

In addition, an amendment to the Green Public Contracts Programme for 2010-2012 (public procurement contracts based on Law No. 11(I)/2006 and Law No. 12(I)/2006) introduced the following provisions:

- Incentives for photovoltaic installations on the roofs of government buildings. This incentive applies mainly to schools and military camps. The target is that 50% of these buildings acquire photovoltaic installations.
- Incentives for the installation of solar panels in schools. Initially, panels were installed in 6 schools for central heating support. After a financial assessment, this measure was extended to include a greater number of schools.

(ii) RES-H building obligations

Decree No. 446/2009 contains the following regulations for buildings:

- Mandatory solar installations on every new residential building to satisfy domestic hot water requirements.
- RES installations on every new building for power generation.

(b) Heating & Cooling

Support schemes

At the moment, there are two grant schemes for RES Heating and Cooling (H & C) in Cyprus.

(i) Subsidy (SSEEA) schemes

Under the SSEEA scheme, grants are allocated to encourage the installation of H&C plants. The scheme applies to: (a) natural persons and public entities, and (b) private entities, respectively. The amount of the grant is a certain percentage of the amount invested.

Policies

Cyprus has integrated the European Directives into the national legislation. As Cyprus is a small isolated island, some measures are not feasible.

(i) Exemplary role of public authorities in accordance with Art. 13 Abs, 5 RES Directive

The same apply as in section (i) under "Policies", above.

(ii) RES-H building obligations

The same applies as in section (ii) under "Policies, above.

(c) Transport

Support schemes

Cyprus provides grants for RES used in transport.

(i) Subsidy (SSEEA)

Under the SSEEA scheme, grants are allocated to encourage the production of biofuels for transport. The scheme applies to private entities. The amount of grant is a certain percentage of the investment. Grants are awarded by the Administrative Committee of the Special Fund for RES and Energy Efficiency.

Main entities/stakeholders related to the Cyprus energy sector

(a) Energy Service – Ministry of Commerce, Industry and Tourism

The Energy Service of the Ministry of Commerce, Industry and Tourism has the overall responsibility of Energy in Cyprus and specifically for:

- Monitoring and coordinating the supply and availability of sufficient energy capacity for domestic needs.
- Monitoring and participating in the formation of the European Policy for energy issues.
- Suggesting ways for the implementation of the European Acquis, assisting in the preparation of laws, regulations, rules e.t.c. and implementing programmes for their promotion.
- Preparing and implementing programmes for energy conservation, the promotion of renewable energy sources (RES) and the developing of technologies for the utilization of RES
- Assisting the Government in the formation of the national energy policy for Cyprus in coordination with all other bodies involved.

(b) Electricity Authority of Cyprus (EAC)

The Electricity Authority of Cyprus is an independent, semi-governmental corporation established under the Electricity Development Law Cap. 171 of 1952, in order to exercise and perform functions relating to the generation and supply of energy in Cyprus. As already mentioned, the Cyprus energy industry is dominated by the EAC which is the only electricity producer (from conventional energy sources) in Cyprus and the leader of the energy sector. The EAC's operations break down to the following units:

- Generation business unit
- Network business unit
- Customer Service business unit
- Common Services business unit

(c) Cyprus Institute of Energy (CIE)

The Cyprus institute of Energy was founded in year 2000 by the Minister of Commerce Industry and Tourism and it is administered by a five-member board instated by the Council of Ministers. CIE is funded by the Republic of Cyprus and other Semi Governmental and International Organizations.

CIE's mission is based on the following:

- The promotion of Energy Conservation and Rational Use of Energy.
- The development and promotion of Renewable Energy Sources (wind, solar, biomass, hydro, geothermal or any other form of known renewable energy, or may prove worthy of consideration in the future) in Cyprus.
- Any activities with the scope of promotion of both of the above issues with the scope of and further utilization of financially feasible Energy Technologies.

For the implementation of the above objectives, CIE is involved in several competent programs, cooperates with other international organizations with common goals, employs when necessary experts and consultants, undertakes applied research and offers technical guidance and information. Generally, it conducts a wide range of activities regarding the information, promotion and utilization of new Innovative Energy Technologies and especially Renewable Energy Technologies.

(d) Cyprus Energy Regulatory Authority (CERA)

CERA was created out of the need of the Republic of Cyprus to harmonize with the Directive 96/92/EC of the European Parliament and of the Council of 19 December 1996 concerning the common rules for the internal electricity market in the European Union.

CERA is an independent authority of the Republic of Cyprus and has executive powers and responsibilities in the energy sector. The main statutory objectives of CERA are the following:

- To encourage, promote and safeguard the healthy and substantial competition in the electricity and natural gas markets.

- To protect consumers' interests.
  To promote the development of economically viable and efficient electricity and natural Gas markets.
- To ensure the security, continuation, quality and reliability of electricity supply.
  To take into consideration the protection of the environment.
- To encourage the efficient generation and use of electricity.
  To promote the use of Renewable Energy Sources (RES).

Furthermore, CERA has the power and authority:

- To administer, control, impose, amend or revoke licenses of companies in the energy sector.
- To advise the Minister on all matters relating to electricity.
- To ensure compliance with the Transmission and Distribution Rules and the Electricity Market Rules.
- To regulate the tariffs, charges and other terms and conditions implemented by licensees for any services provided.
- To establish, publish and enforce quality standards with which licensees comply.
- To handle complaints about services provided by licensees.

(e) Transmission System Operator - Cyprus (TSO)

The Transmission System Operator (TSO) was established under the decision of the Government of the Republic of Cyprus for harmonization with Directive 96/92/EC of the European Parliament and of the Council of the 19th December 1996, concerning the common rules for the internal electricity market, and at a following stage the compliance with the EU Directive 2003/54/EC.

In general, the responsibilities of the TSO are:

- The efficient operation of the Transmission System.
- To ensure, on a day-to-day basis, the availability of generation resources and ancillary services.
- To ensure that the Transmission System is developed and maintained so that it sustains safety, reliability, security of supply, economic viability and efficiency.
- To prepare and annually revise a ten-year development and investment plan of the Transmission System.
- To operate the electricity market.
- To ensure the coordinated operation of the Transmission and Distribution Systems by arriving to all necessary agreements with the DSO, which in the case of Cyprus is EAC.
- To prepare, revise, as necessary, and submit to CERA for approval the Transmission and Distribution Rules as well the Market Rules.
- To determine the connection and use of system charges and arrange for the charging of all those who use or intend to use the Transmission System for transferring the energy they produce to their Consumers.
- To keep all necessary system records regarding the use of the Transmission System.
- To prepare all necessary monthly accounts according to the exact operation of each Producer with respect to the energy used by his Consumers.

(f) Cyprus Organisation for Storage and Management of Oil Stocks (COSMOS)

The Cyprus Organisation for Storage and Management of Oil Stocks (COSMOS) is a public body founded and operating under the Maintenance of the Oil Stocks Law of 2003 - 2005. It was founded for the purpose of harmonization with European Directive 68/414/EEC, imposing an obligation on member states of the European Union to maintain minimum stocks of crude oil and/or petroleum products. COSMOS is a non-profit semi-governmental organisation operating under the supervision of the Minister of Commerce, Industry and Tourism of Cyprus.

The mission of COSMOS is to maintain and manage the minimum stocks of crude oil and oil products of Cyprus, which have to be available at all times. However, it cannot interfere with oil prices in the local market, as its main purpose is to use the oil stocks only in cases of shortages or supply difficulties, and only after an Order by the Minister of Commerce, Industry and Tourism.

(g) Natural Gas Public Company (DEFA)

This company has been established for the development of the internal gas market and network, and is responsible for the import, storage, distribution, transmission, supply and trading of natural gas, and the management of the distribution and supply system of Natural Gas in Cyprus. The council of Ministers of the Republic of Cyprus issued a decree appointing DEFA as the sole importer and distributor of natural gas in Cyprus and directing DEFA to proceed with securing the necessary Natural Gas quantities at the best commercial terms.

The scope of action of DEFA includes:

- Buying, importing, holding, using, distributing, selling, supplying natural gas, in any form.
- Operation of the natural gas transmission and distribution network.
- Signing of treaties/conventions with the Republic of Cyprus or any other country, company, organisation etc.
- Negotiating, buying, selling, managing, storing, importing, exporting, ee-exporting etc., any goods, tangible or intangible, including natural gas.

DEFA's mission during the initial phases of its operation will be:

- To secure sufficient natural gas supplies at the lowest possible prices, to cover the needs for Electricity Power Generation and subsequently to also supply industries, hotels and households.
- To develop the necessary gas network infrastructure.
  The Gas Network will initially consist of 3 pipelines connecting the Gas Import Hub with the three existing downstream Power Stations.

(h) Cyprus National Hydrocarbons Company Ltd (CNHC)

Cyprus National Hydrocarbons Company Ltd (CNHC) was established in October 2012 through a decision of the Republic of Cyprus Government's Council of Ministers, in accordance with Article 16 of the Hydrocarbons Cypriot Law 4 (I)/2007, as the Entity responsible, on behalf of the Government, for the setting up and management of the relevant infrastructure for the proper exploitation of hydrocarbons.

This includes the continuation of the negotiations with Noble Energy International Ltd, the supply of natural gas to Cyprus from Block 12, the development of the leased Blocks, the establishment of an LNG Plant at Vasilikos Area and the conclusion of any specific agreements or other matters which may be deemed necessary for both the supply of natural gas and the export of hydrocarbons in any form.
In addition to this, the Council of Ministers, has mandated CNHC to undertake the following main activities:

- Hydrocarbon trading.
- Participation in the construction of new facilities required for the production and exploitation of hydrocarbons, such as pipelines, LNG plant/terminal, installations for the export of hydrocarbons.
- Participation in the exploration and exploitation of hydrocarbons, including production, processing and transportation.
- Participation in the operation and management of new facilities for the monetization of hydrocarbons on behalf of the Republic of Cyprus.
- Management of the Vasilikos LNG Project on behalf of the Republic of Cyprus.
- Ensure, as a matter of priority, that Cyprus' needs are fully satisfied from hydrocarbons found in the Cyprus exclusive economic zone.

(i) Cyprus Energy Agency (CEA)

The Cyprus Energy Agency is a non-profit public organization, established to promote renewables, energy saving, rational use of energy and sustainable transport. The establishment and operation of the Cyprus Energy Agency is supported by the European Commission through the Intelligent Energy-Europe programme and the Union of Cyprus Communities.

The main objectives of the Agency are to contribute to the achievement of the sustainable development, taking into consideration the Lisbon Strategy and the European Strategy for Sustainable Development and the energy policy of the European Union, which aims the security of energy supply, competitiveness, sustainability, tackle climate change, promotion of renewables, energy savings and efficiency and sustainable transport. The CEA aims at:

- Providing information and raising public awareness.
- Providing professional training and education.
- Promoting local/European/international collaborations.
- Contributing to research and development.
- Protecting the environment

(j) All the enterprises within the energy sector

This includes mainly the various companies that have been granted permits from the Cyprus Government, to produce energy from renewable energy sources, engineering companies offering related consulting services to these companies etc.

Relationships/Interdependencies between stakeholders

Strong relationships/interdependencies exist between all the above stakeholders, as they all work synergistically towards the implementation of the Government's national energy policy, each stakeholder through its different role. Furthermore, most of the above stakeholder-entities have been created under the initiative of the Ministry of Commerce, Industry and Tourism which is inter alia, the main actor for the formulation of the Government's national energy policy.