UNIVERSIDAD PONTIFICIA COMILLAS

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA (ICAI)

OFFICIAL MASTER'S DEGREE IN THE ELECTRIC POWER INDUSTRY

Master's Thesis

Energy Sustainability through Climate Services

Author: Dania Carolina Ortiz Acosta
Supervisor: Yannick Perez and Serge Pajak

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Summary

The energy sector has been recognized as a priority area for the Global Framework for Climate Services (GFCS), being an international initiative to provide weather and climate services to improve the world´s economy and welfare.

Within this framework, the World Meteorological Organization (WMO) which is the United Nations Agency in charge of the implementation of a model to interact with the Energy Stakeholders, providing them tangible solutions that increase their sustainability and resilience, this last as a result of the GFCS Energy Exemplar.

One of the pillars of the project is the identification and adaptation to the needs of the key decision-makers, as the best way to positively impact their planning processes and operations.

For implementing tailor-made climate services, a business plan has been developed, answering to the new roles that international organizations need to play in the evolving and challenging economies, having a closer and more proactive perspective. Secondly, and with the aim of proving the concept of the project, Colombia has been selected as a pilot country. A study case has been developed to prospect the project in the energy sector within the country.

A third research topic includes the elaboration of a Climate and Weather services for the Energy Sector Handbook document, that can act as a support tool for the WMO network to fully understand and relate with the benefiters of the project (Energy Stakeholders).

All the research has been developed under a business oriented perspective, as the best approach to relate with the energy stakeholders and especially with the private sector.

As one of the results of the research, four different methodologies (licensing, retailing, membership and partnership model) have been identified as the possible paths to implement the GFCS Energy exemplar and pursue its objectives.

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Chapter 1: Introduction

The Thesis that is now presented is part of the input to the GFCS Energy Exemplar proposal, with the specific objective of expanding the description of the energy sector and contribute to understand its interaction with the weather climate services and find the most adequate approaches to reach and interact with the Energy Sector through tailor-made climate services.

Three documents that have been developed as input of the project are now described:

- ✓ Energy Exemplar Business Plan: Description of the possible implementation methodologies (licensing, retailing, membership and partnership model), including all the required actions for executing the GFCS Energy Exemplar in any energy system.
- ✓ Colombian business case: Description of the Colombian energy sector and country, to study the available pathways to implement tailor-made climate services, and as a proof of the climate services concept.
- ✓ Climate Services for Energy Handbook: description of the energy subsectors and activities (transmission, different sources of generation, retailing, etc.) and the tailor-made climate services that could improve their operation and planning.

The research can be highlighted by a sound business characterization perspective, even as WMO is an international organization, it could be said that it is a very technical specialized UN agency, then a lack of administrative/social orientation was identified, and remarked as necessary to fully interact with the Energy stakeholders (especially with the energy private sector actors). Subsequently administrative analysis tools as SWOT and FODA have been done and included in the research.

Another section to be highlighted and that represents a cornerstone for the project is the Evaluation and Metrics, where different assessment methods have been selected, and particularly the Energy and Climate and Weather Indicators represent an alternative to measure the real outcome of the implementation of the project in any selected country or by type of activity (of the energy provision chain). The proposed metric systems may become a reference for the energy sector in the world, and as a direct consequence contribute to spread the initiative among the target sector, as the private sector and other relevant energy stakeholders have a result orientation, and indicators is the best way to fit that characteristic.

The greatest challenge of the project is to propose alternatives on how the GFCS Energy exemplar is an innovative and practical tool to gauge the attention and participation from the Energy Stakeholders.

The detailed motivation and the objectives for the research and the project are presented in the body of the document, however it could be highlighted the importance of the energy sector for the development and growth of any country and the close relationship among climate and weather to the efficient, sustainable and reliable provision of energy.

The main research question is how to implement successfully the GFCS Energy Exemplar, considering the particular characteristics of the WMO, the Energy Industry and the expected impacts on it.

Thesis Framework and Methodology

The international authority in provision of this climate services is nowadays the WMO (World Meteorological Organization), being the specialized agency of the United Nations for weather and climate (meteorology), geophysical and hydrological sciences. WMO establishes a cooperation framework among the member countries for the development and management of programs. The WMO executes its programs through the National Meteorological and Hydrological Services (NMHSs), these specialized centers are supported by the WMO.

WMO is continuously defining and updating its programs with the objective of generating weather, climate and water-related data, creating observation and monitoring standards among others. Global Framework for Climate Services (GFCS) was established in 2009, as a program led by the WMO, but promoted by the United Nations to act as a general basis to structure some other derivate projects in the different Agencies of the UN, supporting decision makers in some economic sectors where the climate is a crucial element. Initially the sectors included were Food Security and Agriculture, Water, Health and Disaster Risk Reduction. The GFCS aims to be an international mechanism to enhance the quality, quantity and application of climate services.

By 2015, Energy was included as the fifth of this sectors. As the first of the energy projects included in the GFCS, the Energy Exemplar project is the product of this whole new scheme.

By climate services it is understood all the data that provides climate information for assisting decision makers. Such services are science oriented based, that lead to a high-quality data provision and must respond to the user´s needs. For the provision of the climate services, different analysis, projections, scenarios and assessments are done by the WMO network members. For the integral provision of the climate services and with the aim of tailoring them to the user´s request, the meteorological information can be combined with non-meteorological data, as socio-economic information.

Traditionally this information has been provided for free, as a public good, however for the importance of the provided information and the expanding amount of users, different private entities have decided to be climate services supplier and to charge for their services. Some agents act as generators and some others just as providers.

Going more in detail about the provision of similar services, it could be said that there are different public organizations in charge of creating scientific data, similarly as WMO does, however there is another category of competitors to be highlighted being private entities that gather the climate data (adding or not an extra value) and offer it to the final users.

The weather company. www.theweathercompany.com/

Climate Risk Analysis. www.climate-risk-analysis.com/

Climate Corporation. www.climate.com/

Predictia. www.predictia.es/

Prescient Weather. www.prescientweather.com/

Climpact. www.climpact.com/

It has to be noted that some energy utilities, specially the big international ones, can gather directly their own climate data and produce their own reports and forecasts.

WMO has stated in its Principles, that the Climate information is primarily an international public good, nevertheless this statement has been recently modified in the practice through the WMO programs, as there is a need to interact closer with the real benefiters of the programs and the provided services, then the need to provide value for the money paid for the services emerges. The creation of a business plan aims to be the answer to this last need, as a new role to be played by an international organization as WMO, helping to demonstrate the added value that the GFCS Energy Exemplar brings to the energy sector through the provision of climate services.

Methodology

The main research question is how to implement successfully the GFCS Energy Exemplar, considering the particular characteristics of the WMO, the Energy Industry and the expected impacts on it.

In order to respond to the research question, the selected methodology of this report has followed a qualitative basis. The use of this type of approach is well-known among the International Organizations as the WMO, and traditionally, WMO implements its projects and programs by approaching and interacting with the national authorities (meteorological and non-meteorological agencies) in the participating countries by project or program. Nevertheless, recent organizational orientation modification has led to focus the efforts in redefining the implementation methods, evolving to more practical and interactive ones, especially with the private sector in order to facilitate and ease a direct interaction with the real benefiters of the programs and projects.

An initial review of the variety of methods that are available to assess how a project (as the Energy Exemplar) can be implemented was initially done. Considering the Documentary Analysis, as an adequate method to obtain data from previous documents of other programs´ implementation, relevant information can be revealed, but as the Energy Exemplar and the energy branch have been recently included as a priority area for the GFCS by the WMO, there is no existing information about precedent programs or similar projects that can be used as a reference.

Another available option in order to select the best way to implement the project was to conduct a qualitative information gathering through surveys or interviews, in order to know about the needs, experiences and perspectives from the different stakeholders that could be involved in the implementation of the Energy Exemplar project, but for the variety and complexity of the participating agents that can contribute with relevant knowledge or experiences that help to answer the research question, and that can produce standardized, comparable and useful information, surveys or interviews have not been selected as the main method, moreover the information that can be gathered through this process will not fully provide all the information required to identify and propose the available implementation methodologies for the Energy Exemplar.

Then as the last two options do not fully represent the best way to address the research in the most integral way (as could only generate information for some specific areas of the Energy Exemplar project implementation selection), however the information that can be generated can be valuable for some particular section of the study.

Then it was decided that the best method to adopt for this investigation was to develop a business plan, this decision has been influenced by the interactive and proactive perspective with the private sector that is wanted to be adopted by the WMO, with the aim of knowing the real needs of the project' benefiters and adapting the project to better satisfy them.

A business plan represents the process that has been selected to create a written outline that ease the evaluation of different aspects of the implementation of the GFCS Energy Exemplar, through it is possible to evaluate the particular characteristics of the WMO, the Energy Industry and the project (Energy Exemplar) itself.

By preparing the business plan it has been intended to elaborate a roadmap that leads a general scheme of the basic aspects that have to be considered in order to define the possible implementation strategies of the project and that could subsequently been adapted to produce a specific business plan for every country where the Energy Exemplar may be implemented.

Writing a business plan is a recommended tool to fully evaluate the feasibility of a project, making it a popular tool among entrepreneurs and business evaluators.

Nowadays, business plans are normally organized into a generic format, acting as a template to fill in with the information and research results for every specific project. For this particular report, different business plans templates have been evaluated, including the available formats by recognized Universities and Business Schools as the Baiada Institute for Entrepreneurship, Tec de Monterrey University, Massey University, University of Wisconsin , the proposed sections to be filled in by each template are considerable similar among the different outlines that were reviewed, then no single template was selected, nevertheless the business plan was prepared similarly to the proposed procedure used by the City University of Hong Kong, and a compilation of the core common elements that were identified in all of the templates that were reviewed, including some complementary sections for a more sound study.

One of this extra sections was a SWOT analysis, that was included in the first sections of the business plan. The SWOT test has widely been applied in many business investigational studies and helps to detail the features of the studied item.

Additionally, a case study has been elaborated, with the objective of obtaining further in-depth information of the Colombian Energy Sector, as Colombia has been selected by the WMO as a priority country to be studied and to implement the Energy Exemplar in the short term, then by an exploratory study it is possible to understand the Energy Sector from different perspectives as the political, economic, social and technological (presented in the PEST Analysis). For the case study to present a deeper and insight of the Country and its participating stakeholder, and specially to gain a detailed understanding of the perspective of the energy utilities in the country through a detailed illustration of their interaction with the climate services, in order to gather the required information an interactive process was established with the energy stakeholders and survey was applied to them.

The design of the questionnaire used as the market research was based on a previous surveys applied by the WMO to evaluate how climate services are managed by the national meteorological agencies in the member countries of the WMO, and adapted to collect the information useful that could offer an effective angle of the interaction of the selected entities and the climate services, and therefore give the most tailored made approach to the project. The eligibility criteria required individuals to be an energy generation utility, as a result homogeneity among the participants was not a feature of the study, as the amount of MW produced by each company and the amount of employees vary considerably among the participants, however this study, as a qualitative questionnaire was included in order to gain insights into the real position of the climate services for the Colombian utilities.

The study case that has been developed for Colombia has the aim to be replicated in the near future by the WMO for exploring the energy sectors in the countries that have also been selected as priority ones (Peru, Bhutan, Burkina Faso, Tanzania, Dominica, Moldova, Papua New Guinea) being the selected countries to start the implementation of the Energy Exemplar.

The Business plan includes some sections that have been previously defined by the WMO to describe the GFCS program, as the general framework of the Energy Exemplar, these sections include: Mission, Principles, Pillars, Areas of Focus and Description of the services, this last one has not been modified from the original definition made by the WMO, by the technical specifications that must be stated (in section 2.0 Products and Services), Communication Strategy (in section 6.0 Marketing Plan), and The Technical capabilities of executing facilities known as the National Meteorological and Hydrological Services (NMHSs) (in section 8.0 Organizational characteristics).
It has to be mentioned that these sections have been complimented and readapted in order to fully support the objectives of the business plan.

The main disadvantage of applying a business plan in order to evaluate all the affecting variables of the Energy Exemplar, WMO and the energy sector, and be able to identify and propose the feasible strategies for the implementation methodologies is that the decision is dependent on qualitative variables and the quantitative components that may be considered do not have a lot of weight (i.e. they are only included as part of the statistical information of some analysis criteria).

A major problem of having a pure qualitative study is that the research provides valuable data about user needs, behavior patterns, but an standardization of data is not possible, therefore an statistical comparison has not been done, but as and advantage of the research, is the flexibility that will led to respond to the changes in the project that could emerge for adapting the study to the countries to be studied.
The main contribution of this thesis is to identify different implementation strategies for the Energy Exemplar, as the available and feasible ones, according to the objectives of the project and the characteristics of the Organization. Moreover generating a business plan allows to have a different approach to interact with the energy stakeholders and specially to adapt the project for a more interactive relationship with the private sector (as one of the focus benefiters of the project).

Another relevant contribution of this report is the proposal of a Monitoring and Evaluation system, through the Key Metrics and Indicators, representing an innovative tool to assess the development of the measured project and the its impacts, and opportunely correct or adapt for a more effective consecution of the results and even a better execution of the project.

Chapter 2: State of the art

Even as the importance of the climate services to improve the Energy Industry has recently been recognized (Energy chapter incorporation to the GFCS in 2015) by the UN organizations, the need of having a resilient energy sector has always been recognized and will increasingly be supported as the climate change international negotiations advance, driving to the incorporation of renewable energy and cleaner technologies.

The below enlisted documents can be mentioned as relevant related studies. It can be noted that the studies have been developed by International entities as the world bank, WEC and other relevant world organizations, with the aim of providing a general framework to take actions to improve the Energy Sector, then WMO, as the most adequate international agency to respond, has decided to include energy as a priority area to be improved by the creation and increment of resilience through tailor-made climate services.

- ✓ Climate Impacts on Energy Systems by the World Bank in 2010.
- ✓ Climate Change: Implications for the Energy Sector by World Energy Council in 2014.
- ✓ Building a Resilient Power Sector by the World Business Council for Sustainable Development in 2014.

Through the documents it has been proved that there are enough reasons to fortress the relationship among the energy sector and the weather and climate services, oriented to mitigate and opportunely adapt to the impacts of climate change, considering the ways to react to the adverse impacts and take advantage of generated opportunities.

Chapter 3: Business Plan

1.0 Executive Summary

The Energy industry, despite its knowledge and master are relatively recent, has become necessary in all aspects and activities of any society. As a very complex sector, a major transformation process has started since a couple of years ago, specially driven by the less predictable demand patterns and the need for involving a more diversified generation mix. The Incorporation of renewable energy has made that weather and climate are becoming increasingly critical for the balancing of energy supply and demand. Then Climate services are crucial elements for the different time scales operation and planning of a resilient and efficient energy system.

GFCS, as the Global Framework for Climate Services, is a global initiative, spearheaded by WMO for supporting decision-making in climate sensitive sectors. Reliable climate information and data represent an opportunity to increase the resilience in the evolving energy systems of our days and the upcoming ones, by leveraging the power of improved, more user-friendly and tailor-made climate services.

In order to reach the target sector and to fully improve its security and sustainability, a business plan has been developed, including the description of the current energy sector´s situation, through a market analysis and a SWOT Analysis of the proposed tailor-made climate services, information that has led to the identification of four possible implementation methodologies (retailing, licensing, partnership and membership model). The correspondent marketing and financial plans have also been included.

The documents highlight the roles of WMO and its network for an efficient execution of the project (especially new and innovative ways). Sustained and effective leadership and coordination are key, if customer oriented climate services are to be embraced and adopted by the energy stakeholders (especially by the private sector).

The necessary characterization and adaptation of the project to the particular characteristics of the participant energy stakeholders is another remarkable feature of the project.

The energy sector as a primary one, has continuously enlarged in demand and as a consequence its supply has subsequently grown, however some generation sources have been more extensively used than others, and differentiation among regions can also be done, where the per capita consumption varies considerably from country to country.

It is easy to perceive that the current and future market for climate services is expanding, and that as the energy systems evolve, new opportunities and niches may also arise for providing accurate climate services to improve the current systems.

2.0 Products and Services

2.1 Problem worth solving

Energy need is increasing day to day, its participation spectrum is a priority situation to be improved in the world, where energy is normally included as a crucial element for the economic and social development of our present and future days. Countries' governments have enhanced their national development plans by improving their energy sector energy, and energy is normally present in the national and international agenda's definition. This importance can be explained, as that in most of the cases, energy investments represent a significant portion of a country's GDP. This last contributes to consider and plan the energy industry from very different angles, with the objective of improving the sector itself and the country development conditions.

Energy is an essential element for almost all aspects of current life, including basic services of any developed society, as education, health, provision of goods and tertiary services. Despite the energy importance, challenges faced by the sector have been enlarging abruptly, to the point we had arrived in our days of a non-sustainable energy model, where the energy sector emissions contribute with the largest proportion to the total GHG emissions, 30% of the total. (US EPA [2016])

Indeed this last situation has acted as major driven for regulatory bodies and other policy making support entities to implement a more sustainable policy framework, as it is the case of stablishing the emissions reduction targets under the UN Framework Convention on Climate Change, and as a direct consequence for cleaner energy demand, however to create sound and resilient energy systems (and as renewables are directly affected by climate and weather variability and climate change derived risks), a proficient provision of climate and weather services is required.

An opportune tool for facing all the new and upcoming challenges of the energy decision process is to provide enhanced tools and systems to properly analyse and manage risk under hydro-meteorological conditions, and related with the climatic variability and change. The development and application of targeted climate products and services through the Global Framework for Climate Services (GFCS) will help to reduce considerably the hydro-meteorological hazards risks, improve the energy sector efficiency through a better operation and to better respond to the opportunities that are derived from climate change and climate variability.

The main focus of the GFCS Energy Exemplar is to address climate services needed to support:

Greater climate resilience and adaptation across the sector, due to its fundamental importance for development;

The important role of efficiency and reduction of energy consumption with consequent emissions reduction in support of mitigation targets;

The growing renewable sub-sector, given the apparent climate sensitivity of renewables on the one hand and the policy priority accorded to them due to their GHG emissions reduction benefits on the other.

The focus has been defined as a response to the energy sector need of being cost-efficient, but at the same time sustainable and reliable.

Accurately assessing climate risks for the energy sector is difficult because of the uncertainty in predicting the level, impacts and timing of climate threats. Climate change uncertainties come from three sources (WBCSD 2014):

Economic and policy uncertainty. It is not clear how emissions of GHG will be affected by demographic and socio-economic trends, technologies and the political commitments.

Scientific uncertainty. The understanding of the functioning of the complex climate system is still developing. While the link between GHG emissions and global temperatures is quite clear, the impacts at regional levels and the reaction of affected systems (e.g., lakes, glaciers, etc.) are more difficult to predict.

Natural variability. Given the complexity and interlinked nature of the climate system, climate models can provide statistical information and causal relationships but not a deterministic prediction.

Another important outcome of the successful development of the project is the contribution that can be done for reducing the number of people without energy, as climate services for some specific sources of energy may create a more solid atmosphere for the deployment (investment) in some remote areas, where energy has not reached yet. This represents a major goal as today an estimated 1.2 billion people (17% of the global population) remain without electricity, and 2.7 billion people (38% of the global population) put their health at risk through reliance on the traditional use of solid biomass for cooking (IEA, 2015).

2.2 Our Solution

GFCS, were decided to be established in 2009, as a UN global initiative, being a multidisciplinary initiative that includes the collaboration of different UN agencies, although WMO acts as the leader for guiding the development and application of science-based climate information and services in support of decision-making in climate sensitive sectors.

Different governments and their leaders, with participation from the academia and other agents (more than 500 scientists) agreed to develop the GFCS (http://www.gfcs-climate.org).

In response to the perceived needs, initially the GFCS established four priority areas: agriculture and food security, water, health and disaster risk reduction. And in 2013, as a result of different situations, but specially recognizing that energy and climate and weather are intrinsically related, energy has been defined to be the fifth priority area.

The particular objective of creating resilient energy systems through the GFCS has also emerge from the global need for the improvement of the energy provision (especially cleaner and more efficient).

Mission of the GFCS Energy Exemplar

By developing user-tailored weather-water-climate services in close cooperation with the Energy industry, the GFCS Energy exemplar will enable it to better manage the risks and opportunities arising from extreme events, climate variability and change. The GFCS will ensure that the resulting science-based climate information leads to improved planning, policy and operational activities.

Vision of the GFCS Energy Exemplar

By enabling better development and incorporation of science-based climate information, improve the management of the risks of climate variability and change and adaptation to climate change that affect the energy sector and to become a global reference for the decision making process in the Energy sector.

Principles

1. High priority for the needs of **climate-vulnerable developing countries**
2. Primary focus is the **better access and use of climate information** by users
3. Framework will address needs at three spatial scales: **global, regional and national**
4. Climate services must be **operational and continuously updated**
5. Climate information is primarily an **international public good** and governments will have a central role in the Framework
6. The Framework will encourage **global, free and open exchange** of climate-relevant data
7. The Framework will **facilitate and strengthen** - not duplicate
8. The Framework will be built through **partnerships**

Pillars

The GFCS is supported by a network of technical experts; national, regional and global specialized centers and services; and international partners. Its implementation plan spans five areas of activity (or pillars):

User Interface Platforms (UIP) – forums for forging the stakeholder relationships needed to define needs and respond to requirements for climate information and services in particular sectors and contexts

Climate Services Information System (CSIS) – for producing and distributing climate data and information tailored for policy- and decision-support

Observations and Monitoring (Obs/Mon) – for generating the necessary data for the development of climate services

Research, Modelling and Prediction (RMP) – to advance the science needed for improved climate services and climate-related outcomes

Capacity Development and Support – to support the systematic development of the institutions, infrastructure and human resources needed for effective climate services.

Work in each of these areas will be undertaken to support the specific needs of the energy sector. Due to their high sensitivity to climatic factors, renewables such as wind, bioenergy, solar and hydropower and their connecting infrastructure will receive particular attention.

Areas of Focus

Work to be undertaken during the implementation of the Exemplar reflects the project stages of a generic energy system, namely from planning to construction, to operation & maintenance, including also the balancing of supply and demand:

Identification & Resource Assessment

Impact assessments (incl. infrastructure and environment)

Site Selection & *Financing*

Operations & Maintenance

Energy Integration

2.3 Validation of Problem and Solution

The need of improving energy systems has been identified and increased in concern, particularly around climate impacts on the energy industry. World-leading energy organisations as the WB, WBCDS, IEA among others have been taking action to ensure that energy systems become more resilient to changes in the climate; different publications have been issued in order to provide accurate and opportune information to the targeted sector (risk, opportunities and mitigation strategies). However, for the continuous changing situation that the sector faces, it is important to contribute to its improvement through in the most possible proactive way.

The GFCS Energy Exemplar Business Plan, proposes different implementation methodologies that have been identified as possible pathways according to the participant of the energy industry needs. WMO, as the project leader, has adopted a more practical approach, providing not only informative tools, but applied ones. Through a solid interaction among the energy sector, the implementation of the GFCS Energy Exemplar has a customer orientation base.

Indeed, the GFCS Energy Exemplar offers a unique opportunity to provide an overarching framework to help guide investments for the development of key enablers such as user interface platforms, climate services, observations, research and capacity building which will ensure a more robust implementation of resilience and adaptation measures for the energy sector.

One of the core elements of the implementation of the process is to demonstrate the added value of the project and to illustrate accurately the benefits to the Energy Sector Stakeholders. As the GFCS Energy Exemplar can benefit all energy industry activities (normally influenced by meteorological events), from the well-known energy sources to the new evolving ones, same as the activities of the energy provision process (as distribution, transmission, retail markets, risk hedging among other related business).

To contribute to the added-value of the project proof, key indicators and metrics are proposed, as a tool to efficiently evaluate differences among the operations and especially the outcomes of the energy sector in monetary and productive terms after participating in the GFCS Energy exemplar.

As expected the direct benefit may vary from agent to agent, as their particular features, affection and even opportunities from climate change and climate and weather variability depend on their specific features. Nevertheless, the expectations among the target agents may coincide, as they all want to have a useful tool to improve their efficiency (economic and social particular goals may be considered) and to reduce harmful emissions or contribute to other environmental objectives. Thus the aim of this Exemplar is to improve energy industry resiliency, while also indirectly contribute to mitigate the GHG emissions targets.

The GFCS Energy Exemplar has been defined as a coordinated mechanism that allows energy sector stakeholders to acquire wider access to climate information and services, but also more oriented to their particular needs. Once more the diversity among the energy stakeholders would require segmentation and adapted implementation strategies, so fully customer oriented services are achieved. The experience using climate services will tend to vary considerably not only among countries or regions, but also among the different users in the whole energy provision process, some of the biggest differences among the agents is totally related with the amount of available economic resources applied to the climate services (could include in-house generation, gathering, outsourcing the services in their totality or some other different combinations).

The proposed coordinated (bilateral or multilateral relationships) will lead to the full engagement of the energy sector stakeholders, that at the same time, the interaction could generate an overall improvement of the implementation and operation of the GFCS Energy Exemplar, enabling the hydro-meteorological specialists to better understand the real requirements of the targeted group and therefore respond to them in the best way.

With the aim of being as interactive and cooperative as possible, the GFCS Energy Exemplar will incorporate relevant information and other technological contributions from the interested stakeholders to contribute to the project; this last represent a unique and different strategy of implementing the Energy Exemplar, being specially different from the common relationships among non-governmental agencies, the private sector or any stakeholder, giving the opportunity to make suggestions or give feedbacks, with the aim of improving the communication and implementation strategies and the final outcomes. To reinforce this idea, a system of evaluation on the overall performance and detailed implementation of activities, through different indicators and surveys is proposed.

The possible implementation paths differ considerably from one another, still the integrative guideline that has been proposed present the advantages and drawbacks of each identified alternative, even when the implementation methodologies can vary, the project relies on the customer orientation and participation, totally convinced that tailor-made climate services can advance in the integration of parallel efforts (climate services providers and users in the energy sector) to better integrate climate information and expertise into the energy sector decisions and operations.

Remarkable examples about how opportune climate services have improved the decisions may be highlighted, demonstrating that a tangible and real situation for improving the adaptation of the energy sector are available. And that creating resilience against climate change related hazards and the climate and weather variability is feasible.

One step that remarks climate services importance, is the recognition on how hydro/meteorological information can improve planning and operation. As an example, around 5% of the total Electricité De France (EDF)'s 2013 income was attributed to effective management of weather and climate conditions in France.

Targeted climate services as a practical solution were stated in the Implementation Plan of the Global Framework for Climate Services' (WMO 2014a), as 'The natural evolution of Framework-related activity will see other sectors come into focus. As an example of a sector that is likely to be considered as one of the next priority areas, the energy sector is recognized for its importance in sustainability and in climate adaptation and mitigation. This sector is particularly sensitive to weather and climate and is therefore an experienced user of climate information.'

2.4 Description of the Services

Tailor-made climate services definition can include an extensive perspective, then the interaction among the selected users may be recommendable as a first approach, and the fact of being customer oriented services opens a wide range of possible actions and alternatives to fit the services with the real needs. Based on the previous WMO and NHMSs experiences and know-how for tacking specific users in some other sectors or priority areas, has made easier to elaborate a detailed list of products and services.

One of these experiences, and in order to continue with the climate services definition process, on March 2015, WMO organised a Private Sector Partnership Forum '*Climate Services and Decision Support Tools for*

the Energy Sector' held at the WMO Secretariat, in Geneva, Switzerland, where recognized and qualified energy sector representatives, together with the meteorological community, worked in favour to identify priority hydro-meteorological products and services to improve the decision process in the energy sector. As a result of the interaction among the Forums participants, seven climate product/services were developed:

[1] http://www.wmo.int/worldmetday/content/private-sector-partnership-forum.

- Scenarios for energy mixes
- Delivering decision-support climatic scenarios data for use in the energy sector
- Multi-year prospective climatologies for the energy sector
- Training in the use of extended-range weather forecasts
- Seasonal forecasting for hydropower production
- Seasonal forecasting for energy demand
- Observations and reanalysis data for energy

A more exhaustive description is presented in the tables below, including relevant details, providing an initial set of proposals that can be applied to different energy industry participants, still with the aim of being really customer oriented products and to be differentiated, a subsequent client's needs assessment and adaptation process may be required.

1	***Scenarios for energy mixes***
Product/Service	Design energy mix and % for each component that will meet the country's electricity demand both near term and long term.
Description	1. Demand must equal supply 2. Supply can be generated from a known mix of options 3. Problem is to compartmentalise each energy component and define its expected potential contribution to the energy mix. a. Using the current climate, it is possible to build an expected (mean) supply profile over a typical year (including diurnal and seasonal variability) b. Based on climate record can then quantify variability around this mean supply profile to build a range of supply. c. Need to explicitly identify thresholds at which extreme conditions impact supply (eg wind over a threshold and turbine must be turned off, cooling water for thermal plant eg nuclear reactor too high so need to wind back power generation) d. Around these energy profiles build a further uncertainty range which is driven by those considerations that we don't know with certainty eg climate change which we may have some confidence but also issues that are completely unknown e. Other future considerations that can impact this supply profile should be considered such as whether storage solutions can modulate the effectiveness of a component such as PV which has a strong diurnal cycle. f. Externalities must be acknowledged, for instance a dam may serve multiple purposes such as water supply, flood mitigation so that it may not be possible to operate it purely on the basis of energy production 4. A unit cost of energy (possibly variable based on scale) can be derived (must also acknowledge uncertainties in this, as it is impossible to accurately predict commodity prices etc. that some components will depend on) 5. Demand forecast should also be compartmentalised and its expected profile defined. Clearly seasonality affects, extremes in demand. a. In same way need to identify future unknowns. For instance, climate change may have future impacts on water availability in Mediterranean climates. Some countries are being forced to consider desalination which will become a large part of the electricity market demand side.

	6. Problem becomes one of optimisation to match the profiles in demand with the mix of supply in the most cost effective way. The problem of the range of uncertainties in supply must be within the range of redundancy that will be required to meet the ultimate objective of supply always meeting demand at all cost. ***Optimisation process*** 7. Models exist to optimally deploy different energy sources in the day to day operation of the energy network – names to be confirmed but they feed systems such as SCADA 8. Such models could be adapted to take as input our supply scenarios (with their ranges) to develop our planning mix of energy. ***Using forecasting to tune optimal mix*** 9. The energy mix has the potential to be tuned according to expected weather conditions. 10. For instance, if the lowest cost component can produce more power in the outlook period, its percentage should be maximised and other units can be wound back 11. There are existing systems (Supervisory Control and Data Acquisition, SCADA) that currently model the mix of different energy sources. 12. If NWP forecasts (and possibly climate outlooks) could be integrated into such decision support tools this would enable a better decision making process that more optimally tuned the energy mix. 13. Past data exists that could validate such a framework 14. Some production systems have far more inertia than others and there is limitation on their ability to stop and start 15. The timescales for decision making around these high inertia systems (e.g. only have 3 steam production systems running instead of 4 because confident there will be sufficient wind energy generated) are such that NWP forecasts are quite reliable. As such there is significant potential to use forecasts to supplement a system such as SCADA. ***Regional Markets*** 16. Where an energy market is not constrained to an individual country, decisions around energy mix should not be made in isolation. 17. If a country decides to change its energy mix this can bring surplus energy to the market that makes other countries energy generated overpriced. 18. Such decisions have perverse political implications even if they bring a lower energy cost to the market. Accordingly, the politics of such decisions need to be carefully worked through. ***Storage of excess energy generated*** 19. Some innovative solutions to the previous problem of cheaper energy coming onto the market e.g. Switzerland: they purchase the cheapest energy (rather than use their own hydro) and then use the excess energy to pump water to a higher reservoir banking the potential energy. Effectively a water battery. 20. Others use this same concept domestically so they put in additional PV/wind to generate excess energy when they can, use this to pump water and then use the potential energy when the wind/solar is not available. 21. Such flexibility seems to be very valuable as there will be times when generate more energy than required is generated, for the operator to have flexibility to bank some of the additional supply.
Objective	Want to match the energy supply mix from each component including its variability to meet the expected demand in the most cost-effective manner acknowledging that demand must always be met. The tolerance for black outs is effectively zero.
Benefits	• Energy demand will be met through a well thought out range of expected scenarios (including climate change scenarios)

	○ Low tolerance for black outs will be avoided by pre-planning • Energy mix will be provided in the most cost effective manner
Outputs	• Energy production profile of each energy mix (with ranges, uncertainties and unknowns built in) • Energy demand profile scenarios (with ranges and uncertainties or projections) • Optimisation tool to take into account component mix profiles as well as externalities
Activities	• Build profiles for each supply component • Build profile for demand
Inputs	• Last 20 years of energy usage to build a model around energy demand • Last 20(-100) years of climate information (solar, wind, rainfall, streamflow, dam levels, etc). 20 years gives typical; 100 years gives better sampling for extremes to inform design e.g. 1 in 50-year extreme event
Partners	• Energy suppliers • Climate data holders • Infrastructure designers

2	***Delivering decision-support climatic scenarios data for use in the energy sector***
Product/Service	Climatic projections for renewable energy generation, transmission and distribution
Description	Climatic scenarios for sector-specific impact studies, including generation, transmission and distribution of energy.
Objective	To provide the energy sector stakeholders with the relevant climate scenarios for the medium term (20–30 years) and long term (50–100 years) planning, according to the lifetime of the energy infrastructure (grid infrastructure, lines, stations, dams, equipment, management, power plants etc).
Benefits	• Inform and support political decision makers, • Assist energy sector managers in their pursue of efficient energy planning, • Address and support other concurrent sectors of the economy (e.g., farming, water management, including drought or flood control) • Inform and support the end users, including the citizens • Improve operational activities such as regulation of dams and rivers • Ensure the sustainability of the socioeconomic activities • Efficient environmental security planning
Outputs	• Since we are targeting different social, economic and technical segments, the output should be custom made to fill in the needs of the user. So, gridded data should be provided to the engineering and science communities. However, charts, tables, diagrams should be more appropriate for easier understanding and interpretation by policy makers. • Guidelines to conduct impact studies • Description of the methodology adopted so that it can be in principle applied to any region. • Software for downscaling and extracting the needed information for the preparation of impact studies. • Tools to interface climatic scenarios data with impact models. • Uncertainty assessment studies.
Activities	• Selection of appropriate model or combination of models. Analysis of models' performance/sensitivity. • If existing climatic scenarios for selected variables are not sufficient, then adapt or post-process for more refined information. • Search for existing climatic scenarios for selected variables (temperature and rainfall, for example) and their spatial resolution. These can be used directly or post-processed for refined information, if needed. • Formulate the output according to user needs (gridded data, graphics, etc)

	• Uncertainty estimation and capacity building. Ensure that the users are informed of the uncertainties and be able to incorporate this information in their own simulation and decision processes.
Inputs	• Securing the necessary hardware, software and other resources (look for partnerships, if needed), • Determine the time frame for projections so that we specify the objective (i.e., decadal versus climatic projections), • Collection, formatting and archiving of existing data/observations to be used in model validation and hindcasts, • Search for existing climatic scenarios for selected variables (temperature and rainfall, for example) and their spatial resolution. These can be used directly if they fulfil the needs.
Partners	• Politicians • Decision makers • Researchers • Energy regulators • Energy commissions • Meteorological services • Industry representatives • Regulators • Financiers • Citizens • Regional climatic centres

3	***Multi-year prospective climatologies for the energy sector***
Product/Service	Provision of guidance on how to project climatologies for the future (10 - 30 years)
Description	There is a need for guidance on best practices for generating coarse spatial resolution, but high temporal resolution climatologies that can be used as projections for the coming 10-30 years. The climatologies should include at least temperature and precipitation, and should retain realistic covariability in space and time. The information is to be used to help the energy sector anticipate significant changes in the demand and production pattern at regional scale
Objective	High quality climatologies for anticipating changes in future demand and possible disruptions to supply
Benefits	• Technical: better representation of possible climate outcomes to better operate existing energy systems by anticipating possible risks • Management: scientifically validated methodologies for defining climatologies; harmonization of definitions
Outputs	• Guidance document on methodologies for generating climatologies (short-term, GFCS year-4, i.e. first 2 years) • The climatologies themselves, designed and organised by region (defined by interconnection of power networks – typically sub-continental) (longer term, GFCS year-6 and 10)
Activities	*First 2 years* • RMP: Research on different methodologies (including dynamical, statistical and hybrid) for projecting climatologies that retain realistic temporal and spatial covariability. • UIP: More thorough regionally and nationally based needs assessments for climate information for planning needs for the next few years. In particular, the need for projections that represent multi-annual variability may differ from region to region, as may the climate parameters of interest, definitions of extremes, and acceptable validation criteria. *Subsequent 4 years*

	• CSIS: RCCs and some NMHSs generate climatologies using recommended methodologies. • CSIS: RCCs and some NMHSs validate climatologies with focus on extreme events.
Inputs	• Historical high temporal resolution climatologies • Decadal climate projections and relevant models (e.g., weather generators) • Reanalyses (including ensembles to represent uncertainties) • Validation criteria • Ancillary data for defining relevant spatial scales
Partners	• Climate research community • Statistical modellers • Transmission System Operators (TSO) • National regulation authorities • Power companies

4	***Training in the use of extended-range weather forecasts***
Product/Service	Two-way training on the need for and use of extended-range weather and intra-seasonal forecasts
Description	• There is a need for training of energy system manager and team members in the use of probabilistic forecasts, including ensemble predictions and multi-model ensembles • There is a need for training of climate scientists to understand the decision-making process and potential climate inputs of the energy sector
Objective	Raise the awareness and mutual understanding between the climate and energy sector
Benefits	• Better use of existing weather and climate information products • Improved service provision
Outputs	• Training programme addressing different needs of possible target audiences • Workshop reports and recommendations where appropriate • Trained personnel in the energy and climate sectors • Online training materials focused on specific issues
Activities	• CD and UIP: Formulation of a training programme addressing different needs of possible target audiences • CD: A series of two-way 1- to 5-day training workshops • CD: Development of online training materials focused on specific issues
Inputs	• Existing training materials, including online tools • List of training needs
Partners	• Climate research community • Energy community • Experts in training in cross-sectorial settings • IT experts for online materials

5	***Seasonal forecasting for hydropower production***
Product/Service	Provision of seasonal forecasts of dam inflow
Description	There is a need to improve inflow 1- to 12-month forecasts at the scale of the watershed
Objective	Optimise management of water resources for generating power in the context of multiple uses
Benefits	• Better reservoir management, including less frequent water shortages for power generation and other uses • Decreased cost of power generation • More reliable and cheaper supply of energy

	• Provision of information at appropriate resolutions
Outputs	• Ensemble (rather than probabilistic) forecasts of monthly or seasonal accumulated dam inflow for the next 1 to 12 months • Monthly or seasonal ensemble forecasts of daily rainfall and temperature for the next 1 to 12 months
Activities	• RMP: Research to improve forecasts • RMP: Downscaling of climate information to relevant spatial and temporal timescales • UIP: Working groups to assist in the design of the forecast system, and to address possible constraints in using the information (e.g., legal constraints on standard operating procedures) • RMP and UIP: Pilot studies to demonstrate value of using seasonal climate information
Inputs	• Basin-level hydrological models • Monitoring and recent historical climate information for operational forecasting • Historical climate and river-flow information for verification and for training of statistical models
Partners	• Research community • NMHSs • Dam managers

6	***Seasonal forecasting for energy demand***
Product/Service	Seasonal forecasting temperature with a focus on high-impact events
Description	There is a need to improve on the widespread use of climatology of anticipating anomalous periods of demand for energy
Objective	Improve anticipation of large fluctuations in demand for energy, and thus reduce the risk of power disruption
Benefits	• Better anticipation of high-impact weather events resulting in improved management of demand-supply balance; better scheduling of use of production units • Lower production costs
Outputs	Prototype forecast products for high-impact temperature events (defined in terms of area, duration and intensity)
Activities	• RMP: Improve forecast skill generally, and investigate predictability. Verification. • UIP: Interaction to define criteria • CD: Training • CSIS: Seasonal forecasts
Inputs	• Historical temperature data • Historical demand data • Seasonal forecasts • Downscaling tools • Criteria for definitions of relevant temperature events
Partners	• Research community • NMHSs • TSOs • Energy companies

7	***Observations and reanalysis data for energy***
Product/Service	Observations and reanalysis data needed for specific uses for power generation, demand estimation and assessment of risks associated with extreme events

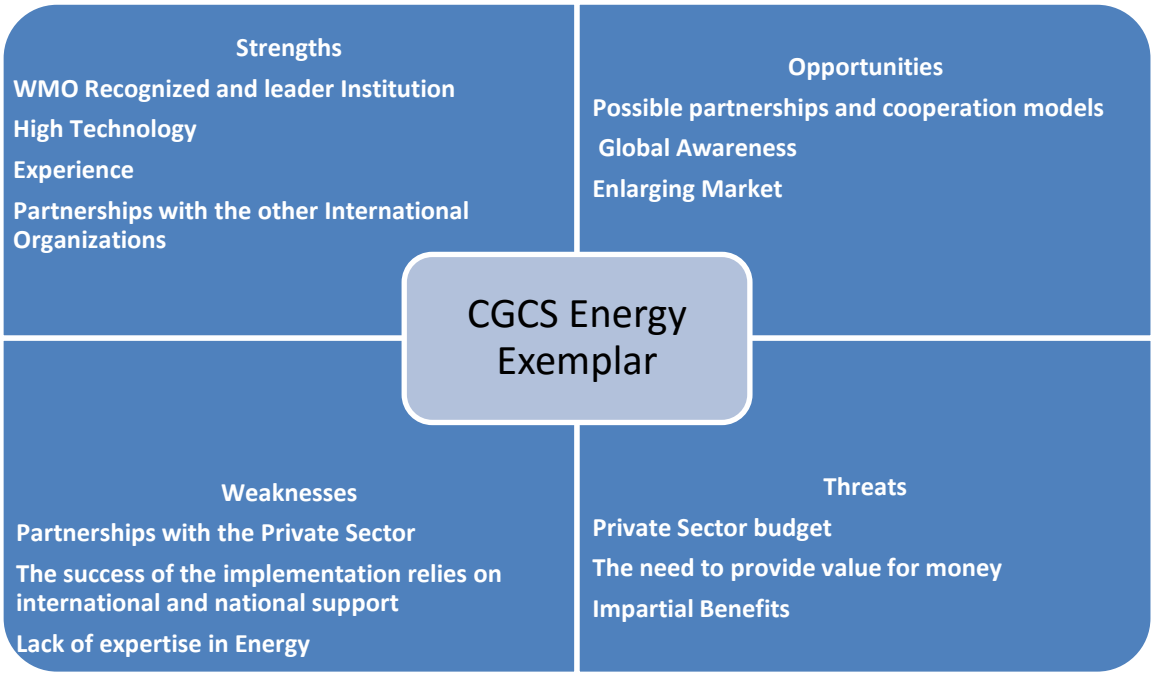
Description	Meteorological variables needed for conversion to energy demand and supply and for estimation of risks
Objective	Increased efficiency and cost-effectiveness at various stages of planning, design, and operation through the use of data in support of decision-making
Benefits	Data inputs for improved: • Long term plans • Resource assessments • Financing • Forecast development • Climate change scenarios • Risk assessment for design and management and insurance resulting in improved outcomes for associated stakeholders
Outputs	Solar data • Global Horizontal Irradiance • Direct Normal Irradiance • Cloud images • Temperature (efficiency of PV) • Wind gusts for risk assessment • Hail for risk assessment Wind data • continuous wind speed and direction at different heights (80-100m) • temperature (monthly summaries or more frequent) • pressure • roughness/land use Hydro data • precipitation • soil moisture • river flow • wind • temperature • humidity • soil type • land use • floods Ocean data • wave height • wave direction • wave spectrum • bathymetry • salinity • current • tides • sea level Extremes can be characterized from the above by specifying location, duration, magnitude and timing
Activities	• Define the requirements • Inventory available information • Evaluate usability/suitability of available data • Define quality control and assurance criteria • Perform appropriate downscaling of reanalyses

	• Construct data product meeting requirements from available data if necessary (e.g. reanalysis, blended product)
Inputs	TBD
Partners	• NMHSs • GEO • IRENA • World Bank ESMAP • Private sector (including as sources of observations, as well as consumers) • Insurance companies • IPPs • Research centres and academia • Comprehensive nuclear Test Ban Treaty Organization (observation network and international data center)

3.0 SWOT Analysis

A SWOT Analysis (strengths, weakness, opportunities and threats) has been elaborated, examining the GFCS Energy exemplar from an internal (WMO and its network) and external (targeted market, relevant competence, society and other energy stakeholders) perspective.

By strengths all the core advantages and fortress are described, as important elements for the implementation and success of the project; weaknesses or drawbacks can be understood as all the negative inner features that do not contribute to the most efficacious project achievement; opportunities describe all the possible situations existing in the society that may contribute to positive outcomes; by threats all the risks and possible menaces that cannot be controlled from the inner perspective and that could affect in a negative way are described.



Strengths

- **WMO recognized and leader institution**

WMO is one of the most recognized organizations in climate and weather information, accounting with a sound leadership on climate services provision.

- **Sound Network**

WMO operates through a network of 191 members in 6 different areas of the world, covering all the world's areas. NMHSs act as implementers and delivers of weather and climate services.

- **Accurate Information**

The climate information generation relies in the high technology and scientific processes.

- **Experience**

For more than 65 years, WMO has acted as the United Nations specialized agency, to bring together international cooperation in the field of meteorology, hydrology and geophysical sciences.

- **Partnerships with the other International Organizations and Development Entities**

Besides WMO members, other inter- and non- governmental, regional, national and local stakeholders have worked in partnership to develop targeted climate services.

- **GFCS as an enabler**

As the global mechanism to bring together efforts to improve the quality, quantity and application of climate services, GFCS sets the framework for Climate Services applied to the Energy Sector. Different UN agencies (WHO, WB, UNDP, IFRC, UNISDR, WFP, UNESCO, FAO) have related activities and programmes to plan and implement the GFCS, their mandates and priorities are being aligned too.

Weakness

- **Partnerships with the Private Sector**

WMO as an international organization, does not have a high amount of partnerships with the private sector agents, still WMO has the possibility to improve this situation and be able to bring together efforts to have collaborations with important private entities.

- **The success of the GFCS Energy Exemplar implementation relies on international and national support**

WMO acting as the project leader requires a sound support from all its network and especially from the collaboration of key agents as the private sector and other relevant energy stakeholders.

- **WMO team**

As Energy has recently selected as a priority area of the GFCS, the energy expert team is not as enlarged as some other areas within WMO, however the participating team has a high level of technical qualification, and works closely with experts in other related areas as hydrology, biofuels, business and other crucial areas. Nevertheless this possible weakness is expected to be mitigated through the collaboration and partnership with some other agents (councils, academia, organizations, private and public sector).

Opportunities

- **Global Awareness**

The concern about a better energy system (more resilient and cleaner), has been spread worldwide and will continue to do so, as the global related policy framework is being adapted to fulfil sustainability objectives. Indeed global efforts have been oriented to create an adequate guideline for the deployment and development of cleaner technologies (most of them highly dependent on climate information for their best operation).

As a particular case, Sustainable Energy for All (SE4ALL), was launched at the end of 2011, as a UN initiative, and has been extended worldwide. The initiative intention is to sum efforts for improving energy access in our days, based in a sustainable strategy, and calling for the participation of different agents of the society.

- **Possible partnerships and cooperation models**

As a result of the global awareness that has been described, and some other drivers, there are several organizations (public, private and NGO's) working and developing similar, complementary or related projects, with the aim of creating a more sustainable society (especially focused on the energy system improvement) and mitigating the GHG effects, among other environmental objectives, hence strengthening cooperation with other multilateral and bilateral development agencies (either governmental and non-governmental) civil society, private sector and other agents can be very feasible and resourceful, all bringing efforts for best achieving shared objectives.

- **Enlarging Market**

Due to the increasing energy demand and the need to satisfy it with cleaner technologies, the market for providing climate services to the energy utilities will continue to be extended.

Threats

- **The need to provide value for money.**

Climate Services can be considered as public goods, then providing climate and weather services to the energy sector can represent a challenging task, as WMO will need to partner in non-common ways with the industry, playing different roles as the ones that have been played until now, demonstrating the added value that the GFCS Energy Exemplar brings to the energy sector.

- **Challenging tasks**

WMO as a scientific and non-governmental agency does not have a high expertise in some key areas to successfully implement the GFCS Energy Exemplar, as marketing, retailing and pricing strategies (business related areas), then extra efforts and appropriate expertise may be required to ensure the correct implementation of the process.

- **Stakeholders acceptance**

Even as the awareness about the importance of cleaner and more sustainable energy processes is now being enlarged, the relationship among climate services and the energy sector may not be very advanced or recognized, especially the benefits from the climate information for decision makers have not been threaten as a priority element for the efficacy among stakeholders, then proven examples may be necessary for reinforcing the importance and utility (profitability) of the services in the sector. This threat could be mitigated as the evolution of the process happens, strengthening the perception and acceptance of the targeted sector and some other crucial agents.

- **Impartial Benefits**

Climate Services may not be generated in the same way (type and quantity), even as the most adequate quality standards are included in all the implementation activities and procedures. The distinction perceived is related to the differences among the countries or regions, thus in order to mitigate this threat the need of reinforcement from a technical perspective may be required in some countries or areas.

- **Country's needs; agent's needs**

Climate Information needs may vary considerable from country to country, then generalized proposed processes or services could represent a greater challenge, varying from utility to utility, being resource demanding (human, financial and technical).

- **Diverse implementation methodologies**

Differentiation among big and small utilities could represent another crucial element for the implementation of the GFCS Energy Exemplar, then the proposed implementation methodologies (pricing, membership, partnership and licensing model) are very different among them, and may not allow to create an expertise in the first years of the project.

- **Private Sector budget**

Similarly, as the previous threat, the differences among the energy stakeholders, and related with the economic, technical or expertise capacity of the agents, may influence on the budgetary assignation to participate in the project, a market bias and a final supply price driver can be generated of these differences, leading to not fully benefit all the targeted users, but instead to become an advantage for the companies who have the higher resources.

4.0 Market Analysis Summary

Learning about the industry will help to define the implementation methodology that best suits the energy features (together with the offered services characteristics), as there are several external conditions that can affect the development of the project. The greater the knowledge about the industry, the greater the advantage and the possibility to have more successful results.

The energy market analysis includes a description of the energy subsectors and activities, the industry economics, relevant participants, distribution patterns, possible competitors, and other relevant market information.

4.1 Market Segmentation

A market segmentation will ease the way of interacting with the different agents and utilities of every stage of the energy provision chain, leading to a detailed and tailored interaction with the targeted sector.

As one of the cornerstones of the implementation of the Exemplar is to improve the resilience of the energy sector with the development of climate services, a classification of the main generic stages and their climate

information requirements is now presented, identifying key elements of the energy industry operation in a wide view:

Identification & Resource Assessment – Requires climate information (historical and projected) for an initial assessment of the energy resource and the required infrastructure, and for management of weather/climate hazards and risks.

Impact assessments (including infrastructure and environment) – Requires detailed and tailored weather and climate information (historical and projected) for codes, standards, site-specific designs and policy, to assist with the construction and maintenance of the energy system infrastructure (e.g. power plants, solar collectors or coal mines), including connecting infrastructure for energy transmission, distribution, and transfer. It also requires detailed site-specific and regional climate information (mainly historical) for assessments and mitigation of impact of energy systems on the surrounding environment (e.g. air quality modifications), on human health (e.g. air particles), and on ecosystems (e.g. solar plants, marine turbines) and wildlife as well as potential contributions to GHG reduction.

Site Selection & *Financing* – Requires highly detailed site-specific climate information (mainly historical) for rigorous resource assessment, risk management and financial closure.

Operations & Maintenance – Requires highly detailed site-specific weather and climate information (predicted, historical and projected) for efficient running of the energy system as well as for site maintenance (e.g. on/off-shore wind turbines or oil rigs)

Energy Integration – Energy supplied by individual generators needs to be dispatched in a balanced/integrated manner to suitably meet energy demand

Market trading (including supply and demand forecasts) & Insurance – Requires highly detailed weather and climate information (predicted and historical) for efficient use of generated energy via optimal balancing of supply and demand as well as for pricing of insurance structures used to hedge against market volatility and/or risks to assets, such as wind farms, oil rigs and transmission infrastructure.

Energy efficiency – Requires highly detailed climate information (predicted, historical and projected) for an efficient use of generated energy via measures such as optimal infrastructure siting or use of shading on hot days to offset air conditioning energy use.

For each of these focus areas, the requirements for climate services are mapped against each of the five GFCS pillars:

1. User Interface Platforms (UIP) – forums for forging the stakeholder relationships needed to define needs and respond to requirements for climate information and services in particular sectors and contexts
2. Climate Services Information System (CSIS) – for producing and distributing climate data and information tailored for policy- and decision-support
3. Observations and Monitoring (Obs/Mon) – for generating the necessary data for the development of climate services
4. Research, Modelling and Prediction (RMP) – to advance the science needed for improved climate services and climate-related outcomes

5. Capability Development – aimed at supporting the systematic development of the institutions, infrastructure and human resources needed for effective climate services, accounted for in each of the four above pillars.

Making a market segmentation allows the particular objectives to be better identified and pursuit, it also allows to better assess the available resources (internal and external). A second classification has been done, based on the particular activity of the chain value of the energy process (or energy subsectors).

Generation: thermal, solar, wind, nuclear or chemical energy is transformed into mechanical energy, and then into electrical energy. Each type of energy represents a very different opportunity to provide tailor-made climate services, as the particular requirements may differ considerably.

Transmission and Distribution: after generating the electricity, it is normally transported in very high voltage lines (between 220 and 500 kV) to the distribution network, where it would be subsequently transformed in a lower voltage, to be supplied to final users. Even if the climate services for transmission and distribution may be different, some of the infrastructure used in both situations is normally shared and may face similar threats and weather and climate variability risk exposure.

Retail markets, emission market trading and risk hedging activities: similar as the previous sub segments each section represents a very unique part of the process with very particular features, nevertheless these three can be grouped as upstream activities. And even as the useful climate services may not be very straight forward to be identified, especially as there is no physical infrastructure directly related with their core operations, different can be identified for the possible interest and benefit for the companies of this category.

Integration models and other public policies: as another particular target group, decision makers related with the long term decisions may be also segmented, where relevant topics as interregional market integration, national generation mixes and other relevant policies creation processes may be included as benefiters of tailor-made climate services provision.

Another important task of the segmentation, is to analyse how big is each subgroup in terms of economic, human and technical resources, acting as reference of how economically valuable it could be to prevent any damage from extreme climate hazards or any loss on the normal operation process caused by weather and climate variability and how interesting is for each subsector to participate in the project.

A future expected scenario based on more sustainable regulatory policies is yearly made by the International Energy Agency (IEA), projecting the evolution of the market for every energy activity in the long term. To estimate the future size and relevance of the interest groups, some highlights of the report are now presented. (2014 and 2015 Energy Factsheet report available at http://www.worldenergyoutlook.org/media/weowebsite/2015/WEO2015_Factsheets.pdf and http://www.worldenergyoutlook.org/media/weowebsite/2014/141112_weo_factsheets.pdf).

Generation

The world's appetite for electricity lifts demand by more than 70% by 2040, and there is a concerted effort to reduce the environmental consequences of power generation. Renewables overtake coal as the largest source of electricity by the early-2030s and account for more than half of all growth over the period to 2040.

Oil and Gas

World energy sector investment totals $68 trillion from 2015 to 2040, of which 37% is in oil and gas supply, 29% in power supply and 32% in end-use efficiency. Of the power generation capacity investment in the New Policies Scenario, more than 60% goes to renewables, led by China, the European Union, the United States and India. While often less prominently discussed, energy efficiency investment (led by transport and the buildings sectors) is no less important in scale than other parts of the energy system.

Renewables

The share of renewables in total power generation rises from 21% in 2012 to 33% in 2040, as they supply nearly half of the growth in global electricity generation. Renewable electricity generation, including hydropower, nearly triples over 2012-2040, overtaking gas as the second-largest source of generation in the next couple of years and surpassing coal as the top source after 2035. Rapid expansion of wind and solar PV raises fundamental questions about power market designs: their ability to ensure adequate investment in conventional power plants and long-term reliability of supply. China sees the largest increase in generation from renewables, more than the gains in the EU, US and Japan combined.

Biofuels

Biofuels use more than triples, rising from 1.3 million barrels of oil equivalent per day (mboe/d) in 2012 to 4.6 mboe/d in 2040, by which time it represents 8% of road-transport fuel demand. Advanced biofuels, which help address sustainability concerns about conventional biofuels, gain market share after 2020, making up almost 20% of biofuels supply in 2040. Reflecting limited cost reductions and increasing use, subsidies to biofuels increase steadily and make up 20% of cumulative renewable energy subsidies over the projection period.

Transmission and Distribution

Global investment in the power sector amounts to $21 trillion through to 2040, with over 40% in transmission and distribution networks. Residential electricity prices increase in nearly all regions, in part due to rising fossil fuel prices. However, electricity becomes more affordable over time in most regions, as income levels increase faster than household electricity bills.

Retail markets, emission market trading and risk hedging activities

By 2035, investment in low-carbon energy supply rises to almost $900 billion and spending on energy efficiency exceeds $1 trillion, double the respective amounts seen in 2035 in the New Policies Scenario

As energy customer’s needs are changing rapidly, the market is responding at the same speed, the new energy world tends to be greener and more decentralized, if it could be described in a couple of words; still the general lines of the emerging market do not describe how diversified it is and will continue to be. From the large international companies, to the smaller ones, from the monopoly energy systems to the vertical oriented ones, among other differences. It is clear that this diversity will continue to enlarge as the technology and some other energy trends continue to evolve, and could lead to a big challenge for the provision of tailor-made climate services, as the required efforts to adapt the resources could become a threat. On the other hand, the accumulated know-how and the increasing expertise, after the project is implemented in different energy systems of the world will help to provide the most innovative customer solutions to provide fully tailored services.

4.2 Target Market Segment Strategy

In order to better satisfy the needs of the identified target market, segmentation may also include a specific strategy to attend each group necessity.

Further description and detailed information to define the best strategy for each subgroup is available in the Annex 5. Climate Services for the Energy Sector Handbook.

4.3 Market Needs

For providing tailor-made services, oriented to satisfy the real market requirements, different needs assessment processes may be required, then NMHSs will act as the primary enablers for gathering the adequate information about the particular needs of each energy system stakeholder.

Strong communication among the NMHS and the Energy Sector is mandatory not only for the identification of needs, but at all the time frames of the GFCS Energy Exemplar implementation, (as part of the fully interactive process that has been defined and for the customer orientation that characterizes the project).

With the aim of identifying the industry real needs, some valuable interaction can also happen among partner organizations such as emergency management agencies, national/regional energy organizations, business councils or any other leader entity that interacts with the energy sector.

WMO is highly interested in avoiding the duplication of efforts from NMHS or any other participant, as some sectorial needs assessments or any relevant reports have been done in different countries, that could provide generic or particular information, useful information may be already available related with similar energy systems in another country (systems that share characteristics as the main generation sources or grid structure, etc.), as even as the characteristics of each system could vary considerably, but there could always be valuable information and experiences that are worth to be shared among NMHSs.

Other key agents to be mentioned for the market needs assessment, are the sectorial stakeholders that could include agencies, organizations or civil society, representing a proactive channel to gather information or to recover related documents, as some previous information assessment that have been done and that contribute to WMO and the NMHSs to adopt new roles, and to establish new communication models, being possible to interact in a multidirectional way (dialogue and feedback from stakeholders).

In any of the cases, identifying the target benefiters' needs may include an initial research about expressed needs from the sector, with this aim a marketing research is proposed. Adaptation to the particular features of every country or region may be required.

As any market research, particular steps are required to successfully develop the needs information gathering, here a general description of the process to facilitate the adaptation for each energy system.

- Objective definition: for the Energy Exemplar implementation, identifying the final user's needs is crucial to develop or adjust the climate services for providing the most adequate tailor-made climate services. This core step will help to develop a more focused and effective market research. As has been noted the general objective of the research is to identify the energy industry needs in the selected country or region.
- Research design: definition of the methodology to apply the research (survey, focus group or other), and to determine the question´s structure.
- Research tool design: definition of the questionnaire if the survey methodology has been chosen. For focus groups, questionnaires may be applied by the moderator, together with some other materials. With the aim of having an efficient set of questions, it is recommended to previously test the survey with a small selected audience, being able to opportunely make any necessary adjustment for a better outcome.
- Audience selection and Data Collection: According to the general and specific goals of the market research, the audience has to be matched. Then the next step and depending on the research methodology that has been selected, is to run a focus group or implement the designed survey.
- Data analysis: Initial structuration of the information may be followed by the preparation of summaries, using the available and most adequate analysis tools for organizing the information (as SPSS, Excel or any other convenient software).
- Results communication: presenting the identified trends or any other valuable information through charts, tables, or any graph may be very useful to overview the results, however differentiation among the qualitative and quantitative data must be highlighted, as the way to process and present them differ considerably.

  An example of a survey to be applied as part of the market research can be found in Annex 1. The objective of this research is to gather information about the use of the climate services within the project benefiters, please note that some of the searched information could already be known if an initial need's assessment is available.

  The objective of the application of the proposed survey in Annex 1 is to know in more detail the climate services management in a selected area or energy subsector, enhancing the tailoring of the climate services according to their particular characteristics and needs.

  Further research and detailed information gathering may be required according to the specific particularities of the selected project or depending, on the information that is available for the targeted country or region.

4.4 Market Trends

The number of global processes and agreements that continuously, help to raise the profile and urgency of strengthening met/hydro services is increasing year to year, some worldwide spread initiatives can be highlighted: as the UN sustainable development goals, the framework for disaster risk (under the auspices of the United Nations Framework Convention on Climate Change), the Paris Agreement, among other public and private initiatives. Moreover, as the interest, demand and awareness of the importance and affection of climate change, weather and climate variability for primary sectors (especially for the energy

sector) will continue to be highlighted, a higher number of publications and initiatives are anticipated to come in the next years.

Supported by the existing programmes and frameworks, technological advances, available resources, final user's and society participation and other drivers, the energy sector will continue to incorporate a higher share of renewable energy in all the regions of the world. However, the cleaner energy deployment may not be similarly spread among the world (as several economical, technical and regulatory constraints influence the decision).

As a clear example of the sustainable perspective trend, renewables-based generation is expected to reach 50% of the total generation in the European Union by 2040, around 30% in China and Japan, and above 25% in the United States and India (WEO, 2015).

In Parallel to the renewable energy incorporation to the energy mix, some other remarkable trends for the energy sector are the incorporation of batteries, and other sources of storage, smarts grid, electric transportation and new forms of energy generation (WEO, 2015).

4.5 Market Growth

The energy market is expected to enlarge as a response of different economic and social circumstances, in parallel with the world population (for the year 2040 will increase to 9.157.233.000) (Population Pyramid of WORLD in 2040, 2016). Nevertheless, the efficiency in the new technologies in the whole energy industry will try to constraint the global demand.

The energy demand is expected to react to the development of some other sectors, and by having this information available, some generation sources focusing may be eased and opportunely used.

Figure 1. World Final energy consumption by sector

	1990	2012*	2020	2025	2030	2035	2012-2035**
Buildings	2 228	2 929	3 171	3 337	3 513	3 691	1.0%
Industry	1 813	2 607	3 063	3 254	3 391	3 541	1.3%
Transport	1 581	2 478	2 840	2 999	3 157	3 322	1.3%
Non-energy use	479	818	991	1 069	1 131	1 183	1.6%
Agriculture	181	196	221	233	244	253	1.1%
Total	6 281	9 028	10 285	10 892	11 436	11 990	1.2%

* 2012 data are preliminary estimates. ** Compound average annual growth rate.

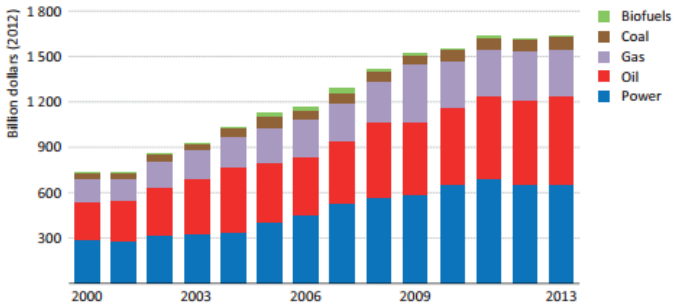
Note: Mtoe ■ million tonnes of oil equivalent.

Source: (WEIO, 2014)

For achieving the expected and efficient growth, more sustainable and secure policies are required, especially for deploying the renewable power sources in a faster and more resilient way. Some of these policies have been employed in the past years, i.e. the subsidies to aid the deployment of renewable energy technologies in the power sector were $112 billion in 2014 (plus $23 billion for biofuels) Source: (IEA, 2015). Particularly the global wind energy market has acquired and will continue to have a preponderant role of the most deployed technologies. For 2013 it was worth $130 billion in 2013 and $165.5 billion in 2014. The market is expected to grow at a compound annual growth rate (CAGR) of 7.2% between 2015 and 2020 resulting in $176.2 billion in 2015 and $250 billion in 2020. (Wind Energy: Global Markets - EGY058B, 2016)

As the tailor-made climate services provision that the GFCS Energy Exemplar has decided to implement does not cover only the renewables subsector, but it is intended to be a support tool for all the different subsectors and activities, the expected investment in the complete energy industry may be revised.

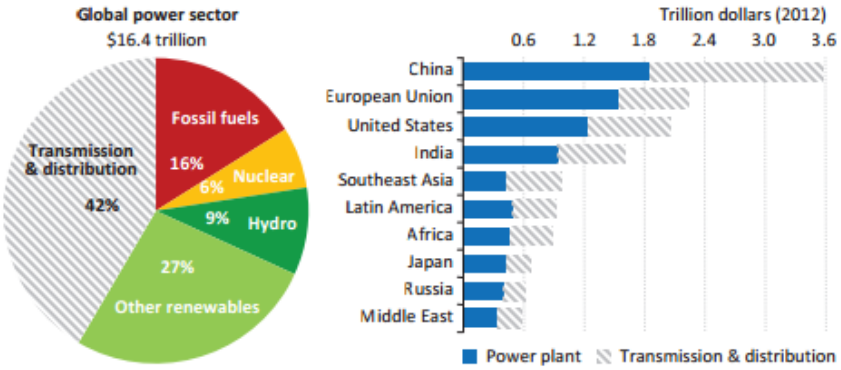
Figure 2. Investment in global energy supply



Source: (WEIO, 2014)

Over the period to 2035, the investment required each year to supply the world's energy needs rises steadily towards $2 000 billion, while annual spending on energy efficiency increases to $550 billion (IEA, 2014).

Figure 3. Cumulative global power sector investment by type and selected region, 2014-2035

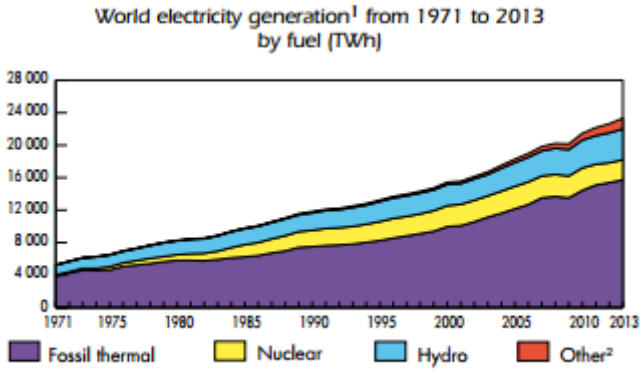


Source :(IEA, 2014)

From a wide perspective, it can be expected that not only policies will tend to prefer lower carbon energy options, but from the technical, technological and cost perspective, positive trends will favour renewable energy increase and the less cost efficient to fall or disappear.

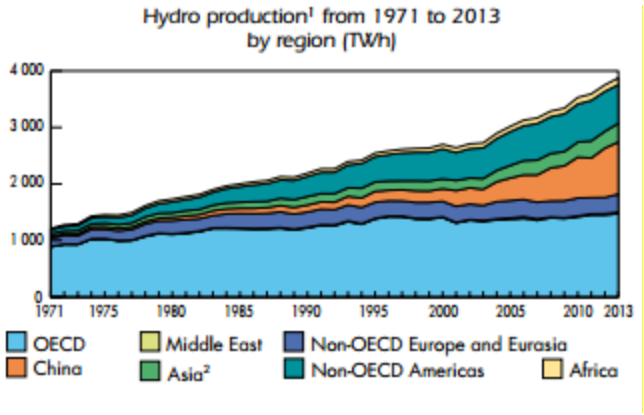
Continuing with the information that has already been presented of the market growth. Some remarkable and detailed figures about the past evolution of the electricity generation and hydro power production (including a world distribution) are now presented, being part of the 2015 assessment about the future of the energy sector done by the IEA in 2015.

Figure 3. Electricity generation by fuel



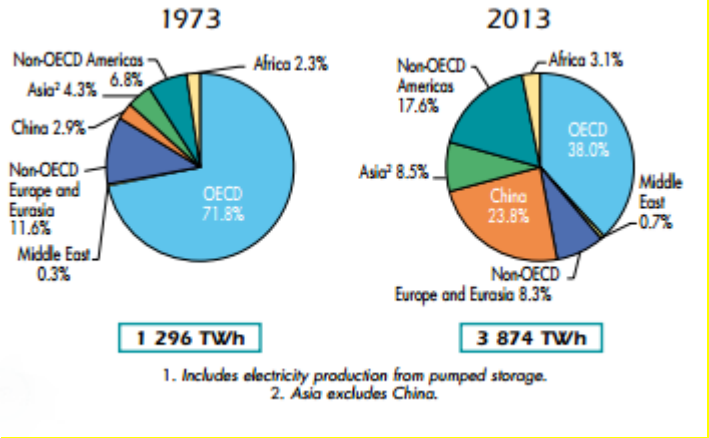
Source: (IEA, 2015)

Figure 4. Hydro production



Source: (IEA, 2015)

Figure 5. 1973 and 2013 regional shares of hydro production



Source: (IEA, 2015)

It is clear that the energy market will continue to be enlarged and the generation options will continue to be modified, however limiting the world demand is one of the objectives of different global initiatives for being able to create a more sustainable system and reach the goals that have been settled around a cleaner energy industry. Then efficiency will play a crucial role. Tailor-made climate services represent an opportunity for improving the related and necessary efficiency regulation, the improvement of energy systems through these policies has been proven. In OECD countries, efficiency measures reduce demand growth to 60% of what would otherwise be expected (IEA, 2015).

4.6 Key Participants

The possibility to orient the climate services to the customer's needs opens a wide field of benefiters, as noted before, climate and weather information interfere in their operation and planning processes, and different types of partnerships or relationships can be built among them, however with the aim of

concentrating efforts and being an starting point for the project implementation, a list of energy related associations is now presented for some processes of the energy provision chain.

Key identified participants according to the market segmentation B (section 4.1 Market Segmentation)

Generation:

- Geothermal Energy Association
- World Bioenergy Association
- International Hydropower Association (IHA) (International)
- International Solar Energy Society
- Solar Cookers International
- Solar Energy Industries Association (SEIA)
- World Wind Energy Association
- Organization of Petroleum-Exporting Countries (OPEC)
- International Network for Sustainable Energy
- Renewable Fuels Association

Transmission, Distribution:

- European Network of Transmission System Operators for Electricity
- European Network of Transmission System Operators for Gas
- European Distribution System Operators' Association for Smart Grids

Wholesale and Retail markets, emission market trading and risk hedging activities:

- National Energy Marketers Association
- Energy Storage Association
- Alliance for Financial Inclusion (AFI)
- Bank for International Settlements
- OPEC Fund for International Development (OPEC Fund)
- World Bank Group
- World Trade Organization (WTO)
- European Association of Public Banks
- Global Federation of Insurance Associations: GFIA

Integration Models and other public policies:

- Organisation for Economic Co-operation and Development (OECD)
- Clean Energy Business Council
- Renewable Energy and Energy Efficiency Partnership (REEEP)
- Geothermal Resources Council
- Global Wind Energy Council
- Biomass Thermal Energy Council (BTEC)
- European Renewable Energy Council
- Green Power Forum
- Sustainable Energy for All (SE4ALL)
- International Renewable Energy Agency
- World Council for Renewable Energy
- International Energy Agency
- Energy Charter
- Energy Community
- International Energy Forum (IEF)
- Agency for the Cooperation of Energy Regulators (ACER)

Even as the project is intended to be implemented by priority countries' selection at the first stages, some consecutive or parallel pathways may be implemented for the participation and engagement with some key international companies. A list of significant energy agents is now presented, being highlighted by their size, capacity or market share:

Company's Name	Country	Description	Source of Generation	Market Value
Duke Energy	United States	Delivers energy to 7.2 million customers. With 57,700 MW of capacity.	Diverse sources, including renewables.	$49.3 billion
GDF Suez	France	117.1 GW of installed power-production capacity Inc. 21.5GW (18.3%) in renewable energy. 8.1 GW of capacity under construction.	Diverse sources, including renewables.	$45 billion
Southern Co.	United States	It has 4.4 million customers and nearly 46,000 megawatts of generating capacity.	Coal and fossil fuels	$39.6 billion
EDF	France	With 28.6 million customers in France, and operations around the world	Mainly nuclear and hydropower	$35.3 billion
Iberdrola	Spain	Global enterprise, with around 32 million customers and several subsidiaries	Different generation sources. High	$33.6 billion

			volume of wind energy production	
Dominion Resources	United States	approximately 25,700 megawatts of generation	Focused on natural gas	$32.7 billion
E.ON	Germany	E.ON is an international privately-owned energy supplier, with more than 26 million customers	A majority of renewable energy can be observed	$32.5 billion
Enel	Italy	Global enterprise with 39,979 MW of installed capacity.	Different generation sources. High volume of wind energy production	$32.2 billion
NextEra Energy	United States	Operating in North America approximately generating generates 17,771MW.	Focused on wind and power	$31.6 billion
Exelon	United States	34,700 MW of owned capacity.	Generation from nuclear, natural gas, hydro, wind and solar	$28.5 billion

Source: own elaboration from companies´ webpages and http://www.energydigital.com/utilities/2679/Top-10-utilities-companies-in-the-worl

4.6 Competition

Supply and demand are time to time the mayor drivers in a market place. Demand as how much consumers wish to be provided and supply how much producers offer. Then as any normal good or service market, competition may also be considered for defining the best GFCS Energy Exemplar implementation.

Responding to the energy trends and specially to the increasing deployment and localization of renewable sources in the world, some areas in the world have a higher concentration of renewable share of their total generation than others, thereafter climate services provided from private entities have increased faster in some regions than in others, nevertheless empowerment of public climate providers has also occurred.

4.7 Competitors and Alternatives

As climate service provision could include a wide range of specific options, defining the competitors can become a though task, however some existing private and public entities have been identified, as providers of similar services.

The available alternative climate service providers, are presented as possible counterparties, different ways to partner are presented in section 5.2 Implementation Methodologies, bringing together efforts that can increase the credibility and success of the GFCS Energy Exemplar implementation, reducing individual resource use or duplication of efforts.

Climate information and data assessment and provision require a multidisciplinary approach, then strengthening linkages between different expert groups, stakeholders and especially alternative service providers, represent a great opportunity to better know the target group and have a more customer oriented climate services provision.

With the aim of engaging key members that will contribute to achieve common goals, some institutions and programs have been identified, for developing cross-cut alternatives and are presented in Annex 2, as Complementary/alternative methods and tools for climate risk assessment.

An increasing number of private companies provide climate services with the orientation of having an added value on them, being more interesting and useful for users and especially for the private sector of different industries. These entities are continuously developing tools that help their benefiters to manage climate-related risks in the most effective ways.

It has to be noted, that some of these companies do not generate the weather and climate information, but act only as information gatherers and providers, in any case they sell climate services to users (added-value can happen or not). Some identified entities are:

The weather company. www.theweathercompany.com/

Climate Risk Analysis. www.climate-risk-analysis.com/

Climate Corporation. www.climate.com/

Predictia. www.predictia.es/

Prescient Weather. www.prescientweather.com/

Climpact. www.climpact.com/

4.8 Competitive Advantage

Different advantages can be recognized for the GFCS Energy exemplar, as the initiative itself represents an innovative solution to improve the resilience of the energy sector, covering an important gap that has been identified in the sector, where new and creative partnerships will be developed among the participating agents, and WMO and the NMHSs will cope their efforts and resources for developing new roles and ways to participate in the challenging and evolving energy sector.

Some elements have been defined as pillars for the management of the GFCS Energy Exemplar to be included in the climate services, and helping to consolidate the climate services as an efficient and world spread reference tool for improving the resilience of the energy sector:

- *Products* – generating and making available a set of historical, real-time, and prospective products about climate variability and change and their impacts; and,
- *Support* – providing assistance in the interpretation of those products and in the identification of a sensible set of decision options;

- *Feedback* – communicating between users and providers so that ways of improving the products and support can be identified on an on-going basis.

Then the competitive advantage of the project is its customer orientation, as the value-adding process of the GFCS Energy Exemplar to the energy sector, through the provision of targeted services to specialized applications and decisions processes (providing information not only relevant and trustworthy, but opportune and useful for the benefiter's needs).

5.0 Implementation Summary

5.1 Implementation Plan

With the firm perspective to provide to the energy sector a channel to improve their overall resilience, tailor-made services to enable timely and appropriately the best reaction to face the risks and opportunities arising from climate change and climate variability, the GFCS Energy Exemplar aims to be the supporting and practical tool for defining the best strategy based on scientific knowledge of climate information and predictions, and that may be incorporated in the processes of policy and operation planning of the benefiters. In order to pursue this last objective, an adequate implementation plan that seeks to integrate the different times frames of the energy sector has to be selected.

As expected, the GFCS Energy Exemplar is intended to be an ongoing project for a long time and which scope becomes greater through time, so that it converts into an international reference and especially a making decision pillar in the energy sector worldwide.

Another key objective of the implementation of the GFCS Energy Exemplar, is to contribute to demonstrate the value of the project, highlighting the circumstance that the provision of climate services benefits the principal recipients (energy stakeholders).

Moreover, the effective initial implementation of the GFCS Energy Exemplar, can have a positive impact on the execution of new and subsequent stages of the ones that have been defined up to now. Similarly, a successful implementation process can ease the project spread through the selected priority countries and non-priority ones. And can facilitate to define and implement other GFCS projects (although not been included in the energy industry or any of the other GFCS four priority areas) in any industry sector that could be improved through the provision of tailored climatic services.

Four specific methodologies have been selected as the possible implementation channels, independently of the selected approach some generic implementation activities are listed below:

- The utilization of specific administrative tools are suggested to be applied for a better implementation process of the project, most of these techniques are well-known and documented information is available about them, easing their use, as could be the case of the Gantt charts (highlighted for their popularity and easiness to be used), helping to structure the

project implementation and to identify the relationship and sequence among the activities, prepare progress reports, and help to analyse trade-offs, among other benefits.

- Increase the capacity to reduce risk threats and rise the resilience of the energy sector through continuous and specialized user training. Considering that the involved actors are very different, it will be necessary to organize user groups by type of activity or subsector.
- Promote a disaster risk reduction component to be included in the regional and national frameworks and plans, especially oriented to reduce risks affecting the energy system of the country or region through the correspondent climate information and services.
- Provide guidance on the development and implementation of extreme weather events early warning systems in the energy sector, leading to a better and more coordinated relationship among the institutions related to disaster risk management, the correspondent authorities and the private sector.
- Coordinate national or regionally programs on climate change, fitting all the relevant relationships and sources related to sustainable development and the energy sector, so that focal synergies are achieved and existing channels that facilitate the GFCS Energy Exemplar execution are leveraged.
- Strength regional and national support networks, in order to increase institutional capacities to benefit the priority selected sector, and ease the current available channels for the implementation of the project and further initiatives.

A process of adaptation and adjustment to the activities just described can be expected, as the project implementation advances in each country or energy subsector. The activities are not limitative, instead have been enunciatively listed and considered for a possible adjustment according to the change in priorities, resources and other special circumstances through the evolution of the project.

Resources

As has been seen on the strengths description of the SWOT analysis, there are many available resources that favour the implementation of GFCS Energy Exemplar, highlighting the human, technological, material and financial resources that may be accessible through WMO, its network and externally. In order to have the most effective management on the available and possible resources, an initial identification of the internal resources is always recommended.

A subsequent analysis to be done is the resources' assessment of the different participating agents (NHMSs, country, energy sector stakeholders, company or utility in particular), with the aim of making a correct measurement and evaluation of them, facilitating the identification and adjustment of the project on a real basis.

Moreover, it is also recommendable to quantify the future resources, defined as those that are currently not active, but are considered as potential, and include a description of what are the limitations that have not allowed them to be quantified as active resources at the time of the valuation.

5.2 Implementation Methodology

Four different approaches are now presented, the reason of not selecting one model as the ideal one to be applied for the whole project is that the energy sector is very wide and diverse among each country or region. Some countries have a very mature industry, as have been operating under a liberalized scheme since the 1980's (i.e. Chile), while other countries have selected to continue under a monopolistic structure. Some other important differences account on the generation mix, responding to different selection criterion (resource availability, economical profitability, national or international request etc.).

Another important feature that differentiates one energy system to another (and related with the previous paragraph) is the amount of renewable energy share of the total energy generation, as even as the GFCS Energy Exemplar is intended to be applied for most of the energy provision processes, a sound and straightforward relation among renewables and climate services has to be recognized.

Even as the spectrum of differences among energy systems is high, as the project advances, a further categorization of countries may be able to be done, clustering them according to their most remarkable characteristics. In a like manner, as the GFCS Energy exemplar is spread, the experience of applying some of the four proposed methodologies could lead to the selection of the best practices of one or more of them, evolving to an improved unique approach.

For the initial stage of the GFCS Energy Exemplar, and after the resource identification and detailed study of the energy system is done (through the market research), the selection of the most accurate implementation process is a possible task.

Retailing/Commercial Model

For the past decades, the retail business model has been the most popular business strategy. With a very simple focus: to sell products or services to the clients.

For the GFCS Energy exemplar the main focus is to provide costumer solutions and improve the resilience of the energy sector, then under this model, monetary resources may be raised for the enlargement and spread of the project.

In the retail model normally the products/services price is settled after adding a mark-up from the total cost, but for the nature of the services and the fact that are not provided to a mass market can complicate defining the price strategy, particularly as WMO is not a profit organization, but an intergovernmental agency whose objectives and practices are not related at all with a profit stream model.

The level of expertise of WMO and its network allows to orient the service provision in a very specific categorization, targeting the selected markets, then value added can be measured through the preferences the targeted agents, as happens in any open goods/service market, where the clients value what they pay for.

Complementary and with the emphasis that has been expressed through this document, customer orientation is one of the greatest benefits of the retail model.

Customer orientation can be stimulated through the creation of a WMO Catalogue of Climate Services for the Energy Sector, as a valuable element of the retail model (not always used), and a supportive tool for offering scientific specialized services for the energy industry.

The creation of a climate services catalogue has the aim of presenting an overview of the available climate services in an organized document that gathers the description (impacts, outcomes and other relevant details) about every specific service offered by WMO and the NHMSs.

WMO Catalogue will gather all the information from the different NHMSs and other network agents, through a combined effort among all the relevant sources, identifying and providing the necessary information on available and possible services to best target the energy sector (and some other interested sectors). The primary purpose of having a catalogue is to provide a single document to easily allocate and update the network capabilities and to be able to present it to all the possible customers and participants.

Another important outcome of having a catalogue of services, is to bridge support services for all the energy related actors, as some services can be strictly related to satisfy some specific area of the energy sector, but may be also useful to improve another non expected area of the sector, however offering a robust collection of information on the service possibilities will improve the interaction among the WMO and its network and the target users, leading to the most appropriate resource and capability entailment. Enhanced communication among WMO and NMHSs will act as the pillar for sharing the pertinent information to be included in the Catalogue.

A catalogue of services is not restrictive to a greater range of services that can be provided by the WMO network agents, the project has the strong orientation of satisfying specific needs from the customers, providing tailor-made services, and nevertheless more general services could also be included. Then the Catalogue of Services could include either general or specific service alternatives.

A periodic update (every six or 12 months) may be the best way to include new services and modify any required information. For the proposed adjustment a process of interaction among the energy stakeholders is suggested, through expert workshops or any other interactive channel that allows to receive information from the real users of the services, particularly as has been previously mentioned, one of the guidelines of the GFCS Energy exemplar is the strong interaction with the energy industry, a dialogue will permit to have a useful feedback about the services received and an update the available services.

Having a Catalogue of Services will help to identify and create particular interests from the energy sector stakeholders (and from stakeholders of other sectors), as a way to make public the current proficiencies and expertise to provide climate services.

The advantages of selecting a retail model are now described:

- Easy to execute
- Energy public sector and some other key users already understand the model and are used to it
- Income potential, resources that can be used for the continuation and enlargement of the project or any other objective
- Allows to be competitive
- Initial economic valuation of the hydro/met services has been done
- WMO and its network prestige are positively related with the price definition
- Customer relationship is strengthen

Disadvantages

- If there is no sound differentiation from similar services in the market, the project's objectives may be on risk
- Even as the model is worldwide know, WMO as an international organization is not used to the model and conflict of interest could be created or some other operative problems related with lack of experience on retail and commercial models
- Creation of profits is not one of the goals of WMO or the project, and can derive in an income distribution problem, or other possible monetary related threats
- Defining prices represent a multidisciplinary and complex task
- Time and other resource demanding

Industry Stakeholders' relationship

The energy sector is in a transition process, moreover the interaction among different market participants has evolved for improving the range and quality of this interactions and specially, the generated outcomes. This entire process, has led to new forms of partnerships, where some agents have become more active, leveraging innovative types of synergies.

As expected all the proposed relationships are based in a win-win approach, which sometimes could represent a challenge, because of the diversity of the participants and their particular interests, still some of the most important available collaborations include coalitions, initiatives, alliances and partnerships. In any of the cases, international standards and best practices may govern them. WMO, as any other international agency, relies on its ability to partner effectively with relevant third parties, for the success of shared goals.

Some general characteristics in any of the possible partnerships (including the membership implementation model), such as the need for the GFCS Energy Exemplar to enter into new and creative

forms of interactions at the national, regional and global levels. For these different forms of synergies to success, more flexible and with a wider scope interactions are required.

Even as synergies are always orientated to a better resource management and challenge address, different constraints may be taken into account, with the aim of minimizing the possible risks and to accurate manage the obligations among partners, everything done under the correspondent legal framework (signature of legal obligations among the participants will be required).

Membership model

This implementation approach is based on requesting a fee to the GFCS Energy Exemplar members, in a periodical base (i.e. every 12 months). A monetary contribution is done to the WMO as the leader and coordinator of the project by those interested and benefited participants. The scope of the audience that is assumed to be attracted on the project are mainly energy-related companies, in parallel to other relevant actors of the sector.

As expected the aim of the proposed membership subscription and paying the correspondent fee is not to build a revenue or profit stream, instead the main objective of this methodology is to have the direct participation and engagement of external targeted agents, enrolling them as project participants that help to consolidate the climate services in the regions where they are settled and abroad and have a more solid interaction and communication processes that drive to a fully understanding of their needs and requirements.

Under the political and social framework of the current days, it is easy to perceive that the proposed implementation model, may result relatively fluent to be applied in some countries while not very easy in some others, as the agents of each individual energy system in the world have very different characteristics, both in comparison with energy agents abroad and within its country's borders.

Differentiation among the amount of future member's, as there may be some energy systems where the amount of possible members is high (liberalized and mature systems), while some other may be characterized of having only one national integrated company.

Membership fee definition

Establishing the fee to be paid as membership is always a challenging task, insisting on the idea that the membership model does not pursues to be a revenue stream, but a way to engage the targeted sector.

Memberships can be defined on a single amount for every participant or apply a differentiating mechanism to better suit the member's economic conditions.

If as single amount approach is selected, different considerations have to be valued in order to define the payments, as if they are too high, the possibility of small agents to participate may be reduced, even creating a market bias, as the companies participating as contributors could ask for a higher benefit for their economic contribution or receive any other monetary or non-monetary profit that could become a

market driver in some systems, especially as in the energy sector there is a high share of small to medium size companies participating in the energy provision process, and related with the energy generation from renewable sources.

If the fee is too low, the engagement and collaboration that is searched, with the purpose of having a fully customer oriented project, may not be enough.

As a second approach, through a differentiated fee, the agents' segmentation based on activity can be complemented with a size or income differentiation among the target audience, easing the way to determine the particular membership's fee.

Independently of the countries and similar to the participation model of the United Nation's Agencies, contributions paid in a differentiated way from country to country could represent a threat to the project, as normally in the private sector, the lack of a pro-development and collaborative perspective is a common characteristic. However, a global awareness of improving the overall energy system may contribute as a driver for companies to engage with the proposal and to contribute with monetary amounts that may be used to reinforce the project according to the priority needs and topics.

Nevertheless, from all the available options and modalities of the Membership methodology, the approach that best fits the objectives of the GFCS Energy Exemplar is to create a membership with a differentiated fee, and independently of the sum paid as the fee, highly threatened agents (i.e. renewable energy generators or high risk subsectors in a particular time and place) will receive the requested services as a priority.

For the membership model to succeed, interest and engagement from the selected audience are some key elements, fortunately the climate change international negotiations, together with the civil society request and a general awareness to become a more sustainable society, have lead that a continuously growing number of industry leaders (as well as small organizations) are in a transition process in order to better align their business strategies under a sustainability scheme.

In the membership model, the differentiation of the provided services can constraint the renewal of the participation from the agents, as Meteorological and hydro information to be generated and distributed is most of the times dependent on the NMHSs capabilities, and as the provision of tailor-made climate services will be directly affected on the national or regional available competences and know-hows. This last, one of the reasons for strengthening NMHS and its capabilities, as the GFCS Energy Exemplar and other WMO projects to be spread require a more reinforced network to be developed, improving the quality of the services provided not being constrained in the country or region where are generated.

In a membership model, periodical meetings, workshops and trainings can represent an effective way to interact among the members, contributing to the customer oriented perspective that characterizes the GFCS Energy Exemplar.

The main advantages of the Membership model:

- Helps to mitigate risk
- It is useful to develop new markets as it is the case of the Energy area for GFCS
- Leverage from the Energy stakeholders may be increased as more attention can be gauged from possible members
- Facilitate the communication among the targeted audience
- Contribute to cultivate sound relationships with stakeholders
- Ensures an economic inflow, helping to develop a budget
- It is easy to be embraced by the private sector

The main disadvantages of the Membership model:

- Promotes a perceived value from members
- Membership fee definition can result challenging
- Expectations among the benefits can differ according to the fee paid

The membership program is not exclusive to companies that are not directly participating in the energy industry, as for the impact that the GFCS Energy Exemplar can provide through building a more resilient energy sector (contributing to the development of the society), interest from external agents may also be raised. Big corporative companies to midsize and small companies have decided to establish Corporate Social Responsibility programmes related with GHG emission reduction or some other sustainability related ones.

A list of global Companies and their sustainable declarations is presented in Annex 3.

Licensing

As the third proposed methodology, the licensing model is an alternative implementation model, where WMO as the project leader and coordinator, will enable a climate services development through a climate services user interface, licensing the technology to the targeted customers (energy sector stakeholders). NMHSs will act as the main enablers of the process.

The methodology is based in a compensation payment for using the licensed platform by the consumers of the platform.

One core element of the licensing business model, is the licensing agreement to be signed as the legal vehicle for defining each participant's responsibilities.

A major advantage to be highlighted from this model is the fact that basic met/hydro services can normally be provided at the same production cost, independently of the amount of users, then developing a climate services user interface can ease spreading the services among the stakeholders and standardize in some way the implementation of the GFCS Energy Exemplar among the users of an energy system and among

countries. Nevertheless, as the GFCS Energy Exemplar customer orientation is key for the achievement of the general project's goals, the standardization could only happen in a relative low way.

An adaptation of the proposed interface has to be done to adjust the provision of the climate services to the user's needs. Two different lines of climate services user interface platform are proposed:

- With the objective of covering a wider audience, the first interface proposed is related with providing general weather and climate data, and the use of it by one user does not interfere with the provision of the services to other users. Then economies of scale can be created, as the number of users is increased, the production costs remain constant. This interface is the most adequate for providing climate services for each energy subsector, as the required information tends to be the same among the energy segmented users (by type of activity).

- The category of licensed product proposed is totally aligned with one of the core pillars of the GFCS Energy Exemplar, being the differentiation among the climate services provided for every customer. The tailoring provision of services that is searched could be benefited from the licensing model as developing a personalized interface platform can ease the interaction among the final user and specially to develop a sound dialogue about its particular needs and requests.

A second classification can be done, depending if the provided licenses are exclusive or non-exclusive, explained by exclusive that only the determined set of benefiters can use the services, and non-exclusive one refers to an open model, where several receptors can use the interface. This can represent a challenging task as it has to considered, that met/hydro services may fall into an important category that economists refer as public goods. The key attribute of public goods that distinguishes them from private goods is the fact of being considered as non-rivalry. Non-rivalry means that once a basic met/hydro service is provided for one person, it is available for all to be used. One surprising implication of non-rivalry is that the optimal price to charge for a public good, such as many met/hydro services, is zero. The intuition behind this puzzle is that, once a basic met/hydro service, for one and all, has been provided, society benefits if more people use it, and charging a price would only deter use of the public good.

Further research has to be done for selecting the most opportune characteristics of the licensed services, and specially related with the pricing strategy.

Another important element, for the best execution of the licensing methodology is the development of the interface with the best technological capabilities and standards, leading to an adequate operation and use from the users.

Identified advantages:

- Climate Services can be easily spread and can reach the selected audience in a direct and effective way
- WMO strengthens its leadership
- As some processes do not require supervision from WMO, some resources may be saved.

Identified Disadvantages

- If the licensing agreement is not correctly written it could create some legal problems.
- License royalties' definition can become a challenging task
- Definition of type of interface: exclusive license or non-exclusive license and general or tailor-made option
- For the licensing model to be successful, more mature projects may be required
- Necessary technology development

Partnership

Different types of partnerships are nowadays available, and the reasons that promote their development are continuously increasing. The general objective of creating partnerships is to share the skills, knowledge, capabilities or any other useful resource to ensure the success of shared projects or any particular interests.

As another alternative to implement the GFCS Energy Exemplar, partner with international and national entities is proposed. The methodology focuses in building sound relationships that can ease (in different ways) the generation and delivery of the climate services.

Similarly, as the Membership model, the global awareness around sustainability and specially related with climate change and GHG mitigation and adaptation is crucial for the partner's integration. The partnership model would search to increase the list of current GFCS partners, and to focus the efforts in favour of the GFCS Energy exemplar.

Also partners can be a useful way to develop relationships with different audiences, as initial partnerships can contribute to the evolution and strengthen of some other derivate partners to be engaged in the project.

For the differences among the possible partners, related with the particularities of the energy stakeholders, it has to be recognized that partnerships can take many forms. Some of these alternatives are very recognized procedures, as technical, economical or communication partnerships. On the other hand, more creative ways to partner have evolved and are nowadays being considered as innovative solutions to improve the participants´ contribution.

For some partners to engage, the demonstration on the advantages and positive outcomes resulting from joining forces may be necessary, still a considerable number of participants can be expected at the early stage of the project, as GFCS itself already has a long list of partner organizations.

An important element for the GFCS energy exemplar partnership model to success is the communication plan, as for this model it is absolutely necessary to be able to communicate the benefits, the options and all the relevant details to the possible stakeholders, special efforts may be required to prove the added value of the project and the partnership.

In general, the partnership model is well known from the private and public perspective. Among the United Nations agencies, it has been successfully spread as a continued way to promote the advantages of some programmes and joining efforts to improve interesting shared projects.

Remarkable examples of partnerships among the private sector and international organizations can be mentioned, UNIDO (United Nations Industrial Development Organization) is continuously joining efforts to develop new synergies, as it has a strong relationship with the private industrial sector. UNIDO has created the Business Partnership Programme with the aim of harnessing the new and shared expertise and resources of the partners to tackle relevant shared global threats (more information and details http://www.unido.org/index.php?id=1002991).

UNISDR (United Nations International Strategy for Disaster Reduction) has established an intensive campaign to work closely with the private stakeholders for the past years. In 2015, ARISE was established as the Private Sector Alliance for Disaster Resilient Societies, resulting from merging the UNIDO's Private Sector Advisory Group and the Private Sector Partnership. The goal of ARISE is to find synergies with the private sector to create more risk-resilient societies. More than 140 private sector members have been affiliated to the global initiative (more information and details http://www.unido.org/index.php?id=1002991).

UNICEF (United Nations Children's Fund) works on partnership models specially oriented to attend countries' needs. UNICEF has formed alliances with key actors of the society (religious and government organizations) in Angola for strengthening the current programmes in the country. Some other knowledge and resources sharing process have been developed in Philippines, East Africa, and Jordan. (More information and details http://www.unicef.org/about/partnerships/index_60258.html).

For the characteristics of the GFCS Energy Exemplar and with the aim of achieving opportunely the goals of the project, some partnerships have been identified:

- **Expertise Partnership**: As a complement to WMO and its network expertise, know-how contributions form partners may be crucial, as their operating fields perspective provides essential insights for the continuous improvement of the GFCS Energy Exemplar, leading to a coordinated interaction among the energy stakeholders and a better technical capability. This type of partnership is very relevant, as the energy sector requires a high and specific expertise.

Possible partners: Private and public energy companies, Research Centres and Universities among other energy stakeholders.

- **Capacity partnership:** Partners can help to reach a wider audience or more detailed services, through the provision of particular climate services that may be elaborated by means of the equipment, infrastructure, experienced staff, or any other external resource. R&D collaborations are also included in this category.
  Possible partners: Private and public weather and climate Centres, Research Centres and Universities, private energy companies that generate their own climate and weather services.

- **Communication partnership:** Oriented to coordinate a joint outreach strategy, for spreading the project among all the interested audience, and among the potential future partners. Some other activities allowed in the communication partnership may include to organize, host or coordinate any event (as partners' meetings, forums, courses).
  Possible partners: UN Agencies, government and non-government associations, civil society, public and private energy companies.

- **Financial partnership:** direct financing mechanisms among WMO, its network members and the energy partners will enable a sounder monetary basis, that will help to implement the GFCS Energy Exemplar in a more solid way and especially to be able to extended it faster. Particular and hybrid financing mechanisms may be revised for selecting the best alternative according to the partner's needs.

  Possible partners: Government and non-government associations, civil society, public and private energy companies, philanthropic organizations or Foundations, Development Banks and financial entities.

- **Learning partnership:** As an alternative partnership, the idea is to help WMO to generate ideas and enrich the GFCS project, developing content and input for the project and scale them up.
  Possible partners: civil society, non-profit organizations, Universities and Research Centres), think tanks, training institutions.

A combination of more than one category is available according to the counterpart´s needs and preferences, and other interesting relationships may be considered as partnerships, being discovered through the interaction of the agents and the GFCS Energy Exemplar (through WMO and the NMHSs) as the project is implemented and developed.

Note that not all the partnerships may continue through time, as efforts and resources may be concentrated for particular shared objectives, and may not be interesting to continue the relationship in a longer timescale.

There may be the possibility that some agents are interested in not having a strong relationship but still interested in participating in some way, therefore and with the aim of not excluding interesting collaborators, some other informal ways of participation may be enabled.

For any of the formal partnership models or any less formal way of association, the core elements of the relationship are founded on sharing objectives based in strong interests, a high sense of responsibility and collaboration, the availability of the committed resources, to follow the standards and parameters defined.

Similar advantages and disadvantages are shared among the partnership and membership implementation model.

Advantages of the model:

- Helps to mitigate risk
- It is useful to develop new markets as it is the case of the Energy area for GFCS
- Leverage from the Energy stakeholders may be increased, as more attention can be gauged from possible members
- Facilitate the communication among the targeted audience
- Contribute to cultivate sound relationships with stakeholders
- It is easy to be embraced by the private sector and other stakeholders
- Knowledge and resource enhancement

Disadvantages of the model:

- Disagreements and friction risks among partners may occur, as some decisions can be shared
- Partnerships are usually imitated too a very specific way of collaborating
- The program will require more flexibility

A list of cross cut activities developed by possible partners has been developed (Annex 2). These possible interactions will enable supportive actions to favour a more resilient energy sector as a generic and common objective.

After the four methodologies have been analysed, it has been identified that a combination of some of the core elements of each methodology can be done, and that may eventually lead to a more standardized and improved implementation plan.

Corporate Social Responsibility

As one of the main drivers of companies' participation in sustainability programs nowadays, Corporate Social Responsibility (CSR) will contribute to conform a larger and more solid network among the WMO and the energy industry, especially with the private sector, as the CSR generates and promotes a duty sense for developing actions in the best interests of society and the environment. Being particularly useful either from the Membership or the Partnership approach.

In a very favourable way, this new wave of sustainability awareness benefits sustainable oriented projects, as the GFCS. Everyday more companies, are aligning their business models or other internal strategies to a greener perspective. It seems that the private sector has evolved on perceiving CSR as a trend, to fully consider it as a core element of their corporate strategy.

CSR is strictly embedded with the objective of having a new role of business in society. The CSR inclusion started several years ago, resulting in the nowadays enhancement of it, as the benefits of orienting a company to an environmental awareness strategy are well-known and no longer considered as a complementary action (eventually having a CSR strategy can turn into a profitable situation for the company, instead of a costly one). Then a second big output, and totally related with an economical profit, is the condition that CSR oriented companies could increase their respectable and prestigious reputation, helping to attract different interesting stakeholders (investors, consumers and civil society).

According to the particular company´s objectives and structure, CSR can take diverse forms and applications, in any case the positive impact that is searched will help to attract the interest of private sector and other agents to the project, constructing win-win relationships among the GFCS Energy Exemplar users.

6.0 Marketing Plan

Communication is a vital task to strengthen partnerships between the energy sector and the meteorological community towards the development of useful and effective climate services, to deliver the GFCS key messages.

From a very simple perspective, the marketing plan is the definition of the best way to communicate to the public that a service is offered. As a consequence, the plan can be an important element on the early days of the project, but the marketing plan is a support tool for the whole life of the project.

Depending on the type of business and customer to be satisfied and corresponding to the user's segmentation, specifications about how to outreach every subgroup can be done. Also as the project evolves an adjustment process could be considered, despite a global marketing guideline has been elaborated.

6.1 Communication Strategy

The cornerstone of a marketing plan is the definition of the communication and outreach strategy.

Four strategic goals have been defined for all the GFCS projects:

1. **Continuously raise awareness about the needs, usefulness and benefits of the Framework to Partners, Members, funding agencies and users;**

2. **Gradually develop sustainable partnerships and foster a sense of ownership with the lead UN Agencies and NGOs of the priority areas and identify a selected few non-traditional WMO**

partners, i.e. from think-tanks, philanthropic organizations and user communities to successfully deliver the Framework;

3. **Attract and, if possible, secure sustainable funding for the administrative expenses of the framework and the activities of the Implementation Plan by demonstrating the added value the activities and the framework have;**

4. **Promote the implementation of all activities set out in the Implementation Plan including the adoption of Frameworks for Climate Service at the national level and communicate success stories as they arise (inter)nationally.**

Collaboration

- *The opportunity offered by GFCS*: potential partners need to know that a framework is now available to develop climate information activities/services in a more effective way;
- *The benefits of collaboration*: potential partners need to understand the final products that could result from collaboration, such as new tools for improved climate risk management decisions, or information factsheets to inform the energy sectors about latest developments by the climate community;
- *What is available and what is possible*: climate service providers need to be able to describe in non-technical terms the existing technologies and climate products (such as their specifications and formats), as well as their limitations;
- *Willingness to understand and improve*: climate service producers must show willingness to take time to understand potential partners' climate information requirements and the information used for energy;
- *Willingness to jointly develop, test and upgrade climate products*: climate service producers must convey willingness to work with other stakeholders, rather than alone in, say, meteorological services, by also establishing community of practice, and network of partners and experts supporting and implementing climate and energy work;
- *Willingness to be proactive*: climate service providers need to be keen to engage the energy industry in information sessions, via such mechanisms as webinars, workshops and community events.

Continuously national, regional and international events, forums and meetings are being organized, giving the possibility to gauge the attention of possible participants and enable an easier pathway for engagement between the energy industry and the weather and climate community. Some international events that have been identified are: The International Conference Energy & Meteorology series, the American Meteorological Society sessions on Weather, Climate, and the New Energy Economy and the European Meteorological Society sessions on Energy Meteorology.

Similarly, the energy private sector organizes different international or regional meetings, being a great opportunity to interact with the participants, then similarly as the private companies a sound marketing campaign could act as a tool to really integrate the GFCS Energy Exemplar to the competitive private environment, being a challenging task that would require new efforts and resources to be applied for the developing this new role for WMO and the NMHSs.

7.0 Monitoring and Evaluation

As the last step for a complete implementation process, monitoring and evaluating the activities and the outcomes represent the best alternative to analyse the progress made and to opportunely correct or adjust any possible tangents.

Then a valuation system is now proposed, consisting in three different sub activities, that focus in particular elements of the project, but analysing the core components of the GFCS implementation.

First a qualitative review based on parameters is proposed, helping to identify the overall progress of the project activities, oriented to diagnose a tangible progress of the actions. A second mechanism has been defined through an indicator system (quantitative and cost-benefit basis), and a third system has been created through a user's oriented survey, that eases gathering information from the target users about the perceived benefit received from using the GFCS Energy Exemplar. Each of the evaluation mechanism has a different particular objective, but the overall goal is to be able to assess the project from different angles.

The three proposed mechanisms represent the evaluation of the efficiency of the project, applying them at a specified time or at the end of a determined period and. Nevertheless, a regular monitoring must be carried out using traditional administrative and planning tools such as notification procedures and reports.

WMO as leader and coordinator of the project may be the best suited participant for the preparation of the report of the proposed assessments, however thanks to the participation and close cooperation with the NMHSs, they represent the most appropriate channel for the implementation of the evaluation systems and information gatherers (for the expected close interaction with the energy stakeholders).

The period of application of assessment proposed is annual, as significant differences between time periods may be identified and evaluated within the selected timescale.

Note that qualitative information can improve the policy effectiveness, giving the ability of energy decision makers to anticipate to stressful situations in different time frames.

Qualitative evaluation of the GFCS Energy exemplar implementation:

For the proposed activities of the implementation plan, a number of high priority parameters have been established, which will focus on the priority areas that facilitate the achievement of the objectives of the project per se.

Parameters

- **The optimal use of resources:** all the activities of the Implementation Plan of the GFCS Energy Exemplar are subject to the proper management of resources, including financial, material, technological and human capital, among others, and their contribution to achieve high rates of efficiency in the overall results of the project. Stressing the possibility to develop and use specific indicators that are able to evaluate the obtained outcomes in relation to the invested amount of resources.
- **Quality:** as one of the principal influencers of the economy in our days, and not only in the private sector, but widespread in society. WMO, as the leader and coordinator of the project, and under the standards that characterize specialized agencies of the United Nations System, seek to permeate each and every one of the specific and general actions of the GFCS Energy Exemplar, and to guide the NMHSs to maintain and improve their quality standards, that may be directly translated in the improvement of the tangible results, favouring the beneficiary group (energy sector).
- **Orientation to cover user`s needs:** being one of the essential characteristics of the GFCS Energy Exemplar, the implementation methodology will be oriented to satisfy key user´s needs, through tailor-made services.
- **Time:** normally regarded as a resource, in this occasion represents a parameter, with the aim to respect the phases marked for each of the stages of the project implementation.

The parameters above described seek to be a general framework and reference to the project enablers, since it must be taken into account the differences from country to country, where the GFCS Energy Exemplar will be applied. And most likely, there will be some variances between the results of the project execution among every energy system, in any case it is necessary to define general parameters that promotes the successful implementation of the Project and to some extent, relative standardization of some activities.

For the qualitative nature of the parameters, two assessment methods are the most opportune ones, the first one a 360 evaluation, as a feedback from the main users, the NMHSs and WMO Auto evaluation and analysis.

The second alternative for assessing the parameters is through benchmarks, using data and estimates from other implementation processes of the GFCS Energy Exemplar in different countries, or subsectors in the same country, being a challenging task as the comparison of the countries project´s outcomes is directly influenced by different macro economical and particular country characteristics and expert

judgment may be required as a helpful reference for companies to relate their development and performance for a determined period of time and the GFCS Energy Exemplar participation.

Further research is required to relate each parameter with a correspondent benchmark, as preparing specific benchmarks, may be a difficult task as the level of maturity and the characteristic of every energy system has to be considered, however some possible estimations can be done, according to the country-specific estimates of weather and climate conditions, structure of the economy and other factors as the weather dependence of the economy; meteorological vulnerability; the current status of met/hydro service provision; national climate; agency capacity; and national economic structure. These factors, and the extent to which they influence the benchmarks, are estimated based on quantitative data and expert assessments.

An example two general benchmarks are now proposed, related with the assessment of the overall GFCS Energy Exemplar development:

- The level of annual direct economic losses caused by met/hydro hazards and unfavourable weather events, expressed as a share of the annual budget (country or company).
- The level of annual prevented losses, with and without modernization, expressed as a percentage of the total level of losses.

Some other benchmarks that help to evaluate the long-term success of the overall project could be assessed in terms of a more efficient energy supply, reduced impacts on energy infrastructure, lower overall energy costs, and increased access to energy.

Key Metrics and Indicators

With the aim of measuring changes in the overall and particular elements of the energy system, and specially oriented to evaluate the resilience, easing the way to review the Energy Exemplar results, some cost-efficiency related indicators have been defined. Also indicators will lead to identify (opportunely) some elements to be adjusted, for achieving to better results.

Each energy segment is affected in a different way by the climate and weather variability and climate change, then creating a single metric for evaluating the energy system resilience is a challenging task, still analysing the impacts on the whole energy system can be done through wider indicators.

Most of the indicators here presented are related to extreme weather events damage resistance and operation in stressful climate conditions.

Two different categories of indicators are now presented. The main purpose of this indicators is to evaluate the activities of the energy provision chain. The General Indicators make reference to the main activities affected by the weather events. The Detailed Indicators measure tangible improvements after receiving tailor-made climate services by the GFCS Energy Exemplar use.

Fossil Fuels and Thermal

General

- Number of oil reserves physically affected by extreme weather events
- Number of oil and gas installations affected by extreme weather events (onshore and offshore)
- Number of accidents on maritime fuel transportation related to extreme weather events

Detailed

- Water availability for cooling procedures in thermal power plants (cubic meters)
- Number of delay days in the maritime fuel transportation
- Number of delay days in the maintenance schedule
- Amount invested for risk hedging activities (monetary unit)
- Economic losses in infrastructure (monetary unit)

Nuclear

General

- Number of accidents related to extreme weather events

Detailed

- Water availability for cooling procedures in nuclear power plants (cubic meters)
- Number of delay days in the maintenance schedule
- Amount invested for risk hedging activities (monetary unit)
- Economic losses in infrastructure (monetary unit)
- Economic losses in operations (monetary unit)

Hydropower

General

- Number of accidents related to extreme weather events
- MW produced/ installed capacity

Detailed

- MW produced/ water availability
- Expected installed capacity expansion (MW) according to the expected water availability
- Number of delay days in the maintenance schedule
- Amount invested for risk hedging activities (monetary unit)
- Economic losses in infrastructure (monetary unit)

- Economic losses in operations (monetary unit)

Transmission

General

- Quality of electricity supply (frequency of blackouts/brownouts)

Detailed

- Number of delay days in the maintenance schedule
- Amount invested for risk hedging activities (monetary unit)
- Economic losses in infrastructure (monetary unit)
- Economic losses in operations (monetary unit)

Biomass

General

- Energy produced per planted area
- Percentage of biomass used for energy purposes

Detailed

- Number of delay days in the fertilizing schedule
- Amount invested for risk hedging activities (monetary unit)
- Economic losses in failed yields (monetary unit)
- Expected installed capacity (MW)

Wind

General

- MW Produced/Installed Capacity

Detailed

- Number of delay days in the maintenance schedule
- Amount invested for risk hedging activities (monetary unit)
- Economic losses in infrastructure (monetary unit)
- Economic losses in operations (monetary unit)
- Expected installed capacity (MW)

Market (for each timescale market)

General

- Energy price maximum (monetary unit)
- Energy price minimum (monetary unit)
- Liquidity of the market (number of participants)

Decision Makers

General

- Diversity of electricity generation mix in a country (amount and share of each generation technology)
- Share of energy produced from renewable energy amount and share of each generation technology)
- Total efficiency for the electricity generation (MW produced/MW Installed capacity)

Note that the general indicators do not directly reflect how climate services can help to improve the resilience of an energy system, however do reflect how each generation source or element has been performing during the evaluated period, generating useful information to identify, from the energy stakeholder´s perspective (especially from the perspective of policy makers), how the climate and weather services availability is related with their operation and planning decisions. The detailed indicators do reflect the direct affection of the climate services and their measurement and utilisation will help as the cornerstone for demonstrating value to the stakeholders (and potentially participants).

User´s Perception assessment

A Survey on the perception of benefits from the target users has been developed, with the aim of assessing their perspective on the impacts of the program, and specially oriented to assess the improved climate-informed energy decision-making process that results in outcomes such as relevance and quality of forecasts for energy demand and supply, effectiveness of warnings for energy infrastructure impacts, and achievement of better awareness of climate and energy interactions.

GFCS Energy Exemplar user's survey

1. What were the expected benefits of participating in the GFCS Energy Exemplar?

2. Has any improvement in the operations been perceived as a direct result of the project implementation? Please detail.

3. Has any improvement in the planning process been perceived as direct result of the project implementation? Please detail.

4. Is there a budget for weather information? If the answer is "yes," please also indicate the approximate amount (monthly budget).
   From $ 0 to $ 1.000 USD_____
   From $ 1.000 to $ 5.000 USD_____
   More than $ 5.000 USD_____

5. Has the budget for weather information been modified in the past year? If the answer is "yes," please detail.

6. Mention any example concerning the impact and consequences of extreme climate events that have occurred within the past year that has affected in some way your operation.

7. Do you think the GFCS Energy Exemplar has helped to prevent any of the extreme climate events? Please detail.

8. Does the GFCS Energy Exemplar has affected the internal policy making process? If the answer is "yes," please detail.

9. Does the GFCS Energy Exemplar has affected the Maintenance plan definition?

10. Does the company Have climate risk management strategies and practices? If the answer is "no," are there any plans to establish any plan?

11. Indicate the approximate budget assigned or to be assigned for risk hedging activities.
From $ 0 to $ 1.000 USD_____

From $ 1.000 to $ 5.000 USD_____

More than $ 5.000 USD_____

8.0 Organizational characteristics

WMO is an intergovernmental organization with a membership of 191 Member States and Territories, as the specialised agency of the United Nations for meteorology and hydrology (including weather and climate), WMO headquarters are held in Geneva, Switzerland. WMO coordinates a network of the National Meteorological and Hydrological Services (NMHSs) of its Members.

Since its establishment, WMO has played a unique and powerful role in contributing to the safety and welfare of humanity. Under WMO leadership and within the framework of WMO programmes, National Meteorological and Hydrological Services contribute substantially to the protection of life and property against natural disasters, safeguarding the environment and enhancing the economic and social well-being of all sectors of society in areas such as food security, water resources, transport and recently included energy.

WMO promotes cooperation in the establishment of networks for making meteorological, climatological, hydrological and geophysical observations, as well as the exchange, processing and standardization of related data, and assists technology transfer, training and research. It also fosters collaboration between the National Meteorological and Hydrological Services of its Members and furthers the application of meteorology to public weather services, agriculture, aviation, shipping, the environment, water issues and the mitigation of the impacts of natural disasters.

8.1 Location and Facilities (NMHSs)

The National Meteorological and Hydrological Services (NMHSs) of its191 Members operate the:

1. WMO Global Integrated Observing System (WIGOS) enables the collection of data from 17 satellites, hundreds of ocean buoys, thousands of aircrafts and ships and nearly 10,000 land-based stations;

2. WMO Global Telecommunication System (GTS) is composed of a dedicated network of surface and satellite-based telecommunication links and centres operated around the clock all year round. It interconnects all NMHSs for collection and distribution of all meteorological and related data, forecasts and alerts, including tsunami and seismic related information and warnings. More than 50,000 weather reports and several thousand charts and digital products are disseminated through the WMO GTS daily. WMO is building on its GTS to achieve an overarching WMO Information System (WIS), enabling systematic access, retrieval, and dissemination and exchange of data and information of all WMO and related international Programmes. WIS will also be able to provide critical data to other national agencies and users dealing with many sectors including disaster risk management;
3. WMO Global Data-Processing and Forecasting System (GDPFS) involves three World Meteorological Centres and 40 Regional Specialized Meteorological Centres, including Regional Specialized Meteorological Centres (RSMCs), Regional Climate Centres (RCCs) and Regional Drought Management Centres. They process data and routinely provide countries with analysis and meteorological forecasts, supporting early warning capacities through the NMHSs.
4. In addition, WMO supports 30 Regional Training Centres, providing technical training for management and operations of the NMHSs.

Source: (*WMO Operational Network* [2016])

8.2 Technical capabilities

WMO technical capabilities are continuously improved. Powerful information processing tools in WMO centres process the data collected from the tens of thousands of land-based observing platforms and Earth-observing satellites. Scientists develop and use numerical models based on physical laws to produce weather and air-quality forecasts, climate predictions, risk assessments, early warning for extreme events and a growing range of services for the public and decision-makers all over the globe.

WMO coordinates and organizes research programmes that contribute to the scientific understanding of the dynamical physical and chemical processes in the atmosphere and oceans, as well as the interactions of various components of the Earth system on all time- and space-scales. That understanding has helped achieve unprecedented improvement in the quality and accuracy of numerical weather prediction. This, in turn, has greatly enhanced the accuracy and usefulness of weather forecasts, warnings of extreme events, seasonal predictions, climate-change projections and environmental predictions.

WMO promotes research into fundamental scientific understanding of the physical climate system and climate processes needed to determine to what extent climate can be predicted and the extent to which humankind influences climate. It promotes the advancement of atmospheric sciences in understanding atmospheric composition changes and consequent effects on weather, climate, urban environment and marine and terrestrial ecosystems.

The WMO Atmospheric Research and Environment Programme accelerates improvements in "nowcasting" (forecasting the next six hours) and one-day to two-week high-impact weather forecasts for the benefit of society, the economy and the environment. It also focuses on tropical cyclones and monsoons. Other programmes aim to measure and understand the influence of greenhouse gases and other climate-changing particles and chemicals in the atmosphere. Climate research on global to regional scales and time horizons ranging from weeks to centuries is coordinated by the World Climate Research Programme (WCRP) co-sponsored by WMO, the International Council for Science and the Intergovernmental Oceanographic Commission of UNESCO. By facilitating analysis and prediction of variability and change in the Earth's systems to address an increasing range of applications for the benefit of society, WCRP directly underpins the needs of the United Nations Framework Convention on Climate Change and the IPCC Assessment Reports. WMO has been one of the leaders of the International Polar Year (2007–2008). This intensive campaign of internationally coordinated interdisciplinary scientific research and observations focuses on the Earth's polar regions to enable a better understanding of our future climate, among other things. The polar regions provide both a window into the planet's past climate through ice cores and a view of our current climate, as glaciers, ice sheets and other ice and snow cover at the poles are extremely sensitive to climatic changes.

It is highlighted that climate, weather and water information can support optimal development and use of renewable energy resources, such as hydropower, wind, solar and biological energy. Such information also can underpin the routine operation of nuclear power plants, coal power plants and other forms of energy production. WMO facilitates the exchange of data that can help energy developers and managers better plan for changes in energy demand, the development of local energy systems and compliance with environmental requirements.

8.3 Leadership

As important as the technical expertise, for WMO being a leader and specialized institution on the meteorological service provision, represents a cornerstone for the successful implementation and continuation of the GFCS Energy Exemplar. For this leadership to come an inherently international activity requiring global coordination, worldwide observation networks and efficient international data exchange is required.

Over the past 150 years, the global meteorological community has built up the scientific understanding and technical infrastructure needed to support the provision of comprehensive weather and climate services to both national and international users in every country. The global meteorological service system is based on a strong tradition of voluntary cooperation through WMO, with every WMO Member country contributing what it can to the international effort and every country able to draw, according to its needs, on the global system to support the provision of essential services to its national community (WMO, 1990).

Comprehensive, high-quality and robust observational networks; – Efficient data collection and management, and rapid information exchange; – State-of-the-art information technology and computing facilities; – Sophisticated data-analysis schemes and powerful simulation and forecasting models; – Improved understanding of meteorological and hydrological phenomena through ongoing scientific research;

One challenge is that it has long been understood that investments in NMHSs provide countries with a greater return of more than an order of magnitude in economic benefits, then the enlargement of their capabilities is the vitally important task of improving its technical and non-technical advantages.

Most countries place the highest priority on the provision of warning services enabling communities to prepare for, and minimize the impacts of extreme hydro/meteorological phenomena such as tornadoes, storms, hurricanes, heat waves, wildfires, floods and droughts.

9.0 Financial Plan

9.1 Climate Services value

Climate services generate economic and social value through the information provided, information can deliver enormous benefits to society. Reliable weather, climate and water information enables individuals, households, organizations, businesses and governments to take decisions which reduce the impacts of natural hazards, enhance the safety and convenience of daily life, increase business profitability, address the challenges of public health and poverty alleviation, improve productivity, strengthen national economies, protect the environment and provide a more secure basis for future planning on hourly to century timescales.

The benefit of climate services can vary from each region, mainly depending on the response from decision makers and agents to take opportunely preventive actions. In any case, energy as a key development sector, will be benefited from accurate and sound information and the subsequent improvement of planning and decision processes.

9.2 Funding Plan

Each proposed implementation methodology (licensing, membership, partnership and retailing model) represents a diverse way of sourcing, from monetary contributions, to members' fee or pricing for the provision of the service. From a broad perspective of the Energy Exemplar, an effective communication of the benefits of the project is the best way to engage the interesting actors and cornerstone to leverage economic resources.

Nowadays the arrangements of the climate services have been oriented to satisfy the energy sector, in many instances, fall short of meeting the identified needs. Nevertheless, as has been shown in the market analysis of this business plan, there is a vast, and yet largely untapped, potential to improve these arrangements and enhance the quality and utility of climate services for the overall improvement of the

energy sector and specially the resilience that the systems required and to have a contribution to this improvement.

The Energy Exemplar is critical, given ongoing investments in energy systems and increasing amounts of investment needed in the coming years. To 2035, annual investment needs are projected to steadily rise towards $2 trillion, while annual spending on energy efficiency increases to $550 billion. This means a cumulative global investment bill of more than $48 trillion. It is important for these investments to incorporate the best climate information as support, particularly since infrastructure investments can be threatened by weather and climate severe impacts (WEIO 2014).

9.3 Resource mobilization

In the organized economic models of the current days, a number of energy associations/organizations involved in mobilizing resources is available and their engagement to the project represent an opportunity to improve the financial position of some countries. Some of the organizations have the particularity that are continuously strengthening links between energy and weather and climate. The Partnering with these organizations would facilitate resource mobilization by assisting to navigate international funding procedures for development, environment and climate-change adaptation in the context of energy resilience, access, efficiency and sustainability. A detailed list of possible fund is available in Annex 5, noting that not all the funds are applicable to every country, subsequently a categorization of the funds has to be done, according to the country where the GFCS Energy Exemplar is to be implemented.

Another key source of funding, and according to the GFCS Energy exemplar characteristic of being a customer oriented project, the collaboration of the private sector is an alternative for building resilient, efficient and sustainable energy systems. As stated in the available sources of partnership, the private sector has much to contribute for developing and implementing climate change adaptation solutions, including sector specific expertise, technology, efficiency and an entrepreneurial spirit, correspondingly to the wide collaborative alternatives, a sound dialogue and feedback may reinforce these relationships.

Moreover, the Energy Exemplar, as a private sector need satisfier, has the opportunity to become a self-funding project, through the membership, licensing, partnership or retailing implementation methodologies.

9.4 Expenses

Met/hydro services generate net economic benefits through an integrated process. The costs of producing met/hydro services are associated with observations, modelling, forecasting and service. Once basic met/ hydro services are produced, they may undergo repackaging and tailoring into more specialized products by the NMHSs or other service providers before they are consumed by user communities.

Since multiple met/hydro services tend to be developed and provided jointly, finding the incremental cost of an individual met/hydro service can be challenging. In addition to provision costs, any use of a decision maker's time or other resources is also considered a cost associated with the met/hydro service enterprise.

The benefits of met/hydro services, minus their costs – which economists refer to as net benefits – represent the societal value or worth of met/hydro services. Whether and how much public funds should be devoted to met/hydro services are important public policy questions.

9.5 Pricing Strategy

As noted above, for climate services to be provided in an income base, and integrated process is required, and one of the steps for this to happen is the pricing strategy. There are no market prices for many of the key outcomes associated with the use of met/hydro services, assigning monetary values to these outcomes will therefore require the use of non-market valuation methods, including revealed preference and stated-preference approaches.

Inevitably, the level and quality of meteorological and hydrological services vary considerably from country to country depending, among other things on the technical capabilities and the energy market characterization. This last represent a challenge, as for some types of services, expressing their value in quantitative or monetary terms may not be a very straight forward process.

Available information about the amount the value of climate services, that could help as a guide for defining the pricing strategy and therefore being able to construct an income prediction, can be found in the report Valuing Weather and Climate: Economic Assessment of Meteorological and Hydrological Services, done by WMO, the World Bank Group, GFDRR and USAID.

9.6 Income/Revenue Forecast

International donors, financiers and energy stakeholders will be interested in understanding and determining the expected socioeconomic returns of their contributions or investments. Besides for having an accurate planning of the economic sources by WMO, that ease the adaptation and continuation of subsequent stages of the GFCS Energy Exemplar development, having approximate data about the income expected may be a very useful coordination tool. At the early stage of the project, income streams are very difficult to be forecasted.

Chapter 4: Results and Conclusions

Results

Four different methodologies were selected as feasible options for the implementation of the Energy Exemplar project, however there are very different implementation strategies available, and in order to select the more optimal ones a general review was done of different alternatives. These alternatives include: franchise model, freemium model, crowdfunding, Retailing/Commercial Model, Industry Stakeholders' relationship, Membership model. The last four options were the ones selected as feasible, as by their characteristics, offer a possible pathway to implement the Energy Exemplar.

The three options that were not selected have interesting characteristics, however they do not represent a complete alternative to be an implementation methodology. The franchise model is not feasible as even as the WMO network is organized through representative offices in the country members, they are not comparable among each other, as differences can be accounted among the available capabilities of each location, then a franchise model is not feasible.

The freemium model is an interesting alternative, as an initial free service is given, then a subsequent provision of the services is given with a correspondent charge for the services, this option has not been considered as a feasible option because it does not represent a consistent difference with a revenue model (Retailing/Commercial Model), where there is a charge for the services to the consumers.

The third option that was not selected, is the crowdfunding, as a model to fund the project, and even as it represents a feasible alternative to provide economic resources to the Energy Exemplar, it does not fully integrate the finals users of the climate services.

Four different approaches were selected as possible methodologies, the reason of not selecting one model as the ideal one to be applied for the whole project is that the energy sector is very wide and diverse among each country or region.

Even as the spectrum of differences among energy systems is high, as the project advances, a further categorization of countries may be able to be done, clustering them according to their most remarkable characteristics. In a like manner, as the GFCS Energy exemplar is spread, the experience of applying some of the four proposed methodologies could lead to the selection of the best practices of one or more of them, evolving to an improved unique approach.

For the initial stage of the GFCS Energy Exemplar, and after the resource identification and detailed study of the energy system is done (through the market research), the selection of the most accurate implementation process is a possible task.

A combination of more than one alternative is feasible, especially some combinations seem particularly effective for the consecution of the objectives.

The Colombian Study Case, include different aspects of the country and the energy sector in order to give a framework to identify the best alternatives form the four available implementation methodologies, it was concluded that for these analyzed characteristics the most optimal strategies are the Retailing/commercial and the Partnership model, as are the ones that best fit for the particular features of the country and the sector, highlighting that the Colombian energy sector is a well-organized and diversified system, where the participation of the interesting agents in the project may be fluent and structured , especially with the support of some key organizations (as regulatory bodies).

As noted, licensing and membership were not selected as optimal methodologies, for the maturity of the project does not fit the required one to establish either one or the other methodology.

Conlcusions

Even as WMO, has not an extensive experience interacting as a provider of climate and weather services to the private sector and the energy area expertise is being developed, the presented business plan presents a practical tool that eases the implementation of the GFCS Energy Exemplar and helps to pursue its objectives, achieving to create a more resilient energy system through tailor-made climate services.

The four identified and proposed methodologies (licensing, retailing, membership and partnership model) have very different characteristics, advantages and disadvantages, and an adaptation process is required for an integral fulfillment of the particular objectives and needs of every country or energy subsector.

After elaborating the Colombian Business Case, it can be identified that the Energy Sector in Colombia is well organized and that there are available, different useful reports about the energy sector that facilitates its study and the interaction with the principal agents. Then in Colombia, as one of the priority countries of the GFCS Energy Exemplar, it would be relatively easy to start the implementation of the GFCS Energy Exemplar, acting as a pilot country. After the market analysis and all the gathered information, the selected methodologies to execute the project in Colombia are Retailing and Partnership model, also for the high share of participation of the hydropower subsector in the energy industry, it has been selected as a relevant niche to focus in the implementation of the project.

As a wider conclusion, after this research and supporting one of the most important challenges of the project, about the participation of the relevant Energy industry stakeholders, it could be said that the project could have relevant impacts for supporting policies, decisions, and general operation of the energy sector, bridging the gap between the most quantitative and technology based climate services and the real needs of the users. The proposed indicators represent a practical way to measure the real impacts on the energy industry after implementing the GFCS Energy Exemplar and to provide value for the invested resources to the participating agents.

Chapter 5: Further research

As a continuation for this study, subsequent topics have been identified:

The impacts that are derivate from climate change and the climate variability will vary from region to region, and considering that the energy systems in every country have particular characteristics, necessary adjustments of the project and specially adapting the business plan to the needs of every targeted energy may be done, leading to fully attend to the climate and weather affection of every country or region.

The Climate Services for the Energy Sector Handbook, as a practical tool for NMHSs to be able to understand about the local or regional energy system and its needs, having an accurate approach with the energy stakeholders, is not finished at the moment of the presentation of this report. Nevertheless, the sections to be studied and to present how tailor-made climate services could improve the operations include: Identification of positive effects of climate change and climate variability in the Smart Grids, Carbon Allowances Market, Decision Makers, Nuclear Energy, Risk Hedging, Fossil Fuels Producers, Gas and Future Energy Trends, Transmission and Distribution Grid, Ancillary Services, Demand and other users like market Operator and Day Ahead Markets.

The licensing and retailing models as one of the four proposed implementation methodologies of the project, will only be correctly executed if the pricing strategy is sound and the economic valuation of the climate services is correctly done, including all the necessary criteria to properly price the proposed tailor-made services.

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Annex 1. Market research survey example

Climate Services Assessment in the Energy Sector Survey

Colombia

Organization Name:

Organization Main Activity: **Number of Employees:**

The objective of this survey is to collect information about the climate services used in the energy sector, with the aim of learning about their particular features within the public and private energy organizations.

Climate Services:

1) Do you need climate information for any operation within the company? How is it used?

2) Do you have an in-house mechanism for climate information generation or it is outsourced?

3) If the climate information is outsourced, which department/area is in charge of gathering it?

4) Indicate the number of people involved in the climate information generation and/or gathering process.

5) Is there a budget for weather information? If the answer is "yes," please also indicate the approximate amount (monthly budget).

From $0 to $1,000 USD_____
From $1,000 to $5,000 USD_____
More than $5,000 USD_____

7bis Avenue de la Paix, Case postale
2300 Nations, 1211 Genève, Suisse

Extreme Climate Events:

6) Mention any example concerning the impact and consequences of extreme climate events that have occurred within the past 20 years that has affected in some way your operation.

7) Did you have resilient-oriented strategies that helped to prevent extreme climate events?

8) What actions were taken after the extreme climate events based on lessons learned?

Risk Management:

9) Does the company have climate risk management strategies and practices? If the answer is "yes," please detail.

10) Indicate the approximate budget assigned for risk hedging.

From $0 to $1,000 USD_____
From $1,000 to $5,000 USD_____
More than $5,000 USD_____

7bis Avenue de la Paix, Case postale
2300 Nations, 1211 Genève, Suisse

Annex 2. Complementary/ alternative methods and tools for climate risk assessment.

One of the identified models for implementing the Energy Exemplar, is through the development of partnerships, creating strategic financial, communication, technical, or other valuable type of collaborations.

For the importance that climate change mitigation and adaption has raised, different public, private and NGOs have defined particular programs, whether similar or complementary actions could be identified for developing synergies within the Energy Exemplar, some methods and tools for climate risk assessment have been identified:

- **European Union Adaptation Strategy**

  http://ec.europa.eu/clima/policies/adaptation/what/index_en.html

  Leader Institution: The European Union (EU)

  The program helps to support adaptation activities of the EU member states, making Europe more climate-resilient, through an improved coordination that enhances all governance levels to respond to climate change impacts, working for mitigation and adaptation and better decision making into EU sector policies and funds, addressing knowledge gaps through research and the European climate adaptation platform (Climate-ADAPT).

- **Deutsche Anpassungsstrategie (DAS)-German Adaptation Strategy**

  http://www.bmub.bund.de/en/topics/climate-energy/climate/adaptation-to-climate-change/

  Leader Institution: German Federal Cabinet

  The program defines a national framework that outlines the climate change impacts for different activities and selected regions, assessing the risks of climate change, and identifying possible needs for action for adaptation measures.
  Other Participating institutions: Centre for climate impacts and adaptation, Federal Environment Agency, Environment Ministry and the Federal Ministry for Education and Research, Climate Service Center.

- **U.S. Global Change Research Program**

  http://www.globalchange.gov/

  Leader Institution: U.S. Federal Government

  Framework of research to create knowledge for answering critical questions about the changing Earth system the best way to respond to it, climate change is a central theme of the program.

  Other Participant Institutions: Department of Agriculture, Environmental Protection Agency Department of Energy, USAID and other nine federal agencies.

- **NASA Climate Change Indicators**

  http://climate.nasa.gov/

  Leader Institution: NASA

The mission of the program is to provide a framework for the different and specific actions developed in the NASA under climate change mitigation and to help to understand climate change through robust scientific data.

- **Euro-Cordex Regional Climate Model Data**

http://www.euro-cordex.net/060378/index.php.en

Leader Institution: different regional climate research in Europe, but currently coordinated by the Climate Service Center Germany (GERICS).

The program generates simulations for the European domain, provided by the participating groups, with a special focus on regional climate simulations.

Other participant institutions: European Unversities and Meteorological Offices

- **NCDC Global Surface Temperature Data**

http://www.ncdc.noaa.gov/oa/climate/ghcn-daily/

Leader Institution: NOAA

Database that includes daily climate records from numerous sources.

- **IPCC Data Distribution Centre**

http://www.ipcc-data.org

Leader institution: IPCC

Provides climate, socio-economic and environmental data, both from the past and also in scenarios projected into the future. Technical guidelines on the selection and use of different types of data and scenarios in research and assessment are also provided.

- **SSP Database (Shared Socioeconomic Pathways)**

https://tntcat.iiasa.ac.at/SspDb/dsd?Action=htmlpage&page=about#intro

Leader Institution: International Institute for Applied Systems Analysis (IIASA)

As an Integrated Assessment Model (IAM), scenarios detailing information on energy, land-use, and emissions projections are developed.

- **GISS Surface Temperature Analysis (GISTEMP)**

http://data.giss.nasa.gov/gistemp

Leader institution: NASA

Global observed surface temperature Graphs and tables monthly updated from meteorological stations.

- **ETCDDI/CRD Climate Change Indices**

http://etccdi.pacificclimate.org/

Leader institution: CLIVAR (Climate and Ocean: Variability, Predictability and Change).

The joint CCl/CLIVAR/JCOMM Expert Team (ET) on Climate Change Detection and Indices (ETCCDI) has a mandate to address the need for the objective measurement and characterization of climate variability and change by providing international coordination and helping organizing collaboration on climate change detection and indices relevant to climate change detection, and by encouraging the comparison of modelled data and observations.

- **Shell Scenarios Web Site**

http://www.shell.com/energy-and-innovation/the-energy-future/scenarios.html

Leader Institution: Shell

Energy scenario tool.

- **CGIAR Temporal and Spatial Analogues Tool**

http://www.ccafs-analogues.org/tool/

Leader Institution: CGIAR

The Climate Analogues approach can identify areas that experience statistically similar climatic conditions, but which may be separated temporally and/or spatially. In essence, the approach allows you to glimpse into the future by locating areas whose climate today is similar to the projected future climate of a place of interest.

- **European Commission Joint Research Centre Sensitivity Analysis Page**

http://ipsc.jrc.ec.europa.eu/?id=752

Leader Institution: EC

Programme oriented to provide general and detailed information about Sensitivity Analysis.

- **Caring for climate**

http://caringforclimate.org/

Leader Institution: UN

UN initiative that brings together leading companies worldwide in climate change management. The initiative has a strong orientation for engaging the public sector and commit it to participate in a more active way.

As one of their activities a Climate Business Forum is organized as a venue to bring together private and public entities and advance on climate mitigation and adaption policy.

- **Global Compact**

https://www.unglobalcompact.org/

Leader Institution: UN

As a UN initiative, it is an invitation to the private sector to align their strategies with different universal principles and values, environmental and sustainability included, national entities

contributed to the Millennium Development Goals, similar reactions are expected for the Sustainable Development Goals.

Some other initiatives and institutions with possible shared objectives:

- ESGP-Earth System Governance Project
- GEF-Global Environment Facility
- CSE-Centre for Science and Environment
- New Climate Economy of the Global Commission on the Economy and Climate
- Open Climate Network
- USAIDS- United Nations Agency for International Development

Source: Institution's website.

Annex 3. Private Sector Corporative Sustainability Declarations

Banks

- **JPMorgan chase**

Energy and Greenhouse Gas Emissions: We take a range of actions to consume energy as efficiently as possible and reduce greenhouse gas emissions, which include: applying best practices throughout our global operations; purchasing and installing renewable energy; and purchasing Verified Emission Reduction credits to offset all GHG emissions associated with employee air travel.

Renewable Energy: We are experimenting with the incorporation of renewable energy and other advanced technology systems at some of our facilities. For example, we have installed solar photovoltaic arrays totalling over 1 megawatt of generating capacity at a number of our data centers and retail bank branches in the U.S. We also support the generation of clean energy by purchasing Renewable Energy Certificates.

Environmental and Social Risk Management: Understanding our clients' environmental and social performance is an important element of how we assess and manage risk. The consequences of failing to appropriately manage environmental and social issues can directly impact our reputation, our clients' operations and long-term economic viability, and the communities and environment in which we and our clients operate.

Financing Sustainable Solutions: We believe there is tremendous potential for energy efficiency, renewable energy and other technologies to help address a range of sustainability challenges. We provide a full suite of advisory, underwriting and lending capabilities for clients who are working across a wide range of sectors and geographies to develop and implement solutions that help meet critical sustainability needs.

Source:https://www.jpmorganchase.com/corporate/Corporate-Responsibility/driving_sustainability_through_business.htm
https://www.jpmorganchase.com/corporate/Corporate-Responsibility/sustainability_in_our_operations.html

- **HSBC Holdings**

We consider issues such as climate change and the impact on local communities that can arise from our financing decisions. This allows us to respond to commercial opportunities and at the same time better manage potential risks to our business. We also help our business customers to understand sustainability risks and make improvements to their sustainability practices.

Climate Business: We recognise and support the move to a low-carbon economy, which will help reduce climate change and benefit communities in the long term. HSBC can play a role by financing climate

business – the goods and services that will thrive in and accelerate this transition to a low-carbon future. Find out more about how we support Climate Business.

Sustainability risk policies: HSBC seeks to ensure that the financial services we provide to our customers to support economic development do not result in an unacceptable impact on people or the environment.

Sustainability Risk Managers are supported by Group Sustainability Risk, a central team responsible for developing policies, guidance, processes and training. In 2015, the Group Sustainability Risk team formally became part of the Group Risk function, to help simplify communication and further improve implementation of the sustainability risk framework.

Source: http://www.hsbc.com/our-approach/sustainability

http://www.hsbc.com/our-approach/sustainability/operations

- **Bank of America**

Bank of America increased its second environmental business initiative from $50 billion to $125 billion in low-carbon business by 2025 through lending, investing, capital raising, advisory services and developing financing solutions for clients around the world. This 10-year environmental business goal speaks to the bank's focus on and commitment to advancing energy efficiency, renewable energy and transportation, in addition to addressing other important areas like water conservation, land use and waste.

Since 2007, Bank of America has provided more than $53 billion in financing for low-carbon activities.

Source:http://about.bankofamerica.com/en-us/global-impact/environmental-sustainability.html#fbid=z_WSPoIpy6z

- **Santander**

For Banco Santander, being sustainable implies doing business and, at the same time, contributing to the economic and social progress of the communities where it is present, taking into account its environmental impact while fostering stable relationships with its main stakeholders.

This business model, together with a solid corporate governance structure, has enabled Banco Santander to retain its leading position among the main international banks in a very difficult economic and financial context and without any state aid.

A sustainable business model: Santander has a sustainable, customer-focused business model oriented towards the generation of stable recurring profits. However, this model integrates not only economic criteria but also ethical, social and environmental criteria. This business model, based on a long-term vision, has allowed Santander to retain its position as a leading international entity, anticipating challenges and taking advantage of the opportunities found in the current changing environment.

Source:http://www.santander.com/csgs/Satellite?pagename=CFWCSancomQP01%2FGSInformacion%2FCFQP01_GSInformacionDetalleImpresion_PT47&appID=santander.wc.CFWCSancomQP01&canal=CSCORP&empr=CFWCSancomQP01&leng=en_GB&cid=1278678164329

Other bank and financing companies:

GOLDMAN SACHS	http://www.goldmansachs.com/citizenship/environmental-stewardship/
CITIGROUP	http://www.citigroup.com/citi/environment/strategy.htm http://www.citigroup.com/citi/environment/data/Corporate_Sustainability_Strategy.pdf

Technology

- **Apple**

Using 100 percent renewable energy is a lofty goal.

In 2015, 93 percent of our energy came from renewable sources. And we're constantly looking for ways to reach 100 percent. In Singapore, we're powering our facilities with a 32-megawatt solar project spread over more than 800 rooftops. In China, we're adding 170 megawatts of solar to begin offsetting the energy used to make our products. And our data centers around the world run on 100 percent clean energy and power billions of iMessages, answers from Siri, and song downloads from iTunes.

Source: http://www.apple.com/environment/

- **Google**

Google is helping to power the world with clean energy. Our goal is100% renewable power, and so far we've committed to purchase over 2.2 gigawatts of renewable energy – equivalent to taking over 1 million cars off the road and making us the largest non-utility purchaser of renewable energy in the world. Separately, we've also committed to invest over $2.5 billion in renewable energy projects, which also makes us one of the largest corporate investors in renewable energy in the world. We believe that through these two initiatives, we're creating a better future for everyone.

Source: https://www.google.com/green/

- **Samsung**

At Samsung, we believe it's our responsibility to do business in a way that enriches our planet.

That's why we carry out a wide range of environmental activities all around the world. We're the leader in delivering innovative eco-friendly products to consumers and are committed to product stewardship throughout the entire lifecycle of our products.

Everything we do is guided by our focus on the "greening" of management, products, processes, workplace and communities. Our green management policy guides and supports the continuous enhancement of greener environment through all of our business activities including product design, manufacturing process and workplace operations.

Source: http://www.samsung.com/us/aboutsamsung/sustainability/environment/

Other technology companies' sustainability programs:

IBM	http://www.ibm.com/ibm/green/
HP	http://www8.hp.com/us/en/hp-information/environment/sustainability.html
ORACLE	http://www.oracle.com/us/solutions/green/overview/index.html
INTEL	http://www.intel.com/content/www/us/en/environment/intel-and-the-environment.html
MICROSOFT	https://www.microsoft.com/about/csr/environmental-sustainability/
SIEMENS	http://www.siemens.com/about/sustainability/en/practicing-sustainability/index.php

Oil Companies

CHEVRON	https://www.chevron.com/corporate-responsibility/climate-change https://www.chevron.com/corporate-responsibility/environment
SHELL	http://www.shell.com/sustainability.html
EXXON MOBIL	http://lubes.exxonmobil.com/Lubes/sustainability.aspx
BP	http://www.bp.com/en/global/corporate/sustainability.html

Automotive manufacturers

- **Volkswagen**

The Volkswagen Supervisory Board consulted intensively on the current situation at its meeting on Friday, September 25th. There is absolutely no excuse for the manipulations which have deeply shocked Volkswagen. The company will leave no stone unturned in getting to the bottom of this, will call those responsible to account, and take the necessary actions.

Source:http://www.volkswagenag.com/content/vwcorp/content/en/sustainability_and_responsibility.html

Other automotive manufacturer companies' sustainability programs:

TOYOTA	http://www.toyota-global.com/sustainability/
BMW	https://www.bmwgroup.com/en/responsibility/sustainable-value-report.html

Pharmaceutical

BAYER	http://www.bayer.com/en/sustainabilitystrategy.aspx http://www.bayer.com/en/sustainability.aspx
Pfizer	https://www.pfizer.com/files/investors/financial_reports/annual_reports/2014/world_environment.htm

Communications

- **Verizon**

Investing in green energy: Powering the nation's most reliable wireless network and Fios Internet service requires a lot of energy. In fact, electricity is the biggest contributor to our company's carbon footprint. That's why we're focused on investing in renewable energy, instituting sustainable real estate practices and installing fuel cell technologies.

$137M /investment in solar and fuel-cell energy

13.2M/kilowatt hours saved by installing solar panels and LED lighting

24/megawatts of green energy deployed in the U.S.

Source: http://www.verizon.com/about/responsibility/sustainability

Other communication companies' sustainability programs:

COMCAST	http://corporate.comcast.com/our-values/environment/green-is-universal
TELEFONICA	https://www.telefonica.com/es/web/sustainability/environment https://www.telefonica.com/es/web/sustainability/the-sustainability-in-telefonica/strategy
AT&T	http://about.att.com/content/csr/home/sustainability-reporting.html
VODAFONE	http://www.vodafone.com/content/dam/vodafone-images/sustainability/downloads/vodafone-full-report-2015.pdf http://www.vodafone.com/content/index/about/sustainability.html/connected agriculture.html

Other global companies

WALT-DISNEY	https://ditm-twdc-us.storage.googleapis.com/envirogoalsandtargets.pdf https://thewaltdisneycompany.com/environment/

NESTLE	http://www.nestle.com/csv/environmental-sustainability
COCA COLA	http://www.coca-colacompany.com/topics/environment/ http://www.coca-colacompany.com/topics/sustainability/
WAL-MART	http://corporate.walmart.com/global-responsibility/sustainability/
UNILEVER	https://www.unilever.com/sustainable-living/the-sustainable-living-plan/reducing-environmental-impact/
JOHNSON AND JOHNSON	http://www.jnj.com/caring/citizenship-sustainability/strategic-framework/Renewable-Use-and-Development http://www.jnj.com/caring/citizenship-sustainability/strategic-framework/climate
PROCTER AND GAMBLE P&G	http://us.pg.com/sustainability
ALLIANZ	https://www.allianz.com/en/sustainability/ http://us.pg.com/sustainability/environmental_sustainability/policies_practices

Annex 4. General Available Funding options.

Name	Description	Webpage
Adaptation Fund	The Adaptation Fund finances projects and programmes that help vulnerable communities in developing countries adapt to climate change. Initiatives are based on country needs, views and priorities. The Adaptation Fund was established under the Kyoto Protocol of the UN Framework Convention on Climate Change, and has committed US$ 338.5 million in 61 countries since 2010 to climate adaptation and resilience activities.	https://www.adaptation-fund.org/
Bio Carbon Fund	he World Bank's Carbon Finance Unit uses funds contributed by governments and companies in OECD countries to purchase greenhouse gas emission reductions, commonly known as carbon credits, generated by projects in developing countries and countries with economies in transition. The emission reductions are purchased through one of our carbon funds or facilities on behalf of the contributor, and within the framework of the Kyoto Protocol's Clean Development Mechanism (CDM) or Joint Implementation (JI).	https://wbcarbonfinance.org/
Global Environment Facility Trust Fund	The Global Environment Facility (GEF) was established on the eve of the 1992 Rio Earth Summit, to help tackle our planet's most pressing environmental problems. Since then, the GEF has provided $14.5 billion in grants and mobilized $75.4 billion in additional financing for almost 4,000 projects. The GEF has become an international partnership of 183 countries, international institutions, civil society organizations, and private sector to address global environmental issues.	https://www.thegef.org/
MDG Achievement Fund – Environment and Climate Change thematic window	The MDG Achievement Fund (MDG-F) was committed to eradicating poverty and inequality and changing people's lives around the world. Set up in 2007 with a generous contribution from the Government of Spain to the United Nations system, we worked together with and in support of citizens and their organizations as well as governments to implement programmes that helped advance the Millennium Development Goals (MDGs) worldwide.	http://www.mdgfund.org

Pilot Program for Climate Resilience	The Pilot Program for Climate Resilience (PPCR), approved in November 2008, was the first program under the SCF to become operational. Its objective is to pilot and demonstrate ways to integrate climate risk and resilience into core development planning, while complementing other ongoing activities.	https://www-cif.climateinvestmentfunds.org/fund/strategic-climate-fund
UNREDD	The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries was launched in 2008 and builds on the convening role and technical expertise of the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP). The UN-REDD Programme supports nationally led REDD+ processes and promotes the informed and meaningful involvement of all stakeholders, including indigenous peoples and other forest-dependent communities, in national and international REDD+ implementation.	http://www.un-redd.org/
Germany's International Climate Initiative	Since 2008, the International Climate Initiative (IKI) of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) has been financing climate and biodiversity projects in developing and newly industrialising countries, as well as in countries in transition. In the early years of the programme, its financial resources came from the proceeds of auctioning allowances under the emissions trading scheme. To ensure financial continuity, further funds were made available through the Special Energy and Climate Fund. Both funding mechanisms are now part of the Federal Environment Ministry's regular budget.	https://www.international-climate-initiative.com/en/about-the-iki/iki-funding-instrument/
Japan's Fast Start Finance	Announced in 2009 pledged USD$15 billion in public and private financial assistance to help developing countries address climate change. Consisting of USD$11 billion in public finance and USD$4 billion in private finance, this Fast-Start Financing (FSF) replaced the government's previous financing mechanism	

	known as the 'Cool Earth Partnership' (2008 - 2010).	
UK Climate Fund	The UK's climate finance helps make some of the poorest and most vulnerable communities more resilient to climate change, for example, supporting the distribution of flood resilient crops and improving early warning systems. It is also helping create a reliable source of energy for communities which improves health, education, and enables businesses to grow, creating jobs and improving incomes and standards of living for the poorest communities. It seeks to prevent emissions now or in years to come through demonstrating how countries can shift to cleaner, low carbon approaches and technology. Our investment in the International Climate Fund is enhancing Britain's place in the world and creating a safer and more prosperous future for us all.	https://www.gov.uk/government/publications/international-climate-fund/international-climate-fund
Global Climate Change Alliance	he GCCA was established by the European Union (EU) in 2007 to strengthen dialogue and cooperation with developing countries, in particular least developed countries (LDCs) and small island developing States (SIDS). It started its work in just four pilot countries. Today it has a budget of more than €300 million and is one of the most significant climate initiatives in the world. It supports 51 programmes around the world and is active in 38 countries, 8 regions and sub regions and at the global level.	http://www.gcca.eu/
Global Energy Efficiency and Renewable Energy Fund	Advised by the European Investment Bank Group, GEEREF is an innovative Fund-of-Funds catalysing private sector capital into clean energy projects in developing countries and economies in transition.	http://geeref.com/
Green Climate Fund	The Green Climate Fund is unique in its ability to engage directly with both the public and private sector in transformational climate-sensitive investments. The Fund will work through a wide range of entities to channel its resources to projects and programmes. Such entities may be international, regional, national, or subnational, public or private institutions that meet the standards of the Fund. Countries may access the Fund through multiple entities simultaneously.	http://www.greenclimate.fund/

Source: Fund's webpage.

Annex 5. Climate and Weather Services for the Energy Industry Handbook

This documents aims to be an orientation tool for Network Hydrological Meteorological Services (NMHSs), and all the members of the WMO Network, to understand the Energy sector of the based country or region to better implement the GFCS Energy Sector through tailor-made climate services.

Biofuels

Biofuels represent an alternative option to replace fossil fuels in the future, being fuels derived from biomass (i.e. obtained from plants and their derivatives). Currently there are different methods for manufacturing biofuels, generally chemical reactions, fermentation and heat processes are used to break down the starches, sugars and other molecules of plants, and to convert them in a fuel.

Biofuels can be used directly, but normally they require to be blended with fossil fuels (gasoline or diesel). Still using ethanol or biodiesel gasoline represents less fuel is burned, leading to big environmental and economic benefits. Environmental for being less polluter, and economical as the amount of crude oil imported from other countries is reduced. Ethanol and biodiesel may be considered as clean-burning fuels (EIA, 2016).

Biofuels are nowadays differentiated in first, second and third generation, depending on the type of vegetal compound they are made off. There are two biofuels that are the most widespread in use and in production, bioethanol and biodiesel.

Bioethanol: is possible to produce it from different biomass sources. The raw material used varies from cornstalks, sugarcane bagasse, perennial grasses, crop residues, some fast-growing trees to municipal organic waste. The biomass is converted into ethanol by fermentation of organic materials using high technological enzymes. Its use is nowadays extended to different applications, however, it is mainly used in vehicle engines, as a partial replacement for gasoline.

Bioethanol has-been broadly popularized in some countries, i.e. in USA almost all the gasoline contains some amount of ethanol. In general, the ethanol content of gasoline engine does not exceed 10% by volume, this gasoline is referred as E10, and gasoline with a 15% ethanol content is called E15. All gasoline vehicles can use E10. Currently, only light-duty vehicles with a model year 2001 or greater can use E15. (EIA, 2015)

Within the available types of bioethanol, there are some types considered as very pure, containing up to 85% of bioethanol, however not every car can use it, but flex-fuel vehicles.

Biodiesel: produced from vegetable or animal oils. There are particular species that stand out for their use to obtain biodiesel, as palm oil, soy and algae (special varieties of algae). The chemical process to convert the oil plants triglycerides, in compounds called esters, is known as transesterification.

Its use has been easily extended, since almost any car that uses diesel can switch to biodiesel without requiring to make adjustments in their engines, thereby it can act as a direct replacement for petroleum,

nevertheless pure biodiesel require some complementary actions for a proper performance, as adding an special anti-freeze.

There are countries in the world where consumption of diesel is higher than gasoline, leading to an easily popularization. By using biodiesel as a fuel, less pollution is produced.

Similar as the Bioethanol, Biodiesel can be blended with petroleum diesel, a wide range of biodiesel types can be found, as B2, B5 and B20, the number represents the amount of biodiesel blended with petroleum diesel (i.e. B20 has 20% of biodiesel and of 80% of petroleum diesel).

Biofuels use have substantially increased since the early 2000's and will continue to enlarge their popularity, promoted by its environmental benefits, easiness of use, and subsidies in different economies.

For 2011, the largest Producers of bioethanol were the United States (63%) using corn, Brazil (24%) using sugarcane, and China. The largest Producers of biodiesel in 2011 were the European Union (43%), the United States (15%), Brazil and Argentina (around 13% each) (EIA, 2016).

In 2012, 6.44 billion gallons of biodiesel were consumed in 64 countries; 54% of the total was consumed in five countries.

World biodiesel consumption, 2012

	Billion gallons	Share of total
World total	6.44	
United States	0.92	14%
Germany	0.75	12%
Brazil	0.74	11%
France	0.66	10%
Spain	0.42	7%
All others	2.96	46%

Source:(IEA, 2012)

Advantages

An important benefit of using fuels made from biomass is that it represents an opportunity to improve the global energy situation, with a significant impact on the environment and also in the national economies. Initially by reducing the use of fossil fuels, as GHG emitters, a positive strait forward result is obtained, the level of emissions produced are much lower than conventional fossil fuels. They can substantially reduce greenhouse gas Emissions in the transport sector (up to 70% -90% Compared to gasoline) (IEA, 2013).

As a substitute for conventional fuel, biofuels provide a viable alternative to the depletion of the fossil fuels, besides a relative independence from their use is promoted, as it allows countries to have fuel production from local crops.

Disadvantages

Although considered as renewable energy, it is not possible to say that biofuels are part of the group of clean energy, as fertilizers are normally used for their production, generating negative impacts on the land and the environment. Moreover, one of the mayor cons that can easily be observed, is the fact that its production may compete for food production, leading to a change in the land use purpose.

Despite the existence of fuels made from biomass in a 100% (B100), with today's technology, biofuels can partially replace fossil fuels, then for the short term, mixing conventional fuels will be necessary.

The production cost of biofuel is considerably higher than fossil fuels. Biofuels are not yet economically competitive, with the sole exception of sugarcane ethanol, which enjoys an untaxed retail price as low as US $ 0.6 to 0.65 per liter (IEA, 2013).

Trends

As agricultural production expands to meet the world's growing food needs through 2050, the supply of associated harvest and processing residues will also expand.

Even as biofuels can be produced almost everywhere, several challenges can be mentioned, depending on several local circumstances as the regulation (sustainability rules) and a relative dependence on future industry growth and technology.

Important opportunities may arise, as biofuels can be used for aviation needs, they can serve as a renewable alternative to jet fuel.

The expansion of the market will continue, even as their production started since a couple of decades ago (1970s), the last ten years has experienced a considerable growth. The increasing production has-been promoted by special regulations (taxes and incentives) that has led to the fossil blending.

In terms of market potential, the International Energy Agency (IEA) projects sugarcane ethanol could provide and advanced biofuels up to 9.3% of the total transportation fuels by 2030 and up to 27% by 2050.

In several countries, research is currently focused on the development of advanced biofuels (i.e. second and third generation biofuels), being produced from non-food vegetable biomass, as woody and straw residues from agriculture and forestry, fast-rotation plants, urban waste and algae-based.

From the non-fossil sources of energy generation (sun or wind), that can be used in transportation, biofuels seem to be the best alternative for ships, jets or any other heavy freight vehicle.

There is also a great potential to increase biomass production in some forests, as large amounts of forest residues could be harvested sustainably for energy purposes. (IRENA, 2016).

Regulation

Several steps can be taken so that bioenergy production expands substantially and sustainably. Best practices can be spread to boost both food and fuel production through higher yields. Forests and degraded lands can be planted with fast-growing trees to produce fuel while sequestering carbon. Advanced technologies can be developed and scaled to produce biofuels at lower cost. (IRENA, 2016)

International standards that lead to sustainability practices may be stablished, as the core elements for the biofuels production are related with soil and water availability, then regulatory bodies, under a sustainability framework, must avoid competition among using water and other resources in a nonsound way that lead to a biofuels and food production.

The EU has defined some sustainability criterion and an audit certification process, for biofuels production a review of the production within a non-high biodiversity areas and non-carbon stock areas is required.

For a scheme to be recognized by the European Commission, it must fulfil criteria such as:

- Feedstock producers comply with the sustainability criteria
- Information on the sustainability characteristics can be traced to the origin of the feedstock
- All information is well documented
- Companies are audited before they start to participate in the scheme and retroactive audits take place regularly
- The auditors are external and independent
- The auditors have both the generic and specific auditing skills needed with regards to the scheme's criteria (EC, 2016).

Promoting regulatory tools is important for the expansion of these technologies. As they may require some boosting from the governing bodies, as in U.S., the Environmental Protection Agency (EPA) is responsible for developing and implementing the U.S. Renewable Fuel Standard (RFS) to ensure that transportation fuel sold in the United States contains a minimum volume of renewable fuel. EPA is developing processes and procedures for how ethanol blends greater than E10 can be sold at retail.

Regulation may ensure that the best cost-effective technologies for biofuels production are promoted, a subsequent yields expansion may be derived, and then capacity building tools may be useful for this last purpose.

However, challenging situations may arise, as developing countries are some of the areas where a considerable amount of land may be available, but modern farming techniques that lead for the best water and land usage could not be available.

Another important challenge for regulatory bodies is how to face afforestation, as yields preparation, degrade the soil, then best land management practices are required.

Climate Services Relationship

As any other yield, biofuels crops may be directly affected by climate change. Agricultural productivity is generally influenced by many factors, including changes in temperature, humidity, precipitation, atmospheric CO2 concentrations and the impact of extreme weather events (FAO, 2015).

Moreover, when biomass is used to produce fuels (instead of residual biomass), adequate water and weather conditions are required, as growing biofuel energy crops could stress water resources, policy makers and planners should focus on developing a sound water management, accounting for potential impact of extreme weather events.

Land desertification is another important element to bear in mind for the long term decisions about growing biofuels crops, then land degradation and water availability are two core issues that require attention, both directly related with weather conditions. Nevertheless, there are some other influent factors to be studied that may not be inextricably related with weather conditions, as the type of crop and the agricultural available technology.

With the aim of reducing uncertainty existing about the timing and magnitude of extreme weather events, particularly to provide information about droughts and floods, their frequency and duration, as may directly impact energy crop production, specialized weather services provide a sound tool that limits climate change risks, leading to a better planning and reliability, and being able to develop the strategies for an adaptation process to avoid or reduce negative impacts.
Weather services that provide information related with changes in precipitation (seasonal patterns and rainfall amount), storm frequency and intensity, sea level rise, rise in average temperatures in most regions, can affect the courses of action that develop appropriate strategies for better yields, and as a consequence increase energy systems resiliency (where Biofuels are present).
Tailored weather services provided to the biofuels producers may not only lead to risk avoidance through an opportune response, but gives the opportunity to take advantage of possible positive impacts that may also arise.

Target Model and Energy Integration

As a consequence of the energy source diversification requirement, the growing concern of environmental protection and security of supply issues, among other circumstances, national authorities have shown strong interest to couple the different electricity markets available in their regions, evolving from national systems to well integrated electricity models.

In general, the world electricity models are nowadays very different within the regions, where vertical-oriented companies and central planning are still present in different economies, evolving to open electricity markets.

As part of the transition stage among electricity markets in the world, energy integration is an important issue in different cooperation agendas, evolving from an open market for several activities to a very solid, well-integrated and coordinated multi-region system. As expected, differences among the participating countries (energy generation mix, connection availability, horizontal/vertical orientation), together with technical, political and environmental constraints act as the main decision drivers for connecting the electricity systems.

Some of the benefits of an integrated energy market are the supplied electricity and gas cost reduction; better energy sector investment; competence among the companies increase, being modernized and becoming more efficient; and strengthen the existing energy authorities at the time, that new and necessary regulatory bodies are created.

This integration will lead to an open, liquid and stable market based model, resulting on secure energy (generation diversification), sustainable energy (incorporation and usage of renewables) and competitive energy (lower energy prices). Having a correctly harmonized model could be the base in order to produce some other important outcomes, as the internalization of externalities and the empowerment of customers.

Therefore, in order to achieve the ambitious integration models, several actions should be directed by the organizing authorities, as have been happened since several years ago, and will continue to happen in the years ahead for the regions where integration processes have started.

One of the bases for a proper transition is through Regulation design and application, therefore some of the key concepts of the Regulation that should be highlighted are the harmonization of the level of unbundling among the energy process activities, Third Party Access and Interconnection, creation of new figures and the definition of their activities and responsibilities in order to increase cooperation among the agents.

A crucial element for the implementation of an integration model is the network, as it is required to have the proper physical infrastructure that the cross border transactions involve, its enlargement is being done among countries through different plans and mechanisms (i.e. in the EU, TYNDP and Projects of Common Interests, giving financial incentives and cost-sharing decisions among project participants). Then adequate Inter Transmission System Operation (TSO´s) compensation mechanisms should be designed, aligning them with important features in competitive scenarios as sending correct economic and locational signals. In order to improve the TSO´s interaction.

The cornerstone for the effective TSO interaction could be the Inter Transmission System Compensation (ITC), being the mechanisms with the aim to have a fair and transparent remuneration of transits due to cross-border trade. For the matter of its importance and as an example, it has been on the list of major topics in the European regulation discussion since the beginning of electricity market liberalization, and bearing in mind that European liberalization started more than two decades ago, it could be said that ITC has evolved as well through time with the objective to develop a liquid electricity market in the participant countries, same as removing trading barriers across the countries´ borders.

In most of the electrical systems, one of the major difficulties is the saturation of transmission lines, the need to interconnect areas where electricity is generated from renewable sources with demand, accelerate and make more efficient natural gas supply and reduce energy losses in transmission and distribution systems. Then the Grid expansion and the correct remuneration method for it, is another very important element to be reviewed for the integration market design, once more mechanisms, should have attractive incentive properties to support grid expansion. However, to define the correct regulation can represent a real challenge, as has happened up to now, several attempts to adequate the implemented

not fully efficient proposals have failed over the last decade. One element that has complicated this definition can be related to the decision that existing and new lines are treated equivalently, a precise methodology to appropriately reward benefits of new lines is required and that could be properly scaled in the system.

National Regulatory Authorities will continue playing a key role, even with the creation of Intraregional Regulators, having several duties and obligations of particular relevance for a successful agreement between the national regulatory authorities and the best functioning of the coupling market. Then the Regulation should reinforce new and current institutions and give the right empowerment that is required, especially in the context where each participating country differs considerably from each other.

The integration models could give the flexibility and strength required in the uncertain energy markets of our times, where new technologies, smart grids, new agents, different roles and climate and energy policies and others that will continue challenging the Regulation to be well adapted to it. Reinforcing the idea, that for the best Market design a reliable system, based on competition, renewable energy and reliable supply is required, then the integration market design could relay in three main pillars:

- **Security of Supply**

Expansion of the system as one of the main issues for the system efficiency and reliability have required continuous planning actions in order to determine the decisions to be taken for the following years, these actions are gathered in different National and Regional Investment Programs, several analysis should be done in order to decide the new projects (profitability and minimum cost based). Although it seems that there is currently sufficient capacity for the supply of electricity in most of the countries, incorporating more users always pose a challenge in meeting the four dimensions of the Security of Supply (Security, Firmness, Adequacy, and Strategic Expansion Policy).

And to be able to achieve a major Security of Supply goal, the Capacity Factor is crucial to have the security of supply that a reliable system requires.

Furthermore, although the systems could have a good reserve margin, this does not exempt it from being vulnerable to failures, unavailability of fuel and other critical events, and there is a significant number of power plants that are still based on fossil fuels use, so better measures for the optimal expansion and technology grid must be reviewed.

- **Competitiveness**

It is well known, that one reason for liberalizing the energy sector is that electricity should not be used as a political tool, in order not to have uncertainty, as time to time big changes and interests in the sector may arise. And adjustments could be to maintain stable electricity prices. Then the justification why government should not control all the Investments, and how Public companies have not been very efficient and some examples of the non-best functioning of the integrated model, have been showed in the past century and are still observed in several countries.

Then unbundled systems, and an integration model seem to be the best alternative, where regulation has to move fast in order to adapt to innovation, where one of the biggest challenges could be the change itself, however the benefits from a competitive well design market is worth the effort for the systems.

For competitiveness among the different systems that may be part of an integrated model, climate services

- **Sustainability**

In order to completely ensure a benefit for the participant countries, environmental matters must be reviewed, where the C02 emissions criteria is one of the most important elements to be considered.

Energy efficiency measures should be aligned to the promotion of clean technologies. In general, countries have taken various measures to promote the use of clean technologies, in order to diversify generation sources as a way to cope with the adverse climate change effects and contribute to a cleaner generation. The implemented measures that include policies, laws, rules and regulations development, all of them aligned in a transversal way, and with the goal of incorporating renewable energy sources into the energy mix. To meet the international standards, regulation wants to ensure capacity with a low emission of CO2. Then order to control the total emissions, one of the most important tools is the management of Clean Energy Certificates, recognizing the production of a given amount of electricity from clean sources.

Fossil fuels are being slowly replaced by renewable energy sources. As an example in 1996, EU commission wanted to double renewable percentage in EU, so two ways were applied, incentives and taxes, each country deciding which one to use, most of the Countries decide to apply incentives, however after almost 20 years, the results does not seem to be as effective as the expectations. In any case renewable energy sources are highly dependent on climate services.

In order to design the best market conditions, all the elements that have been previously presented are crucial but there are some other elements that should be reviewed to stablish the most adequate regulation, some of this issues are ancillary services management, market power potential and effective competition promotion, tariff settling (to apply the methodologies for determining the calculation and adjustment of regulated rates, including the maximum rates of Last Resort Suppliers and the final Basic supply fees), participation in broader regional markets with non-boundary countries, among all some other elements.

Different regions have started electricity integration processes as in the European Union, South America, Africa and Asia, and some other regions have conquered very efficient integration models as in northern Europe and the Pennsylvania, New Jersey and Maryland Interconnection (PJM) in the United States of America.

European Union

The European Union, originated in 1951 with the European Coal and Steel Community (ECSC), by signing the Treaty of Paris, which later led to the signing of Treaties of Rome in 1957, creating the European Economic Community (EEC) and originating the European Atomic Energy Community (EAEC), which has played a key role for the development of the European energy industry.

The current European energy policies are the result of a long period of maturation, with different levels of regulation, where each country has had a different trajectory for their liberalization process, and since more than two decades, different activities have been done for the development of an integration model (Energy Target Model), with the objective of having a common market for electricity within the EU countries, with very important considerations to be taken into account, as the need of cheap and clean energy.

In order to reinforce the available Regulation and speed up the model implementation and the market rules in which it relies, some available tools are the Regional Initiatives for Market Integration and the REMIT (Regulation on Wholesale Energy Market Integrity and Transparency). But one of the cornerstones of the Target model are the Framework Guidelines and the Network Codes that include all the required details for the well-functioning of the integrated system in EU.

As the result of the continuous changing needs of the system, its agents and other related issues, a new framework for the Inter-TSO Compensation mechanism (ITC10) and other developments in the methodology for TSO cost-sharing are being established, highlighting the aim to adapt to the European electricity common market needs. It is very important for regulators, the European Commission and TSOs themselves to ensure that these mechanisms remain effective and are consistently implemented to achieve a common goal. Therefore, on March 2013, ACER published a recommendation on a new regulatory framework for ITC.

According to the different time frames that are required for the adequate energy supply, besides the Wholesale market, the day ahead market plays an important role. As it is based on price coupling, for the Target Model is already working through a single algorithm called Euphemia. For the intraday, an implicit trading mechanism that is able to reflect cross zonal congestions has been defined. This last together with the balancing markets, are still being completed and defined to be integrated in the Target model.

Nord Pool

One of the European experiences that is worth mentioning is Nord Pool, being the only fully integrated international market for the exchange of electricity in operation nowadays. Nordpool is formed by Norway, Sweden, Finland and Denmark

Started in 1996 by Norway, after several reforms were done in 1991 that allowed electricity sector competition. The model is based on the long tradition of cooperation among the participating countries.

The model has the main characteristic of conducting electricity transactions in the wholesale market, relying on the free access to agents and transmission networks that has generated competition among generators. Being a voluntary association, exists in parallel with domestic markets.

South America

During the nineties, South America faced a period of strong restructuration of the electric sector, being Chili one of the pioneers and leaders (not only in the region, but in the world9 reducing the public entities in favor of the private participation and the creation of competitive markets. With this framework the energy integration has been a standing item on the agendas of governments and regional bodies since a long time ago. However, the first decade of this century, when this process of change slowed and has even reversed in some countries, increasing the state involvement, nevertheless the interest in energy integration has been a constant, producing different approaches.

South America shares a lot of resources among the countries and face similar treats, then the optimal use of natural resources and the market optimization, economies of scale, the and the improvement of security of supply.

Fossil Fuel

Oil is a non-renewable fuel, given the long production period involved, and the electric generation based in burning these fuels represents one of the biggest GHG emitters. Currently energy production based on fossil fuels is the most used in the world, and although the expectative is to be reduced, it is representing the largest energy subsector.

Oil is a commodity which is traded in the global markets, defining the crude oil world prices. Brent and West Texas (WTI) are the most important oil price references, acting as worldwide benchmarks. The price difference between the two crudes is not much. Usually WTI has a higher price than Brent, with a slightly difference of US $ 1 or US $ 2.

WTI is the underlying asset in the New York Mercantile Exchange's oil futures contract, and determines the oil price in USA. Brent Crude is a type of oil sourced from the North Sea often used as a benchmark to price oil in Europe, Africa and Middle East (NASDAQ, 2016).

Dubai Crude and OPEC Reference Basket are some other well-known classifications. OPEC Members of the Organization of the Petroleum Exporting Countries (OPEC) produce about 45%of the world's crude oil (CNN, 2013).

The hydrocarbons value chain includes several economic activities, from exploration, production, transportation, refining and commercialization. The process is divided into two broader stages, upstream and downstream. The first is related to exploration and production, the search for resource deposits, drilling of exploratory wells, and subsequently the drilling and operation of wells that carry crude oil to the surface.
Downstream is referred to the crude oil refining and processing and natural gas purification, as well as the commercialization and distribution.

While this report is being written, the oil market is experiencing a particular situation, where the crude oil price has fallen considerably for the last months, as a result of different factors. First, Saudi Arabia, one of the main OPEC's members, has increased its barrels' production, then as a natural consequence of the market, with a supply increment, the price has increased. Additionally, the countries where oil production represents an important pillar for the national economy, production has not been diminished, in order not to face a loss of actual clients and sector recession, however reducing their production could represent the best way to equilibrate the supply.

In the other hand, demand seems not to be increased in the short term, as growth in global oil demand will ease to around 1.2 mb/d in 2016, below 2015's 1.8 mb/d expansion, as notable decelerations take hold across China, the US and much of Europe. (IEA, 2016).

As a direct answer of the current situation, oil industry is being deaccelerated, in general the earnings and stock prices have decreased. The impacts have been greater in upstream companies, while downstream ones have continued with profitable projects, as they have been adapted to work in fracking (for some other fossil fuels).

Advantages

Energy is produced in a very regular manner.

Oil markets are very mature, and in general the industry is evolved in most of the oil productive regions, including the different stages of the process.
High calorific value, making it very energy efficient, also energy generation generally is cost effective.

Disadvantages

The ecological risk is enormous, including not only soil erosion, and biodiversity affection, but being the combustion of Fossil fuels causes the emission of polluting gases.

The formation of an oil reserve takes hundreds of thousands of years, then available oil reserves nowadays may only be for the short to medium term.

Trends

The shale gas fracking in USA and in other regions of the world represents an opportunity for reaching a relative independence from the oil global markets, then some interests could be accounted to limit its rise, and as strategy to oppose this threat, it has been the act of rising the crude oil production in some countries and its subsequent price fallen. Different expectations may be done about the crude oil price for the short and medium term, however as it has been seen in the past, it is very unpredictable and full of uncertainties.

Independently of the oil price, there are some other important factors affecting the use of fossil fuels, such as the fact that global policies are being oriented to reduce the GHG emitter's technologies. And as renewable energy use has advanced in technology and cost, and will continue to do so in the near future,

the use of this alternative energy sources in many countries will heavily increase, promoting the energy independence.

Moreover, following a line of efficiency, it is likely that in the long term, less oil productive economies and technologies with higher costs, may eventually be forced to reduce or stop their production.

From another perspective, and given the evolution of electric cars, it is clear that the world of transportation is also being transformed, thereby the power of the oil companies and agencies could be gradually diminished, or in some other case forcing them to adapt to the new market and technological conditions.

Climate Services Relationship

The relationship between climate services and fossil fuel power generation, is not so easy to be identified, but as nowadays oil competes directly with renewable energy for electricity generation, and that there is a connection between the oil price and investment in renewable (crude oil price decrements may result in less investment). Then the assumption that there will be economies which will be tempted to invest in generation based on fossil fuel instead of renewable energy can be done, being more economically convenient for them. Undoubtedly global negotiations on climate change and GHG mitigation regulation is a necessary tool to control the proliferation of non-renewable energy production.

There are several sectors that are negatively and positively affected by the oil prices variations, especially those sectors whose production processes or services are directly related to oil, so price changes could be important for the demand related on the final good or service, this is likely to happen in the electric cars market, when petroleum and its derivatives retail prices fall, the demand for electric cars would likely tend to decrease.

Another well-known effect of high oil prices is the inflation rates increment, then interest rates and the general cost of living would normally rise, however, it may also act as an energy saving stimulus, affecting energy consumption in the commercial, industrial and domestic sector.

As oil markets act as global or regional markets, whenever a weather event happens in one of the regions may directly affect the price of the commodity worldwide. A very particular example to be highlighted happened in USA, when Henry Hub was out of service briefly from Hurricane Katrina and for some weeks from Hurricane Rita, and as the most important American crude oil price reference, the market was paralyzed.

The world oil market is very complicated and full of drivers, as it is a commodity that is affected by too many factors, not only by supply and demand (where geopolitical conflicts may directly affect), making very difficult to predict the performance of the crude oil price. However, clearing some of the participating elements and its relationships, it is easier to identify that a solid and reliable renewable energy subsector, may act either as a driver or a consequence for the oil price variation.

In another line, the relationship among tailored climate services and the fossil fuels production process is quite evident as relevant. Climate services acting as an infrastructure accidents preventive tool. The opportune research and assessments of the severe weather events impacts lead to the definition of better risk reduction strategies.

Offshore exploration and extraction platforms, pipelines and some other infrastructure facilities are normally located along coastal areas, being very susceptible to extreme weather events. Especially the subsea network in some oil producing regions is particularly vulnerable to hurricanes, typhoons, cyclones or any other severe storm.

Petroleum reserve storage could also be accounted as exposed to extreme weather events, as for the need to be flexible enough for connecting to the commercial oil transport network (barge and ocean vessels are the most common ways for non-continental petroleum transportation). Reserves are typically located close to shore lines, then climate services related to water level rise information and other weather related threats represent a good opportunity to reduce their vulnerability.

Besides improving the preventive actions for the oil production infrastructure, weather services could also be useful in the fossil fuel retail subsector, as they may help to predict variations in demand for transportation, as impact of climate change on consumption in transportation is related with vehicle air conditioning use. A more extended and extreme hot season affect positively the fuel consumption.

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Annex 6. Colombia Study Case

EXECUTIVE SUMMARY

Colombia has been selected as a priority country for the implementation of the Global Framework for Climate Services Energy Exemplar, project with the objective of delivering tailor-made services that contribute to create a more resilient energy system. WMO has developed a study case to describe the implementation procedure of the mentioned project in Colombia.

A business plan is now presented, where the country and the energy sector characteristics are detailed with the aim of having a sound understanding of the crucial external elements that may influence the implementation of the climate and weather specialized services.

A market research has been done where different market analysis techniques have been applied (SWOT and PEST) for gathering the most adequate information that act as support tool for selecting the most adequate business model.

Retailing and partnership are the methodologies that have been selected to execute the GFCS Energy Exemplar in Colombia, as the energy sector has been considered as medium mature and well-organized. The proposed business strategies will ease the socioeconomic impact that providing scientific and specialized climate services wants to bring to the Colombian energy stakeholders. One of the criterion of the implementation procedures is the customer orientation that characterize them.

Relevant cross-cut activities and available funds are included in the Communication and outreach section, for encouraging the opportune utilization of internal and external resources.

Finally, key indicators are proposed as evaluation tools that facilitates to the target group and other users to identify improvements on their operative results, in a cost-effective base.

GENERAL COUNTRY PROFILE

Country name: Republic of Colombia
Government type: democratic republic
Capital name: Bogota
Languages: Spanish (official)
Administrative divisions: 32 departments and 1 capital district
Location: Northern South America, bordering the Caribbean Sea, between Panama and Venezuela, and bordering the North Pacific Ocean, between Ecuador and Panama
(*The World Factbook*, 2016)

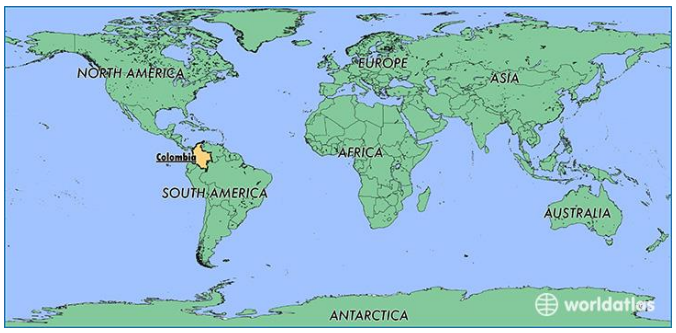


Figure 1. Colombia´s world location. (Where is Colombia?, 2015)

Country current situation

Colombia is a democratic republic, the executive branch dominates the government structure, being the President, the head of the state. Their elective process is based on a four-year term election, with the possibility of a consecutive period. 102 positions and 166 senate chamber of representatives' positions build the Legislative Power.

The current president is Juan Manuel Santos, making his second elective period, its mandate has been characterized by a strong orientation towards achieving peace treaties with the principal guerrilla and paramilitary groups in the country, where for over 50 years have been considered as a national threat.

In another sense, Colombia has worked on building solid trade links between countries through the signing of Free Trade Agreements with neighboring and non-neighboring countries, within an economic internationalization framework, in order to contribute to national development, through a more active participation in the global economy. This has resulted in the growth of certain areas, increasing overall investment, both foreign and national, as unilateral measures to promote trade and investment have been stablished as well. The raw materials sector and the oil and mining sector have been one of the most favored in this respect, however it is not possible to say the same for some other areas.

Regarding the economic situation, it is possible to find different perspectives, where some sources indicate that the Colombian economy has had an extraordinary performance during the past decade. Nevertheless some reports show how the economy has had a slowdown (especially observed through economic indicators presented below). Therefore, it is necessary to make a deeper analysis with relative segmentation in order to understand the different elements that make up the country's economy.

Table 1. Main economic indicators of the country.

Indicator	2011	2012	2013	2014	2015
Population (million)	46	46.6	47.1	47.7	48.2
GDP per capita (USD)	7286	7932	8060	7940	6044
GDP (USD bn)	335	369	380	378	291
Economic Growth (GDP, annual variation in %)	6.6	4	4.9	4.4	3.1
Domestic Demand (annual variation in %)	8.6	4.7	5	6.1	3.4
Consumption (annual variation in %)	5.5	4.8	4.6	4.3	3.7
Investment (annual variation in %)	19	4.7	6.8	9.8	2.8
Industrial Production (annual variation in %)	5	-0.2	-1.8	1.3	0.9
Retail Sales (annual variation in %)	7.8	4.1	4.7	7.6	6.5
Unemployment Rate	10.8	10.4	9.7	9.1	8.9
Fiscal Balance (% of GDP)	-2	-1.9	-2.2	-2.6	-3.1
Public Debt (% of GDP)	33.2	31.7	34.9	37.7	-
Money (annual variation in %)	18.9	16.5	14.7	9.1	12.5
Inflation Rate (CPI, annual variation in %)	3.7	2.4	1.9	3.7	6.8
Inflation Rate (CPI, annual variation in %)	3.4	3.2	2	2.9	5
Inflation (PPI, annual variation in %)	8.7	-4.9	-0.1	6	5.5
Policy Interest Rate (%)	4.75	4.25	3.25	4.5	5.75
Stock Market (annual variation in %)	-18.3	16.2	-11.2	-11	-26.5
Exchange Rate (vs USD)	1939	1767	1930	2389	3175
Exchange Rate (vs USD, aop)	1848	1797	1869	2003	2749
Current Account (% of GDP)	-2.9	-3	-3.2	-5.2	-6.5
Current Account Balance (USD bn)	-9.7	-11.1	-12.3	-19.6	-18.9
Trade Balance (USD billion)	5.4	4	2.2	-6.3	-15.9
Exports (USD billion)	56.9	60.1	58.8	54.8	35.7
Imports (USD billion)	51.6	56.1	56.6	61.1	51.6
Exports (annual variation in %)	43.3	5.6	-2.2	-6.8	-34.9
Imports (annual variation in %)	35.1	8.8	0.9	7.9	-15.5
International Reserves (USD)	32.3	37.5	43.6	47.3	46.7
External Debt (% of GDP)	22.5	21.3	24.2	26.8	38.2

Source: (FocusEconomics, 2016)

Compared with previous decades, Colombia has managed to raise its strength in the monetary, fiscal and financial framework, reducing its macroeconomic volatility, however for the past five years (2011-2015), an important variability has happened in some crucial indicators as the GDP per Capita or the policy interest rate, some notable decreases can be perceived in the unemployment rate and the consumption.

For Colombia it may be required to grow faster and steadily, specially advancing in economic and financial issues, and through innovation, research and development in science and technology, leading to a sound enlargement of some sectors.

Nevertheless, the government firmly believes that the domestic demand will lead the economy to grow by 3% in 2016, and the economic is projected to recover gradually during 2016 and 2017, especially through non-oil investment. As these industries are expected to enlarge, if the government can reach a peace agreement with FARC, as it is expected to happen (*OECD, 2015*)

The economic integration among other countries may continue to happen, Colombia and Peru are expected to enlarge relationships for the geographical closeness they have (IFM, 2014).

Since every country in Latin America has particular features, comparison among them is difficult to be made, still it is possible to identify common processes and challenges among the region.

Some shared challenges faced in the region, are specially related with governance. Advances in every country situation varies widely, but a moderate to high amount of corruption is a constant in all of them, then making more democratic and transparent processes is a required a constant in the countries.

Another challenge to bear in mind, is inequality, as Colombia, similar as other neighboring countries, faces very high levels of human poverty and inequality, largely generated by high rates of unemployment and informal employment, once more, policy reforms are necessary to better position the country in inequality issues, as nowadays and according to the Gini index, Colombia occupies the first places in South America and the 13th place in the world of inequality, with a score of 53.3 for the last assessment that has been done. (*GINI index (World Bank estimate), 2016*)

Colombia as a priority

Colombia has been selected as a priority country for the GFCS Energy Exemplar implementation. Several reasons can be accounted in order to highlight why it is an interesting country and to be one of the eight selected economies to initially implement the project (Colombia, Bhutan, Moldavia, Papua New Guinea, Peru, Domenica and Tanzania).

With one of the highest rates of disaster occurrences in Latin America, Colombia experiences on average 2.97 disasters per year, floods and landslides accounted for a third of these between1970-1999. The increasing intensity of these events has consequently pushed back advances in social development, leading to inequality and poverty (UNDP, 2016).

A great share of these disaster occurrences are produced by the weather and climate extreme events, especially El Niño and La Niña phenomenon are accounted as the mayor threats for the country in terms of weather and climate possible hazards.

El Niño

As a well-known weather phenomenon of our days, it has been an important occurrence for some countries since a long time ago. For centuries, northern coastal line of some South American countries (Colombia, Peru and Ecuador) have distinguish a yearly warming process of their coastal line waters.

This phenomenon happens to be in December, and it has been popularly named as El Niño (Spanish for the boy). As a heating wave of the ocean surface could last several seasons, the impacts could be extended into very different ways in the economies of the threated regions.

As part of the second stage of the climatic phenomenon cycle, La Niña is the second extreme situation were a cold and humid phase. As El Niño, the impacts of this stage extends among the society and some specific sector as the energy industry.

Both El Niño and La Niña are part of a continuous cycle called El Niño-Southern Oscillation (ENSO). These temperature changes are strongly linked to major climate fluctuations around the globe and, once initiated, such events can last for 12 months or more (*WMO*, 2016)

Even as a familiar situation, time to time they have become a more extreme, risky, and with greater impacts and affections. Some years have been particularly notable by the prolongation and intensity of the phenomena, considered as very strong events.

Table 2. Strongest ENSO events

El Niño	La Niña
1982-1983	1973-1974
1997-1998	1975-1976
2015-2016	1988-1989

Source: NOAA, 2016

Even as a focalized weather event, El Niño and La Niña are recognized for their global climate impacts, especially during the Northern Hemisphere winter & early spring. However, parts of the tropics and Southern Hemisphere sub-tropics feel the effects of ENSO during Northern Hemisphere summer months (June-August) (*NOAA,2016*).

A cost estimation (in US Dollars) for the 1982-1983 El Niño (very strong event) country impacts is now presented:

Flooding	
Bolivia	$300,000,000
Ecuador, Northern Peru	$650,000,000
Cuba	$170,000,000
U.S. Gulf States	$1,270,000,000
Hurricanes	
Tahiti	$50,000,000
Hawaii	$230,000,000
Droughts/Fires	
Southern Africa	$1,000,000,000
Southern India, Sri Lanka	$150,000,000
Philippines	$450,000,000
Indonesia	$500,000,000
Australia	$2,500,000,000
Southern Peru, Western Bolivia	$240,000,000
Mexico, Central America	$600,000,000
TOTAL COSTS	**$8,110,000,000**

Source: (Earthguide, 2016)

For the importance of the phenomena, WMO prepares an El Niño/La Niña Update, as a contribution to the United Nations International Strategy for Disaster Reduction (UNISDR), presented in a trimestral basis and by different collaborative institutions of WMO. Available at:

http://www.wmo.int/pages/prog/wcp/wcasp/enso_update_latest.htm

El Niño and la Niña in Colombia represent big challenges for different sectors, especially for the energy sector, as in Colombia more than 60% of the total energy generation is based on hydropower sources (UPME, 2013).

MARKET RESEARCH.

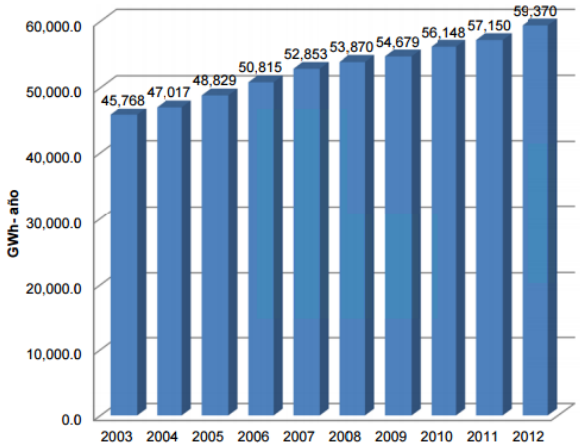
General Description of the Colombian Energy Sector

Demand

Similarly, as the global trend, the national energy demand is expected to rise, explained by different factors, such as the general increment of population (and the urban population increment); more industrialization capacity in the country and its production structure; the expected per capita income increment and all the greater technological innovation and demand for goods that consume energy.

For 2012, the annual energy demand was 59,366 GWh. An increasing rate can be perceived for the past 10 years. (UPME, 2013).

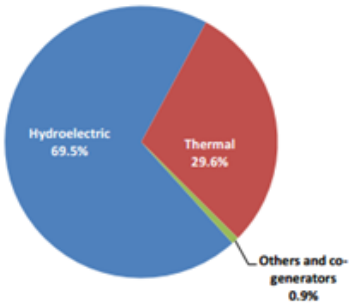
Figure 2. Annual evolution of electrical energy demand, energy and power



Source: (UPME, 2013)

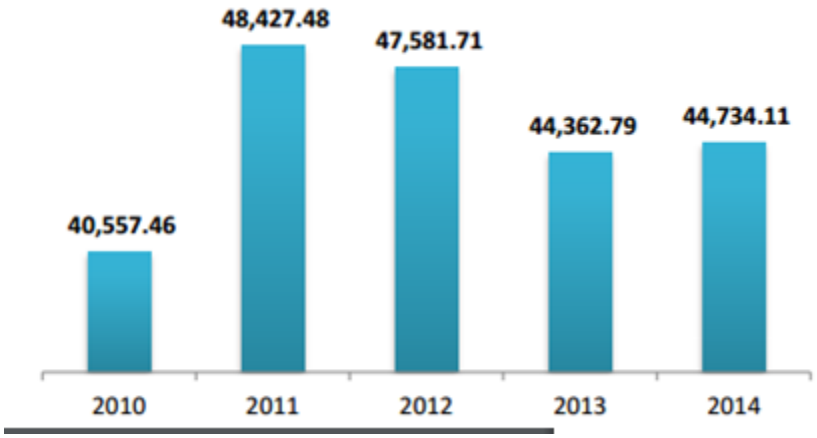
Supply/Generation

Figure 3. Breakdown of the Generation of SIN in Colombia during 2014 (PROCOLOMBIA, 2015)



Source: (PROCOLOBIA, 2015)

Figure 4. Hydroelectric Power Generation 2010-2014 (GWh)



Source: (PROCOLOBIA, 2015)

Agents and Utilities

The number of registered and active market participants of the Colombian Energy is now presented:

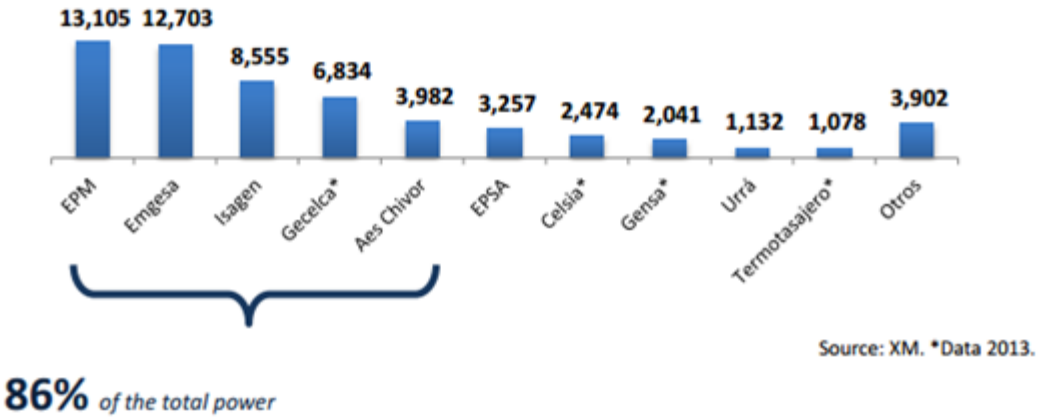
Table 3. Registered and active agents

Activity	Registered	Active
Generation	56	44
Transmission	12	10
Distribution	31	29
Retailing	93	69

Source: agents (XM, 2016)

On table 3, it is easy to identify that the energy sector in Colombia, has a relatively high to medium liquidity, by the number of participant agents, nevertheless according to the available information of power generation by agent, it is noted that the industry is characterized by an oligopolistic behavior from some agents. Some big companies have a demand share of more than 86%, like GECELCA, AES CHIVOR, EMGESA, EPM and ISAGEN.

Figure 5. Main power generating agents in 2014 (GWh)



Source: (PROCOLOBIA, 2015)

PEST Colombia

This analysis represents an assessment of the Political, Economic, Social and Technological situation of the Colombian Energy Sector, helping to determine how some crucial external factors can affect the performance of the business.

Political

Colombia has a solid and well-established regulatory framework: Since 1994, 2 reforms (laws 142 and 143) were implemented aiming primarily to foster the private investment in the sector (PROCOLOMBIA, 2015).

Through the mentioned Laws (also known as the Law of Public Utilities), and based on the mandates of the 1991 Constitution, the competitive market model for the provision of public utilities in Colombia was introduced. Through this rules a competitive base scheme governs the different activities of generation, transmission, distribution and commercialization of electricity (CREG, 2016).

Some relevant aspects of the core laws that regulate the energy sector is the allowance to the private sector to provide public services, the horizontal unbundling of the activities(generation, transmission, distribution and commercialization) and to habilitate the opportune regulatory framework by the creation of the supervisory bodies in charge of particular an relevant tasks, as the Wholesale Electricity Market (MEM), Energy and Gas Regulation Commission (CREG), and the Superintendence of Household Public Services (SSPD).

Some specific and oriented laws can be highlighted, as the Law 1715 of 2014, that supports the integration of non-conventional renewable energy to the national mix. The integration mechanism is supported with a legal and economical (tax and incentives creation).

The regulatory entities of Colombia

Commercial Interchange System Administrator/Administrador del Sistema de Intercambios Comerciales (ASIC): "is the registrar of trade borders, energy contracts in the long term ; of settlement, billing, collection and payment of the value of the acts , contracts, transactions and in general of all obligations resulting from the exchange of energy in the bag, for generators and marketers ; Auctions of Firm Energy Obligations ; maintenance of information systems and computer programs required ; and the fulfillment of the other tasks that are necessary for the proper functioning of the Commercial Exchange System (SIC)." For more information: http://www.xm.com.co/Pages/Home.aspx

Mines and Energy Planning Unit/Unidad de Planeamiento Energético Minera (UPME): "Performs comprehensive planning of mining and energy sector through evaluations, diagnoses of supply - demand of resources and development of indicative plans, to support the Ministry of Mines and Energy and investment decision makers. Manage and administer comprehensively the information mining and energy sectors to support decision -making of public and private actors. Support the MME and other entities in carrying out the calls of the STN, project evaluation coverage, emission concepts to provide incentives,

calculation base price for settlement of royalties, among others." For more information: http://www1.upme.gov.co/

Mining and Energy Ministry/Ministerio de Minas y Energía: "The Ministry of Mines and Energy is a public entity of national character of the central executive higher level, whose responsibility is to manage non-renewable natural resources of the country ensuring better and greater use ; guidance on the use and regulation of them , ensuring supply and ensuring the protection of natural environmental resources in order to ensure their conservation, restoration and sustainable development in accordance with the evaluation criteria , monitoring and environmental management, identified by the competent environmental authority." For more information, please check their webpage: https://www.minminas.gov.co/ministerio

Energy and Gas Regulatory Commission/Comisión de Regulación de Energía y Gas (CREG): "We are a highly technical organization and our goal is that services of electricity, natural gas, liquefied petroleum gas (LPG) and liquid fuels will provide the greatest possible number of people at the lowest possible cost to users and remuneration suitable for companies to guarantee quality, coverage and expansion." For more information: http://www.creg.gov.co/index.php/es

Home Public Services Superintendence/Superintendencia de Servicio Públicos Domiciliarios (SSPD): "is a technical agency, created by the 1991 Constitution that delegated by the President of the Republic of Colombia, holds inspection, surveillance and control entities and companies providing public services." For more information, please check their webpage: http://www.superservicios.gov.co/

Market Experts/Expertos en Mercados (XM): "is the subsidiary of ISA Management specializing in Real-Time Systems. Operates as real-time systems that allow control and operation of complex processes of great impact." For more information: http://www.xm.com.co/Pages/Home.aspx

National Dispatch Center/Centro Nacional de Despacho (CND): "Electric Transmission Company, SA (ETESA) dependent, as a nonprofit organization, coordinates the operations and transactions that occur among participants in the Wholesale Electricity Market. Ensures the arm's in a market environment through clear standards, promoting investment in electrical activity". For more information: http://www.cnd.com.pa/

The Regulatory entities organization is now presented (Sandoval, 2004):

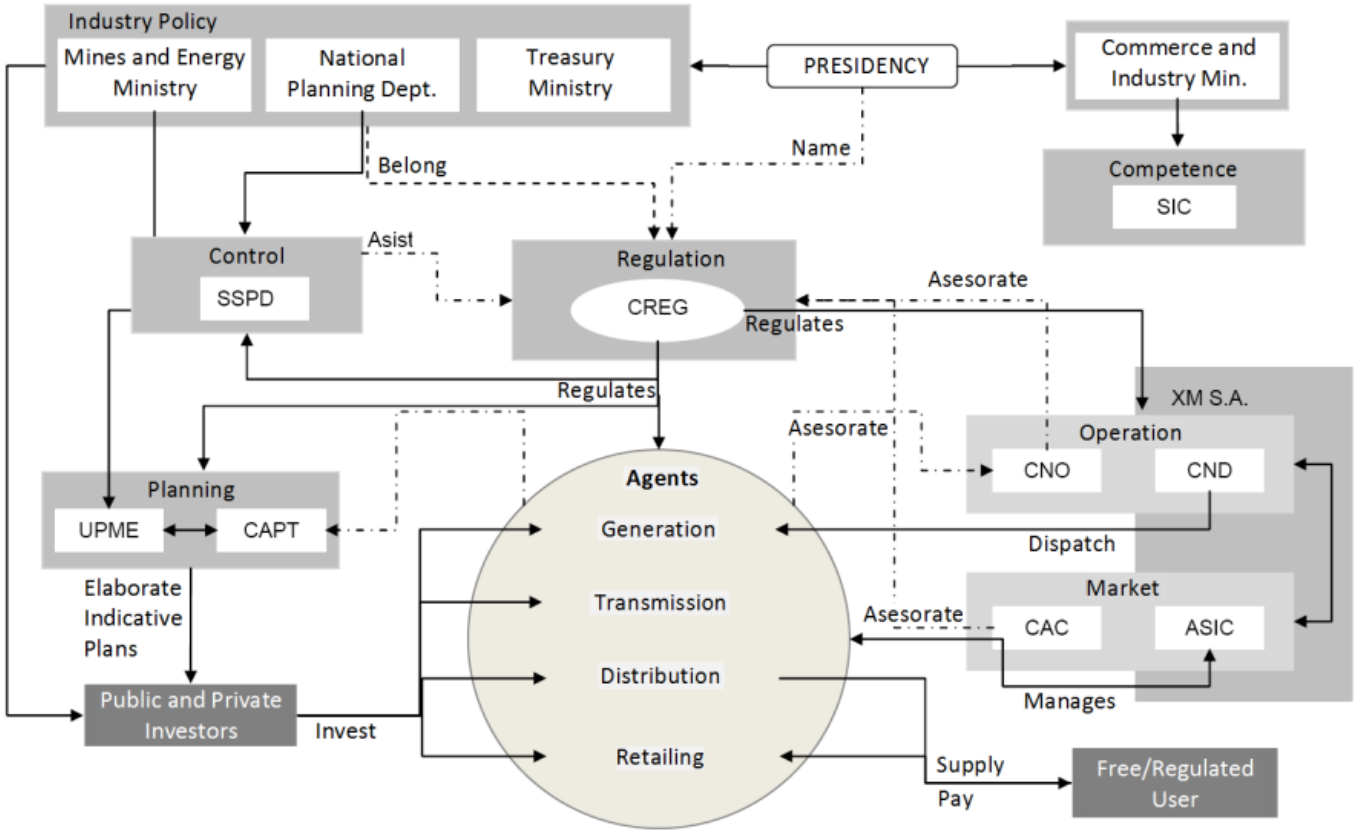


Figure 11. Institutional Sector Scheme (CREG, 2014)

Economical

The Colombian Energy marked allows participants to make transactions since 2006 in the Wholesale Electricity Market (MEM), and for Non-regulated users (known as Large Users and consuming more than 100 KW) to sign bilateral contracts with a free prices and quantities negotiation.

Table 4. Energy Transaction´s main figures

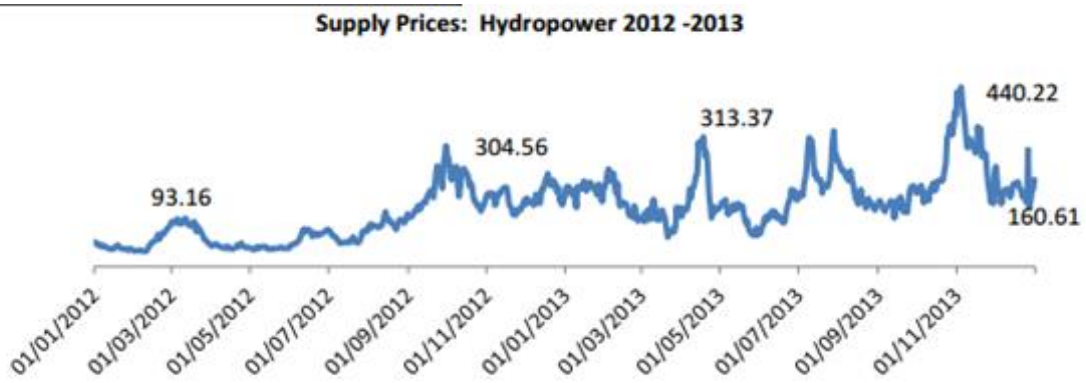
Variable	2014	2015	Variation	Growth
Energy traded in spot (GWh)	15,544	16,905	1,362	8.76%

Energy traded in contracts (GWh)	69,846	71,564	1,718	2.46%
Total energy traded (GWh)	85,390	88,469	3,079	3.61%
Deviations (GWh)	132.5	199.2	67	50.41%
Percentage of demand traded in spot (%)	24.15%	25.56%	0.014	5.87%
Percentage of demand traded in contracts (%)	108.50%	108.22%	-0.003	-0.26%
Value traded in spot (millions of $)	3,452,384	3,909,286	456,901	13.23%
Value traded in contracts (millions of $)	9,181,926	10,263,984	1,082,057	11.78%
Average aritmetic price in spot ($/kWh)	224.99	378.19	153	68.09%
Average price in contracts ($/kWh)	225.51	378.31	153	67.76%

Source: (XM, 2016)

A price fluctuation has occurred during the past years (2012-2013) from $73.29 COP/KWh (0.04 US/kWh) the lowest to $452.81 COP/KWh (0.24 US/kWh).

Figure 6: Supply prices. Hydropower 2012-2013



Source: (PROCOLOMBIA, 2015)

Social

Colombia is a vulnerable country in terms of possible attacks to energy infrastructure, as it has been the case for oil wells, transmission and distribution towers, oil and gas pipelines and other energy infrastructure in the past years.

Uncertainty and impact of Terrorism attacks are perceived as higher than other countries of the region, where, several infrastructure attacks have happened in the past, as from June to mid-July 2014, one of the Guerrilla groups, the National Liberation Army (ELN), assaulted 10 ten times the Colombian energy network.

Another Guerrilla group, the Colombian Revolutionary Armed Forces (FARC), has attacked electric towers in several regions, interrupting the power supply to different communities.

Also from the environmental and weather perspective, Colombia is one of the most vulnerable countries for the possibility of having interruptions on the energy supply. After El Nino phenomenon in December 2015, droughts in the Colombian territory were some of the causes of blackout crisis, as the supply capacity of electricity decreased, due to the climatological conditions that affected the hydroelectric power generators and thermoelectric water reservoirs levels, shortfall in energy production measures were stablished, this last situation is remarked by the Colombian relative dependency on hydroelectric power and the importance of the weather and climate information for the proper operation of the system.

A third social aspect to be highlighted is the non-technical energy losses of the Colombian sector, back in the 1990s Colombia was not the only country affected by high total losses in Latin American, as some other countries have a considerable amount of nonpaid energy, detected as the difference among the amount of electricity injected in the grid and the amount t paid by users, known as non-technical losses.

The situation leads to take preventive actions from the companies (distribution and transmission mainly), establishing specific programs for the improvement of commercial and technical management, through communication campaigns, outsourced services, better technological review implementations and other specialized techniques, but also some actions may be directed by the regulatory bodies as punitive actions and preventive regulation.

As a particular case, CODENSA stablished a customer discipline program, in order to reduce the non-technical losses, a customer type and geographic zone differentiation was done, and specific technical activities were designed, as the individual connections and distribution renewal and maintenance, supply regularization for low-income areas, unmetered customers connection replacement and some administrative actions as customer regularization.
As a result of the program, total losses in distribution declined from 22 percent in 1997 to 10 percent in 2000, consecutive actions have been taken (World Bank, 2009).

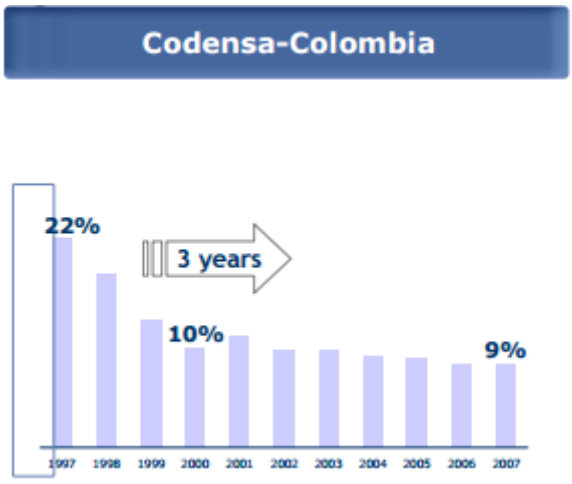


Figure 13. Energy losses evolution.

Technological

In Parallel with the technological evolution that is happening in the world and in different areas of the energy industry, Colombian utilities have implemented several programs for update and improve the system.

The Law 1715 was approved in May 13, 2014 through which the integration of non-conventional renewable energy to the national energy system is regulated and smart grids that add value to the entire chain of supply of electricity to start and open up new possibilities and improvements in efficiency and cost of energy and redound in a lower environmental impact.

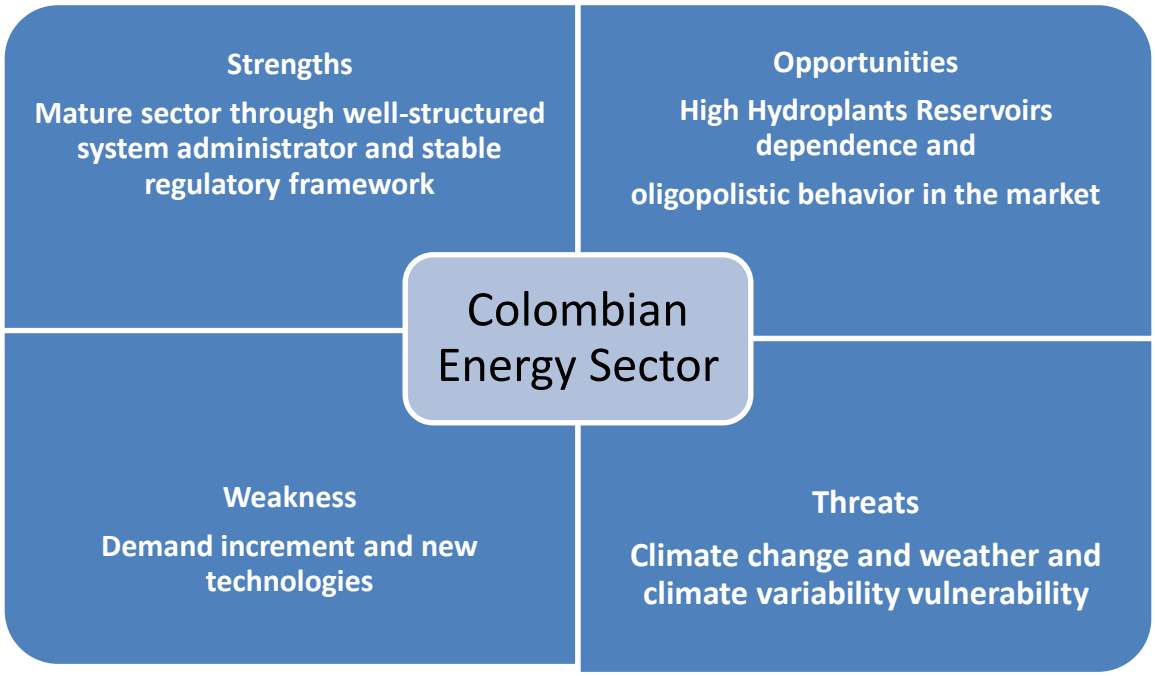
Several Smart grid projects have been lately launched in Colombia, some companies are conducting advanced metering infrastructure development, a particular example of this deployment of smart grid implementations, is the rollout of US grid management company Innovari's platform in Bogota.

Some other cities as Medellin and Cali have already started taking measures, as feasibility studies as a preparation for smart grid technologies deployment.

An initiative proposed in 2011, and leaded by the Mining and Energy Planning Unity (UPME), is "Colombia Inteligente", being a sectorial initiative, with the aim of bringing together different energy stakeholders: energy utilities, energy related research centers (CIDET, CINTEL) and some regulatory and sectoral institutions (CNO, CAC, COCIER), the objective of the project is to generate a decision making support tool for private companies operations and public policies and a roadmap that includes the available options to assess the benefits and impacts of Smart Grids. Colombia Inteligente counts with the participation of the Inter-American Development Bank (IDB).

SWOT Colombia

As a continuation of the Market Research, a SWOT analysis has been developed, to reinforce the information of the Colombian Energy Sector, and as a supportive tool to select the best Tailor-made climate services implementation methodology according to the particular needs in the country.



- **Strengths**

Mature and well organized sector

Well diversified sector

Hydrocarbons represent a strong currency generator for Colombia, important sector for the economy

Foreign direct investment in different energy activities

Strong coal reserves for the future

Scale production of coal

Robust interconnected transmission system

Stable regulatory institutional framework

- **Weakness**

High hydro plants generation dependence

Oligopolistic behavior in the market

The infrastructure and technology cost is high

Hydrocarbons vulnerability, depending on the successful findings of deposits

No possible Natural Gas regasification

The regulatory framework limits competition in generation

Low costs of hydro generation do not allow other technologies to be included

The regulatory framework is not very developed for promoting the entry of renewables

High volume of non-technical losses

- **Opportunities**

Demand Increment

International transmission connections with neighboring countries

International Trade Agreements with different countries

Low installed hydropower capacity compared with the estimated potential, as in Colombia the water resource is robust

Hydrocarbons foreign direct investment focus of exploration and drilling

Growing hydrocarbons derivatives market

Possible new demand for Hydrocarbons through international commercial projects

Hydro plants Expansion projects

New technologies are lowering costs

Recent increased demand for natural gas exports

- **Threats**

Climate change and weather extreme events vulnerability

El Nino affection

Geopolitical adverse circumstances

Social adverse circumstances

De-industrialization of the country that may affect the demand. Drop in the energy sector

Source: (OLADE, 2013).

Target Group

Whenever the market analysis has been done, enough supporting tools are available to select a costumer group to focus the GFCS Energy Exemplar efforts and resources. For Colombia the selected group is the Hydropower subsector.

IMPLEMENTATION METHODOLOGY

After analyzing the country general and more detailed characteristics and the current situation of the Colombian energy sector, the GFCS Energy Exemplar implementation methodologies that have been selected are the retailing model and the stakeholder's partnership.

The implementation of the GFCS Energy Exemplar is enabled by the WMO Network participants, mainly by the NMHSs. For Colombia, the IDEAM (Instituto de Hidrología, Meteorología y Estudios Ambientales), as the Environmental, Meteorology and Hydrology Institute represents the national coordinator and the main enabler to execute the project.

Retailing model

Colombia's Energy Sector could be described as a medium mature and diversified industry, after its liberalization process started in 1995, several transformation actions have happened for creating the system of the current days. One of the characteristic of the system is that it is well-diversified as it includes a considerable variety of agents.

Then being a decentralized and liquid system, settles an adequate framework for implementing a retail model, easing the execution of the project, as the interest and participation of the energy stakeholders is increased.

The Market Analysis that has been developed represents a crucial tool for better implementing the retail model, as the characteristics of the sector helps to define some criterion about the selection of a target group or the definition of a line of climate services that better fit their needs (even in a tailor-made services approach as it is proposed) and how to distribute and reach the targeted benefiters, aligning the different pathways of the retail approach to the real needs of the sector.

A result of this matching process is the decision of choosing only one channel as distributor, being the IDEAM, limiting the provision of the Climate services to the country and giving the possibility to better control the outcomes and the operations of the implementation of the GFCS Energy Exemplar, nevertheless WMO will contribute with its leadership and general coordination.

Another important characteristic that contributes to the success of the retailing model in the Colombian Energy Sector is that it is organized through different public and private entities (associations and councils) that contribute to reach the GFCS Energy Exemplar benefiters in an easier way. In order to have a real and fructiferous approach to the targeted customer's group (Hydropower generation utilities and other relevant agents), strength coordination among some key organizations is one of the first steps, for the retailing model and the partnership one.

Some identified institutions as key collaborators for reaching the energy sector participants are now presented:

CNO (Consejo Nacional de Operaciones, http://www.cno.org.co/) as the National Operation Council is a non-governmental entity, whose operating budget comes from annual contributions of the electricity

sector members that comprise it. CNO is organized through different Committees (Operation, Distribution, Legal, Transmission and Technological), Subcommittees and Working Groups.

BCSD Colombia (CECODES www.cecodes.org.co), as the Colombian Business Council for Sustainable Development (CECODES), has been operating for more than 20 years as a promotor of sustainable development. It is a private sector association, their programs are oriented to help companies to align their business strategies (operation and planning) to an environmental and sustainable orientation. Among its members, different energy utilities can be accounted.

AGOLGEN (Asociacion Colombiana de Generadores electricos), as the Colombian Association of Electric Power Generators, is a non-profit and non-governmental trade organization, with the aim of promoting fair competition among energy utilities and market development has been oriented to improve policy-making processes and sector regulation. Currently 18 generation companies are members of AGOLGEN, representing 86% of the net effective generation capacity in Colombia.

As the following step of the model implementation, and after a segmentation process of the possible customers, the preparation of a Climate Service Catalog has to be done, including all the available services to be provided according to the technical and scientific capabilities of WMO and its network. The Climate Services Catalog tends to be a first approach of satisfying the identified needs after an assessment process, and serving as the cornerstone for an opportune adjustment of the services to the asked requirement of each utility.

It is noticed that technology can help by offering new ways for customers to know the services, reflecting new and innovative ways of interactions for the project. With a customer centric base, either a virtual or physical approach will be operated for offering the Climate Services.

Some potential services have been identified according to the characteristics of the country and its energy system, and being the base for an adjustment process to match the Colombian Stakeholders particularities and need are now described as part of the Colombian Climate Services Catalog. As observed the presented services have a strong relationship with the identified target customers (Hydropower utilities).

CATALOG

1	***Seasonal forecasting for hydropower production***
Product/Service	Provision of seasonal forecasts of dam inflow
Objective	Optimize management of water resources for generating power in the context of multiple uses
Benefits	• Better reservoir management, including less frequent water shortages for power generation and other uses • Decreased cost of power generation • More reliable and cheaper supply of energy

	• Provision of information at appropriate resolutions
Outputs	• Ensemble (rather than probabilistic) forecasts of monthly or seasonal accumulated dam inflow for the next 1 to 12 months • Monthly or seasonal ensemble forecasts of daily rainfall and temperature for the next 1 to 12 months
Activities	• RMP: Research to improve forecasts • RMP: Downscaling of climate information to relevant spatial and temporal timescales • UIP: Working groups to assist in the design of the forecast system, and to address possible constraints in using the information (e.g., legal constraints on standard operating procedures) • RMP and UIP: Pilot studies to demonstrate value of using seasonal climate information
Inputs	• Basin-level hydrological models • Monitoring and recent historical climate information for operational forecasting • Historical climate and river-flow information for verification and for training of statistical models
Partners	• Research community • NMHSs • Dam managers

2	***Scenarios for energy mixes***
Product/Service	Design energy mix and % for each component that will meet the country's electricity demand both near term and long term.
Objective	Want to match the energy supply mix from each component including its variability to meet the expected demand in the most cost-effective manner acknowledging that demand must always be met. The tolerance for black outs is effectively zero.
Benefits	• Energy demand will be met through a well thought out range of expected scenarios (including climate change scenarios) ○ Low tolerance for black outs will be avoided by pre-planning • Energy mix will be provided in the most cost effective manner
Outputs	• Energy production profile of each energy mix (with ranges, uncertainties and unknowns built in) • Energy demand profile scenarios (with ranges and uncertainties or projections) • Optimization tool to take into account component mix profiles as well as externalities
Activities	• Build profiles for each supply component • Build profile for demand

Inputs	• Last 20 years of energy usage to build a model around energy demand • Last 20(-100) years of climate information (solar, wind, rainfall, streamflow, dam levels, etc). 20 years gives typical; 100 years gives better sampling for extremes to inform design e.g. 1 in 50-year extreme event

3	***Delivering decision-support climatic scenarios data for use in the energy sector***
Product/Service	Climatic projections for renewable energy generation, transmission and distribution
Objective	To provide the energy sector stakeholders with the relevant climate scenarios for the medium term (20–30 years) and long term (50–100 years) planning, according to the lifetime of the energy infrastructure (grid infrastructure, lines, stations, dams, equipment, management, power plants etc).
Benefits	• Inform and support political decision makers, • Assist energy sector managers in their pursue of efficient energy planning, • Address and support other concurrent sectors of the economy (e.g., farming, water management, including drought or flood control) • Inform and support the end users, including the citizens • Improve operational activities such as regulation of dams and rivers • Ensure the sustainability of the socioeconomic activities • Efficient environmental security planning
Outputs	• Since we are targeting different social, economic and technical segments, the output should be custom made to fill in the needs of the user. So, gridded data should be provided to the engineering and science communities. However, charts, tables, diagrams should be more appropriate for easier understanding and interpretation by policy makers. • Guidelines to conduct impact studies • Description of the methodology adopted so that it can be in principle applied to any region. • Software for downscaling and extracting the needed information for the preparation of impact studies. • Tools to interface climatic scenarios data with impact models. • Uncertainty assessment studies.
Activities	• Selection of appropriate model or combination of models. Analysis of models' performance/sensitivity. • If existing climatic scenarios for selected variables are not sufficient, then adapt or post-process for more refined information. • Search for existing climatic scenarios for selected variables (temperature and rainfall, for example) and their spatial resolution. These can be used directly or post-processed for refined information, if needed. • Formulate the output according to user needs (gridded data, graphics, etc) • Uncertainty estimation and capacity building. Ensure that the users are informed of the uncertainties and be able to incorporate this information in their own simulation and decision processes.

Inputs	• Securing the necessary hardware, software and other resources (look for partnerships, if needed), • Determine the time frame for projections so that we specify the objective (i.e., decadal versus climatic projections), • Collection, formatting and archiving of existing data/observations to be used in model validation and hindcasts, • Search for existing climatic scenarios for selected variables (temperature and rainfall, for example) and their spatial resolution. These can be used directly if they fulfill the needs.

The preparation of the proposed catalog will require the essential process of the climate services valuation for a consecutive pricing establishment. WMO, World Bank Group, USAID and GFDRR have started this task, resulting on the Valuing Weather and Climate: Economic Assessment of Meteorological and Hydrological Services document. Available at:

https://www.gfdrr.org/sites/default/files/publication/SEB%20HYDROMET.pdf

After the services to be provided and the retail channel have been defined, the following step is to define a communication and marketing strategy.

Stakeholder's partnership

The Stakeholder's partnership as a complementary methodology to the GFCS Energy Exemplar implementation, tends to enlarge the outreached energy agents, as there may be a strong group of participants that can contribute in different ways to the project, and that share common interests, and are not able to participate as customers. It has to be noted that the main objective is to create a more resilient system, not a profit stream, then a partnership model poses an effective way to include some agents that may not be able to engage in the retail model, but still have the need of the tailor-made climate services provision.

Creating partnerships represent a way to mutually benefit, as the GFCS Energy Exemplar can contribute from different perspectives to improve the energy sector in Colombia. Including business partners opens the scope of the project, as the amount and type of benefiters is enlarged.

Some possible partnerships that have been identified are now described:

- Expertise Partnership: As a complement to the WMO and its network expertise, know-how contributions form partners is crucial, as their operating fields perspective provides essential insights for the continuous improvement of the GFCS Energy Exemplar, leading to a coordinated interaction among the energy stakeholders. This type of partnership is very relevant, as the energy sector requires very detailed expertise.

- Capacity partnership: Partners can help to reach a wider audience through more detailed services, collaborating with the provision of particular climate services that may be elaborated by means of the equipment, infrastructure, experienced staff, or any other external resource. R&D collaborations are also included in this category.

- Communication partnership: Oriented to help the project in its outreach strategy, for spreading the project among all the interested audience, and among the potential future partners. Some other activities in this matter are related with helping to organize, host or coordinate any event (as partners meetings, forums, courses).

- Financial partnership: direct financing mechanisms among the WMO, its network member and the partners will enable a sounder monetary base, that will help to implement the GFCS Energy Exemplar in a more solid environment. Particular and hybrid financing mechanism may be revised for selecting the best alternative according to the partner's needs.
- Learning partnership: As an alternative partnership, the idea is to help WMO to generate ideas and enrich the GFCS project, developing content for the programs and scale them up.

A combination of more than one category is available according to the counterpart needs and preferences, and other interesting relationships may be considered as partnerships, being discovered through the interaction of the agents and the GFCS Energy Exemplar as the project is implemented and developed. A list of cross cutting possible partners is presented in the Communication and Outreach strategy section. These possible interactions will enable supportive actions to favor a more resilient energy sector as a direct outcome and some other indirect results.

Note that not all the partnerships may continue through time, as some may more interesting than others from the different participating agent's perspective.

There may be the possibility that some agents are interested in not having a strong relationship, but still interested in participating in some way, therefore and with the aim of not excluding relevant collaborators, some other informal ways of participating may be enabled.

A compilation of organizations that have been identified as possible partners is now presented:

Associations

Name	Web Page
ANDEG National Association of Generation Utilities-Asociación Nacional de Empresas Generadoras	http://www.andeg.org/
ASOCODIS Colombian Association of Electric Energy Distribution-Asociación Colombiana de Distribución de Energía Eléctrica	http://www.asocodis.org.co

ANDI Colombia National Business Association Asociación Nacional de Empresarios de Colombia	http://www.andi.com.co/cgc
CEO Water Mandate	www.ceowatermandate.org
CIER Organismo Internacional del sector energético de América Latina y el Caribe	www.cier.org.uy
Clúster Energía Eléctrica de Medellín	www.redclustercolombia.com
CME (Comité Minero-Energético)	www.cmecolombia.co
Risk and Insurance Management Society	www.rims.org

Source: Own elaboration

Regulatory Entities

Name	Webpage
Ministry of Mines and Energy	
Departamento Nacional de Planeación	https://www.dnp.gov.co/
COLCIENCIAS-Departamento Administrativo de Ciencia, Tecnología e Innovación	http://www.colciencias.gov.co/
CREG Comisión de Regulación de Energía y Gas	http://www.creg.gov.co/
Ministerio de Ambiente y Desarrollo Sostenible	http://www.minambiente.gov.co/
ANH- Agencia Nacional de Hidrocarburos	http://www.anh.gov.co/Paginas/inicio/defaultANH.aspx

Source: Own elaboration

Other Institutions

Name	Webpage
CIIEN - Centro de Investigación e Innovación en Energía	www.ciien.org
CLC: Corporate Leadership Council	www.cebglobal.com
Mesa del sector eléctrico (SENA)	www.mesadelsectorelectricocolombiano.blogspot.com
Mesa Nacional de Adaptación al cambio climático	www.dnp.gov.co
Sistema Nacional de Gestión de Riesgo de Desastre	http://www.sigpad.gov.co/

Academia/Research Centers	Not Available
Asociación de Energías Renovables	Not available

Source: Own elaboration

COMMUNICATION AND OUTREACH

A communication and outreach campaign is one of the core elements to successfully implement the project. The objective of the campaign is to create trust among internal and external stakeholders throughout the project implementation process, providing the relevant information and selected messages for stakeholders to fully understand the GFCS Energy Exemplar objectives and expected outcomes.

As part of the communication campaign, identifying cross-cut activities is the most practical way to detect where possible shared projects and objectives are being addressed by other institutions, and in that way a possible duplication of resources is avoided, and even a shared plan can be developed for integrating knowledge or any other useful resource.

In addition, the GFCS Energy Exemplar objectives are well aligned with an international approach of having a more sustainable strategy that has been promoted for the past years and nowadays in the private and public sector.

The environmental approach will continue to be spread in the future years, as all sort of associations and civil society are continuously improving the frameworks for having more sustainable businesses, better adapting to the climate change threat and specially oriented to mitigate the GHG and other anthropogenic sources of pollution.

Cross-cut activities

World Bank

http://en.openei.org/wiki/Colombia-World_Bank_Climate_Projects/

Active World Bank Climate Projects in Colombia

- Rio Frio Carbon Offset Project (0.3M) Carbon Offset
- Integrated Mass Transit Systems Second Additional Financing (300M) IBRD/IDA
- Colombia: San Nicolas Carbon Sequestration Project (4.74M) Carbon Offset
- CO: Caribbean Savannah Carbon Sink project (2M) Carbon Offset
- Jepirachi Carbon Off Set Project, Carbon Offset
- COLOMBIA - Amoya River Environmental Services, Carbon Offset
- Colombia: Integrated National Adaptation Program (5.4M) Global Environment Project
- CO-FURATENA AGROINDUSTRY CARBON OFFSET (0.75M) Carbon Offset

The World Bank has developed several study cases relating climate change and mitigation for Colombia.

- Adapting to Climate Change: Assessing the World Bank Group Experience. Supporting Adaptation at the National and Regional Level
  Available at http://ieg.worldbankgroup.org/Data/reports/cc3_full_eval_0.pdf
- Vulnerability, Risk Reduction, and Adaptation to Climate Change
  Availableat:http://sdwebx.worldbank.org/climateportalb/doc/GFDRRCountryProfiles/wb_gfdrr_climate_change_country_profile_for_COL.pdf

Climate Services for Resilient Development (CSRD)

http://www.ccrdproject.com/

As a USA Federal Government, is a Public-Private Partnership to Empower Climate-Resilient Developing Nations and Colombia has been selected a pilot country. In 2015, the report Options for Climate Services Investments in Colombia was published.

Caring for climate

http://caringforclimate.org/

UN initiative that brings together leading companies worldwide in climate change management. The initiative has a strong orientation for engaging the public sector and commit it to participate in a more active way.

As one of their activities a Climate Business Forum is organized as a venue to bring together private and public entities and advance on climate mitigation and adaption policy.

Colombia as a UN member participates through different companies, both external and internal energy sector companies take part of the program.

Global Compact

https://www.unglobalcompact.org/

As a UN initiative, it is an invitation to the private sector to align their strategies with different universal principles and values, environmental and sustainability included. In 2010 Colombia was attached to this initiative, where different national entities contributed to the Millennium Development Goals, similar reactions are expected for the Sustainable Development Goals.

Colombia Integrated National Adaptation Program Global Environment Project

https://www.dnp.gov.co/programas/ambiente/Paginas/plan-nacional-de-adaptacion.aspx/

This project is the national framework to define and implement specific adaptation measures and policy options to meet the climate change impacts. The strengthen of Colombia's capabilities as one of the actions to produce and disseminate useful climate information for operation and decision making, and specially to support the climate change adaptation and mitigation measures and programs in the country.

Some other initiatives and institutions with possible shared objectives:

- USAIDS- United Nations Agency for International Development
- ESGP-Earth System Governance Project
- GEF-Global Environment Facility
- CSE-Centre for Science and Environment
- New Climate Economy of the Global Commission on the Economy and Climate
- Open Climate Network

Funds

Colombia as a climate change threatened country and as a developing country, and some other particular characteristics make it a possible benefiters of different fund calls.

Name	Description	Webpage
Adaptation Fund	The Adaptation Fund finances projects and programmes that help vulnerable communities in developing countries adapt to climate change. Initiatives are based on country needs, views and priorities. The Adaptation Fund was established under the Kyoto Protocol of the UN Framework Convention on Climate Change, and has committed US$ 338.5 million in 61 countries since 2010 to climate adaptation and resilience activities.	https://www.adaptation-fund.org/
BioCarbon Fund	he World Bank's Carbon Finance Unit uses funds contributed by governments and companies in OECD countries to purchase greenhouse gas emission reductions, commonly known as carbon credits, generated by projects in developing countries and countries with economies in transition. The emission reductions are purchased through one of our carbon funds or facilities on behalf of the contributor, and within the framework of the Kyoto Protocol's Clean Development Mechanism (CDM) or Joint Implementation (JI).	https://wbcarbonfinance.org/
Global Environment Facility Trust Fund	The Global Environment Facility (GEF) was established on the eve of the 1992 Rio Earth Summit, to help tackle our planet's most pressing environmental problems. Since then, the GEF has provided $14.5 billion in grants and mobilized $75.4 billion in additional financing for almost 4,000 projects. The GEF has become	https://www.thegef.org/

	an international partnership of 183 countries, international institutions, civil society organizations, and private sector to address global environmental issues.	
MDG Achievement Fund – Environment and Climate Change thematic window	The MDG Achievement Fund (MDG-F) was committed to eradicating poverty and inequality and changing people's lives around the world. Set up in 2007 with a generous contribution from the Government of Spain to the United Nations system, we worked together with and in support of citizens and their organizations as well as governments to implement programmes that helped advance the Millennium Development Goals (MDGs) worldwide.	http://www.mdgfund.org
Pilot Program for Climate Resilience	The Pilot Program for Climate Resilience (PPCR), approved in November 2008, was the first program under the SCF to become operational. Its objective is to pilot and demonstrate ways to integrate climate risk and resilience into core development planning, while complementing other ongoing activities.	https://www-cif.climateinvestmentfunds.org/fund/strategic-climate-fund
UNREDD	The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries was launched in 2008 and builds on the convening role and technical expertise of the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP). The UN-REDD Programme supports nationally led REDD+ processes and promotes the informed and meaningful involvement of all stakeholders, including indigenous peoples and other forest-dependent communities, in national and international REDD+ implementation.	http://www.un-redd.org/
Germany's International Climate Initiative	Since 2008, the International Climate Initiative (IKI) of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) has been financing climate and biodiversity projects in developing	https://www.international-climate-initiative.com/en/about-the-iki/iki-funding-instrument/

	and newly industrialising countries, as well as in countries in transition. In the early years of the programme, its financial resources came from the proceeds of auctioning allowances under the emissions trading scheme. To ensure financial continuity, further funds were made available through the Special Energy and Climate Fund. Both funding mechanisms are now part of the Federal Environment Ministry's regular budget.	
Japan's Fast Start Finance	Announced in 2009 pledged USD$15 billion in public and private financial assistance to help developing countries address climate change. Consisting of USD$11 billion in public finance and USD$4 billion in private finance, this Fast-Start Financing (FSF) replaced the government's previous financing mechanism known as the 'Cool Earth Partnership' (2008 - 2010).	
UK Climate Fund	The UK's climate finance helps make some of the poorest and most vulnerable communities more resilient to climate change, for example, supporting the distribution of flood resilient crops and improving early warning systems. It is also helping create a reliable source of energy for communities which improves health, education, and enables businesses to grow, creating jobs and improving incomes and standards of living for the poorest communities. It seeks to prevent emissions now or in years to come through demonstrating how countries can shift to cleaner, low carbon approaches and technology. Our investment in the International Climate Fund is enhancing Britain's place in the world and creating a safer and more prosperous future for us all.	https://www.gov.uk/government/publications/international-climate-fund/international-climate-fund
Global Climate Change Alliance	The GCCA was established by the European Union (EU) in 2007 to strengthen dialogue and cooperation with developing countries, in particular least developed countries (LDCs) and small island developing States (SIDS). It started its work in just four pilot countries. Today it has a budget of more than €300 million and is one of the most significant climate initiatives in the world. It supports 51 programmes around the world and is active	http://www.gcca.eu/

	in 38 countries, 8 regions and subregions and at the global level	
Global Energy Efficiency and Renewable Energy Fund	Advised by the European Investment Bank Group, GEEREF is an innovative Fund-of-Funds catalysing private sector capital into clean energy projects in developing countries and economies in transition.	http://geeref.com/
Green Climate Fund	The Green Climate Fund is unique in its ability to engage directly with both the public and private sector in transformational climate-sensitive investments. The Fund will work through a wide range of entities to channel its resources to projects and programmes. Such entities may be international, regional, national, or subnational, public or private institutions that meet the standards of the Fund. Countries may access the Fund through multiple entities simultaneously.	http://www.greenclimate.fund/

Source: Fund's webpage.

EVALUATION AND METRICS

Key performance indicators have been defined to measure the outcomes of the implementation of the GFCS Energy Exemplar and specially the improvement of the energy sector resilience against Climate and weather variability and extreme events. They represent a useful tool to improve the overall and specific performance of the project, through its opportune and continued adjustment. And a way to prove the added value of the project and to engage further participants, as some of the indicators are bases in a cost-efficiency perspective, that ease the benefit identification of being part of the project from the energy's stakeholders view.

Two different categories of indicators are now presented. The main purpose of this indicators is to evaluate the activities of the energy provision chain. The General Indicators make reference to the main activities affected by the weather events. The Detailed Indicators measure tangible improvements after receiving tailor-made climate services by the GFCS Energy Exemplar use.

Hydropower

General

- Number of accidents related to extreme weather events
- MW produced/ installed capacity

Detailed

- MW produced/ water availability
- Expected installed capacity expansion (MW) according to the expected water availability
- Number of delay days in the maintenance schedule
- Amount invested for risk hedging activities (monetary unit)
- Economic losses in infrastructure (monetary unit)
- Economic losses in operations (monetary unit)

Transmission

General

- Quality of electricity supply (frequency of blackouts/brownouts)

Detailed

- Number of delay days in the maintenance schedule
- Amount invested for risk hedging activities (monetary unit)
- Economic losses in infrastructure (monetary unit)
- Economic losses in operations (monetary unit)

Wind

General

- MW Produced/Installed Capacity

Detailed

- Number of delay days in the maintenance schedule
- Amount invested for risk hedging activities (monetary unit)
- Economic losses in infrastructure (monetary unit)
- Economic losses in operations (monetary unit)
- Expected installed capacity (MW)

Fossil Fuels and Thermal

General

- Number of oil reserves physically affected by extreme weather events
- Number of oil and gas installations affected by extreme weather events (onshore and offshore)
- Number of accidents on maritime fuel transportation related to extreme weather events

Detailed

- Water availability for cooling procedures in thermal power plants (cubic meters)
- Number of delay days in the maritime fuel transportation
- Number of delay days in the maintenance schedule
- Amount invested for risk hedging activities (monetary unit)
- Economic losses in infrastructure (monetary unit)

Market (for each timescale market)

General

- Energy price maximum (monetary unit)
- Energy price minimum (monetary unit)
- Liquidity of the market (number of participants)

Decision Makers

General

- Diversity of electricity generation mix in a country (amount and share of each generation technology)

- Share of energy produced from renewable energy amount and share of each generation technology)
- Total efficiency for the electricity generation (MW produced/MW Installed capacity)

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Market Research Climate Services Assessment in the Energy Sector Survey Compilation.

Colombia

Organization Name: ISAGEN

Organization Main Activity: Energy Generation **Number of Employees:** 700

The objective of this survey is to collect information about the climate services used in the energy sector, with the aim of learning about their particular features within the public and private energy organizations.

Climate Services:

1) Do you need climate information for any operation within the company? How is it used?

   We do a daily and weekly follow up to the climate information generated by the different international agencies, like NOAA, BOM, ECMWF, among others, in order to have a good perspective of what we can expect in terms in climate and how it will affect our water resources.

2) Do you have an in-house mechanism for climate information generation or it is outsourced?

   ISAGEN has a network of gauges to measure different climate variables, but the majority of the gauges are pluviometric and hydrometric, we only have one or two Principal Climate gauge for each of our tributary basin.

   All the hydrometeorological information is gathered and analyzed by ISAGEN.

3) If the climate information is outsourced, which department/area is in charge of gathering it?
4) Indicate the number of people involved in the climate information generation and/or gathering process.

   We are a group of 9 persons involved in all the process to register, gather and analyze the hydrometeorological information, from the maintenance of the gauges, review and consolidation of the information and analyze and process all the information in order to use it for the inflow projections for the short and longterm planning.

5) Is there a budget for weather information? If the answer is "yes," please also indicate the approximate amount (monthly budget).

   From $0 to $1,000 USD X
   From $1,000 to $5,000 USD_____
   More than $5,000 USD_____

Extreme Climate Events:

6) Mention any example concerning the impact and consequences of extreme climate events that have occurred within the past 20 years that has affected in some way your operation.

   La Niña 2010-2011: We had extreme precipitations during a long period of time, which led to high inflows to our reservoir and eventually, when our reservoirs were full, we had spills. These spills, plus the high generation of the plant and the floods of the rivers downstream of the dams, generated alerts to the community and in some of our power plants the operation was affected, due to the community's complains that the turbinated flow incremented the river flow downstream and worsen the situation.

   El Niño 2015-2016: We had severe drought during a long period and that led to very low levels in our reservoirs. This affected the daily operation, because the objective is to be available for the system, so we needed to administrate the water resource in a way that we could be able to generate most of the time, even with a minimum of generation.

7) Did you have resilient-oriented strategies that helped to prevent extreme climate events?

   With the information from the climate services agency in Colombia, IDEAM, and the information of the international agencies, we try to make the projections of the monthly behavior of the inflows of our hydroelectric power plants. With those projections we try to be prepared for the extreme events that we can anticipate, and adjust our operation policies.

8) What actions were taken after the extreme climate events based on lessons learned?

   We always make the projections of the levels of our reservoirs, in order to have an idea of how much energy we can generate throughout the year and in which periods we can generate more or have to save water for the dry seasons.

   For La Niña events, the projections are very important to anticipate the spills, and try to prevent them with more generation, if possible. Also to inform the community of a possible spill for them to be prepared and implement their emergency plans.

Risk Management:

9) Does the company have climate risk management strategies and practices? If the answer is "yes," please detail.

   No.

10) Indicate the approximate budget assigned for risk hedging.

   From $0 to $1,000 USD_____
   From $1,000 to $5,000 USD_____
   More than $5,000 USD_____

Climate Services Assessment in the Energy Sector Survey

Colombia

Organization Name: AES CHIVOR – an AES Corporation Company

Organization Main Activity: Electric energy generation

Number of Employees: 112 direct and 200 no direct employees

The objective of this survey is to collect information about the climate services used in the energy sector, with the aim of learning about their particular features within the public and private energy organizations.

Climate Services:

1) Do you need climate information for any operation within the company? How is it used?

   Yes, we need climate information daily. Among others, we use information from our hydrometric stations, and information from national and international agencies related with rainfall, temperature, winds and other weather factors.

2) Do you have an in-house mechanism for climate information generation or it is outsourced?

   We developed some tools just for our business. This tools are related with forecast models in order to predict inflows to our reservoir.

3) If the climate information is outsourced, which department/area is in charge of gathering it?

   The tools that we developed since 2007, are reviewed every 2 years for internal procedures.

4) Indicate the number of people involved in the climate information generation and/or gathering process.

   In AES Chivor (Colombia) we are 3 people in charge of it. However, in AES Corp. since 2014 we create a Hydrology Risk Committee, that is in charge of reviewing the present and future scenarios for all the generations business that somehow are affected by weather (approximately 10 countries involved).

5) Is there a budget for weather information? If the answer is "yes," please also indicate the approximate amount (monthly budget).

   From $0 to $1,000 USD_____
   From $1,000 to $5,000 USD_____
   More than $5,000 USD__x___

Extreme Climate Events:

6) Mention any example concerning the impact and consequences of extreme climate events that have occurred within the past 20 years that has affected in some way your operation.

In May 2004, the operation of our plant of 1000 MW of installed capacity had to be canceled for 15 days because an extraordinary inflow came, we had low level in our reservoir and the concentration of the sediments were so high that we had a risk of coollpase in our conductions.

7) Did you have resilient-oriented strategies that helped to prevent extreme climate events?

Yes. We are doing a risk analysis and a resilience plan in order to continue our operations despite an extraordinary weather event.

8) What actions were taken after the extreme climate events based on lessons learned?

Increase weather measuring stations. Study sediment behavior. Apply some commercial strategy that help decrease de risk related with sediments.

Risk Management:

9) Does the company have climate risk management strategies and practices? If the answer is "yes," please detail.

See answers number 7 and 8.

10) Indicate the approximate budget assigned for risk hedging.

From $0 to $1,000 USD_____
From $1,000 to $5,000 USD_____
More than $5,000 USD___x__

Climate Services Assessment in the Energy Sector Survey

Colombia

Organization Name:

GENSA S.A. E.S.P., is public company, it was founded under law 142 de 1994

Organization Main Activity:

GENSA has mainly goals, power Generation, power distribution and power trading.

Number of Employees:

250

Climate Services:

1) Do you need climate information for any operation within the company? How is it used?

Knowing climate information in the country is necessary for the company to assess precipitation events, natural phenomena (Niño - Niña) and other natural factors that are necessary to develop activities of hydrology in hydroelectric projects, also to know the weather conditions in GENSA´areas, where it is responsible for power generation.

2) Do you have an in-house mechanism for climate information generation or it is outsourced?

Gensa has some monitoring stations where it usually takes measurements from the river level and another one hydroclimatological station in Termopaipa thermoelectric power plant.

3) If the climate information is outsourced, which department/area is in charge of gathering it?

Gensa has an environmental staff, who has responsibility to administrate the weather information.

4) Indicate the number of people involved in the climate information generation and/or gathering process.

Three environmental engineers

5) Is there a budget for weather information? If the answer is “yes,” please also indicate the approximateamount (monthly budget).

There is a monitoring program during the year

From $0 to $1,000 USD_____

From $1,000 to $5,000 USD__X___

More than $5,000 USD_____

Extreme Climate Events:

6) Mention any example concerning the impact and consequences of extreme climate events that have occurred within the past 20 years that has affected in some way your operation.

The Niño phenomenon who just happened in the country generated an energy crisis, the water flows suffered a drastic reduction due a sudden temperature increase during six months at least.

7) Did you have resilient-oriented strategies that helped to prevent extreme climate events?

Our main power plants are in an overhauling process in order to reduce ash emitions, also another element like sulfur, coal monoxide.

8) What actions were taken after the extreme climate events based on lessons learned?

GENSA adopts the policy of efficient energy use

Risk Management:

9) Does the company haveclimate risk management strategies and practices? If the answer is“yes,” please detail.

No

10) Indicate the approximate budget assigned for risk hedging.

From $0 to $1,000 USD_____

From $1,000 to $5,000 USD_____

More than $5,000USD_____

Climate Services Assessment in the Energy Sector Survey

Colombia

Organization Name: EMPRESA URRÁ S.A. E.S.P.

Organization Main Activity: Energy Generation. **Number of Employees:** 31.

The objective of this survey is to collect information about the climate services used in the energy sector, with the aim of learning about their particular features within the public and private energy organizations.

Climate Services:

1) Do you need climate information for any operation within the company? How is it used?

   Yes. Inflow projections.

2) Do you have an in-house mechanism for climate information generation or it is outsourced?

   Outsourced.

3) If the climate information is outsourced, which department/area is in charge of gathering it?

   Department of hydrology.

4) Indicate the number of people involved in the climate information generation and/or gathering process.

   2.

5) Is there a budget for weather information? If the answer is "yes," please also indicate the approximate amount (monthly budget).

   From $0 to $1,000 USD__X___
   From $1,000 to $5,000 USD_____
   More than $5,000 USD_____

Extreme Climate Events:

6) Mention any example concerning the impact and consequences of extreme climate events that have occurred within the past 20 years that has affected in some way your operation.

On December, 2010, record rainfall resulted in reservoir at capacity, flooding several towns downstream.

7) Did you have resilient-oriented strategies that helped to prevent extreme climate events?

   No.

8) What actions were taken after the extreme climate events based on lessons learned?

   To operate the reservoir in lower levels.

Risk Management:

9) Does the company have climate risk management strategies and practices? If the answer is "yes," please detail.

   No.

10) Indicate the approximate budget assigned for risk hedging.

   From $0 to $1,000 USD_____
   From $1,000 to $5,000 USD_____
   More than $5,000 USD_____

Climate Services Assessment in the Energy Sector Survey

Colombia

Organization Name: Emgesa S.A. E.S.P

Organization Main Activity: Energy Production **Number of Employees:** 570

The objective of this survey is to collect information about the climate services used in the energy sector, with the aim of learning about their particular features within the public and private energy organizations.

Climate Services:

1) Do you need climate information for any operation within the company? How is it used?

   Yes, we do. We use climate information to forecast the behavior of flows into the reservoirs and hydroelectric plants. So, we decide how to offer the energy and how to operate the plants.

2) Do you have an in-house mechanism for climate information generation or it is outsourced?

   It is outsourced. We also look for climate information in the Web.

3) If the climate information is outsourced, which department/area is in charge of gathering it?

   The Hydrology area.

4) Indicate the number of people involved in the climate information generation and/or gathering process.

   1 professional

5) Is there a budget for weather information? If the answer is "yes," please also indicate the approximate amount (monthly budget).

   Yes

   From $0 to $1,000 USD_____
   From $1,000 to $5,000 USD__X___
   More than $5,000 USD_____

Extreme Climate Events:

6) Mention any example concerning the impact and consequences of extreme climate events that have occurred within the past 20 years that has affected in some way your operation.

   We have been affected by the ENSO. El Niño and La Niña impact Colombia.

   El Niño decreases the quantity of water and the hydroelectric production is reduced. The National Electric System is stressed and there is a lot of pressure to avoid an energy rationing. The energy price soars.

   La Niña causes a lot of floods affecting many people. The discharges from reservoirs increase and they are accused by negatively affecting downstream populations, even when it is not their responsibility.

7) Did you have resilient-oriented strategies that helped to prevent extreme climate events?

   We try to have better information about the probabilities of extreme climate events, to be prepare and, if it is necessary, change the strategy of energy production.

8) What actions were taken after the extreme climate events based on lessons learned?

To have a better communication plan to divulge the way a reservoir is operated. To work in forecast inflows models to evaluate strategies about how and when to use the water.

Risk Management:

9) Does the company have climate risk management strategies and practices? If the answer is "yes," please detail.

   Yes, the Company has been implementing during the last year hedging strategies for the power generation portfolio. Among the strategies are the use of coal plants, as natural hedge and the financial derivatives market (Derivex).

10) Indicate the approximate budget assigned for risk hedging.

   From $0 to $1,000 USD_____
   From $1,000 to $5,000 USD_____
   More than $5,000 USD__X___

Support/interest letters from the Colombian Hydropower subsector.

AES Chivor
somos la energía

Santa Maria - Boyacá, June 14th 2016

GREEN CLIMATE FUND
Songdo Business District
175 Art center-daero
Yeonsu-gu, Incheon 22004
rboscolo@wmo.int, dortiz@wmo.int
Republic of Korea

Reference: Manifestation of interest on the GFCS Energy Exemplar.

Good day,

Recently, AES CHIVOR had the oportunity to learn about the GFCS Energy Exemplar through the WMO. **AES CHIVOR** is the fourth largest energy generator of Colombia, South America. Also, AES CHIVOR is part of AES Corporation that is a US company dedicated to the generation and distribution of energy a Global Level, with operations in 18 countries and a team of 18,500 employees, AES Corp. provides safe, reliable and sustainable energy to more than 100 million people worldwide.

AES Chivor is a Hydroelectric Power Plant of 1000 MW of installed capacity which generates 4060 GWh per year on average. High quality climate, hydrological information and climate forecast is essencial for our normal operation and to establish appropriate measures and strategies to face challenges imposed by the weather like Niño phenomena or others realted with climate variability.

For this reason, we want to be part of this project, and and seek ways of joint cooperation through the WMO.

Best regards,

WILLIAM J. ALARCON F.
General Operations Manager
AES CHVIOR & CIA SCA ESP

República de Colombia
Ministerio de Minas y Energía

CIDET SC - 0123 NTC – ISO 9001:2008
CIDET SA - 0022 NTC – ISO 14001:2004
CIDET SS - 0021 NTC – OHSAS 18001:2007

2016-M-GTA- 099

Montería, 15 JUN. 2016

EMPRESA URRA SA ESP
Correspondencia Despachada
Vigencia: 2016 - Al Contestar Cite Este No: D-15
Fecha de Radicación: 15/06/2016-12:14 PM
Destino: GREEN CLIMATE FUND
Asunto: EXPRESSION OF INTEREST IN GFCS ENERGY EXEMPLAR
Origen: PRESIDENCIA - rafael piedrahita

GREEN CLIMATE FUND
Songdo Business District
175 Art center-daero
Yeonsu-gu, Incheon 22004
rboscolo@wmo.int, dortiz@wmo.int
Republic of Korea

Subject: Expression of interest in GFCS Energy Exemplar.

To whom it may concern,

URRÁ S.A. E.S.P. recently had the oportunity to learn about the GFCS Energy Exemplar through the WMO. URRÁ S.A. E.S.P. has one (1) hydroelectric power plant in Colombia, South America, therefore it's very important to us to have high quality climate and hydrological information, in order to have the best estimation of the inflow for a horizon of 24 months.

We would like to express our interest in the development and participation in this project, and we hope to learn more about it in the future.

Sincerely,

Rafael Piedrahita

RAFAEL PIEDRAHITA DE LEÓN
Technical and Environmental Manager

Copia: Ing. Alfredo Solano Berrío - Presidente

ISAGEN

352

E2016-008932

Medellin, 17 JUN 2016

GREEN CLIMATE FUND
Songdo Business District
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rboscolo@wmo.int, dortiz@wmo.int
Republic of Korea

Reference: Manifestation of interest on the GFCS Energy Exemplar.

Good day:

Recently, ISAGEN has had the oportunity to learn about the GFCS Energy Exemplar through the WMO. ISAGEN is the third largest energy generator of Colombia, South America. We have seven (7) power plants and six (6) of them are hydroelectric. For this reason, it's very important for us to have high quality climate and hydrological information, in order to have the best estimation of the inflow projections for the next 24 months and which are a critical imput for the calculation of the Company's devenues each year.

We would like to manifaste to you our interest in the development and participation of this project, and we hope to learn more about it in the future.

Best regards,

LUIS FERNANDO RICO PINZÓN
General Manager

Copia:352,070,302
Johanna J./Estefania P.

filial de isa

6011 – 11

CITESE 012775 – 1 XM
MEDELLIN, JUN – 24 – 2016 04:14 PM
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Republic of Korea

Reference: Our interest in participating on the GFCS Energy Chapter

Dear Sir/Madam

Recently We've just had the opportunity to attend a teleconference organized by the World Meteorological Organization (Geneve) where the WMO outlined the objectives and scope of the Global Framework for Climate Services –GFCS-, related particularly to the Colombian Energy Producers Sector.

We at XM, as a governmental technical body within the Ministry for Mining and Energy, play a crucial role in the management of the energy sector. The activities carried out by our organization may be summarized as follows: to run the energy stock market, to guarantee the continuous supply of energy at competitive prices with highest standards of quality by operating and to managing the energy assets in this sector, to establish the daily most economic dispatch for energy hydrothermal plants, to plan with several months or years in advance what will be required to guarantee the continuous supply of energy in order to avoid any energy shortage, etc.

To accomplish the aforementioned tasks, It is clear that We must plan the future operation of the colombian hydrothermal energy system well in advance. We need to know how will it behave under such uncertainties as climate, hydrology, etc.

Since most of our energy comes from hydroprojects, It is clear that climate and hydrology plays a role of paramount importance in planning the future operation of this system. Climatological extreme climate events such as El Niño and La Niña add still more difficulties and uncertainties to the planning of the future behavior of our system, making the decision making process even harder, and since investments in this sector are definitely very big, We must act carefully when issuing recommendations.

These are just a few instances that outline the importance of having better knowledge of climate and hydrology. This is an issue that we really need to bring into focus.

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