NREL
NATIONAL RENEWABLE ENERGY LABORATORY

المـكتب الوطـني للكـهرباء و المـاء الصـالح الشـرب
Office National de l'Electricité et de l'Eau Potable

NREL MOU-19-521

Memorandum of Understanding

Between
National Renewable Energy Laboratory
and
Morocco National Office of Electricity and Potable Water

Regarding Coordination on Grid Integration of Variable Renewable Energy Technologies in Morocco

The **National Renewable Energy Laboratory (NREL)** is a national laboratory managed and operated by the Alliance for Sustainable Energy, LLC for the United States Department of Energy (DOE) under Contract No. DE-AC36-08GO28308.

L'Office National de l'Électricité et de l'Eau Potable (ONEE) (National Office of Electricity and Potable Water, as it is known in English), is the national power and water authority of the Government of Morocco.

As part of its mission for DOE , and in coordination with the United States Department of State (DOS), NREL performs independently programmed and funded grid integration activities for selected countries consisting of analysis; training; and characterization and resource mapping for high-penetration of variable renewable energy (VRE) technologies and provides technical assistance to increase a country's knowledge and experience of integration of VRE into traditional power system grids throughout the world.

As part of its mission for the Government of Morocco, ONEE is supporting the Moroccan objectives to reach renewable energy goals of 42% by 2020 and 52% by 2030 by providing access to ONEE power sector information and engagement of representative staff and resources dedicated to furtherance of these Moroccan renewable energy goals.

NREL and ONEE are hereinafter referred to individually as a "Participant" and collectively as the "Participants."

Section 1: Purpose

The purpose of this Memorandum of Understanding (MOU) is to encourage coordination activities in areas of mutual interest and benefit to the Participants in grid integration of VRE technologies in Morocco.

Section 2: Areas and Forms of Planned Coordination

In furtherance of the planned coordination with ONEE, NREL intends to collaborate with representatives of its funding agencies, DOE and DOS, in performing the following activities:

- Analysis of Moroccan grid readiness for high penetration of VRE;
- Trainings for ONEE staff on the grid integration process;
- Characterization and mapping of Moroccan renewable energy resources; and
- As needed technical assistance in response to questions about grid integration of renewable energy.

For clarification purposes only, additional details of NREL's independently programmed and funded planned scope of work is attached as Exhibit 1.

ONEE is independently funded by the government of Morocco and intends to coordinate with NREL on the following activities:

- Provision of power sector information including GIS data, system technology data, and current operational processes;
- Engagement of representative ONEE staff for grid integration trainings;
- Reviews, comments, and input to analysis development and results; and
- Structured questions and inquiries specific to grid integration to meet Moroccan renewable energy goals.

Section 3: Contacts

The following designated representatives should oversee, manage, and facilitate implementation of the coordination activities. All notices, communications, and coordination should involve the following individuals:

NREL:
Ms. Sherry Stout
National Renewable Energy Laboratory
Alliance for Sustainable Energy, LLC
15013 Denver West Parkway
Golden, Colorado USA 80401
sherry.stout@nrel.gov

ONEE:
Mr. Abdelghani Hammadia
L'Office National de l'Électricité et de l'Eau
Potable, Branche Électricité
65 Othman Ben Affane Street
20000 Casablanca Morocco
hammadia@onee.ma

Section 4: Funding

Coordination activities under this MOU are subject to available funds, personnel and other resources of the Participants, including other financial assistance as may be obtained by either one of them from external sources. Each Participant intends to be responsible for its own costs incurred in participating in coordination activities under this MOU, including all administrative costs, overhead expenses, labor costs, insurance costs, travel expenses and similar costs.

Section 5: Dissemination of Information

Planned coordination activities under this MOU may include exchanges of publicly available, non-proprietary business information. Subject to applicable laws and regulations of their respective countries, the Participants may disseminate information, data, and reports of the activities carried out under this MOU. Any information transmitted under this MOU should be accurate to the best knowledge and belief of the transmitting Participant.

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Section 6: Intellectual Property and Confidential Information

The Participants do not anticipate the transfer of rights in intellectual property or the sharing of confidential information under any planned coordination activity under this MOU. If it appears that a particular activity may lead to the creation of intellectual property or the disclosure or exchange of confidential information, the Participants should enter into an appropriate written agreement therefor.

Section 7: General Considerations

This MOU is not intended to create any legally binding rights or obligations between the Participants. Each Participant should conduct the coordination contemplated under this MOU in accordance with applicable laws and regulations to which it is subject and international agreements to which its government is party.

Section 8: Commencement, Modification and Discontinuation

The coordination activities under this MOU may commence upon signature of both Participants and may continue for a period of two (2) years unless discontinued in accordance with this Section. The Participants may discontinue coordination under this MOU at any time by mutual written consent. Alternatively, a Participant which desires to discontinue its participation in this MOU should endeavor to provide the other Participant at least 90 days advance written notice. The Participants may modify this MOU at any time by mutual written consent.

[signatures on following page.]

Signed in duplicate.

For
The National Renewable Energy Laboratory:

DocuSigned by:
W.T. Farris
BE9B84B6D52F446...

Printed Name of Signatory
William T. Farris,
Associate Lab Director

Title

3/14/2019

Date

Place

For
L'Office National de l'Électricité et de l'Eau Potable:

LE DIRECTEUR GENERAL
Abderrahim EL HAFIDI

Printed Name of Signatory

Title

Date 21 FEV. 2019

Place

Exhibit 1

Coordination on Grid Integration of Variable Renewable Energy Technologies in Morocco

Independently programmed and funded scope of work for the National Renewable Energy Laboratory (NREL) and L'Office National de l'Électricité et de l'Eau Potable (ONEE)

Objective

Enhance capacity for integrating high-penetration variable renewable energy (VRE) into the Moroccan power grid to achieve the country's goals of 42% renewable energy in the electricity mix by 2020 and 52% renewable electricity by 2030.

Scope Overview

Morocco is home to abundant renewable energy resources that can contribute to meeting electricity demand and achieving other objectives such as enhanced energy security and a sustainable energy sector. Further, the costs of clean energy technologies such as solar and wind are rapidly declining around the world, strengthening the economic case for deploying these technologies and reaching high penetration levels on national grids. However, integrating VRE poses challenges to traditional power system planning and operation due to the variability, uncertainty, and geographic concentration of solar and wind resources. Addressing these concerns requires an evolution in power system planning for grid operators, utilities, and policy makers.

NREL plans to provide support for analysis of current grid operations, an in-depth training on achieving high VRE levels, resource mapping for solar, wind, and hydrologic resources, and quick-response technical assistance for grid integration.

Task 1: Analysis of Grid Readiness for High-Penetration Renewable Energy

This analysis is planned to include a review of current Moroccan energy sector practices related to grid integration. Topics for review include forecasting, grid flexibility, demand side management, load balancing, and distributed generation integration. NREL plans to acquire data and information on these systems. The analysis is planned to conclude with recommendations to improve grid readiness to integrate renewable energy resources to meet Morocco's goal of 52% renewable electricity.

Task 2: Grid Integration Training

NREL staff plan to present two trainings on grid integration of high-penetration renewable energy.

The first training is planned to be introductory and to be used as an avenue to collect needed data for Task 1. The training is designed as a hands-on working event. Planned topics include:

- Processes and standards
- Solar and wind power forecasting, including tools, methodologies, algorithms, and performance monitoring
- Load analysis and control, including analysis of the residual load demand, characterization and forecasting of distribution generation, and international case studies on best practices
- Storage technologies, including descriptions of current and near-future technical characteristics, operational flexibility, and investment costs
- Market design to address integration challenges, taking into account the context of the Moroccan power system and its interconnections with the Maghreb and the Iberian systems
- Benchmarks of electricity generation costs (Capex/Opex) for different technologies: ultra-supercritical coal, combined cycle gas turbine, open cycle gas turbine, PV, Wind, CSP, pumped storage, and batteries; there will also be cost projections for technologies as available

The purpose of this training is to provide participants with the fundamental knowledge and resources needed to effectively integrate high levels of VRE into the Moroccan grid.

The second training is planned to dive deeper into the areas of interest and the areas of opportunity identified by the NREL analysis (Task 1). This second training also plans to bring in relevant expert speakers, including companies supporting grid operators in the United States, to talk through the process of integrating high levels of renewable energy.

As a result of these trainings, participants will be able to:

- Identify the unique challenges and opportunities associated with integrating significant levels of VRE into the Moroccan power system
- Articulate the importance of flexibility to integrating VRE into the power system and identify institutional and physical sources of flexibility that are most relevant to the Moroccan power system
- Synthesize concepts and best practices into prioritized action plans for improving power system readiness for VRE integration

The primary audience for this training workshop includes power system operators, utilities, and regulators from the Moroccan power sector. Policymakers with a technical focus may also benefit from this training. NREL plans to work with the U.S Department of Energy (DOE), the U.S. Department of State, and Morocco's relevant stakeholders to identify additional participants for attendance.

Task 3: Resource Mapping

NREL plans to create a Renewable Energy Data Explorer (RED-E) platform for Morocco. RED-E facilitates renewable energy decision-making, investment, and deployment through online analytical tools.

NREL plans to provide access to the mapping tool as well as the background data on renewable resources. The tool aims to allow Morocco's relevant stakeholders to:

- Visualize renewable energy resources, infrastructure, and environmental features
- Conduct energy capacity and generation technical assessments
- Conduct optimal site selection analysis

The Africa Low Emission Development Strategies (Africa LEDS) working group also recently identified topics of interest to include in the tool. These include land use, agricultural zones, and national demographics. Layering these socio-economic indicators could help the Government of Morocco prioritize zones for renewable development.

NREL staff plans to work with Morocco's ONEE staff to acquire existing data sets on renewable resources as well as infrastructure, including grid networks, roads, and pipelines. Note that the creation of the tool is planned to be followed by NREL training for Morocco's ONEE staff on how to conduct the analysis. For examples of existing RED-E tools, please see https://www.re-explorer.org/.

Task 4: Quick-Response Technical Assistance

NREL plans to provide up to 180 hours of additional subject matter expert time to answer technical questions on grid integration for Morocco's relevant stakeholders. Topics may include, but are not limited to: codes and standards, load control, forecasting, smart technologies, storage, market design, policy development, designing requests for proposals (RFPs), developing approved supplier lists, and technical review of proposals.

Points of Contact

United States

- DOE Project Lead: Mark Reichhardt, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy
- Principal Investigator: Sherry Stout, National Renewable Energy Laboratory

- Ray Behbehani, Office of International Affairs, U.S. Department of Energy
- Ryan Guirlinger, U.S. Embassy Rabat
- Mustapha El Gamra, U.S. Embassy Rabat

Morocco

- OUMOUNAH Brahim, Director of Strategy and Planning, ONEE
- MELLOUKI FILALI Loumia, Head of Division Planning, ONEE
- NEJJAR Mohammed Khalid, Head of Division Survey and Prospective, ONEE
- HAMMADIA Abdelghani, Coordinator of this Project, ONEE

Key Activities and Timing*

Date	Activity
Day 1	**Scope Finalized** • Final scope and roles decided upon by all participants **Data and Information Collection Begins** • Resources to be identified to NREL staff to provide data related to forecasting, grid operations, demand side management, and distributed generation
Day 1 + 1 month	**Initial Data Collection Complete** • All relevant data to be collected and translated
Day 1 + 2 months	**Data Review Complete** • NREL to present the review of energy system flexibility data
TBD Summer 2018	**Three-Day Training and Working Group on Integration** • Initial training on integration and working group to collect any outstanding data
TBD Summer 2018	**NREL to Deliver Written Recommendations** • NREL to deliver written recommendations based on the results of the training and working group one month after the event
TBD Fall 2018	**In-Depth Training and Working Group on Integration** • In-Depth training on grid integration based on feedback and areas of opportunity identified by NREL • NREL to formally present findings of analysis
TBD Fall/Winter 2018	**RED-E Tool Presentation and Training** • NREL to present the RED-E tool for Morocco • NREL to conduct a 2-day training on the use of RED-E • Participants to provide feedback on tool for any updates or changes
TBD Spring 2019	**RED-E Tool Finalized** • NREL to present finalized tool to relevant stakeholders
Summer 2019	**Quick-Response Technical Assistance Concludes** • NREL to provide technical assistance through the summer of 2019 or until the 180 hours is exhausted

* Timing is approximate, aspirational, and dependent on when initial kick-off of work occurs.