Montenegro

Annex III

TERMS OF REFERENCE (TOR)

The Study of distributed source connection and operation in the electric power system of Montenegro

Background

Montenegro has intensified efforts to facilitate accelerated and more efficient utilisation of the potential of renewable energy sources (small streams, wind, solar, biomass etc.). The research and studies carried out so far have identified significant potential for utilisation of capacities of renewable sources, in particular small hydro power plants (SHPPs) up to 10 MW and wind power plants (WPPs).

Development of concept designs for optimal utilisation of streams and feasibility studies rounded off the initial stage of concession agreements for eight small streams, aimed at harnessing the hydro-power potential by construction of SHPPs. The activities that are currently in progress include tenders for granting concessions for SHHP construction on ten additional small streams and selection of investors to construct wind-power plants of significant capacity on the sites of Krnovo (Nikšić municipality) and Možura (Ulcinj municipality). New tenders for SHPPs are underway, and custom and test measurements of hydro and wind potential are being extended to include additional sites.

Further interest is envisaged to follow in the coming period in solar power plants of smaller capacity and small biomass power plants.

The envisaged output of the Study is explicit technical design for SHPP connection for each individual site whose geoposition and projected capacity are providded. In addition, based on the methodology to be generated by the Study and in line with the know-how transfer envisaged under this ToR, it will be possible to process all new requests for SHPP connection in Montenegro with no additional studies required.

1. **Starting Points for the Study**

Montenegro has no national technical regulations that define distributed source connection to the electric power system networks. Some of the relevant issues are subject of the Interim Distribution

Code and Rulebook on Technical Requirements by Montenenigrin Electric Enterprise (in fruther text EPCG) for SHPP Connection. Until national regulations are in place, EPCG JSC decided to use the following documents:

- Technical Recommendation No. 16: BASIC TECHNICAL REQUIREMENTS FOR SHPP CONNECTION TO THE NETWORK OF THE ELECTRIC POWER DISTRIBUTION OF SERBIA, Public Enterprise Electric Power Industry of Serbia (Elektroprivreda Srbije), May 2003;
- Annex 1 TP-16: Sample calculations to assess the criteria for SHPP connection to the distribution network, Public Enterprise Electric Power Industry of Serbia, May 2003;
- RULEBOOK ON SHPP CONNECTION TO THE NETWORK OF THE ELECTRIC POWER DISTRIBUTION OF THE REPUBLIC OF SRPSKA, I issue, Mixed Holding Company Power Utility of the Republic of Srpska (Elektroprivreda Republike Srpske), Parent Company Jsc, Trebinje, March 2009.

Considering site dispersion and distributed source capacities, connection is envisaged to medium and low voltage distribution networks (35 kV, 10 kV, 0,4 kV) or to 110 kV transmission network.

In the areas with major concentration of renewable energy potential, generation units are expected to be grouped and their connection to transmission network centralised, so as to interconnect with the relatively distant consumption centres.

The points stated above, in conjunction with the specificities of Montenegrin electric power system networks and insufficient research on the possibilities and options for connecting different types and capacities of distributed sources to it, indicate the need for a comprehensive study of connection and operation of existing and potential distributed sources.

2. Purpose and Aim of the Study

The Study needs to elaborate the energy-technical, management, safety and economic aspects of the possibilities and requirements for connection, operation and impact on electric power networks of different types of distributed sources in the areas in Montenegro where potential sites of sources (power plants) are located.

Based on analysis findings, the Study needs to define development plans for the transmission network of the electric power system of Montenegro, with the aim to enable connection and supply of planned distributed source capacity. Concerning the distribution network, specific solutions need to be defined as per individual source or group of sources.

The Study needs to present the procedure and analyses methodology using concrete examples.

The methodologies used in the analyses within the Study need to serve as the basis for further elaboration of connection requirements for specific distributed source facilities to the electric power system networks, within the procedure for issuance of requirements and approvals for connection.

Study implementation will fully involve representatives of the UNDP, Ministry of Economy, EPCG JSC and Transmission JSC, and serve a major purpose of know-how and technology transfer i.e. education of relevant representatives in the given field.

3. Contents of the Study

3.1. In general, the Study will include five sections:

I. Regulatory status in Montenegro concerning connection of distributed sources to the electric power networks and theoretical background for drafting new rules (*Basis*)

I.1. Analitical review of existing regulations on the manner of connection and operation of distributed sources in Montenegro (rules, recommendations etc.)
I.2. Analysis of problems that may arise upon activation of distributed sources in Montenegro due to deficiencies in the existing rules and recommendations
I.3. Theoretical background for the new Rules on distributed source connection in Montenegro

II. Situation analysis and verification of development plans for transmission electric power network (*Review*)

II.1. Overview of the current status of transmission electric power network
II.2. Overview of load and installed capacity forecasts for 110/LV transformer stations that provide the basis for thetransmission network development plans
II.3. Verification of transmission network development results using network models (load flow and safety analyses)
II.4. Verification of transmission network development results using network model with planned distributed sources
II.5. Energy studies of possible transmission network solutions
II.6. Technical-economic optimum of possible solutions
II.7. Proposed concrete technical solutions for transmission network development in the area where concrete distributed source site or source logical unit are located, for the purpose of enabling connection and supply of planned capacity

III. Technical recommendations for connection of distributed sources in Montenegro (*Recommendation*)

III.1. Main characteristics of individual types of distributed sources
III.2. Classification of distributed sources
III.3. Basic methods for activation of distributed sources
III.4. Technical characteristics of interface and connection posts
III.5. Electric power quality
III.6. Reactive power characteristic
III.7. Active power characteristic
III.8. Distributed source operation
III.9. Distributed source maintenance
III.10. Action in case of accidents
III.11. Theoretical examples of distributed source activation

IV. Methodology for elaboration of distributed source connection using demonstration (*Methodology*)

IV.1. Necessary input to be provided by the investor
IV.2. Processing algorithm (work-flow)

- Input data
- Calculation of all technical criteria for different versions (LV, MV, HV)
- Calculation of economic effects of a technical solution
- Final decision on voltage level
- Granting/refusing the approval for the investor's technical requirements

IV.3. Connection Approval format

V. Analysis of concrete examples for granted distributed source concessions in Montenegro (according to the concessionaries' concept/detailed designs) (*Analysis)*

V.1. Situation analysis for transmission and distribution networks, based on inputs
V.2. Application of developed methodology to all examples

3.2. Requirements per Study sections

Ad III - **Recommendation**

Recommendation should include in particular the following:

- Criteria to be met by the power plants at the point of connection to the network (depending on the technical and energy characteristics of local electric power network)
  - Inductive/capacitive range of operation
  - Voltage regulation
  - Short-time overload

  - Fault current contribution
  - Possibility of island operation
- Remote control of power plant to achieve acceptable conditions of netwrok operation:
  - Voltage regulation (voltage set point)
  - Active power regulation (power set point)
- Ways to eliminate/reduce negative effects of distributed source connection to the electric power network
- Impact of electric power network availability on distributed source avilability.

Ad IV – **Methodology**

Examples of analysis, including a commentary on the methodology, procedures and calculations, for the purpose of defining the technical requirements for connection to electric
power networks of different types of distributed sources on specific sites and in different areas of Montenegro. The author of the Study will select suitable examples together with EPCG Jsc and Transmission Jsc.

Ad V – **Analyses**

The analysis based on the adopted ***Methodology*** will serve to define the technical requirements for connection to power networks for realistic examples of distributed sources on specific sites. The author of the Study will perform the selection together with EPCG Jsc and Transmission Jsc.

Examples need to include analyses of the effects of changes in electric power networks due to connection and parallel operation of a distributed source (SHPP, WPP etc.), especially those related to:

- active and reactive power flows and voltage status;
- level and allocation of power losses;
- voltage regulation and reactive power compensation ;
- short circuit power/ current;
- protection, adjustment and selective protection systems;
- reliability and efficiency of switchyard (circuit-breakers on generator terminals e.g. in feed MV/MV transformer stations);
- automatic restart;

electric power quality parameters;

- aspects of angular and voltage stability (static, dynamic/transient stability in specific operation regimes of electric power networks with distributed sources);
- method and place of electric power and power measurement;
- interdependency of functioning of power networks with differing voltage in normal operation and in fault situation;

- indicators of reliability of distribution and transmission networks with distributed source/s;
- remote control of transmission and distribution networks (remote control functions: circuit breaker command; signaling breakers' installation status; protection elaboration; power plant operation regimes: island operation, parallel work with the network, out of order...);
- aspects of development of distribution and transmission networks with distributed source/s (voltage level and the extent of network development required to connect a specific source);
- economic aspects of connection/parallel operation of distributed source and development of power networks for the purposes of distibuted sources (investment in reconstruction of existing or construction of new lines and/or transformer stations for the purpose of quality connection and supply of distributed source capacity, effects of reduced/increased loss, voltage regulation etc.).

Examples should include comparative indicators on the effects and possible limitation of operation in case of connecting certain distributed source capacity to electric power networks of different voltage.

3.4. Inputs:

- Planned and potential distributed sources of electrical power in Montenegro
  - Rated output Pn [kW]
  - Rated cos □
  - Generator type (asynchronous, synchronous)
  - Geographic location of the power plant
  - Type of reactive power compensation
- Transmission network of Montenegrin electric power system, especially in the areas where planned and potential sources are located
  - Minimum/maximum short circuit power on HV level (modeled in SINCAL)
  - Technical characteristics of new transformer stations envisaged by the development plan
  - Single- line diagrams
  - Line voltage level
  - Line impedances (R, X, C, Ro, Xo)
  - Line length
- Distribution network of Montenegrin electric power system, especially in the areas where planned and potential sources are located
  - Rated HV levels of transformer stations
  - Rated MV levels of transformer stations
  - Rated power of HV/MV transformer
    - Short circuit voltage
    - No-load losses
    - Short circuit losses

- Minimum/maximum transformer station load
- Minimum /maximum load of the terminal to which the source is connected
- Single-line diagrams
- Technical characteristics of the terminal envisaged for distributed source connection
  - Overhead line/cable
  - Cross-section of cords/cable (if cable, then its laying) per sections of terminal
  - Impedances (R,X)
- GIS network model (.shp or .dwg) or ortophoto of the area.

4. Study Elaboration

The author will provide a systematic overview of Study inputs, methodology, models, calcualtions, results and analyses (ToR item 3) in user-friendly format in relation to the contents and sequencing of sections/chapters.

5. Know-how Transfer and Use of Software Tools

In the course of developing the Study, the author will enable know-how transfer to representatives of the EPCG. Know-how transfer includes:

- Overall know-how derived from the developed methodology,
- In-house training for 5 engineers on application of the methodology developed under the Study and methodology presentation in the course of the training, using concrete examples from the Study.

6. Inputs for Development of the Study

Inputs for the Study, related to distributed source parameters, energy and technical data and relevant information on the current and planned status of electric power networks and feed transformer stations, will be established in line with the author's methodology requirements.

Detailed data and information on the electric power networks will be prepared for the broader basins of tributaries to major streams in Montenegro with already defined or potential SHPP and WPP sites.

Sources of necessary data and information: study and project documentation of investors in distributed sources; documentation of equipment manufacturers for SHPPs; EPCG Jsc and

Transmission Jsc technical and operational documentation; available studies and analyses of current and planned status of local electric power networks and interdependency in their operation and development.

Together with the UNDP,EPCG and Ministry of economy, the author will define the way to overcome the problem of incomplete relevant data and information in order for the Sudy to achieve its aim.

1. Eligibility Requirements for Bidders

7.1 Size

A bidder is required to be a legal person with minimum annual turnover of EUR 0.5 mill over the past 2 years in the field of projects and analysis of electric power network development.

7.2 References

A bidder is required to possess verified references from the field relevant for this ToR. The refferneces should reffer to:
- reference pertaining to *Recommendations*, valid references are those applied or being applied by a national regulator or relevant energy entity.
- references pertaining to *Analysis*, valid references are deliverables dealing directly with the issues of distributed source connection and operation and clearly demonstrating the bidder's mastery of the methodology needed for successful performance of all assigments from the given field;
- references pertaining to *Review*, valid references are adopted national development plans for transmission and distribution networks.
- other relevant refferences

7.3 Personnel

A bidder is required to possess sufficient number of professional staff with degrees in Electrical Engineering in the field of Electric Power Supply and Automatics, with relevant professional references to implement the Study.

7.4 Software Tools

A bidder has to provide to the EPCG transfer of the following functionalities:

1. Import of raster maps in at least tif, jpeg format;
2. Import of vector maps in at least shp or dwg format;

3. Interactive network modelling;
4. Possibility to model HV/MV and MV/LV transformer stations with number of MV taps and regulation range;
5. Possibility to develop single-line diagrams;
6. Calculation of load-flow and voltage drop with graphic presentation of results given the set criteria;
7. Calculation of short circuit current;
8. Development of safety analyses;
9. Calculation of optimum MV network installation status;
10. Calculation of economic aspect of the elaborated version;
11. Possibility to export results in XML for the purposes of result processing "pivot tables";
12. Installation to PC platform with Windows OS;

all of the above in a ***SINCAL*** program package otherwise available to network operators in Montenegro.

2. Language of the Study

It is requested the Study is to be delivered in both English and Local language.

9. Time Frame

Action plan and dynamics will be specified in cooperation with EPCG and Minitry of Economy, once UNDP finalize the selection process.