

G0520-SASEC Power System Expansion Project Additional Financing Consulting Services (International) on Power System Protection and Utility scale solar in Nepal with relevant capacity development trainings under the Additional Financing on SASEC Power System Expansion Project

Section 7. Terms of Reference

1. Project Background

Government of Nepal has received grant assistance from Asian Development Bank (ADB) for the Additional Financing on the South Asia Sub-regional Economic Cooperation (SASEC) Power System Expansion Project. Part of the facility is provided to Nepal Electricity Authority (NEA) to fund eligible payment under consultant's services. With the facility, NEA intends to undertake the Supervision and Miscellaneous support of the Utility scale Grid-tied PV Solar, High Voltage Transmission and Distribution system projects through an International Consultant in a lump sum mode.

2. Purpose of the Assignment

1. Objective of the Service

The objective of this service from a consulting company/consortium is to provide NEA the followings:

a) Protection Coordination for the INPS

The objective of the service is to develop protection coordination for the INPS to minimize the customer service interruptions and system outage from power system disturbance thereby increasing the reliability and security of the INPS. The Consultant shall study and analyze the electrical system with given data and verify that coordination exists among generator and transmission line protections and generator control, inclusive of generator bus bar protection; develop minimum design guidelines and design philosophy for the protection system of the INPS; and develop and propose modified settings as required to achieve coordinated operation of the protection schemes and generator control so that reliability, system stability and system security of the INPS is significantly enhanced.

b) Training - Substation Design

The objective of the service is to review existing substation technology adapted by NEA and train the NEA employees in various aspects of planning and design of the High Voltage Substations with an aim to help NEA to develop its capability to plan, design and build robust power system in Nepal. The training shall focus on new trends and practices in the industry to help NEA leapfrog in digital technology.

c) Training - Civil Structures and foundation design

The objective of the service is to train the NEA employees in various aspects of civil structure and foundation design of the High Voltage Transmission lines and substations with an aim to help NEA to develop its capability to plan, design and build robust power system in Nepal.

d) Training - Transmission Line Design

The objective of the service is to train the NEA employees in various aspects of planning and design of the High Voltage Transmission lines (monopole, lattice etc.) with an aim to help NEA to develop its capability to plan, design and build robust power system in Nepal.

e) Training - Tower Design

The objective of the service is to train the NEA employees in various aspects of planning and design of the High Voltage Transmission towers (monopole, lattice etc.) with an aim to help NEA to develop its capability to plan, design and build robust power system in Nepal.

f) Training - Grid Tied PV Solar

The objectives of this service are

- a. To review of "Guidelines for developing utility scale solar PV projects in Nepal" issued by Ministry of Energy, Water Resources and Irrigation of the Government of Nepal and provide suggestion to match with international best practices.
- b. To provide training in the "Guidelines for developing utility scale solar PV projects in Nepal" issued by Ministry of Energy, Water Resources and Irrigation of the Government of Nepal.

g) Pre-feasibility and detailed feasibility study for Solar Park

The objective of this service is to conduct all the activities mentioned in a pre-feasibility and detailed feasibility study for Solar Park of areas of the Mustang district near the under construction 220 KV Dana Substation as per guidelines for developing utility scale solar PV projects in Nepal and submit the reports with by recommending an appropriate business model including additional infrastructure requirements like grid extension, road, water supply, etc. with implementation matrix, procurement plan and complete bid documents using reverse auction process that facilitates time efficient and cost effective solar park in Nepal. All tasks required to complete the aforementioned studies including the financial, environmental, procurement related and social studies among others are

considered to be sole responsibility of the company/consortium and shall be considered in the proposal.

The responsibility to complete all the assignments as per requirement of the ToR shall be the sole responsibility of the company/consortium. If required, company/consortium may take additional support from other experts from the field other than specified by the employer to complete the task at no additional cost to the employer.

2. Indicative Duration and Location of the Services

- a) **Protection Coordination for the INPS** -The indicative duration of the assignment shall be ten (10) months. Out of the ten (10) person-month required, two (2) person month is allocated for Home Office and the rest for Field Office. The Consultant is required to visit different substations and offices of NEA in discharge of their duties and responsibilities. The location is Kathmandu and other places in Nepal.
- b) **Training Substation Design**- The duration of the assignment shall be three (3) months. Out of the three (3) person-month required, One and Half (1.5) person months are allocated for Home Office and the rest for Field Office. The location is Kathmandu in Nepal.
- c) **Training - Civil Structures and foundation design** - The duration of the assignment shall be three (3) months. Out of the three (3) person-month required, One and Half (1.5) person months are allocated for Home Office and the rest for Field Office. The location is Kathmandu in Nepal.
- d) **Training - Transmission Line Design**- The duration of the assignment shall be three (3) months. Out of the three (3) person-month required, One and Half (1.5) person months are allocated for Home Office and the rest for Field Office. The location is Kathmandu in Nepal.
- e) **Training - Tower Design** - The duration of the assignment shall be three (3) months. Out of the three (3) person-month required, One and Half (1.5) person months are allocated for Home Office and the rest for Field Office. The location is Kathmandu in Nepal.
- f) **Training - Grid Tied PV Solar**- The duration of the assignment shall be two (2) months. Out of the two (2) person-month required, Half (0.5) person months are allocated for Home Office and the rest for Field Office. The location is Kathmandu in Nepal.
- g) **Pre-feasibility and detailed feasibility study for Solar Park**- The duration of the assignment shall be nine (9) months. Out of the nine (9) person-month required, one (1) person month is allocated for Home Office and the rest for Field Office.

The Consultant is required to visit proposed project site in discharge of their duties and responsibilities. The location is Kathmandu and other places in Nepal.

3. Scope of Services

a) Protection Coordination for the INPS

3.a.1 The scope of service shall include the development of protection system design criteria and guidelines for INPS, integration and coordination of power system protection, calculation and setting of protective relaying systems of Grid Substations including Generating Stations of INPS and capacity building of NEA employees through knowledge transfer. The Consultant shall perform duties related to the protective relaying of transmission lines, substations and power stations, system protection, coordination and control design, relaying standards development and protection management etc.

3.a.2 The Consultant shall be required to frequently consult and interface with the Generation and Transmission Directorates of NEA to gather necessary information and to ensure the integrity of the network. The Consultant shall work together with the Grid Operation Department, System Operation Department, Grid Development Department, Generation Directorate, Transmission Directorate and Project Management Directorate and shall have the responsibility to transfer knowledge and skills to ensure improved maintenance of the protection system of INPS, integration of new infrastructure into the existing system and updating of protection settings as required.

b) Training Substation Design

3.b.1 The scope of the service shall include providing training to the NEA employees in all areas related to the substation planning and design of the substation projects in Nepal. The services shall include the following:

- Providing training and developing all required training material;
- Develop Design Manuals
- Develop Testing and Commissioning Manuals
- Develop Operational Manuals

The consultancy in this regard shall be provided by a trainer who shall specialize in the following area:

- Substation Planning and Design

The services to be provided by the Consultant as described in the following sections shall be performed under coordination of the Project Documentation Expert (a National Expert).

c) Training - Civil Structures and foundation design –

3.c.1 The scope of the service shall include to provide training to the NEA employees in all areas related to the civil structure and foundation design of the transmission line and substations projects in Nepal. The services shall include the following:

- Providing training and developing all required training material;
- Develop Design Manuals
- Develop Testing and Commissioning Manuals
- Develop Preventive Maintenance Manual for Civil Structure of Transmission line and Substation

The consultancy in this regard shall be provided by a trainer who shall specialize in the following area:

- Transmission line and substations civil structure and foundation design

The services to be provided by the Consultant as described in the following sections shall be performed under coordination of the Project Documentation Expert (a National Expert).

d) Training - Transmission Line Design-

3.d.1 The scope of the service shall include providing training to the NEA employees in all areas related to the transmission line planning and design of the transmission line projects in Nepal. The services shall include the following:

- Providing training and developing all required training material;
- Develop Design Manual
- Develop Testing and Commissioning Manual
- Develop Operation Manual

The consultancy in this regard shall be provided by a trainer who shall specialize in the following area:

- Transmission line Planning and Design

The services to be provided by the Consultant as described in the following sections shall be performed under coordination of the Project Documentation Expert (a National Expert).

e) Training - Tower Design –

3.e.1 The scope of the service shall include providing training to the NEA employees in all areas related to the transmission tower design of the transmission projects in Nepal. The services shall include the following:

- Providing training and developing all required training material;
- Develop Design Manuals
- Develop Testing and Commissioning Manuals
- Develop Operation Manuals

The consultancy in this regard shall be provided by a trainer who shall specialize in the following area:

- Transmission tower Design

The services to be provided by the Consultant as described in the following sections shall be performed under coordination of the Project Documentation Expert (a National Expert).

f) Training - Grid Tied PV Solar

3.f.1 The scope of the service shall include reviewing the guidelines to update it as required and provide training in the "Guidelines for developing utility scale solar PV projects in Nepal" issued by Ministry of Energy, Water Resources and Irrigation of the Government of Nepal.

The consultancy in this regard shall be provided by a trainer who shall specialized training in the following area:

- Development of utility scale PV solar Projects

The services to be provided by the Consultant as described in the following sections shall be performed under coordination of the Project Documentation Expert (a National Expert).

g) Pre-feasibility and detailed feasibility study for Solar Park-

3.g.1 The scope of the service shall include a) Pre-feasibility Study for Solar Park of areas of the Mustang district near the under construction 220 KV Dana Substation as per guidelines for developing utility scale solar PV projects in Nepal. b) Detailed feasibility Study for Solar Park of areas of the Mustang district near the under construction 220 KV Dana Substation as per guidelines for developing utility scale solar PV projects in Nepal. c) Recommendation of an appropriate business model including additional infrastructure requirements like grid extension, road, water supply, etc. with implementation matrix, procurement plan and complete bid documents using reverse auction process that facilitates time efficient and cost effective solar park.

The Consultant shall be required to consult and interface with the Utility Scale Grid-tied solar Project during the period of the service. The Consultant shall have the responsibility to transfer knowledge and skills to enable NEA to take such initiatives forward once the consulting support is over.

All the services of the Consultant described in the following sections shall be performed in close co-ordination with Project Management Directorate, Power Trade Department and other relevant departments of NEA and different departments of the Government of Nepal.

4. Duties and Responsibilities

a) Protection Coordination for the INPS

4.a.1 The Consultant shall conduct a situation assessment that includes a comprehensive review of the INPS electricity network from the protection and control system perspective and propose a set of short- and medium-term actions that are required to enhance the network system protection and control.

4.a.2 The Consultant shall also support to build the capacity of NEA in the day-to-day management of the network protection. The Consultant shall develop and conduct on the job training (OJT), for counterpart staff to ensure that they are able to maintain and operate the network in a stable and reliable manner as per the established prudent utility practices.

4.a.3 The Consultant's tasks shall include but not limited to the following:

Task 1: Inception and Data Collection

Task 2: Short Circuit Analysis

Task 3: Protection System Design Guidelines, Schemes Development

Task 4: Capacity Building of NEA Personnel

Task 5: Power evacuation study of all IPPs of the utility scale solar project

Task 1: Inception and Data Preparation

The Consultant shall, immediately upon initiation of the assignment attend the inception meeting organized by NEA. The Consultant shall prepare an information/data document required for this study. The Consultant shall establish communication channels; key contacts, reporting frequency and procedures for the study. Further, the Consultant shall clarify the study methodology, process, assumptions, and reporting needs; and refine the scope of work and schedule, if necessary, to complete the assignment. The Consultant shall also prepare the list of data required and collect the data required from the concerned departments of NEA. The data collection shall include all the data required for the assignment including identification of all the existing generation plants, single line

diagram(SLD) of power plants with layout of existing protection scheme; protection settings for all generators, substations, types of protective relays and their settings; transmission line impedances and charging (positive and zero sequence), ratings (normal and emergency) for all lines in the system; transformer data including impedances, number and range of taps, control mode, vector group, connection to ground and ratings; protection settings for transmission lines, substations; reactive compensation; interrupting capability of breakers etc. NEA shall provide all the necessary help in the collection of the required data from its departments.

Task 2: Short Circuit Analysis

The short circuit study shall be carried out by the System Planning Department of NEA. NEA shall organize a joint meeting of the Consultant with Grid Operation Department, Large Generation O & M Department, Medium Generation O & M Department, System Planning Department and Power Trade Department of NEA to discuss and finalize the system studies such as load flows, short circuit analysis, stability analysis (if any), updating of transmission and generation plan etc. required for the assignment. The results of the system studies shall form the basis for the protection coordination report. NEA shall make available the results/outputs of the studies to the Consultant.

The Consultant shall compare the results of this study with short-circuit withstand ratings of the existing equipment and analyze their suitability, appropriateness and shall provide recommended ratings for breakers, bus bars etc. for all the substations and the power plants.

Task 3: Protection System Design Guidelines, Schemes Development

The Consultant shall perform, among others, the following activities:

- Develop the design criteria and guidelines for the protection system to be adopted for integration of new power plants and substations.
- Conduct Protection analysis and protection device coordination using appropriate computer software. The Consultant shall identify and recommend suitable computer software for protection system coordination.
- Verify the existence of the protection coordination in the INPS and develop protection schemes for the existing system and for system to be developed by 2021 AD.
- Perform relay coordination studies and calculations, prepare and implement relay settings together with the NEA counter-parts.
- Verify protection logic through the function testing of the relay systems and recommend for upgrading / replacement requirement of existing protection system at various substation and power houses.
- Develop manuals for maintenance of protective relays.

- Develop a protection setting register for each substation and power station and copy the current updated protection settings of the protective relays in the register.

Task 4: Capacity Building

- 1 Another objective of the consulting services is the transfer of knowledge in this field to the NEA. This shall be achieved by involving the NEA counter-part staff by the Consultant as much as possible in various activities undertaken during the study including the use of software for necessary calculations and analysis and relay settings in the field.
- 2 The Consultant shall also arrange a **5 (five) day training session in each Grid Division Office** of NEA to ensure that O & M personnel are able to maintain and operate the network in a stable and reliable manner in accordance with the established Prudent Utility Practices. The training sessions shall cover various aspects of protection system such as different schemes of protective relaying, setting of protective relays, protection coordination, testing equipment and testing procedures. The detail curriculum/syllabus of the training shall be as approved by NEA.

Task 5: Power evacuation study of all IPPs of the utility scale solar project

The consultant shall conduct a power evacuation study of all IPPs of the Utility scale solar project

Task 6: Miscellaneous

- Provide inputs and advice to NEA on protection system of transmission lines, substations and power plants as required in line with the tasks stated above;
- Carry out assessment of the existing protection schemes in INPS and verify that protection coordination exists among generator and transmission line protections and generator control protection system and among transmission and distribution systems;
- Analyze reinforcement requirements of the existing Protection system and develop optimum protection schemes for INPS;
- Perform relay settings and relay testing in the Substations and Power Stations;
- Perform the testing of main (primary) as well as back up (secondary) protection system of all Grid substations, transmission lines, NEA owned power plants. Assess the protection system of IPP Power plants at the interconnection point with NEA;
- Prepare and update the protection SLDs;
- Develop protection design guidelines and philosophy to be adopted for integration of power plants and substations;
- Develop maintenance manuals for the protective relays;

- Perform a training needs assessment of NEA staff and preparing a training program in consultation with NEA;
- Train the counterpart staff of NEA in relay coordination using the software employed for protection system coordination study;
- Guide, instruct and engage the national Consultant recruited for assisting him in the various activities of the assignment.

b) Training Substation Design

3.b.1 The Consultant shall be required to carry out following tasks.

Task 1: Training in planning and design

The Consultant shall be required to impart training to the Staffs selected by NEA in the following areas for 132 kV, 220 kV and 400 kV voltage levels of the substation system:

- Substation Planning (Land Selection, selection on types of Substation and other planning related activities) & Design (including all the elements of substation such as bus bar, isolators, circuit breaker, transformer, lightning arrestor, capacitor, reactor, battery charger, control & relay panels, synchronization panels, grounding grid, SCADA and Substation Automation Systems, Communication and its impact on protection system etc.)

The Consultant shall develop the syllabus for the training program in close collaboration with the Project Management Directorate of NEA. The syllabus shall be as per the requirements of NEA and shall impart both theoretical and practical knowledge and concepts including training on software owned by NEA. The training syllabus shall be as approved by NEA.

The Consultant for the training purpose shall develop training manuals with appropriate references to standard text books and IEC standards. The training manual shall consist of theoretical concepts, numerical analysis, empirical formulas, single grams, real case studies and practice exercises.

The training shall consist of class room at NEA and field training in Nepal. The training courses shall be completed in three sessions. The first session shall consist of 15 days of class room training. In the first session of the training the trainees shall be imparted knowledge of theoretical concepts and numerical analysis for equipment selection, sizing and specifications. The trainees shall be exposed to at least five (5) case studies through practice exercises and if required field visits will be carried out. At the end of the first session of the training each trainee shall be administered a written test of three hours consisting of

a case study to test the understanding of the concepts taught. Those failing in the first test shall be given another opportunity.

The Consultant shall organize a second training session for the trainees for a period of fifteen (15) days. The Consultant shall organize training on the use of software owned or identified by NEA. The Consultant shall impart knowledge in the use of software for design, system studies (including transient and stability) and project management through various case studies (at least five). The training shall include load flow study, relay coordination and use of Auto Cad in GIS mapping. At the end of this training session the Consultant shall conduct a test to assess the understanding of the trainees to use these softwares.

The third session of the training shall be of 15 days and shall consists of practical exercise (including the use of software) of at least five real case studies in the above identified areas of capacity building in substation design, project management and planning. The training shall include international best practices in planning, design and project management of substation projects.

At the end of the training program a 3-hour test shall be conducted by the Consultant to assess the understanding and capabilities of the trainees in areas of substation design, project management and planning in which they have been imparted training. NEA shall be responsible for providing class rooms, transportation of trainees and other logistic support required for organizing the training.

Task 2: Development of Manuals

The Consultant shall develop following Manuals complete in all respects for 132 kV, 220 kV and 400 kV Substations for NEA:

- Design Manual: The Manual shall include various scenarios of equipment sizing, and specifications. The Manual shall provide design philosophy to be adopted, empirical formulas for appropriate equipment selection, electrical layout, site plan, foundation plan, interconnection plan, cross sectional, grounding/earthing, lightening protection, protection system and single line diagrams of equipment and substation system etc. The Manual shall include standard design including Bills of Quantity (BoQ) for various capacities of Substation of various voltage levels. The Manual shall contain separate chapters on (i) relay design and coordination (ii) Substation Automation and (iii) SCADA & monitoring systems among others. The Manual shall indicate the information required for substation design, format in which it is to be collected and various system studies to be performed.
- Testing and Commissioning Manual for Substation: The Manual shall contain the activities/steps to be carried out for testing and commissioning of the individual

equipment and the substation system including the protection system. The Manual shall indicate various tests to be performed on individual equipment and the substation system including the protection system. The Manual shall indicate acceptable values of these tests including principles, information, formulas and the formats for computing these results. References shall be made to applicable International Standards.

- Operating Manual for Substation: The Operating Manual shall specify the operating procedures for various individual equipment and the substation system. The Manual shall indicate the system information, the format in which it should be collected and the analysis to be done for timely identification of operating issues. The Manual shall highlight steps to be taken to address various operating issues that are likely to be encountered during Substation operation. The Manual shall also highlight various preventive maintenance measures to be undertaken for safe and efficient operation of Substation systems.

These Manuals shall be as per the standard international industry practices and references shall be made to appropriate International Standards and Codes.

The above- mentioned manuals are to be provide in both the printed format (4 copies each) and softcopy. Also a training completion Report with all details of trainees, their performance evaluation and recommendation for assignments based on their assessment shall be submitted in both the printed format (2 copies) and softcopy.

c) Training - Civil Structures and foundation design

3.b.1 The Consultant shall be required to carry out following tasks.

Task 1: Training in civil structure and foundation design

The Consultant shall be required to impart training to the Staffs selected by NEA in the following areas for 132 kV, 220 kV and 400 kV voltage levels of the transmission line and substations system:

- Transmission line and substations civil structure and foundation design Design (including for all the tower and foundation types of transmission line and substations)

The Consultant shall develop the syllabus for the training program in close collaboration with the Project Management Directorate of NEA. The syllabus shall be as per the requirements of NEA and shall impart both theoretical and practical knowledge and concepts including training on software owned by NEA. The training syllabus shall be as approved by NEA.

The Consultant for the training purpose shall develop training manuals with appropriate references to standard text books and IEC standards. The training manual shall consist of theoretical concepts, numerical analysis, empirical formulas, single grams, real case studies and practice exercises.

The training shall consist of class room at NEA and field training in Nepal. The training courses shall be completed in three sessions. The first session shall consist of 15 days of class room training. In the first session of the training the trainees shall be imparted knowledge of theoretical concepts and numerical analysis for equipment selection, sizing and specifications. The trainees shall be exposed to at least five (5) case studies through practice exercises and if required field visits will be carried out. At the end of the first session of the training each trainee shall be administered a written test of three hours consisting of a case study to test the understanding of the concepts taught. Those failing in the first test shall be given another opportunity.

The Consultant shall organize a second training session for the trainees for a period of fifteen (15) days. The Consultant shall organize training on the use of software owned or identified by NEA. The Consultant shall impart knowledge in the use of software for design through various case studies (at least five). The training shall include structure and foundation design and use of Auto Cad in GIS mapping among others. At the end of this training session the Consultant shall conduct a test to assess the understanding of the trainees to use these softwares.

The third session of the training shall be of 15 days and shall consists of practical exercise (including the use of software) of at least five real case studies in the above identified areas of capacity building in transmission line and substations civil structure and foundation design. The training shall include international best practices in civil structure and foundation design of transmission line and substations projects.

At the end of the training program a 3 hour test shall be conducted by the Consultant to assess the understanding and capabilities of the trainees in areas of transmission line and substations civil structure and foundation design in which they have been imparted training. NEA shall be responsible for providing class rooms, transportation of trainees and other logistic support required for organizing the training.

Task 2: Development of Manuals

The Consultant shall develop following Manuals complete in all respects for 132 kV, 220 kV and 400 kV Transmission lines and substations for NEA:

- **Design Manual:** The Manual shall include various scenarios of civil structure and foundation design and specifications. The Manual shall provide design philosophy to be adopted, empirical formulas for appropriate equipment selection, civil layout, site plan, foundation plan, cross sectional, grounding/earthing and single line diagrams of equipment and transmission line and substations system etc. The Manual shall include standard design including Bills of Quantity (BoQ) for various capacities of Transmission line and substations of various voltage levels. The Manual shall contain among others separate chapters on (i) civil structure and foundation design of the transmission lines and substations. The Manual shall indicate the information required for transmission line and substations design, format in which it is to be collected and various system studies to be performed.
- **Testing and Commissioning Manual for Civil Structure of Transmission line and substations:** The Manual shall contain the activities/steps to be carried out for testing and commissioning of the civil structures. The Manual shall indicate various tests to be performed. The Manual shall indicate acceptable values of these tests including principles, information, formulas and the formats for computing these results. References shall be made to applicable International Standards.
- **Preventive Maintenance Manual for Civil Structure of Transmission line and Substation:** The Manual shall specify the procedures for preventive maintenance. The Manual shall indicate the system information, the format in which it should be collected and the analysis to be done for timely identification of issues. The Manual shall highlight steps to be taken to address various issues that are likely to be encountered during operation.

These Manuals shall be as per the standard international industry practices and references shall be made to appropriate International Standards and Codes.

The above mentioned manuals are to be provide in both the printed format (4 copies each) and softcopy. Also a training completion Report with all details of trainees, their performance evaluation and recommendation for assignments based on their assessment shall be submitted in both the printed format (2 copies) and softcopy.

d) Training - Transmission Line Design-

3.d.1 The Consultant shall be required to carry out following tasks.

Task 1: Training in planning and design

The Consultant shall be required to impart training to the Staffs selected by NEA in the following areas for 132 kV, 220 kV and 400 kV voltage levels of the transmission line system:

- Transmission line Planning (Route Selection, selection on voltage level of Transmission line and other planning related activities) & Design (including all the elements of transmission line, protection and Communication etc.)

The Consultant shall develop the syllabus for the training program in close collaboration with the Project Management Directorate of NEA. The syllabus shall be as per the requirements of NEA and shall impart both theoretical and practical knowledge and concepts including training on software owned by NEA. The training syllabus shall be as approved by NEA.

The Consultant for the training purpose shall develop training manuals with appropriate references to standard text books and IEC standards. The training manual shall consist of theoretical concepts, numerical analysis, empirical formulas, single grams, real case studies and practice exercises.

The training shall consist of class room at NEA and field training in Nepal. The training courses shall be completed in three sessions. The first session shall consist of 15 days of class room training. In the first session of the training the trainees shall be imparted knowledge of theoretical concepts and numerical analysis for equipment selection, sizing and specifications. The trainees shall be exposed to at least five (5) case studies through practice exercises and if required field visits will be carried out. At the end of the first session of the training each trainee shall be administered a written test of three hours consisting of a case study to test the understanding of the concepts taught. Those failing in the first test shall be given another opportunity.

The Consultant shall organize a second training session for the trainees for a period of fifteen (15) days. The Consultant shall organize training on the use of software owned or identified by NEA. The Consultant shall impart knowledge in the use of software for design, system studies (including transient and stability) and project management through various case studies (at least five). The training shall include load flow study, tower spotting and use of Auto Cad in GIS mapping among others. At the end of this training session the Consultant shall conduct a test to assess the understanding of the trainees to use these softwares.

The third session of the training shall be of 15 days and shall consists of practical exercise (including the use of software) of at least five real case studies in the above identified areas of capacity building in transmission line design, project management and planning. The training shall include international best practices in planning, design and project management of transmission line projects.

At the end of the training program a 3-hour test shall be conducted by the Consultant to assess the understanding and capabilities of the trainees in areas of transmission line design, project management and planning in which they have been imparted training. NEA shall be responsible for providing class rooms, transportation of trainees and other logistic support required for organizing the training.

Task 2: Development of Manuals

The Consultant shall develop following Manuals complete in all respects for 132 kV, 220 kV and 400 kV Transmission lines for NEA:

- **Design Manual:** The Manual shall include various scenarios of equipment sizing, and specifications. The Manual shall provide design philosophy to be adopted, empirical formulas for appropriate equipment selection, electrical layout, site plan, foundation plan, interconnection plan, cross sectional, grounding/earthing, lightening protection, protection system and single line diagrams of equipment and transmission line system etc. The Manual shall include standard design including Bills of Quantity (BoQ) for various capacities of Transmission line of various voltage levels. The Manual shall contain among others separate chapters on (i) Profiling and tower spotting using PLS CADD of the transmission lines (ii) Route selection, Identification of land plot and preparation of the Right-of-Way plan along the transmission line route covering land plots, title holders, land area to be acquired/affected as per the NEA prudent practice & process of check survey, and (iii) Sag-tension calculations using PLS-CADD software by preparing sag template in the scale of plan & profile drawings then spot towers on the prepared plan & profile drawings optimally and prepare sag curves for both hot and cold conditions using PLS-CADD software. The Manual shall indicate the information required for transmission line design, format in which it is to be collected and various system studies to be performed.
- **Testing and Commissioning Manual for Transmission line:** The Manual shall contain the activities/steps to be carried out for testing and commissioning of the individual equipment's and the transmission line system including the protection system. The Manual shall indicate various tests to be performed on individual equipment and the transmission line system including the protection system. The Manual shall indicate acceptable values of these tests including principles, information, formulas and the formats for computing these results. References shall be made to applicable International Standards.
- **Operating Manual for Transmission line:** The Operating Manual shall specify the operating procedures for various individual equipment's and the transmission line system. The Manual shall indicate the system information, the format in which it

should be collected and the analysis to be done for timely identification of operating issues. The Manual shall highlight steps to be taken to address various operating issues that are likely to be encountered during Transmission line operation. The Manual shall also highlight various preventive maintenance measures to be undertaken for safe and efficient operation of Transmission line systems.

These Manuals shall be as per the standard international industry practices and references shall be made to appropriate International Standards and Codes.

The above mentioned manuals are to be provide in both the printed format (4 copies each) and softcopy. Also a training completion Report with all details of trainees, their performance evaluation and recommendation for assignments based on their assessment shall be submitted in both the printed format (2 copies) and softcopy.

e) Training - Tower Design –

3.e.1 The Consultant shall be required to carry out following tasks.

Task 1: Training in planning and design

The Consultant shall be required to impart training to the Staffs selected by NEA in the following areas for 132 kV, 220 kV and 400 kV voltage levels of the transmission tower system:

- Transmission tower Design (including all the elements of transmission tower)

The Consultant shall develop the syllabus for the training program in close collaboration with the Project Management Directorate of NEA. The syllabus shall be as per the requirements of NEA and shall impart both theoretical and practical knowledge and concepts including training on software owned by NEA. The training syllabus shall be as approved by NEA.

The Consultant for the training purpose shall develop training manuals with appropriate references to standard text books and IEC standards. The training manual shall consist of theoretical concepts, numerical analysis, empirical formulas, single grams, real case studies and practice exercises considering different terrains of Nepal. The training shall consist of class room at NEA and field training in Nepal. The training courses shall be completed in three sessions. The first session shall consist of 15 days of class room training. In the first session of the training the trainees shall be imparted knowledge of theoretical concepts and numerical analysis for equipment selection, sizing and specifications. The trainees shall be exposed to at least five (5) case studies through practice exercises and if required field visits will be carried out. At the end of the first session of the training each trainee shall be

administered a written test of three hours consisting of a case study to test the understanding of the concepts taught. Those failing in the first test shall be given another opportunity.

The Consultant shall organize a second training session for the trainees for a period of fifteen (15) days. The Consultant shall organize training on the use of software owned or identified by NEA. The Consultant shall impart knowledge in the use of software for design, through various case studies (at least five). The training shall include tower design for all tower types among others. At the end of this training session the Consultant shall conduct a test to assess the understanding of the trainees to use the software.

The third session of the training shall be of 15 days and shall consist of practical exercise (including the use of software) of at least five real case studies in the above identified areas of capacity building in transmission tower design. The training shall include international best practices in design of transmission tower. At the end of the training program a 3 hour test shall be conducted by the Consultant to assess the understanding and capabilities of the trainees in areas of transmission tower design in which they have been imparted training. NEA shall be responsible for providing class rooms, transportation of trainees and other logistic support required for organizing the training.

Task 2: Development of Manuals

The Consultant shall develop following Manuals complete in all respects for 132 kV, 220 kV and 400 kV Transmission towers for NEA:

- **Design Manual:** The Manual shall include various scenarios considering hilly and plain terrain of Nepal of equipment sizing, and specifications. The Manual shall provide design philosophy to be adopted, empirical formulas for appropriate equipment selection, layout, site plan, foundation plan, cross sectional, grounding/earthing, lightening protection, protection system and single line diagrams of equipment and transmission tower system etc. The Manual shall include standard design including Bills of Quantity (BoQ) for various capacities of Transmission tower of various voltage levels. The Manual shall contain among others separate chapters on (i) Using PLS-Tower to design tower of all types. The Manual shall indicate the information required for transmission tower design, format in which it is to be collected and various system studies to be performed.
- **Testing and Commissioning Manual for Transmission line tower:** The Manual shall contain the activities/steps to be carried out for testing and commissioning of the individual segments of the transmission tower system. The Manual shall indicate various tests to be performed on individual equipment and the transmission tower system. The Manual shall indicate acceptable values of these tests including

principles, information, formulas and the formats for computing these results. References shall be made to applicable International Standards.

- Operating Manual for Transmission tower: The Operating Manual shall specify the operating and preventive maintenance procedures for the transmission tower system. The Manual shall indicate the system information, the format in which it should be collected and the analysis to be done for timely identification of operating issues. The Manual shall highlight steps to be taken to address various operating issues that are likely to be encountered during Transmission tower operation. The Manual shall also highlight various preventive maintenance measures to be undertaken for safe and efficient operation of Transmission tower systems.

These Manuals shall be as per the standard international industry practices and references shall be made to appropriate International Standards and Codes.

The above- mentioned manuals are to be provide in both the printed format (4 copies each) and softcopy. Also a training completion Report with all details of trainees, their performance evaluation and recommendation for assignments based on their assessment shall be submitted in both the printed format (2 copies) and softcopy.

f) Training - Grid Tied PV Solar Pre-feasibility and detailed feasibility study for Solar Park-

3.f.1 The Consultant shall be required to carry out the following tasks:

Task 1: Pre-Feasibility study for Solar Park of areas of the Mustang district near the under construction 220 KV Dana Substation as per guidelines for developing utility scale solar PV projects in Nepal

Task 2: Detailed Feasibility study for Solar Park of areas of the Mustang district near the under construction 220 KV Dana Substation as per guidelines for developing utility scale solar PV projects in Nepal

Task 3: Recommendation of an appropriate business model including additional infrastructure requirements like grid extension, road, water supply, etc. with implementation matrix, procurement plan and complete bid documents using reverse auction process that facilitates time efficient and cost effective solar park.

The Consultant shall analyze prevailing practices, procedures and provisions in the grid-tied PV solar in Nepal and recommend required interventions to realize time efficient

and cost effective solar park in Nepal. Further, the consultant is required to recommend an appropriate business model including additional infrastructure requirements like grid extension, road, water supply, etc. with implementation matrix, procurement plan and complete bid documents using reverse auction process that facilitates time efficient and cost effective solar park.

For all the above- mentioned tasks, the consultant shall submit separate reports in print format (4 copies each) and shall also provide softcopy of the reports with all excel, word and software files that have been used to evaluate the findings for the report.

4. Qualification / experience and Input of the Consultant

a) Protection Coordination for the INPS

4.1 Person month input

International Expert: An indicative ten (10) person-month services are required to perform the services. The Consultant shall be assisted by two National Experts and two NEA Counterpart Engineers. Out of the ten (10) person-month required, two (2) person month is allocated for Home Office and the rest for Field Office.

National Experts: An indicative eight (8) person-month each service is required to perform the services by two national experts.

NEA counterpart Engineers: Full-time Electrical Engineers (2 Numbers) will be deputed by NEA for the assignment to support the International Expert to complete the assignment. The travelling expenses of the NEA counterpart Engineers shall be borne by NEA as per prevailing bylaws.

4.2 Qualification/Experience Requirements

a. International Protection Expert

Academic Capabilities:

Mandatory Requirement:

- i. Minimum Master's Degree in Electrical Engineering/Power system Engineering/Control System Engineering

Professional Experience:

Mandatory Requirements:

- i. Minimum 10 years of experience in designing protection system for the integrated power system
- ii. Experience as a consultant in the development/review of network protection schemes and the calculation and implementation of protection relay settings with the modern testing equipment available in the market

iii. The Consultant should have strong understanding of protective relaying scheme and concepts, communication scheme and control scheme including SCADA and communication systems and operation and control of switchyard protection equipment.

Preferred Requirement:

i. Knowledge of applicable technical standards such as IEC, ANSI, IEEE etc. The Consultant should be competent to use any of the test equipment such as OMICRON CPC 100, OMICRON CMC 356, Frejer win etc. to perform protection Relay testing and analysis completely.

Geographical Experience:

Preferred Requirement:

i. Preferably worked in the developing country other than the home country in the field of power system protection.

Expert is required to substantiate his/her experience and qualification by submitting appropriate notarized certificates.

National Experts: Electrical Engineers (2 Numbers)

Academic Capabilities:

Mandatory Requirement:

i. Minimum Bachelor's Degree in Electrical Engineering/Power system Engineering/ Control System Engineering

Professional Experience:

Mandatory Requirements:

i. Minimum 1 year of experience in protection system related works in the integrated power system

Preferred Requirement:

i. Preferably experience working with international institutions.
ii. The Consultant should be competent to use any of the test equipment such as OMICRON CPC 100, OMICRON CMC 356, Frejer win etc. to perform protection Relay testing and analysis completely.

Geographical Experience:

Preferred Requirement:

i. Preferably worked in protection system related works in the integrated power system in Nepal

Expert is required to substantiate his/her experience and qualification by submitting appropriate notarized certificates.

b. Training Substation Design

4. Qualification / experience and Input of the Expert

4.1 Person month input -

An indicative three (3) person-month services are required to perform the services. Out of the three (3) person-month required, One and Half (1.5) person months are allocated for Home Office and the rest for Field Office.

4.2 Qualification/Experience Requirements for the Expert

The Consultant undertaking this assignment shall be evaluated based on:

International Expert – Sub Station Design Trainer

Academic Capabilities:

Mandatory Requirement:

- i. Minimum Master's Degree in Electrical or Power Engineering

Professional Experience:

Mandatory Requirements:

- i. Minimum 10 (ten) years of experience in designing of the substations system
 - ii. Experience as a consultant in substations project of at least 400 kV Voltage Levels (including design and software application in design)
 - iii. Experience as a trainer of successfully completing similar assignment of training (including training on software to be used) in substations design of 400 kV or above Voltage Level

Geographical Experience:

Preferred Requirement:

- i. Experience in providing similar training in the developing country other than the home country

Expert is required to substantiate his/her experience and qualification by submitting appropriate notarized certificates.

c) Training - Civil Structures and foundation design

4. Qualification / experience and Input of the Expert

4.1 Person month input

An indicative three (3) person-month services are required to perform the services. Out of the three (3) person-month required, One and Half (1.5) person months are allocated for Home Office and the rest for Field Office.

4.2 Qualification/Experience Requirements for the Experts

The Consultant undertaking this assignment shall be evaluated based on:

International- Civil Structures and Foundation design Trainer

Academic Capabilities:

Mandatory Requirement:

- i. Minimum Master's Degree in Civil or Structure Engineering

Professional Experience:

Mandatory Requirements:

- i. Minimum 10 (ten) years of experience in civil designing of the transmission line and substations system
 - ii. Experience as a consultant in transmission line and substations project of at least 400 kV Voltage Levels (including design and software application in design)
 - iii. Experience as a trainer of successfully completing similar assignment of training (including training on software to be used) in transmission line and substations design of 400 or above kV Voltage Level.

Geographical Experience:

Preferred Requirement:

- i. Experience in providing similar training in the developing country other than the home country

Expert is required to substantiate his/her experience and qualification by submitting appropriate notarized certificates.

d) Training - Transmission Line Design

4. Qualification / experience and Input of the Expert

4.1 Person month input

An indicative three (3) person-month services are required to perform the services. Out of the three (3) person-month required, One and Half (1.5) person months are allocated for Home Office and the rest for Field Office.

4.2 Qualification/Experience Requirements for the Experts

The Consultant undertaking this assignment shall be evaluated based on:

International: Transmission Line Design Trainer

Academic Capabilities:

Mandatory Requirement:

- i. Minimum Master's Degree in Electrical or Power Engineering

Professional Experience:

Mandatory Requirements:

- i. Minimum 10 (ten) years of experience in designing of the transmission line
 - ii. Experience as a consultant in transmission line project of at least 400 kV Voltage Levels (including design and software application in design)
 - iii. Experience as a trainer of successfully completing similar assignment of training (including training on software to be used) in transmission line design of 400 kV or above Voltage Level

Geographical Experience:

Preferred Requirement:

- i. Experience in providing similar training in the developing country other than the home country

Expert is required to substantiate his/her experience and qualification by submitting appropriate notarized certificates.

(e) Training - Tower Design

4. Qualification / experience and Input of the Expert

4.1 Person month input

An indicative three (3) person-month services are required to perform the services. Out of the three (3) person-month required, One and Half (1.5) person months are allocated for Home Office and the rest for Field Office.

4.2 Qualification/Experience Requirements for the Experts

The Consultant undertaking this assignment shall be evaluated based on:

International- Tower Design Trainer

Academic Capabilities:

Mandatory Requirement:

- i. Minimum Master's Degree in Electrical or Civil or Structure Engineering

Professional Experience:

Mandatory Requirements:

- i. Minimum 10 (ten) years of experience in designing of the transmission line tower
- ii. Experience as a consultant in transmission line projects of at least 400 kV Voltage Levels (including design and software application in design)
- iii. Experience as a trainer of successfully completing similar assignment of training (including training on software to be used) in transmission line tower design of 400 kV or above Voltage Level)

Geographical Experience:

Preferred Requirement:

- i. Experience in providing similar training in the developing country other than the home country

Expert is required to substantiate his/her experience and qualification by submitting appropriate notarized certificates.

f) Training - Grid Tied PV Solar

4. Qualification / experience and Input of the Expert

4.1 Person month input

An indicative two (2) person-months services are required to perform the services. Out of the two (2) person-months required, half (0.5) person months are allocated for Home Office and the rest for Field Office.

4.2 Qualification/Experience Requirements

The Consultant undertaking this assignment shall be evaluated based on:

International Expert:

Academic Capabilities:

Mandatory Requirement:

- i. Minimum Master's Degree in Renewable/Electrical or Power or Solar Engineering

Professional Experience:

Mandatory Requirements:

- i. Minimum 10 years of experience in Grid tied PV solar.
 - ii. Experience as a consultant in grid tied PV solar projects of 200 MW or above capacity (including design and software application in design).
 - iii. Experience as a trainer of successfully completing similar assignment of training (including training on software to be used) in grid tied PV solar.

Geographical Experience

Preferred Requirement:

- i. Experience in providing similar training in the developing country other than the home country.

Expert is required to substantiate his/her experience and qualification by submitting appropriate notarized certificates.

g) Pre-feasibility and detailed feasibility study for Solar Park

4. Qualification / experience and Input of the Expert

4.1 Person month input

The indicative duration of the assignment shall be nine (9) months. Out of the nine (9) person-month required, one (1) person month is allocated for Home Office and the rest for Field Office. The Consultant is required to visit proposed project site in discharge of their duties and responsibilities.

4.2 Qualification/Experience Requirements

The Consultant undertaking this assignment shall be evaluated based on:

International Expert:

Academic Capabilities:

Mandatory Requirement:

- i. Minimum Master's Degree in Renewable/Electrical or Power or Solar Engineering

Professional Experience:

Mandatory Requirements:

- i. Minimum 10 years of experience in Grid tied PV solar projects
 - ii. Experience as a consultant in the preparation of the detailed feasibility study for utility scale grid tied PV solar of 200 MW or above capacity.
 - iii. Experience as a consultant in the preparation of the business model for utility scale grid tied PV solar of 200 MW or above capacity.
 - iv. Preparation of bid document using reverse auction method for grid tied PV solar of at least 200 MW.

Geographical Experience

Preferred Requirement:

- i. Worked in developing country other than the home country in the Grid-tied PV solar sector.

Expert is required to substantiate his/her experience and qualification by submitting appropriate notarized certificates.

5. Reporting Requirements, Time Schedule for Deliverables and Implementation

Arrangement

a) Protection Coordination for the INPS

5.a.1 The Consultant shall prepare various reports and maintain records documenting decisions made at meetings and progress achieved. All documents and reports shall be made available in electronic format to NEA. The reporting shall, in general, comprise of the following:

- (i) Inception report;
- (ii) Draft final and final report of the Protection System Coordination Study;
- (iii) Assessment Report of the existing protection system for substations and power plants in the INPS;
- (iv) Descriptions of short circuit studies illustrated with diagrams, tables, exhibits, graphs and charts;
- (v) Tabulations of equipment ratings versus calculated short circuit values and X/R ratios, and commentary regarding same;
- (vi) Protection Scheme for INPS including relay coordination data, calculation sheets in a substation wise format, protection coordination curves, generator capability curve coordinated with R-X impedance diagrams, tabulations of relay, circuit breaker trip settings;
- (vii) Technical specification for protective relays;
- (viii) Protection system design guidelines and philosophy;
- (ix) Manual for relay coordination, relay testing and relay setting;
- (x) Protection setting Register for each Substation and Power Station;
- (xi) Project Completion Report (PCR) as per requirement of NEA and ADB.

5.a.2 All documents and reports shall be made available on electronic and printed format (2 Copies each) to NEA. All reports shall be in English language. Also, the softcopy of the reports with all excel, word and software files that have been used to evaluate the findings for the report shall be provided.

5.a.3 The Consultant shall report to the Project Management Directorate (PMD) of NEA and headed by the Deputy Managing Director who reports directly to the Managing Director of NEA.

b) Training - Substation Design

5.b.1 All manuals and Training Completion Report as stated above.

5.b.2 The above mentioned manuals are to be provide in both the printed format (4 copies each) and softcopy. Also a training completion Report with all details of trainees, their performance

evaluation and recommendation for assignments based on their assessment shall be submitted in both the printed format (2 copies) and softcopy.

5.b.3 The Consultant shall report to the Project Manager, Utility Scale Gridtied PV Solar Project, Project Management Directorate (PMD) of NEA.

c) Training - Civil and Foundation Design

5.c.1 All manuals and Training Completion Report as stated above.

5.c.2 The above mentioned manuals are to be provide in both the printed format (4 copies each) and softcopy. Also a training completion Report with all details of trainees, their performance evaluation and recommendation for assignments based on their assessment shall be submitted in both the printed format (2 copies) and softcopy.

5.c.3 The Consultant shall report to the Project Manager, Utility Scale Gridtied PV Solar Project, Project Management Directorate (PMD) of NEA.

d) Training - Transmission Line Design

5.d.1 All manuals and Training Completion Report as stated above.

5.d.2 The above mentioned manuals are to be provide in both the printed format (4 copies each) and softcopy. Also a training completion Report with all details of trainees, their performance evaluation and recommendation for assignments based on their assessment shall be submitted in both the printed format (2 copies) and softcopy.

5.d.3 The Consultant shall report to the Project Manager, Utility Scale Gridtied PV Solar Project, Project Management Directorate (PMD) of NEA.

e) Training - Tower Design

5.e.1 All manuals and Training Completion Report as stated above.

5.e.2 The above mentioned manuals are to be provide in both the printed format (4 copies each) and softcopy. Also a training completion Report with all details of trainees, their performance evaluation and recommendation for assignments based on their assessment shall be submitted in both the printed format (2 copies) and softcopy.

5.e.3 The Consultant shall report to the Project Manager, Utility Scale Gridtied PV Solar Project,

Project Management Directorate (PMD) of NEA.

f) Training - Solar Design

5.f.1 Review of manual and Training Completion Report as stated above.

5.f.2 All Reports shall be submitted in both the printed format (2 copies) and softcopy.

5.f.3 The Consultant shall report to the Project Manager, Utility Scale Gridtied PV Solar Project, Project Management Directorate (PMD) of NEA.

g) Pre-feasibility and detailed feasibility study for Solar Park

5.g.1 For all the above mentioned tasks, the consultant shall submit separate reports in print format (4 copies each) and shall also provide softcopy of the reports with all excel, word and software files that have been used to evaluate the findings for the report.

5.g.2 The Consultant shall report to the Project Manager, Utility Scale Gridtied PV Solar Project, Project Management Directorate (PMD) of NEA.

6. Client's Input and Counterpart Personnel

(a) Services, facilities, and property to be made available to the Consultant by the Client:

Administrative support for Consultant: If required by local regulations, NEA will provide Consultant with necessary support letters for obtaining visas and permits. The cost and timing of obtaining the above is entirely the responsibility of the Consultant.

Office Space, Office Equipment, Transportation and Accommodation: NEA will provide office space, necessary furniture and office equipment (computers, telephone etc.) in Kathmandu. The Consultant shall make his own arrangements for any other requirements including the transportation and accommodation in Nepal at no additional cost to the employer. The Consultant shall arrange itself any other testing equipment and software required during execution of works. The Consultant shall be responsible for operation & maintenance of office equipment and consumables necessary for its own use.

NEA shall facilitate access to the Consultant to other government agencies for communications, collecting of relevant information, data, documents, etc. and other activities related to the consultant's assignment.

(b) Professional and support counterpart personnel to be assigned by the Client to the Consultant's team:

The services to be provided by the Consultant as described in the above trainings shall be performed under coordination of the Project Documentation Expert (a National Expert) of the client.

NEA counterpart Engineers: Full-time Electrical Engineers (2 Numbers) will be deputed by NEA for the assignment to support the International Expert in Protection Coordination of INPS to complete the assignment. The travelling expenses of the NEA counterpart Engineers shall be borne by NEA as per prevailing bylaws.

7. Client will provide the following inputs, project data and reports to facilitate preparation of the Proposals:

"Guidelines for developing utility scale solar PV projects in Nepal" issued by Ministry of Energy, Water Resources and Irrigation of the Government of Nepal.