REPUBLIC OF TURKEY
MINISTRY OF ENVIRONMENT AND URBANIZATION
General Directorate of Construction Affairs

TURKEY ENERGY EFFICIENCY IN PUBLIC BUILDINGS PROJECT
(P162762**)**

TERMS OF REFERENCE (TOR) FOR

CONSULTING SERVICES FOR ENERGY AUDIT REPORTS, DETAILED DESIGNS AND TECHNICAL SPECIFICATIONS FOR ENERGY EFFICIENCY BUILDING RENOVATIONS (REF: EEPB/WB/MoEU/QCBS-DES&SUP-04)

I. Introduction

The Ministry of Environment and Urbanization (MoEU) has received financing from the World Bank toward the cost of the Energy Efficiency in Public Buildings Project (EEPBP) and intends to apply part of the proceeds for consulting services.

The project investments will focus primarily on the renovation of central public buildings with high energy consumption and shorter pay-back periods. The proposed project would be implemented through two components: (i) energy efficiency (EE) investments in central government buildings; and (ii) technical assistance (TA) and project implementation support. The General Directorate of Construction Affairs (GDCA) under the MoEU has been delegated to assume overall responsibility for the project. This will include completion of the necessary activities to support project preparation as well as implementation for the six-year project period. In parallel, grant funding has been mobilized from the Clean Technology Fund (CTF) to help analyze the investment needs and potential of the central government buildings.

The GDCA has established a project implementation unit (PIU) to adminster all aspects of the project, including selection of the buildings, procurement of the various contractors (e.g. energy audits, technical designs, renovation works, construction supervision, savings verifications, technical assistance or consultancies, etc.), and monitoring.

Through the EEPBP, approximately 500-700 public buildings will be renovated for EE. Investments would include building envelope measures (roofs/wall insulation, windows, doors), heating/cooling systems, water heating, pumps/fans and lighting and some renewable energy (RE) applications (e.g., rooftop solar PV, biomass heating, solar water heating, geothermal heat pumps) to offset the building's electricity/fuel use. A limited amount of funds may be allocated for non-EE/RE measures (e.g., rewiring, minor structural repairs, painting, seismic safety, etc.).

Within the framework of the EEPBP, a consulting firm will be employed to conduct investment grade energy audits, prepare detailed designs and technical specifications of selected public buildings.

II. Scope of Services

The Consultant will be required to conduct investment grade energy audits for all buildings and prepare detailed designs (including architectural, mechanical and electrical designs), and technical specifications, cost estimates and bills of quantities (BoQs) for energy efficiency renovations in public buildings based on energy audit reports. The Consultant shall also identify environmental and social risks associated with the planned renovation works and prepare Environmental and Social Management Plans (ESMPs).

Estimated total area of buildings for renovation in 6 building complexes are 290.515mt², having 27 separate building blocks as listed below. (It should be noted that slight changes may occur in the list, in number of buildings or locations). One or two of the buildings will be renovated by an energy service company (ESCO). For this building, detailed designs will not be required. Final informations will be provided in RFP document.

LIST OF BUILDINGS- DES&SUP-04						
	NAME OF BUILDING	**RELATED INSTITUTION**	**CITY**	**TOTAL AREA m2**	**ENERGY AUDIT**	**No. blocks**
1	Ankara Yildirim Beyazit Üniversitesi	Ankara Yildirim Beyazit Univercity	ANKARA	75.097mt²	No existing audit	4
2	Göç İdaresi Genel Müdürlüğü Hizmet Binası	Ministry of Internal Affairs	ANKARA	16.368mt²	No existing audit	1
3	T.C. Ticaret Bakanlığı Eskişehir Yolu Yerleşkesi A ve B Blok	Ministry of Trade	ANKARA	75.895mt²	No existing audit	2
4	Karabük Valiliği	Ministry of Internal Affairs	KARABÜK	16.994mt²	No existing audit	1
5	Karabük Üniversitesi Safranbolu Fethi Toker Güzel Sanatlar Fak.	Karabük Univercity	KARABÜK	22.680mt²	No existing audit	1
6	Eskişehir Teknik Üniversitesi	Eskişehir Teknik Univercity	ESKİŞEHİR	83.481mt²	PARTIAL (7 blocks, 20.442mt² have no existing audit, 11 blocks 63.038 mt² have audits dating 2014)	18
			TOTAL	**290.515mt²**		**27**

III. Description of the Consultants's Tasks

Task 1: Conduct investment grade energy audit report

The consultant shall conduct investment grade energy audits of public buildings to identify and recommend energy efficiency measures (EEMs) for implementation of energy efficiency (EE) investment according to the audit template given as an Annex. The activities required to conduct investment grade energy audits include, but may not be limited to, the tasks described in the following sections. The work conducted should comply with the principles and processes described in ISO 50002. Some of the buildings as mentioned above have energy audit reports dating 2014, the consultant will also revise these audit reports.

1a) Prepare inception report to be delivered two weeks after contract signing as a roadmap and, The inception report shall: (i) define the aims and objectives of the services to be provided, (ii) set out a detailed work program for the rest of the project, (iii) state when the field work will take place for the site visit for the audit, (iv) identify potential problems to overcome and possible solutions; (iv) identify counterpart staff in the Client's office and other organizations; and (v) include a stakeholder analysis identifying other third party organizations involved in the project implementation process.

1b) Conduct preliminary reviews: Perform an initial energy use evaluation by reviewing all utility data and building or system diagrams, which can include architectural plans, electrical plans and

cuts, electrical board schemes, thermal systems (production and distribution) plans, equipment lists and catalogues, operation and maintenance logs, and other available facility information.

The initial activities under this task include determining the required scope of work, identifying key personnel (including personnel responsible for Operation and Maintenance (O&M) and energy-related issues); and requesting specific information and data. The data to be requested and collected from the building managers should include, but may not be limited to:

- Energy bills for the past three calendar years; all forms of energy should be included in this analysis
- Online billing data
- Building Management System (BMS) history and data
- Building layout drawings and site plans
- Equipment lists for main energy-using equipment
- Process flow diagrams
- Process and instrumentation drawings (P&IDs) for large energy users
- Operational, weather and other data relevant for energy use (occupancy, weather, production data)
- Copies of any previous energy audits, studies or details of known opportunities for energy efficiency
- Details of upcoming organisational changes or other investment plans that are expected to affect energy efficiency or energy use

Review all available facility documentation with site representatives where possible. Review at least three years of energy data and discuss year-to-year variations and seasonal variations in energy use patterns. Calculate the baseline consumption, i.e., the expected energy consumption under current operating conditions, based on historical consumption data for a selected reference period. The baseline consumption shall be normalized as defined in ISO 50006 and later be revised using data from site assessments.

1c) Conduct site assessments: Further investigate the major energy-consuming processes in the facility. At the end of this task, the buildings and systems descriptions and collection of consumption and other relevant data to propose and describe EEMs should be completed. All relevant findings related to the visual inspections, field measurements, and interviews must be included in the energy audit report. The site assessment shall focus on all passive and active systems available on site and will include, but may not be limited to, the following subtasks:

- Conduct visual inspections
- Develop field measurement plans
- Conduct field measurements
- Conduct field interviews

1c.1) Conduct visual inspections: Conduct visual inspections in a walk through to verify the completeness and accuracy of available documentation. This will include, but may not be limited to:

- Construction details of the building envelope (e.g., walls, roof, windows, doors) and related insulation values
- Heating and cooling production systems (e.g., chillers, boilers) and their capacities, rated efficiency, and maintenance status

- Heating, Ventilation and Air Conditioning (HVAC) distribution system capacities, rated efficiency, and maintenance status
- Electrical motors, their end-use, efficiency data, and maintenance status
- Type of control methods and operation schedules
- Interior and exterior lighting systems and related controls
- Service hot water systems, their storage capacity, efficiency, and maintenance status
- Renewable Energy (RE) generation and integration with building systems
- Other relevant energy consumption drivers

Where relevant, the report should include images to present the current state of the facility, possible shortcomings in the construction or in systems maintenance.

1c.2) Develop field measurement plans: Define and agree on a field measurement plan with the building supervisor and the O&M team. The measurement plan may be revised based on the findings during field measurements or other tasks of the energy audit. The type of measuring equipment to be used shall be selected according to the nature of the variable to be measured, its amplitude, the operating range, the required accuracy, and the operating conditions for installation and use of the equipment. The Consultant shall be responsible for the measurements, even if some measurement equipment is installed by a third party.
The measurement plan shall include, but may not be limited to, the following items:

- Methodology for measurements and their level of accuracy
- Check of proper operation of measuring equipment
- Verification that measurements by the measuring equipment are accurate and repeatable
- List of relevant measuring points, associated processes within the building/system (e.g. water temperature flow for chiller exit line to check the efficiency), and measuring equipment to be used
- Accuracy and repeatability required for measurements and their associated measurement uncertainty
- Duration and frequency of each measurement (e.g. instantaneous or continuous measurements)
- Frequency of collection of each measurement
- Definition of a time period for measurements that is representative
- Relevant variables provided by the organization, for example, operating parameters and production data
- Responsibilities for carrying out measurements, including staff working for or on behalf of the organization

Pre-arranged checklists (e.g., American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) sample forms for energy audits) may be used to structure the measurements and all the data aggregation. Sampling procedures may be required when it is not practical or economically feasible to analyse all the information available during an energy audit. Sampling is described in clause B.3 of ISO 19011:2011.

1c.3) Conduct field measurements: Perform all necessary on-site measurements to detail the energy baseline and collect data required for identifying EEMs. Install and operate the necessary energy monitoring equipment on-site suitable for the relevant data collection

(e.g., data loggers, flue meters, temperature and hygrometer sensors, electric/gas meters, air and water flow meters, thermal cameras). If is not possible to measure the actual performance of systems and equipment (e.g., due to temporary malfunction, or out of season audit), performance of the systems and equipment shall be simulated based on theoretical and inspection data.

Field measurements should include, but may not be limited to:

a) Building envelope: Windows, doors and insulation
   - Outside and inside surface temperatures
   - Thermal image for energy loss/gain and surface temperature
   - Insulation layer thickness
   - Glazing details/thickness
b) Heating/cooling production and distribution system
   - Input values like electrical instantaneous and continuous power consumption for electrical based systems (e.g., chillers, fan, pumps)
   - Enthalpy measurements for chillers and boilers
   - Output values like airflow, water flow, air and water temperatures
c) Efficiency of boilers and other heat-generating equipment
   - Flue gas temperature and chemical composition (O_2, CO_2)
   - Fuel/gas instantaneous consumption
d) Electrical consumption of lighting systems
   - Electrical instantaneous and continuous power consumption for sample circuits
   - Lighting level (lux) in sample representative locations
e) Motors (including fans, pumps) and other plugged systems
   - Electrical instantaneous and continuous power consumption for sample circuits.
f) Other energy consumption systems and equipment.

During the field measurement phase, the client or building personnel should provide the corresponding relevant variables, e.g., operating parameters, production data, occupation data. Additional measuring points, appropriate measuring equipment, associated processes and feasibility of installation may be identified during field measurements.

1c.4) Conduct field interviews: Interview key stakeholders (e.g., building manager, O&M staff, and users) to assess O&M routines, potential changes in user patterns (e.g., number of users or changes in user behaviour), and comfort levels (e.g. indoor temperature, air quality, lighting levels) and to collect/confirm other relevant information. Interviews shall consider data collected during the previous tasks and aim at obtaining relevant information to explain seasonal and year-to-year changes in historical energy consumption, identifying current energy management practices and improvement potential, and identifying the feasibility of potential EEMs.

1d) Data analysis: Revise the baseline energy consumption using data collected in previous tasks. Identify EEMs and their investment costs, energy savings, and cost benefit. Develop scenarios for different combinations of EEMs with consideration of cross-effects between different EEMs. The audit report should document methodology, assumptions, and supporting calculations. This task will include, but may not be limited to, the following subtasks:

(i) Describe audit scope

(ii) Review energy baseline and conduct EEM calculations
(iii) Determine investment costs
(iv) Establish different investment scenarios
(v) Conduct financial analysis
(vi) Determine energy performance class

1d.1) Describe audit scope: Describe buildings and systems analysed in the energy audit (e.g., areas/buildings covered, building envelope, heating/cooling, lighting and RE, alternatives to fossil fuel-based heating).

1d.2) Review energy baseline and conduct EEM calculations: Review the preliminary assessment of the energy consumption baseline using data collected in the previous tasks, including:

a) Use measurement data to explain the consumption behaviour of the main users and refine the energy consumption baseline.
b) Compare energy consumption with specific energy use values of similar buildings if available
c) Study the historical pattern of energy performance and establish relationships between energy performance and the relevant variables (e.g., heating/cooling degree days, occupation)
d) Assess existing energy performance indicators(s) (e.g. kWh/m^2 or kWh/occupant) and additional energy performance indicators (e.g., kWh/degree)

If there is insufficient quality data for setting up the baseline, dependencies and correlations between historical data, field data and other variables (e.g. weather-related variables, occupancy, events, documented equipment malfunctions, etc) should be used to establish a suitable baseline. This process has to be documented in the report.

The field measurements and the catalogue/historical data must be used for the calculation to simulate the future energy performance with the proposed EEMs. Several software tools can be used for baseline and EEM simulation calculation (not exhaustive): *Trace* for life cycle analysis; *Energy Plus*, *IESV* or *Carrier HAP* for energy modelling. Software tools to be used to simulate the level of service and envelope requirements may include: *Dialux* for lighting levels; *TS 825 Heat Insulation Standard* for insolation requirements.

EEMs shall be developed based on the specific building analysis, but typical measures that should be considered include:

- New or improved shell insulation
- Renewal of window and doors
- Heating boiler renewal
- Boiler burner adjustment
- Boiler waste heat recovery integration
- Renovation of cooling/chiller systems
- Variable speed circulation pumps and fans
- Piping and duct insulation
- Thermostatic valve usage in heating/cooling circuit
- Lighting ballast type renewal
- LED lighting systems
- Movement sensor integration to lighting systems

- Building automation systems
- Energy monitoring system
- Upgrade of electric motors with high-efficiency models
- Cogeneration/Trigeneration
- Photovoltaic (PV) systems
- Solar water heating
- Biomass or other alternatives to fossil fuel-based energy.

In all cases, the main energy-consuming vectors have to be addressed in the EEM proposal. The RE generation should be carefully detailed, with simulation production, grid connection point and relevant construction requirements, if any. No-cost measures, e.g., energy management and O&M, shall be stated but not included in the financial analysis.
The indirect effects of the EEM implementation have to be considered:

- Repairs or operational changes required for the EEM to be effective
- Impact on O&M procedures and cost
- Impacts on occupant health, comfort or safety, as well as non-energy benefits, especially improvements to health, safety and environment, changes in equipment run time, and maintenance labour hours
- Commissioning requirement

1d.3) Determine investment costs: Accurate investment cost need to be determined for the financial analysis by gathering equipment, installation and construction costs from a sample of vendors and contractors. Costs should include any specific considerations for the particular facility and all indirect costs needed for implementation (e.g., scaffolding, pipe accessories, civil construction works, electrical connections, changes in electrical boards). O&M costs, commissioning, and reinvestment cost have to be included in the financial analysis.

1d.4) Establish different investment scenarios: Three different scenarios of combination of EEMs shall be presented in the audit report:

a) Base scenario with EEMs that save a minimum of 20% of the baseline consumption and a payback period shorter than 12 years for the combination of EEMs
b) Deep renovation scenario with EEMs that save a minimum of 30% of the baseline consumption and a payback period shorter than 20 years for the combination of EEMs
c) Recommended package of EEMs, which could be a selection of EEMs from the base and deep renovation scenario

All EEMs that were considered but not included in any of the scenarios should also be presented in the report.
The scenario construction will depend on the specific circumstances, but some general guidance can be provided in the next paragraphs and in the table below:

a) The base scenario should include retrofitting the insulation and fenestration according to the TS 825 Heat Insulation Standard, basic building-level energy metering, and other EEMs with shorter payback periods.
b) The deep renovation scenario should always include additional insulation and window/door upgrade, include upgrades of EEMs from the base scenario, and include additional EEMs not included in the base scenario. The payback period for the building

envelop measure can be longer than 20 years, but the individual payback periods for all other EEMs should be shorter than 20 years.

c) The recommended package can comprise a combination of EEMs from the base or deep renovation scenario but should not include (i) EEMs with payback periods longer than 20 years and (ii) EEMs with payback periods longer than the lifetime of the equipment.

Existing situation	Base Scenario	Deep Scenario
Insulation/fenestration not standard	Insulation/fenestration as in TS 825 Heat Insulation Standard	Insulation/fenestration better than TS 825 Heat Insulation Standard
Insulation/fenestration as in TS 825 Heat Insulation Standard	-	Insulation/fenestration better than TS 825 Heat Insulation Standard
EFFE1 or EFF2 motors	IE3 motors	IE4 motors
EFFE1 or EFF2 motors	IE3 motors	Variable Frequency Drive (VFD) with IE3 motors
Conventional Boiler	Condensation Boiler	Heat pump or biomass boiler
Air-Cooled Chillers	New Air-Cooled Chillers	New Air-Cooled Chillers with VFD
Water-Cooled Chillers	New Water-Cooled Chillers with heat recovery	New Water-Cooled Chillers with VFD compressors
Stand Alone Split System	New Inverter stand-alone Split System	New Volume Refrigerant Variable centralized system
Old Air Handling Units (AHU)	-	New AHU with heat recovery and VFD
-	PV Generation with shorter payback (e.g. on the roof)	PV Generation with longer payback (e.g. on a carpark)
-	Basic energy monitoring	Full BMS system
-	Cogen/Trigeneration with Shorter Payback (e.g. small packaged without chilled water production)	Cogen/Trigeneration with Longer Payback (e.g. full cogen with Abortion chiller)
-	Solar Water Heating (e.g. small system with natural convection)	Solar Water Heating (e.g. pump system with storage)
-	Insulation of Fittings, Valves, Piping	-
-	Application of Outdoor Air Compensation to Controlling of Boiler	-
-	Replacement of Circulation Pumps	Circulation Pumps with VFD pressure controlled
-	Application of Motorized Two-Way Valve	-
-	Replacement of conventional Luminaires for LED	Replacement of conventional Luminaires for LED and motion automated system
-	Efficient belts for fan motors	-

Some EEMs presented in base, deep, and recommended scenario need to be recalculated for each scenario due to the cross effects that may arise (e.g., piping insulation savings will decrease with better envelope insulation).

A basic energy monitoring system should be included in all scenarios, i.e., building-level energy meters, or submeters that can be aggregated to provide building-level energy use data (electricity, natural gas, fuel oil, propane, etc.). Utility-owned meters capable of aggregating base building-level resource use are acceptable. The basic system can be standalone, i.e., without automated report capabilities or software aggregation.

1d.5) Conduct financial analysis: Each measure and scenario must include a Cost-Benefit Analysis with the calculation of energy cost savings, simple payback period, NPV and IRR

over a 20-year period. The financial analysis must be presented in USD and TRY. The USD/TRY exchange rate will be fixed for each audit. If the net life of the measure is lower than the NPV timeframe, re-investment costs need to be included in the analysis. O&M costs and other indirect related costs should be included in the analysis. Investments are made in year 0 (or when re-investments take place) and the savings will start in year 1. Details of the financial analysis are laid out in the audit report template in Annex 1.

1d.6) Determine the energy performance class: Determine the energy performance class of the building in the current state so that it can be compared to the performance class after renovation (issuance of an actual energy performance certificate is not required for the building in the current state). The performance class to be achieved has to be calculated using the recommended measures list. In any case, the proposed scenario must achieve at least an Energy Performance Class (EKB) C.

1e) Complete audit reports: The report should follow the audit report template in Annex 1. Changes to the report structure have to be authorised by the client. The audit report should be concise and clearly written; capture all calculations, analyses and assumptions; and discuss difficulties encountered in data collection and field work.

Deliverables

- 1a) Inception report
- 1e) Investment grade Energy audit report

Task 2: Prepare detailed renovation designs and technical specifications

2a) **Collect any required information and prepare required supplemental drawings** of audited facilities, where drawings do not otherwise exist. The Consultant shall conduct site visits and prepare project plans (drawings) for selected buildings including actual measures of windows, entrance doors, building envelope, and unheated areas – building roof and basement; description of windows, doors, external walls, and materials of which buildings are made. The consultant shall also prepare a report indicating the existing situation and including the photos and descriptive captions of all building elements and systems.

2b) **Prepare detailed renovation designs and technical specification**: The technical designs and all tender documents for the construction tender shall be prepared based on the approved energy audit reports and a cost-benefit analysis, using clear energy savings indicators, which then should be monitored and verified upon project completion.
Following agreement between the PIU and the beneficiaries on the EE/RE measures to be included, the Consultant will prepare detailed renovation designs and technical specifications for works to be tendered and implemented in the selected public buildings. General and specific technical specifications for technical drawings and mechanical and electrical works shall be prepared in accordance with MoEU's "Construction Works, Civil, Mechanical Works and Electrical Works General Specifications". However, if no proposed interventions are being considered for a particular area (e.g., no lighting or other electrical measures), detailed (e.g., electrical) drawings may not be required.
Design drawings should be presented in such a way that:

- The drawings can easily be understood
- They visually communicate the concept to the beneficiary and the construction contractor
- They are legible
- All information from previous revisions and updates are included.

The design drawings should include the following aspects:

- Site layout and the location of the works to be constructed
- Plan views and sections

There will be three sets of technical drawings and details in 1/50 scale, and details including system details (for interventions 1/20, 1/5 scales, 1/1 scale if needed), which have to be compliant with the applicable in force regulations:

(i) **Mechanical drawings** (in conformity with the heating zone where the building is located): The mechanical installation drawings should include the components recommended to be replaced by the energy audit. Heating, cooling, ventilation and sanitary plumbing projects and system drawings specific to each project should be prepared according to the obtained energy energy audit reports in conformity with electrical and architectural designs. Heat insulation calculations and reports should be prepared according to TS 825 Standard.

(ii) **Electrical drawings:** The electrical installation drawings should include the components recommended to be replaced by the energy audit. MV distribution, transformer, generator, UPS, lighting, socket (mains and UPS), mechanical and force distribution, cable transportation, earthing and lightning protection, elevator, table loading tables, strong current column diagram and calculations (lighting, heating, short circuit, voltage drop). Energy efficiency comparisons (comparison of current and new status) should be shown in the corresponding plans. Necessary infrastructure plans should be prepared for the remote monitoring of energy consumption.

(iii) **Architectural drawings:** Site layout, floor plans/construction plans with all partition types and details, lighting plan for ceilings, interior elevations and sections, and details.

The renovation designs shall be certified by the Consultant according to applicable legislation and standards of Turkey. The specifications shall be prepared in accordance with the Building Code, current By-law Concerning Construction in Planned Areas, By-Law on Building Energy Performance and related Turkish legislation and standards.

Company should also propose measures to be taken in order to meet the national norms, standarts and legislations about additional aspects (e.g., indoor air quality, humidity, comfort levels, fire protection measures).

Regarding hospitals, if the Health of Ministry or hospital administrations request COVID-19 measures for any of its buildings in list, mechanical drawings should include measures to be taken such us modifications in filters or mechanical installations for COVID-19 patient rooms.

The draft renovation design must be submitted to the beneficiary for formal consent, and to any required third parties for review and certification. Any comments provided by the beneficiary, third party auditor or the PIU must be taken into account before the designs are finalized.

The technical specifications for each measure should include description of individual actions and unit's measures (BoQs, pricing preambles and costs estimates including a unit price analysis for special items). The consolidated bill of quantities (BoQ) should be prepared in compliance with unit price guidelines of MoEU and other relevant state authorities and market prices, which should include the material/equipment, quantity, technical specifications, and estimated cost. BoQs prepared by the Consultant should be in compliance with pricing preambles, technical specifications and other relevant parts of the tender documents to be prepared. Relevant BoQs and technical

specifications shall be prepared by the Consultant in detail and shall be submitted to the Client for approval, following the decision of the Client on which parts of these works shall be integrated to the relevant parts of the tender documents.

The Consultant, before finalizing and submitting the technical designs and tender documents to the PIU, shall present the technical designs to the beneficiary (and their user committees) to ensure there is no objection and technical designs are appropriate for the needs of the beneficiary and function of the building. The Consultants shall submit a letter countersigned by the principal and/or directorates of the relevant public buildings and the Consultant's representative indicating that the principal and/or directorate is informed about and agreed on the Final Architectural, Structural, Mechanical and Electrical works subject to tendering following the decision of the Client on the works approved to be integrated to the relevant parts of the tender documents.

Deliverables

- 2a) Supplemental drawings
- 2b) Detailed renovation designs and technical specifications (including BoQs and cost estimates)

Task 3: Identify environmental and social risks and prepare Environmental and Social Management Plans (ESMPs)

3a) **Identify environmental and social risks associated with the building renovations:** Identify environmental and social risks associated with the building renovation, including identifying presence and quantity of any hazardous materials (specifically asbestos and mercury containing light-bulbs) that would have to be removed as part of the renovation works.

3b) **Prepare site specific Environmental and Social Management Plans (ESMPs):** Prepare site-specific environmental and social management plans (ESMPs) in consultation with the construction contractors and submit them to the PIU for approval within 30 days of the construction site delivery. The ESMPs shall include specifications and bill of quantities for removal, packaging, transport and disposal/interim storage of hazardous materials, personal safety equipment and monitoring requirements (the Environmental Mitigation and Monitoring Measures based on the Environmental and Social Management Framework, ESMF) and estimate of costs for the measures. This will also include the location where the asbestos can be disposed and the interim storage location for the mercury containing light-bulbs as per ESMF and Turkey legislation.

Deliverables

- 3a) Report on environmental and social risks covering each building site
- 3b) ESMP for each building site

IV. Deliverables and payment schedule

All Documents need to be in Turkish language. The documents of the first 5 buildings will be also in English. Approved detailed designs and technical specifications shall be delivered as one hard copy (signed and stamped) and three DVD soft copies (including drawings in PDF and AutoCAD format).

The deliverables for each task will be submitted to and approved by the PIU. The Consultant must obtain approval for each deliverable before moving to subsequent tasks. The table below summarizes the deliverables and includes an indicative timeline and payment schedule.

Task	Deliverable		Deadline (months after contract signing)	Payment (% of total payment)
1	Conduct investment grade energy audit report			
	1a	Inception report	1st month	10 %
	1b	Conduct preliminary reviews	1st -4 th month	25 %
	1c	Conduct site assessments		
	1d	Data anaysis		
	1e	Complete audit report		
2	Prepare detailed renovation designs and technical specifications			
	2a	Supplemental drawings	2 rd -3 rd month	10 %
	2b	Detailed renovation designs and technical specifications (including BoQs and cost estimates)	4 th - 7th month	40 %
3	Identify environmental and social risks and prepare Environmental and Social Management Plans (ESMPs)			
	3a	Report on environmental and social risks covering each building site	3 rd month	5 %
	3b	ESMP for each building site	3 rd month	10%

V. Facilities provided by the consultant

The Consultant is responsible for the establishment of an audit and design group who are experienced in the preparation of architectural, structural, electrical, mechanical, designs relevant with the renovation works for EE/RE. This group shall be a complete team including project management, structural engineering, architecture, mechanical and electrical engineering and cost estimating, benefit-cost analyzing to support the development of tendering documents. Therefore, the Consultants shall separately indicate the staff to be assigned in the preparation of designs and documents by indicating positions planned to be assigned for each staff.

The Consultant must ensure that its professional staff has adequate support and equipment. All costs for equipment and administrative and logistic support must be covered by the Consultant and included in the bid price, including:

- All costs arising from the activities of its staff during the contract period, including accommodation, allowances, transportation, insurance, etc.
- Automotive, equipment, office supplies and hardware and software to ensure that the monitoring is fully functional;
- All communication costs, including fax, email, telephone, etc.
- All the equipment, instruments, services and logistical support required for the implementation of the contract, and any costs incurred during its preparation of documents and drafts, copying, printing, etc.
- Technical equipment at the monitoring site;
- Other equipment, instruments, services and logistical support necessary for the implementation of the contract.

- Excellent written and spoken English and Turkish is required. If the Consultant will require a translation services, it will be at his own expenses and the Consultant will be responsible for the accuracy of the translation.
- The Consultant is required to obtain all the necessary permits, approvals, payment of all fees and contributions, as well as all the other elements necessary for the work of his professional staff who is engaged at his own expense for the performance of this Contract.

VI. Timeline

This assignment will be held prior to the fourth quarter of 2020 and finalised in 7 months period.

Key staff

1 Team leader / Engineer with at least Master degree in Civil Engineering or Mechanical Engineering with 10 years experience relevant to the project.

2 Mechanical Engineer with at least 5 years professional experience relevant to the project, preferable in energy efficiency and renewable energy; with at least Master degree, having energy manager or audit-project certification given by Ministry of Energy and Natural Resources, expertise on ESCO contracts, expertise on M&V will be an asset,

3 Electrical Engineer with at least 5 years professional experience relevant to the project, preferable in energy efficiency and renewable energy; with at least Bachelor degree, having energy manager or audit-project certification given by Ministry of Energy and Natural Resources, expertise on ESCO contracts, expertise on M&V will be an asset,

4 Architect with at least 3 years professional experience in energy efficiency and renewable energy and relevant to the project; with at least Bachelor degree.

5 Environmental Engineer or equivalent with at least 3 years of experience in preparing Environmental and Social Management Plan and checklist, experience in preparing hazardous material inventories in buildings, in particular asbestos and experience with requirements and practice for proper asbestos and mercury containing CFLs removal, handling, transport and disposal/storage including monitoring and personal safety equipment requirements, with at least Bachelor's degree.

Non-key Staff

- Additional engineers, construction specialists, Cost and Planning Engineer, Quality Control and Quality, Occupational Health and Safety Specialist and other staff should be included to adequately carry out all aspects of the assignment.

General qualifications <u>of all consultants:</u>

- Strong knowledge of local laws, standards and norms about building construction,
- Prior experience on conducting energy auditing of buildings and preparing audit report,
- Prior experience on preparation of detailed technical designs (architectural, structural, mechanical and electrical installation),
- Engineer's authorizations for conducting energy audit reports in building sector from MENR,
- Engineer's authorizations for design preparation in buildings in compliance with local legal requirements,
- Knowledge of environmental management, health and safety,
- Good communication, management, organization and reporting skills,
- Excellent knowledge of Turkish and English language,
- Excellent communication, presentation and use of basic computer (Microsoft office, AutoCAD etc.) skills.

VII. Support to be provided by the client to the consultants

- The client will provide the consultant the existing drawings in dwg or pdf format (if the drawings exist)
- The client will provide the consultant list of the buildings having energy auıdit reports from 2014 that can be used to prepare detailed energy audits of the buildings to be renovated.
- The client will sign letters with the beneficiary buildings that describe the responsibilities of the beneficiary, including appointing a contact/facility coordinator for all project phases, facilitating access to buildings or facilities, providing existing documentation, etc.

Annex 1: Audit Template

Index

1. Cover Page

Main components:

a) Report title (with Building/Facility Name);

b) Entity for which Building/Facility has been audited;

c) Location of Building/Facility;

d) Building type (hospital, school etc.);

e) Building picture;

f) Date of report;

g) The firm responsible for the Audit;

h) Consultants certificate numbers.

2. Table of Contents, Tables and Figures

Table of Contents should include all significant headings, sub-section headings and appendix sections. Ensure that the table of contents is updated when the report is finalized. It is also desirable to add tables for relevant figures and tables. The abbreviations and acronyms used should also be indicated and explained in a friendly format, and the conversions and reference values should be presented, either at the beginning of the report or in the first Appendix.

3. Executive Summary

All information in the Executive Summary should be drawn from the detailed information of the full report. Must be concise and up to a point. The minimum contents should be as follow:

a) Short building description (owner, size, type of use, systems, insulation, etc.), using a table with this format:

Ref	Category	Description
1	Name of Building/Building Group	
2	Owner	
3	Year of Construction	
4	Purpose of Use	
5	Number of Buildings in Building Group	
6	Enclosed Volume	
7	Construction Area	
8	Building Floor Area	
9	Annual Heating Degree Days	
10	Annual Cooling Degree Days	
11	Heating/Cooling System	
12	Insulation Status	

Ref	Category	Description
12	Number of employees	
13	Number of other building users	
14	City	
15	Building Address	
16	Postal Code	
17	Phone number	
18	Fax Number	
19	email address	
20	Energy manager	
21	Certificate number of the energy manager	
22	Phone number	
23	Fax Number	
24	email address	
25	Energy Performance Certificate number (if any)	

b) Key yearly energy consumption:

Year	Total Annual Average Energy Consumption [TOE]
Year #1	
Year #2	
Year #3	
Year #(…)	
Baseline Energy use	

c) General Indicators:

#	Indicator	Units	Year #1	Year #2	Year #3	Year #(...)	Average
1	Energy Consumption per m^2	kWh/m^2 year					
2	Emissions per m^2	Ton CO_2 eq. /m^2 year					
3	Emissions per person	Ton CO_2 eq. /person year					
4	Fuel Consumption per HDD	kWh / HDD m^2 year					
5	Electricity consumption per CDD	kWh / CDD m^2 year					

d) Key systems and equipment analysed.

e) Resume of building energy consumption and consumption breakdown, through a table and a graph:

	Annual Energy Use [TOE]	Annual Energy Cost [TL]	Cost [TL/TOE]
TOTAL Baseline Energy Usage			
TOTAL Energy Savings			
TOTAL Proposed Energy Usage			

	Electrical				Fuel #(…)				Total		
year/month	Consumption [kWh]	Consumption [TOE]	Share of Total Consumption [%]	Total Cost [TL]	Consumption [kWh]	Consumption [TOE]	Share of Total Consumption [%]	Total Cost [TL]	Consumption [kWh]	Consumption [TOE]	Total Cost [TL]
Year #1 total											
Year #2 total											
Year #3 total											
Total											

Insert a slice graph of the last table for easy reading of the total values.

f) Summary of recommended energy conservation measures (including cogeneration and renewables opportunities), annual energy savings and cost savings. There should always be four tables: i) base scenario, ii) deep renovation scenario, iii) recommended package and iv) measures that were studied but not taken into account. Refer to the Energy Efficiency Measures (EEM) chapter for scenario detail. The tables for all scenarios should follow this format:

No.	EEM	Estimated annual energy savings [TOE]	Estimated annual cost savings [TL]	Estimated implementation cost [TL]	Payback period [years]	IRR	NPV
1							
2							
(…)							
Total							

g) The EEMs that were studied but not proposed should be presented. The analysis for all the factors may not be detailed, but the reason for not being proposed has to be carefully explained. The table should follow this format:

No.	EEM	Estimated annual energy savings [TOE]	Estimated annual cost savings [TL]	Estimated implementation cost [TL]	Payback period [years]	Data based on the base or deep scenario	Comments
1							
2							
(…)							

h) Briefly present No Cost, Operations and Maintenance (O&M) or energy management opportunities, if any.

4. Energy Audit

In this chapter, there should be clearly stated all the information regarding the existing systems, from their basic characteristics to their energy consumption and their role in the energy profile of the installation.

4.1. Building Info

The building description must contain sufficient baseline details about the building (e.g., year built, number of remodels, type of construction), including measured and/or verified area.

a) General

Building layout (show sections and years if remodelled), general construction, types of spaces/general layout, floor area. Explain, if needed, the different areas used (e.g. net, built, etc.).

b) Envelope

Describe the components/layers of the envelope (construction materials used for the exterior walls, roof and basement), including insulation material and its thickness, R-values/U-values of the envelope, condition, wall/roof/floor areas, and presence of asbestos or other materials. Indicate if the U-Values of the envelope components are relevant for the TS 825 Building Insulation Code for the region of the building. A table for comparison can be given. Use TS 825 Local Building Insulation Code, when possible.

c) Windows

Glazing type, frame type, location and dimension (area) of each unique type, shading, orientation, operability, weather-stripping, and condition. Include U or R-values, approximate Solar Heat Gain Coefficient (SHGC), and window tint description. Note if specific windows are left open for purposes of ventilation or comfort issues. Indicate also areas per different glazing/construction solution. Indicate if the U-Values of the windows are relevant for the TS 825 Building Insulation Code for the region of the building. A table for comparison can be given. Use TS 825 Local Building Insulation Code, when possible.

d) Observable deficiencies

Indicate the existence of wall cracks, observable structural elements, leakages, mould or other observable building pathologies.

e) Other

Insert floor plans that include all buildings.
Pictures of major building elevations and exterior. Include additional photos and descriptive captions of all building elements, systems, or conditions that are related to the proposed EEMs (included in EEM Section or Appendix).

4.2. Building occupancy

Provide a brief narrative describing typical daily, weekly, and annual occupancy patterns. Be sure to note unusual patterns, weekend or summer occupancy, especially if they affect total or seasonal energy usage. This information is also useful when comparing to Heating, Ventilation, and Air Conditioning (HVAC) schedules and understanding opportunities or limitations for certain EEM savings. Use a table format like this:

Indicate Building/Area	Hours/day	Days/week	Annual hours	# during normal occupancy	% of the building used

4.3. Equipment Info

a) Description of systems or equipment audited, their capacities and ratings, design and operating conditions, equipment schedules, etc., including information such as the type of systems, controls, type and number of auxiliary equipment, etc. Performance of systems or equipment audited (e.g. COP or SEER).

b) The system descriptions must contain sufficient detail to understand the building's major energy-using systems, including HVAC, Domestic Hot Water, Lighting, Plug Loads, and Other.

The narrative should include explanations on the system type, age, nameplate capacity, condition, controls, the area served by each unit, operating schedules and sequence of operation/controls overview, current capabilities and limitations, and any significant known or suspected issues. This information should provide the necessary background to understand each EEM proposed.
Any equipment information (e.g., power, capacity, nameplate power, etc.) must be provided, as well as a citation of data sources (e.g., data logging, cut sheets, design drawings, engineering assessment, etc.) for each critical value and condition.
Summary findings from the equipment surveys should also be included in the narrative. The full equipment surveys must be included in the Appendix.
Include a description of any operation or conditions that are outside of recommended or standard ranges (e.g., excessive run times, over or under-lit areas, high or low setpoints, etc.).

1. HVAC

   Include a summary description of the HVAC system and HVAC zone(s) floor plan. Include a summary of the sequence of operations and fan schedules (detailed documents/tables to be included in the Appendix). Descriptions can be grouped into the following categories:

   a. Boiler and Chiller Plant

   Include a description of boiler and chiller plant(s), along with the distribution and condensate systems and cooling towers, where applicable. Describe the air handling or terminal units served by each plant and the zones they serve. Include equipment surveys in the Appendix.

   b. Airside and Other HVAC System Equipment

   Include a description of system equipment (e.g., furnaces, unit ventilators, radiators, heat recovery, etc.) and the zones they serve. Include equipment surveys in the Appendix.

   c. Packaged Units

   Include a description of packaged unit equipment (e.g., DX, Heat pumps, RTUs, etc.) and the zones they serve. Include equipment surveys in the Appendix.

   d. Building-Level HVAC Controls

   Individual equipment controls should be included with notations of the related equipment that they control. Building level/global controllers should be explained in the narrative. Include existing control configuration(s) and operating sequence(s).

2. Domestic Hot Water (DHW)

   Include a summary description of equipment, fuel type, capacity, the area served, and settings. This should include a description of tank and distribution, end-uses (e.g., showers for PE class and sports, kitchen, laundry, etc.). Note the major end-use fixture types (e.g., faucets, showers, dishwashers, etc.) and if any end-use equipment has unexpectedly high hot water usage or leaks. Include equipment survey in the Appendix.

3. Lighting (Interior and Exterior)

   Include a summary description of equipment, areas served, and controls. Include lighting survey in the Appendix.

4. Pumps and fans (electrical motors)

   Include a summary description of equipment if not addressed in the HVAC chapter. Include equipment surveys in the Appendix.

5. Plug loads and Other Equipment

   Only include data if it is relevant for the audit work. If so, include a summary description of the location, type, and quantity. Include equipment survey in the Appendix.

6. Mechanical systems Insulation

   Refer and describe all insulation used in mechanical systems.

c) Equipment info should include an explanation for the assumption of working hours.

d) It should also note any deficiencies with the current operations – under/overheating/cooling, unused equipment, broken/missing lights, equipment capacity too big/small.

4.4. Energy consumption data

4.4.1. Rates and providers

In this section should be stated the actual tariffs and utility providers for the facility. The cost should be separated between the fixed tariff (e.g. power) and the net energy (e.g. kWh) tariff.

		Year #1	Year #n
Electric Utility Provider	Type of tariff		
	TL/kWh		
	Yearly average spending		
Natural gas Provider	Type of tariff		
	TL/kWh		
	Yearly average spending		
Other energy Provider	Type of tariff		
	TL/kWh		
	Yearly average spending		

In the “Other Energy Provider”, all different types and amount of fuels have to be clearly specified.

If there are large differences between years (e.g. changes not explained by simple economic cycles), the Consultant must explain the possible reasons carefully. Ensure that units are correct.

4.4.2. Energy consumption Profile

This table has to be made with the actual energy and utility provider data and should reflect an overview of the total consumption and cost of energy on a yearly basis.

	Electricity				Fuel #(…)			
year/month	Maximum Demand [kW]	Consumption [kWh]	Consumption [TOE]	Total Cost [TL]	Maximum Demand [kW, m3, ton]	Consumption [kWh]	Consumptio] [TOE]	Total Cost [TL]
(January…December)								
Year #1 total								
(January…December)								
Year #2 total								
(January…December)								
Year #3 total								

Add a column for each different type of fuel.
The Time Period should include (if available) at least three years of consecutive monthly data and three-year average. Be sure to include all-electric/gas/fuel meters if there are more than one.

year/month	Consumption [TOE]	Ton CO_2	Total Cost [TL]	TOE/cost [TL]	CO_2/cost [TL]
Year #1 total					
Year #2 total					
Year #3 total					
Average					

The reports should offer some explanation for the presented data on energy use. For example: if gas use increases over 10%, or energy unit prices change significantly from year to year.
Year to year changes (from each of the previous energy consumption data) should be presented and add the narrative to explain fluctuations.

Primary Energy [ToE]	YY1-2	YY2-3	YYn-n+1
Variation change [%]			

4.4.3. Energy Consumption Graphs

Display three years of consumption data graph (time on the x-axis). If available, show monthly values for all three years. All electricity, natural gas, and other fuels used at the facility need to be graphed (each on the separate chart). The graph could be line or bar graphs or any form that visually shows patterns. It has to be properly scaled for relevant information.
Include a brief narrative describing seasonal utility usage patterns and anything that stands out (e.g.,

note and explain any anomalies, etc.). Explain any trends. As relevant, correlate with features that may drive consumption profiles (e.g., occupancy, use patterns, degree days, etc.), and introduce them in a secondary axis to each graph

5. Energy Efficiency Measures Detail

The EEMs list will be presented in scenarios tables. The tables should follow this format:

No.	EEM	Type of energy [eletrical, gas	Estimated annual energy	Estimated annual energy	% of total consumption [TOE] savings	Estimated annual cost savings [TL]	Emissions reducing [tCo2]	Estimated implementation cost [TL]	Payback period [years]	IRR	NPV
1											
2											
(…)											
Total											
Total Energy Savings [%]											

As indicated in the executive summary, three scenarios (along with three tables) will be presented:

a) Base scenario with measures that save a minimum of 20% and the average payback period as a bundle will not exceed 12 years.
b) Deep renovation scenario with measures that will have a minimum of 30% and the average payback period as a bundle will not exceed 20 years.
c) Recommended bundle of measures (this could be a selection of measures from the base scenario, a selection of measures from the deep renovation scenario, or a mix of measures from the base and deep renovation scenario).

Provide an extra line for each type of energy vector that is saved in each measure.
After the table section, provide a complete description of each EEM proposed. Describe how the system/operation would be made more efficient or how the new equipment would reduce energy use. The description must be sufficient to ensure facility staff understand how proposed EEM can be implemented or how this information will be used by an engineer/contractor for design and specification work.
If there are differences from the base scenario and the deep scenario for the same EEM, please describe the rationale (e.g. different savings values for the same piping insulation measure).
The EEM presentation and analysis are detailed in the Appendix sections (under “General notes regarding EEMs”).

6. Energy Management and no/low-cost opportunities

a) Energy Management or O&M Measures

Include any relevant operational or maintenance measures. Follow the same instructions and template used for EEMs. This section would also include any negative energy savings measure that may be necessary for the implementation of an EEM or needed to help meet a specific operation or maintenance requirement (e.g., increased ventilation or lighting levels).

b) Low and No-Cost EEMs

Include a list of any important Low or No-cost EEMs applicable to the facility.
Please include a brief note for any measures analysed, but not included in EEM section of the report. Also, explain if any measure was not analysed, but sections of the audit report may suggest a measure might be needed (e.g., uninsulated shell but payback would have been over 50 years).

7. Building Management Systems (BMS) and metering systems

Add BMS if needed in the EEM list. As a general rule present a monitoring system with central control in the deep renovation scenario if the facility can manage it and only recommend it if payback for this measure is less than 20 years.
Please note that basic building-level metering should be a mandatory measure in all scenarios if does not exists and if exists has to be described even if briefly in the systems description. The basic version should be aimed at primary level energy and to Install new or use existing base building-level energy meters, or submeters that can be aggregated to provide base building-level data representing total building energy consumption (electricity, natural gas, fuel oil, propane, etc.). Utility-owned meters capable of aggregating base building-level resource use are acceptable. The basic system can be standalone (e.g. without automated report capabilities or software aggregation).

8. On-site Generation and Renewable Energy Systems

Include data, on-site generation and RE systems. Some issues have to be addressed in the narrative, in text or table format: Total power, total production, installation summary description, connection point, if there is an off-site sale of energy (etc.).
Include some schematics (e.g. drawings for Photovoltaic (PV) panel installation site). Present in the Appendix calculation sheet for forecasted production.

9. Energy Performance Class (EKB)

The building energy class should be stated in a short table:

Current Energy Performance Class	Energy Performance class under Proposed Scenario

10. Energy Performance Contracting (EPC) methodology

For future reference, this chapter shows the approach to be used for EPC contracting. There should be a clear path and hard data for reference energy consumption data (baseline), reference conditions for measurement and verification (M&V) accordingly with International Performance Measurement and Verification Protocol (IPMVP) and a general description of what events will be accepted for baseline change.
The general information should be given in a table format:

Proposed EEM	M&V Option based on IPMVP	Correction Factor (%)	Sensitivity (%)

Proposed EEM	M&V Option based on IPMVP	Correction Factor (%)	Sensitivity (%)

Proposed EEM	Total Usage Area that Project will effect	Electricity Consumption	Natural Gas Consumption	Other Fuel (Please Specify) Consumption	Total Energy Consumption	Total Energy Consumption Cost	Reference O&M Cost	Total Emissions
	[m2]	[TOE/Year]	[TOE/Year]	[TOE/Year]	[TOE/Year]	[TL/Year]	[TL/Year]	[Ton CO2 Eq.]

11. Audit Appendixes

The report appendixes must contain useful information to understand the narrative of the EEMs choice, but also to keep all this information form the main body of the report, for simplicity of analysis. The appendixes can be the following:

a) General Information Appendixes

- Audit Team;
- References, Reference Values and Abbreviations;
- Equipment and their certifications used in Audit.

b) General Audit Appendixes

- Energy End-Use Calculations;
- Energy Modelling Documentation;
- Equipment Surveys;
- The sequence of Operation.

c) EEM Related Appendixes

- Cogen details;
- EEM Specific Requirements;
- EEM Energy Calculation;
- EEM Cost Estimation;
- EEM Cut Sheets.

d) Site Measurement Appendixes

- Onsite Visits and Monitoring;
- Data logging and Monitoring Results.

e) Administrative Appendixes

- Audit Team;
- References, Reference Values and Abbreviations;
- Measurement Equipment and certifications used in Audit.

12. General Information Appendixes

12.1. General Notes

General requirements are items that the energy Consultant must use based on the information gained during the audit. Energy Audit Reports must follow this template report:
Energy Efficiency Measures (EEMs) and Simple Payback (SP) Requirements.

a) All potential EEMs with a *likely* SP less than 20 years (or insulation measures with any SP) must be analysed.
b) All analysed EEMs must be included in the Energy Audit Report.
c) Alternate formats may be used only after requesting and receiving prior written approval. If used alternate formats must still include all Sections Headings and required information, be presented in a concise manner, and include all supporting data and documentation.

Energy Audit Reports must be complete and well written. The report should demonstrate sufficient clarity to persons possessing moderate facility knowledge and an average understanding of energy engineering principles. They must be consistent and accurate. Values and measurements for a specific item or usage should be consistent across the entire Energy Audit Report and all supporting documents, including spreadsheets, modelling files, and other related documents.
Information on data collection for the principal energy systems and end uses, should be presented if needed with on-field interviews:

a) What is, if any, the current metering setup;

b) Data source. Statement about which data was used and which was measured, and which was estimated;

c) Provide a complete description of existing conditions. Provide a summary of all related measured site data, including monitoring results, measurements, light levels, and other relevant information. Include sketches, photographs and expanded narrative for clarity where applicable or required.

12.2. Calculations and Energy Modelling Requirements

Calculations used in analyses must be supported with sufficient detail and include justification of all assumptions. Calculations completed in spreadsheets must not hide any cells or contain any data, formulas, or referenced cells that are not relevant to the particular audit.
Consultants must use industry-accepted calculation methods to predict achievable energy savings (e.g. ASHRAE Guideline 14, etc.). Calculation methods and assumptions must be clearly stated and supported. Accepted sources and citations may include metered data, peer-reviewed and industry-recognized white papers, energy clearinghouses, textbooks, and other similar sources. Use of such sources must be cited and clearly presented.

For modelling, use building annual energy or use hourly simulations of energy use by energy source suitable for determining both load analysis and the proposed energy use for each proposed EEM. The Energy Audit Report must clearly and separately list the baseline and proposed (post-EEM) parameters and inputs. All modelling inputs should reflect actual building characteristics and conditions as described in the Energy Audit Report.

12.3. Energy Modelling Documentation

If completing energy modelling using whole-building energy simulation computer programs, the Consultant must use annual energy use hourly simulations. Guidance and requirements for modelling done with annual energy use hourly simulations can be found in the ASHRAE 90.1-2016 Appendix G. The firm must include all of the following documentation in this Appendix:

a) Which modelling software and version was used;
b) How the model was calibrated to utility data to be within ± 10 per cent;
c) Key model inputs and outputs for each modelling run.

All inputs and outputs should match narrative and data presented in the Energy Audit Report (e.g., equipment survey, data logging results, building characteristics narrative, etc.).
It is still necessary to provide a summary of how the EEMs save energy along with the details as to how estimated energy savings were calculated. Energy auditing firms should fully understand the methodology behind any energy-savings calculations provided by the model, detail this methodology in the Energy Audit Report, and be able to explain the accuracy and reasonableness of any savings estimates.

12.4. Equipment Surveys

A simple template for an equipment survey has to be used for the survey. One example is below (chillers). Complete the tables and provide any additional information to document all equipment at the facility fully. Any necessary information or system characteristics that cannot be fully incorporated into the tables should be included in alternative tables and narrative within the report.

General Information								
Ref.	Area Served	Year	Manufacturer	Model	Capacity [kW]	Refrigerant	Type	Air or water-cooled

Ref.	Efficiency			Controls		
	COP 100% load	COP 50% load	Eurovent	supply setpoint	Return Setpoint	Recovery setpoint

Ref.	Measurements				
	Water supply temp	Water return temp	Intake power [kW]	Water flow [l/h]	Outside temperature

12.5. HVAC Controls

If applicable, provide a detailed narrative for building-level/global controllers. The narrative for controls should include:

a) Age and condition;
b) Type (electronic, pneumatic, combination);

c) Manufacturer and model number;
d) Areas and equipment controlled;
e) Control configuration and operating sequence;
f) Control capabilities and limitations (e.g. optimized start, web interface);
g) Maintenance or operational issues.

12.6. Equipment Survey: Domestic Hot Water

Provide a detailed narrative for Hot Water production and distribution systems and controls. Include a brief explanation of the end uses locations and needs in terms of power and temperature. The actual system behaviour should also be analysed from user feedback in terms of flow availability and temperature.

12.7. Equipment Survey: Lighting

Include all interior and exterior lighting showing specific locations by area, space, room number, or other individual space identification with the actual number and type of existing fixtures. Survey the building to determine connected interior and exterior lighting power and energy usage. Document existing lighting levels, lamp and ballast types, wattages, and controls. Use sampling if more efficient. Document the existence of any hazard's materials, including PCBs and mercury.
It is important to refer if the actual lighting levels are not satisfactory or if there are an important percentage of the lighting fixtures not working or disconnected from the occupants or facility manager feedback.

13. EEM Related Appendices

13.1. General notes regarding EEMs

a) EMMs scenarios

As already stated in the main template body, the EEMs list will be presented in scenarios tables.
The objective is to show the bundling effect of EEMs. The bundling scenario will be treated as one stand-alone EEM, with the totals being the cross-effect value from the whole bundling analysed together.
As guidance, the recommended package should not include i) measures with payback periods longer than 20 years and ii) measures with paybacks longer than the lifetime of the equipment. For the insulation and window/door upgrade, the preference is to recommend the deep insulation and window/door measure as long as the payback less than 20 years.
If no EEMs can match the conditions, the table will be empty.
If there are obvious problems for improved insulation application, the Consultant can skip the analysis stating the technical rationale in the narrative.
There should be different formatting (e.g., font colour) to highlight what insulation is added in the basic and deep renovation scenario compared to the existing situation.

b) EEM Description

Provide a complete description of each EEM proposed. Describe how the system/operation would be made more efficient or how the new equipment would reduce energy use. The description must be sufficient to ensure facility staff understand how proposed EEM can be implemented or how this information will be used by an engineer/contractor for design and specification work.
Recommendations must meet current code requirements and standard design recommendations:

1. Describe any repairs or operational changes required for the EEM to be effective. Outline how the implementation of EEM may impact operations and maintenance (O&M) procedures and cost, any

new operating skills required, recommended training & hiring, and any impact on existing equipment life;

2. Briefly describe any other impacts on occupant health, comfort or safety, as well as non-energy benefits, especially improvements to health, safety and environment, decreases in equipment run time, and maintenance labour hours. This should also include: Hazardous material disposal issues (e.g. PCB ballasts, asbestos) and ventilation and indoor air quality (IAQ) issues (e.g. new equipment may increase ventilation);
3. Commissioning Requirements. Include documents related to commissioning and scope of services in the Appendix;
4. The Systems/Equipment responsible for any meaningful consumption has to be addressed the EEM list to avoid having large consumption vectors without any intervention. If they are not addressed, the Consultant should briefly explain why.
5. A detailed explanation should also be given in the case that one particular equipment is not changed by not only more efficient but also for smaller capacity systems due to heat/cooling supply from trigeneration and reduced loads from insulation/window upgrade, for example

c) EEMs cross effect.

When considering multiple EEMs with interactive effects between measures, the order of analysis must start with load reduction measures and proceed with distribution systems and associated equipment efficiencies, and then plant and heat rejection systems.
For EEMs that involve system interactions within a single EEM (e.g. lighting retrofits that affect HVAC loads), those system interactions should be considered within that particular EEM analysis.
When analysing measures with interactive effects, including in the analysis:

1. Explanation of how EEMs interact with one another;
2. If and why savings from this EEM may be more or less effective depending on other EEMs;
3. Note if EEM is independent of all other EEMs in terms of savings or its practical application.
4. Interactions within lighting EEMs should be shown on the same row in the table (i.e., electrical savings entered as a positive value (net of cooling savings if any) and any non-electric heating should be entered as a negative value in appropriate heating fuel column. Assumptions on heating/lighting interactions (e.g. percentage of heat loss to conditioned space) should be explained in the EEM Section of the report.
5. If including mutually exclusive EEMs, list each as an individual row on the tables. Only one of the mutually exclusive EEMs should be included in the TOTAL EEM Energy Savings calculation (e.g. include only the recommended EEMs as to not “double count” measures in the total).

For each EEM, note if any significant variance in savings (+/- 20%) would occur if that measure is performed stand-alone, without the other proposed EEMs (for example, boiler replacement without other load reduction EEMs).

d) Cost-Benefit Analysis

Include a Cost-Benefit Analysis (e.g. payback, NPV and IRR) for each individual EEM and for the bundle total.

1. Energy Savings: Calculate estimated energy savings and energy cost savings associated with each proposed EEM. When estimating energy cost savings, use and display current energy prices and rates, or refer to the report.

2. Cost Estimates: Provide summary cost estimates in the table, with detailed cost estimates located in the Appendix.
3. O&M savings are included in the EEM cost and should be described in the EEM section.
4. There must exist a clear indication (on the table, on footnote etc.) of the reference prices used for energy.

13.2. Cogeneration/Trigeneration details

If cogeneration (or trigeneration) is evaluated as energy efficiency improvement, then natural gas increase and electricity reduction should be given in details in a table format.

Fuel Consumption at Full Load [kw]	Max.Electricity Generation [kWe]	Max. Heat Generation [kWt]	Annual Expected Electricity Generation [kWh]	Annual Expected Heat Generation [kWh]	Annual Operation and Maintenance Cost [TL]	Annual Fuel Cost [TL]	Total Electricity and Heat Savings [TL]	Investment Cost [TL]	Pay Back [Year]

13.3. Financial analysis and legal requirements

The discount rate for NPV calculations (USD based) is 5.5%.
The exchange rate to be used is 6 TL/USD.
The NPV analysis is made over 20 years.
For NPV calculations investment expenses should occur in Year 0 and the first annual energy cost savings should then be accounted for in Year 1. The re-investments should be accrued in the year they are expected to occur. The O&M and other recurring yearly costs should be stated when they occur at today's prices.
The average life span of the EEMs, is the following:

EEMs	Working life [years]
Building insulation	35
Building windows	35
LED Lighting fixtures	12
Controls (BMS. Lights etc.)	10
Distribution systems (air&water)	20
Solar PV	25
Chillers and boilers	20
Other heat generation devices	20

LED working life is based on 50 000 hours. The 12 years of working life assume roughly 4150 hours per year. If the usage is significantly different, please adjust the working life, based on the actual working life of the proposed LED.
If other values are used, or if there are systems not referred to in the table, please describe the rationale, as a footnote of the EEM table.
The energy cost should be kept constant.
If the NPV period analysis is larger than the EEMs useful life, some reinvesting funds have to be considered for the savings to be considered over the full NPV time analysis.

13.4. Lighting Measures (Interior and Exterior)

a) Provide a detailed lighting schedule showing specific locations (by area, space, room number, or other individual space identification) with the proposed number and type of new lamps, luminaires, ballasts and fixtures. Should be in table format.
b) When adding or upgrading lighting controls, detail the proposed operation scheme. Include the number, type, and location of new controls. Include explanation, assumptions, or data-logging to support any reductions in light levels or operating hours.
c) Recommend using sketches of new fixture layouts or controls to explain proposed measures.
d) Calculate the reductions in lighting energy and include any increases or decreases in other forms of energy use, such as increased heating, associated with installing the EEM.
e) For calculations, include all results, explain methodology and assumptions, and document all key input variables.
f) Use lighting simulation software (Dialux or equivalent) to verify the new fixture layout or fixture distribution. Verification must be used when minimum light levels and uniformity are a safety concern (e.g. parking lots, pedestrian areas, stairways, etc.).

13.5. EEM Investment Calculations

Include all supporting documentation for EEM Energy Calculations. Include key documents:

a) Materials & Equipment: Identify vendor and contact person who provided material and equipment estimates. Include dates and sources of information.
b) Labour: Must use prevailing wage rates. Include separate "Hours" and "$/Hour" rate. If vendor quotes are used, including dates and sources of information.
c) Itemize specific costs related to design and engineering, contractor overhead and profit, and contingency, if any. Document the source of estimates, amount, and a brief description that includes assumptions and data sources.
d) Disposal & Salvage: Indicate any required or expected disposal costs, including hazardous materials or abatement. Include any salvage value or possible reuse of materials. Document the source of estimates, amount, and a brief description that includes assumptions and data sources.
e) Commissioning: Include estimated commissioning cost for EEMs that require commissioning.
f) Add any additional explanation in the narrative below the table.

13.6. *EEM Cut Sheets*

Include all manufacturer or vendor cut sheets and performance data for recommended equipment and systems. Indicate or highlight key specifications (e.g., efficiency rating, wattage, size, etc.) used in developing the EEM and EEM savings.

14. Site Measurements Appendixes

14.1. Onsite Visits and Monitoring

a) For each visit, list:
   - Date,
   - Purpose;
   - Critical notes or findings.
b) For each dataset/parameter, list the following:
   - Dates (Installed and removed);
   - Logging period (if different):

- For instantaneous/point measurements: List date, time, location;
- Purpose and Measured Parameter(s);
- Placement (equipment, location, etc.);
- Quantity and type;
- Logging Interval(s).

c) Any issues or abnormalities that may have affected monitoring data.

14.2. Data Logging and Monitoring Results

Include a summary description of data logging and monitoring methodology. Include monitoring type (e.g., instantaneous, load profile, periodic total) and general approach. Trend data should indicate duration and intervals, with key monitoring graphs and charts included.
Must include all key results that support the assumptions and recommendations made in the Energy Audit Report.
All charts and graphs should include a brief explanation of results and significance to the Energy Audit Report findings. Include annotations to graphs and charts as needed to illustrate key points or explain anomalies.