Renewable Energy and Energy Efficiency for Sustainable Energy

Energy Audit Agreement

Co-Funded by the European Union
بتمويل مشترك من الاتحاد الأوروبي

ENERGY AUDIT AGREEMENT
FOR REESTART PROJECT
BETWEEN ICU AND THE ESCO

ACKNOWLEDGEMENTS

This document was prepared by REESTART Team in joint effort between ICU presented by Mr. Mohammad Ismail - REESTART project engineer; and LSES presented by Mr. Jean Paul Sfeir – REESTART technical advisor. REESTART Team would like to thank Mr. Mario Goraieb - REESTART project manager; and Mr. Walid El-Baba LSES president.

This Document has been produced with the financial assistance of the European Union. The contents of this documents are the sole responsibility of ICU and can under no circumstances be regarded as reflecting the position of the European Union.

For further information:
- Istituto per la Cooperazione Universitaria (ICU): www.icu.it
- REESTART Project: www.reestart.eu
- Lebanese Solar Energy Society (LSES): www.lses-lb.org

This Agreement can be downloaded from http://www.reestart.eu

REESTART PROJECT

REESTART (Renewable Energy and Energy Efficiency for Sustainable Energy Transition and Reinforced Trust) is a project co-funded by the European Union and is part of a wider programme aiming at "Promoting innovation and entrepreneurship in support of Lebanon's clean energy transition".

REESTART's main objective is to encourage the private sector, including Energy Services Companies (ESCOs), to invest in alternative sources of energy and energy savings in order to promote entrepreneurship, innovation and job creation in support of Lebanon's clean energy transition. This will be achieved through the launch of the following:

(1) Capacity Building Programmes dedicated to Energy companies in Lebanon
(2) Awareness Campaign for Lebanese Market
(3) Open Call and Selection of 35 SMEs
(4) Implementation and monitoring of 6 Pilot Projects based on ESCO business model

Lebanese ESCOs interested in being part of REESTART's Activities were called to submit their corresponding SME clients. The SMEs submitted were assessed and 35 SMEs were selected according to their:

a. Technical & Energy Saving Potential
b. Capacity and Financial Sustainability
c. Gender Diversity

Moreover, other selection criteria considered diversity of projects involving several factors including:

a. Sector of activity
b. Geographic location
c. Geographic market coverage
d. Company Size
e. Energy mix
f. Energy flow diversification
g. Potential for replicability

Following REESTART's Activities the Energy Company will be trained to perform the energy audit and the full elements of the ESCO model, through three main training modules:

(1) Energy Module; The energy company will be trained to perform the energy audit and implementation phase and then certified with the Energy management certification (CEM)
(2) Measurement and Verification Module; The energy company will be trained to measure and verify the energy savings and then certified with the measurement and verification certification (CMVP)

(3) Performance Contracting Module; The energy company will be trained to conduct the ESCO business model through the energy performance contract and then certified with the Performance Contracting certification (PCF)

The Certified Energy Company – ESCO in partnered with the selected SME will conduct a detailed Energy Audit to the facility according to the scope laid out in this Energy Audit Agreement. REESTART Project will support the conduct of the energy audit through partial subsidy by a maximum 50% of costs and up to a maximum amount of 5,000 € per audit paid directly to the ESCOs to remunerate its work.

6 pilot projects will be selected among those delivered in the 35 SMEs in order to implement the envisaged RE/EE installations and demonstrate the underlying ESCO Business Model, technology and process innovation. The intervention plans will be selected based on the following criteria:

(1) The green and efficiency impact of the proposed intervention, that shall bring at least 20% energy savings (kwh produced through RE instead of diesel generators, reduced kwh energy consumption) and 20% CO2 reduction;
(2) The innovation level of the proposed RE/EE measures; the baseline credit worthiness profile of both the ESCO and the SME;
(3) The soundness and financial viability of the EPC proposed by the ESCO (guaranteed costs savings; ROI and payback period, risks allocation);
(4) The SME plan to turn green (e.g. envisaged adoption of RE, waste management, reduced CO2) and improve its positive environmental/ social impact;
(5) Possibility to measure results achieved (in terms of energy/ costs saving, CO2 reduction, etc..) during the Action lifetime.

Priority is given to EPCs with intrinsic economic viability/sustainability (positive NPV, short term payback period, etc..), regardless of the partial action coverage, and to SMEs-ESCO couples that can co-finance a higher share of the investment.
Selection will be conducted so to ensure diversification of beneficiaries' ESCO and SMEs in terms of size, business sector, RE/EE technologies piloted, geographic zones. Selected pilot intervention plans will be deployed through: establishment and signature of the EPC between concerned ESCOs and SMEs; partial coverage of installation costs from the Action; installation and commissioning of RE/EE technologies; continuous monitoring of energy and costs saving by the ESCO to measure the achievements of targets identified in the EPC.
Involved ESCOs will receive technical advice in the definition of the EPC and underlying business/ revenue model. The Action will partially subsidize RE/EE installations by directly purchasing part of the equipment, thus lightening the effective investment that is required to ESCOs and/ or SMEs. The Action subsidy amount will be defined specifically for each SME – ESCO couple according to the overall intervention cost, their financial capability/ credit worthiness and availability of guarantee/ cash collateral.

In any case, the subsidy will cover up to 70% of the overall intervention costs and not be higher than 110,000 € per single project. It will take form of a matching capital to the investments made by ESCO.

ENERGY AUDIT AGREEMENT

This Document presents the Energy Audit Agreement between ICU and the Certified ESCO.

The Agreement defines the items in which the ESCO should accept and undertake in the process of the Energy Audit.

The Agreement includes Three Main Attachments;

1- **Attachment A. Scope of Work (SoW)**

Attachment A. Scope of Work (SoW) defines the mandatory requirements for the energy audit and project development proposal. It is presented as a simple chronological sequence, but this does not preclude repeated iterations of certain steps.

2- **Attachment B. Methodology of Work (MoW)**

Attachment B. Methodology of Work (MoW) details further analysis and considerations that the ESCO should take into account in order to enrich the energy audit report.

Details of Attachment B: Methodology of Work are not considered mandatory requirements for the energy audit approval, but nonetheless their inclusion is accounted for in the evaluation and selection of the pilot project.

3- **Attachment C. Notice of Acceptance of the Energy Audit Agreement**

Attachment C. Notice of Acceptance of the Energy Audit Agreement shows the SME's acceptance for the ESCO to perform all the items of the Scope of Work (SoW), as contemplated in the Energy Audit Agreement.

Contents

Energy Audit Agreement

1. Introduction

Party A: ICU "Istituto per la Cooperazione Universitaria Onlus" whose address is Baabda, Baabda Str. Hekmah Building 5th floor; Presented by REESTART Project Manager Mario Goraieb

Party B: The ESCO Name; whose address is ----------; Presented by Name

This document defines the Energy Audit and Project Development Proposal Agreement for the implementation and submission of an Energy Audit Report and a Project Development Proposal for the SME Name, SME address, all prepared, based on, and as defined by the Scope of Work ("SoW").

This Agreement is made and entered into as of Date, between Party A: ICU and Party B: ESCO Name.

W I T N E S S E T H

WHEREAS, This Agreement was created for use by REESTART Project to obtain an Energy Audit and Project Development for SMEs facilities from a private energy service company (ESCO).

WHEREAS, limited funds have been budgeted, appropriated and otherwise made available; a sufficient unencumbered balance thereof remains available for payment; and the required approval, clearance and coordination have been accomplished from and with Party A.

WHEREAS, Party B is a company with experience and technical and management capabilities to provide for the discovery, engineering, procurement, installation, financing, savings guarantee, maintenance and measurement and verification of energy, and operational saving measures at facilities similar in size, function and system type to Owner's facilities; and

WHEREAS, Party B has submitted a response to Party A's Request for SME-ESCO Partnership to implement an energy audit within the SMEs' facilities mentioned above; and

WHEREAS, SME Owner has selected Party B to provide the services described herein; and

WHEREAS, SME Owner desires to enter into a Contract to have Party B perform an Energy Audit and Project Development Proposal to determine the feasibility of entering into an **Energy**

Savings Performance Contract to provide for installation and implementation of energy, demand, and operational saving measures at Owner's facilities.

WHEREAS, if energy, demand, and operational saving measures are determined to be feasible, and if the amount of savings can be reasonably sufficient to cover all costs, associated with an Energy Savings Performance Contracting project, the parties intend to negotiate an Energy Savings Performance Contract under which Party B will design, procure, install, implement, maintain, and measure and verify savings from such energy, operating saving measures. However, this intent does not commit the SME Owner to entering into such an Energy Savings Performance Contract.

THEREFORE, the parties agree as follows:

Party B agrees to perform an Energy Audit in accordance with the **Attachment A. Scope of Work (SoW).** Party B agrees to complete the Energy Audit and Project Development Proposal and provides to Party A & SME Owner a final report within [Number of Days –120 days recommended depending on size and complexity of facilities] calendar days from the execution of this Agreement.

The SME Owner agrees to assist Party B in performing the Energy Audit in accordance with the **Scope of Work,** and agrees to work diligently to provide full and accurate information. The parties contemplate that this will be an interactive process and that the Owner will review and determine acceptance of the SoW through **Attachment C Notice of Acceptance of Energy Audit Agreement**.

Party B agrees to work diligently to assess the validity of information provided and to confirm or correct the information as needed.

2. Delivery Time

Within [Number of Days –120 days recommended depending on size and complexity of facilities] calendar days from the execution date of this Agreement, Party B must deliver the final version of the report.

After the designated delivery time, the report will be further examined by Party A. If deemed necessary, any required adjustments shall be done to the energy audit report by Party B within a period of time to be specified by Party A depending on the weight of the adjustment.

3. Compensation to ESCO

After Party A's Approval of the report's final version, Party A shall pay to Party B a sum of Five Thousand Euros (5,000 €) equivalent to 50% of the Audit cost. The remaining additional fees are to be compensated by the SME owner to the ESCO through the SME-ESCO partnership.

The SME Owner shall have no payment obligations under this Agreement.

4. Scope and Methodology of Work

The Energy Audit and Project Development Proposal shall be performed as described in the **Attachment A: Scope of Work (SoW).**

All items of Attachment A: Scope of Work are mandatory requirements for the energy audit.

Attachment B. Methodology of Work (MoW) details further analysis and considerations that the ESCO should take into account in order to enrich the energy audit report.

Details of **Attachment B: Methodology of Work** are not considered mandatory requirements for the energy audit approval, but nonetheless their inclusion is accounted for in the evaluation and selection of the **pilot project**.

5. Notice of Acceptance of Energy Audit Agreement

Attachment C. Notice of Acceptance of Energy Audit Agreement shall be signed by the SME owner prior to the signature of the two parties of this agreement.

6. Termination

6.1 Termination for Default/Cause

6.1.1 Default

If Party B refuses or fails to timely perform any of the provisions of this Agreement, with such diligence as will ensure its completion within the time specified in this Agreement, Party A may notify Party B in writing of the non-performance, and if not promptly corrected within the time specified, Party A may terminate Party B's right to proceed with the Agreement or such part of the SoW as to which there has been delay or a failure to properly perform. Party B shall continue the performance of the SoW to the extent it is not terminated and shall be liable for excess costs incurred in procuring similar goods or services.

6.1.2 ESCO's Duties

Notwithstanding termination of the Agreement and subject to any directions from Party A, the Party B shall take timely, reasonable and necessary action to protect and preserve property in his possession installed for the Energy Audit process at the SME's Faculties.

6.1.3 Excuse for Nonperformance or Delayed Performance

Party B shall not be in default by reason of any failure in performance of this SoW in accordance with its terms if such failure arises out of “force majeure” (e.g. acts of Nature; acts of the public enemy; acts of the Government and any Owneral entity in its sovereign or contractual capacity; fires; floods; epidemics; quarantine restrictions; strikes or other labor disputes; freight embargoes; or unusually severe weather). Upon request of Party B, the Party A shall ascertain the facts and extent of such failure, and, if such Party A determines that any failure to perform was occasioned by any one or more of the excusable causes of the “force majeure”, and that, but for the excusable cause, Party B's progress and performance would have met the terms of the SoW, the delivery schedule shall be revised accordingly.

6.1.4 Erroneous Termination for Default

If after notice of termination of the Party B's right to proceed under the provisions of this clause, it is determined for any reason that Party B was not in default under the provisions of this clause, or that the delay was excusable, the rights and obligations of the parties shall be the same as if the notice of termination had not been issued pursuant to the termination for convenience clause.

6.2 Termination for Convenience

6.2.1 Termination

The SME Owner may, when the interests of the SME Owner so require, and after consulting with Party A, provide a sufficient cause to terminate parts of the SoW, for the convenience of the SME Owner. The SME Owner shall give written notice of the termination to Party A and Party B specifying the part of the SoW terminated and when termination becomes effective. This in no way implies that the SME Owner has breached the Agreement by exercising the Termination for Convenience Clause.

6.2.2 ESCO's Obligations

Party B shall incur no further obligations in connection with the terminated work and on the date set in the notice of termination Party B will stop work to the extent specified. Party B shall also terminate outstanding orders and subcontracts as they relate to the terminated work. Party B shall settle the liabilities and claims arising out of the termination of subcontracts and orders connected with the terminated work.

6.2.3 Compensation

Party B’s compensation is contingent upon non-termination for convenience. Upon termination for convenience, Party A will take appropriate measures for compensation taking into consideration the weight of the terminated work, and the interest of Party A and Party B.

7. Energy Savings Performance Contract

The Parties and the SME intend to negotiate an Energy Savings Performance Contract under which Party B will design, install and implement energy and operating savings measures which the Parties have agreed to, and provide certain maintenance and monitoring services.

However, nothing in this Agreement and SoW should be interpreted as an obligation on any of the Parties and the SME to execute such a contract. The terms and provisions of such an Energy Savings Performance Contract will be set forth in a separate contract.

8. Extent of Agreement

8.1

This Agreement, with its attachments and annexes, represents the entire and integrated agreement between Party A and Party B and supersedes all prior negotiations, representations or agreements, either written or oral. This Agreement may be amended only by a written instrument signed by Party A.

8.2

The SME Owner and Party B understand and agree the attachments and exhibits hereto are and shall be an integral part of this Agreement and the terms and provisions thereof are hereby incorporated, made a part of and shall supplement those recited herein. In the event of any conflict, or variance, the terms and provisions of this printed Agreement shall supersede, govern and control.

9. Owner's Special Provisions

No Special Provisions were inserted.

Party A [ICU]

Presented by: _____

Title: _____

Signature: _____

Party B [ESCO Name]

Presented by: _____

Title: _____

Signature: _____

ATTACHMENT A. Scope of Work (SoW)

The purpose of this Scope of Work is to develop the Energy Audit to be implemented by the ESCO; deliver the Energy Audit Report and develop a project development proposal.

If any of the following services detailed below are not required for a given project, the ESCO and ICU may agree to modify the Scope of Work.

All items of Attachment A. Scope of Work are mandatory requirements for the energy audit.

I. Energy Audit and Report

1. Collecting Data

This will be an interactive approach in working with the SME Owner.

The SME Owner agrees to work diligently to furnish ESCO, upon request, accurate and complete data and information, as available. Owner will allow ESCO reasonable access to facility staff to ensure understanding of existing systems and opportunities. Owner may conduct the task to collect utility information from utilities in order to reduce ESCO time and expense.

The ESCO shall collect data and background information from the Owner concerning facility operation and energy use, including any changes to operation, energy use anticipated within the next 5 years. ESCO agrees to work diligently to assess validity of information provided and to confirm or correct the information as needed. Where information is not available from the Owner, ESCO will make a diligent effort to collect such information through the facility inspection, staff interviews, utility companies, and site measurement.

Further considerations and analysis on data collection are mentioned in Attachment B: MoW section 5.1.

The Information Requested is as follows:

1.1 General Facility Information

Collect General Facility Information (data and background information on buildings, equipment, energy use and costs, and facilities operation);

Collect the following information:

- Building list with square meters and age (including age of major remodels or additions)
- Construction data of buildings and major additions including building envelope, window specifications/performance and roof/wall assembly.
- General use of facility

For Additional Industrial data, refer to SoW section 4.

1.2 Equipment and Facility Information

- **Equipment Descriptions**: Descriptions of all major energy consuming or saving equipment;
    a. List of energy using systems, processes and equipment;
    b. Energy generation and supply methods;
    c. Energy carriers, present and available;
    d. Energy related data:
    d.1) Delivered, produced and exported energy, for each energy carrier (for example identify the energy streams for a CHP unit, or for photovoltaic systems where production is used locally or exported);
    d.2) Energy consumption data (or readings with related time and date) of any available meters or counters (e.g. heat meter, domestic hot water meter, fuel meter, burner hour counter);
    d.3) Data from individual metering, if available;
    d.4) Short-interval (e.g. hourly) energy demand / load curve, if available;
    d.5) Relevant related measurements;

- **Facility Descriptions**: Description of any structural or building use changes such as **Past Changes**:

    Record of any improvements or modifications related to energy or operational efficiencies that have been installed during the past three years. Information on important changes in the past 3 years or the period covered by the available operational data, concerning:
    a. the physical form of the building;
    b. the spaces – either in dimension and/or in use;
    c. the building envelope (renovation of windows, added insulation, etc.);
    d. the technical building systems and the areas they serve;
    e. the tenant arrangements;
    f. occupancy of spaces (different occupancy times, extended hours behaviour and internal loads);
    g. set points and occupant behaviour;

- **Future Plans:** Description of current or future plans regarding building or equipment modifications in the next 5 years.

- **Drawings and Specifications:** Drawings, as available (may include mechanical, plumbing, electrical, building automation and temperature controls, structural, architectural, modifications and remodels). Original construction submittals and factory data (specifications, pump curves, etc.), as available

For Additional Industrial data, refer to SoW section 4.

1.3 Review Historical Utility and Onsite Generation Data

Prior to the site visit, review monthly and annual utility data. The data shall include a minimum of 12 consecutive months, up to four consecutive years shall be used as available, aggregated for the whole building;

Historical Billing Data; The following data shall be reviewed:

- Years for which data are collected, indicating calendar year or beginning and ending months.
- Utility or other energy suppliers (electricity, natural gas, fuel oil, steam, chilled or hot water).
- Monthly and annual electricity use (kWh) and cost ($) for each year (total cost including taxes and fees).
- Actual or billed monthly peak electric demand (kW).
- Monthly and annual site fuel (or other energy source) use in their respective billing units, and cost ($). If fuel is delivered as a liquid or solid, estimate and report the annual amount used from actual delivered quantities or inventory change for each year.
- Peak or billed monthly fuel, steam, hot-water, or chilled water demand (in appropriate units), if reported, for each year.
- Onsite generation data (kWh).
- Annual EUI (MJ/m2·yr) and ECI ($/m2·yr)

1.4 Review Rate Structure

For each metered energy source, identify utility rate/tariff schedule elements, such as the following (if existent):

a. Time-of-use structure
b. Block structure
c. Number of accounts for each energy source (if any)
d. Basic service charge
e. Power factor charges
f. Consumption charges

Note 1: For each delivered energy source, including non-metered energy sources identify delivered fuel rate/tariff schedule, including taxes.

1.5 Operations Information

- Occupancy schedules
- Usage information
- Description of current energy management procedures
- Description of current operational practices
- Records of maintenance expenditures on energy using equipment, including service contracts

For Additional Industrial data, refer to SoW section 4.

1.6 Other relevant data

- Other relevant economic data;
- The status of the energy management system.

2. Facility Site Visits

Further considerations and analysis on facility site visits are mentioned in the Attachment B: MoW section 5.2.

2.1. Facility Site Survey

Accompanied by the building operator or maintenance staff member, a qualified energy auditor shall conduct a walk-through survey of the facility to become familiar with its construction, equipment, operation, and maintenance.
In visiting the building and systems, the energy auditor should gather suitable information to evaluate actual performance of the audited object and to assess feasibility of improvements.

Perform "late-night" surveys outside of normal business hours or on weekends to confirm building system and occupancy schedules, if deemed necessary.

2.2. Checklists - Annex C

Survey and examine all items and places in the Checklists of Annex C.
Annex C is to be filled and submitted with the Energy Audit Report.

2.3. Key operating parameters

The existing operating parameters for energy-using systems shall be determined in terms of the following.
The following key operating parameters are to be inspected and determined through the site visits:

a. Operations set points, or designation of manual order if applicable, including, but not limited to the following:
a.1. Space heating and cooling temperature set points
a.2. Space humidity set points
a.3. Space lighting levels
a.4. Economizer control parameters
a.5. Hot-water or steam supply set point controls
a.6. Chilled-water supply set point controls
a.7. Condenser water temperature set-point controls
a.8. Supply air temperature set-point controls
a.9. Service hot water (SHW)/domestic hot water (DHW) storage and delivery temperatures
a.10. Fan system flow controls (such as duct static pressure setpoint control)
a.11. Ventilation level controls (where present, such as CO2 controls)
a.12. Hydronic loop system flow set points
a.13. Heating and cooling systems enable conditions
a.14. Any other industrial systems setpoints

b. Operating schedules, including, but not limited to the following:
b.1. Major equipment operating schedules

b.2. Occupied or unoccupied hours in controlled zones
b.3. Space temperature set point schedules
b.4. Warm-up and cool-down periods
b.5. Unoccupied override conditions
b.6. Lighting occupancy schedules and controls
b.7. Industrial systems Operating Schedules

c. Equipment efficiencies (and the method for determining the efficiencies), including, but not limited to the following:

c.1. Steady-state combustion efficiency and overall/seasonal boiler efficiency
c.2. Cooling equipment efficiency
c.3. Heating/cooling distribution efficiency, including
    c.3.1. motor efficiencies and
    c.3.2. pump and fan efficiencies
c.4. Industrial equipment efficiencies

d. Qualitative assessment of the following:

d.1. Duct and/or piping leakage losses
d.2. Duct and/or piping insulation losses
d.3. Steam trap losses
d.4. Over Conditioning losses
d.5. Energy recovery efficiency
d.6. Transformer efficiency

Use data loggers and conduct interviews with facility operation and maintenance staff in determining the above parameters

For Industrial Parameters, refer to Section 4.

3. Analysis

Further considerations and methodology of analysis used in the energy audit are mentioned in the Attachment B: MoW section 5.3.

3.1 Inventory of Existing Systems and Equipment

Presented in detail through Excel format and appropriately inserted in the report.

3.1.1 Compile an inventory based on a physical inspection of the major electrical and mechanical systems at the Facility, including:

- Cooling systems and related equipment
- Heating and heat distribution systems
- Automatic temperature control systems and equipment
- Air distribution systems and equipment
- Outdoor ventilation systems and equipment
- Kitchen and associated dining room equipment, if applicable
- Exhaust systems and equipment
- Hot water systems
- Electric motors 5 HP and above, transmission and drive systems
- Interior and exterior lighting
- Laundry equipment, if applicable
- Other major energy using systems, if applicable
- Industrial systems

3.1.2 Address the following considerations:

- The loads, proper sizing, efficiencies or hours of operation for each system; (Where measurement costs, facility operating or climatic conditions necessitate, engineering estimates may be used, but for large fluctuating loads with high potential savings, appropriate measurements are required unless waived by the Customer).
- Current operating condition for each system;
- Remaining useful life of each system;
- Feasible replacement systems
- Hazardous materials and other environmental concerns

Use data loggers and conduct interviews with facility operation and maintenance staff regarding systems operation, occupancy patterns and problems with comfort levels or equipment reliability.

3.2 Establish Baseline and Energy Breakdown

Further considerations and methodology of analysis used in establishing the baseline and elaborations on the categories of the energy breakdown are mentioned in the Attachment B: MoW section 5.3.3.

3.2.1 Estimate Loads

- Estimate loads, usage and/or hours of operation for all major end uses of total facility consumption including: Space heating, Space cooling, Air distribution, Water distribution, SHW/DHW, Conveyance, Lighting, Plug loads, Process Loads (to be elaborated in section SoW section 4 - Industrial process), Refrigeration, Information Technology, Other.
- Where loading or usage are highly uncertain (including variable loads such as cooling), ESCO will use its best judgment, calculation, simulation, spot measurements or short-term monitoring. ESCO should not assume that equipment run hours equal the operating hours of the building(s) or facility staff estimates.

3.2.2 End-Use Breakdown

The energy use allocation shall be quantified for each end-use system and separated by energy source type in accordance with this section and reported in accordance with *Attachment B: MoW Section 5.3.2.2. End-Use Systems*

End-use system types shall be categorized as follows, as described in Attachment B: MoW Section *5.3.2.2*:

a. Space heating
b. Space cooling
c. Air distribution (fans)
d. Water distribution (pumps)
e. SHW/DHW
f. Conveyance
g. Lighting
h. Plug loads
i. Process loads (Industrial)
j. Refrigeration
k. Information technology
l. Other

"Process loads" are to be provided as specified in section 4, providing the industrial inventory and breakdown.

3.2.3 Estimate Baseline

- Examine utility bills for the past 48 months for electricity, gas, fuel, etc.
- Establish base year and/or baseline consumption
- Present base year and/or baseline consumption in terms of energy units (kWhth, Kwhe, kW), in terms of dollars, and in terms of dollars per square meters.
- Describe the process used to determine the base year and/or baseline consumption and demand (averaging, selecting the most representative contiguous 12 months, or sampling).
- Consult with facility personnel to account for any anomalous schedule or operating conditions on billings or equipment conditions that could skew the base year and/or baseline representation.
- ESCO will account for periods of time when equipment was broken, malfunctioning, or not operating in calculating the base year or baseline definition period.

3.2.4 Reconcile Estimates

- Reconcile annual end-use estimated consumption and demand with the annual base year consumption. The purpose of this is to place reasonable limits on potential savings.
- The "Others" category shall not be more than 5%.
- This reconciliation will place reasonable "real-world" limits on potential savings.

3.2.5 Baseline Adjustments

- Propose adjustments to the baseline for energy saving measures that will be implemented in the future.

4. Industrial Systems

4.1 General

This section is exclusive for the SMEs that require industrial process audits only.

Significant energy-efficiency improvement opportunities exist in the industrial sector, many of which are cost-effective.

The requirements of the Industrial audit are part of the full energy audit. The energy auditor shall extract additional requested data (Check Section 4.2 for Additional Requested General Data and 4.3 for equipment specific data), perform additional field work (Check Section 4.4), and analyze the collected data as specified in sections 4.5 and 4.6.

4.2 Additional Requested General Data

a) Processes related data:
a.1) Information on industrial systems (process/utilities)
a.2) Information on the manufacturing process: technical data on product and product quality
a.3) Current operating conditions (setpoints) for utility processes and manufacturing processes; special conditions and restrictions for the process and the environment (safety, pollution, Health, etc.);

The requested data can be based on PFDs, invoices, contracts, measurements, calculations, Basis of operating hours and installed capacity (technical characteristics), documents on operational procedures and maintenance, discussions with operating and maintenance personnel, etc.

b) Gather control strategies and review the BACS sequence of operations, control set points, and sequences.

4.3 Additional Requested SME and Equipment Specific Data

a) General information on corporate governance:

a.1) processed / manufactured products;
a.2) daily / annual production;
a.3) Name of the energy manager;
a.4) name of the person responsible for the transport;
a.5) hours of operation;

a.6) commissioning and shutdown processes;
a.7) Shift organization.

b) Energy sources:

b.1) List of energy sources for processes used on site;
b.2) Daily / monthly / annual consumption.

c) Energy management:

c.1) breakdown of energy consumption;
c.2) measurement, maintenance of measuring devices;
c.3) tariff;
c.4) invoice amounts (fuel, electricity, etc);
c.5) peak demand management;
c.6) Energy management and monitoring levels: which key figures, who is monitoring them?
c.7) operational board of directors;
c.8) Training of the workforce in the rational use of energy.

d) Internal Transport, handling of materials and products in the facility:

d.1) maintenance of planning and control book;
d.2) energy consumption;
d.3) Internal Transport routes, overhead traveling cranes, helpers, etc .;
d.4) Personnel transport at the industrial site (excluding the company's own Schedule).

e) Manufacturing process:

e.1) Description, make of equipment;

e.2) Type of operation:

e.2.1) drying;
e.2.2) heating, boiling, sterilizing, polymerizing, melting, etc .;
e.2.3) concentration;
e.2.4) thermal separation (distillation column, evaporator, etc.);
e.2.5) incineration;
e.2.6) assembly of components (soldering, welding, etc.);

e.3) Type of machines:

e.3.1) crucible furnace, vacuum furnace, hood furnace, Siemens-Martin furnace, etc .;
e.3.2) tunnel, shaft, drying tower, cylinder dryer, etc .;
e.3.3) incinerators, etc .;

e.4) built-in thermal power;

e.5) type of fluid (hot air, steam, hot water, etc.);

e.6) recyclable condensate;

e.7) Manufacturing capacities and output speeds (number of parts, square meters manufactured or kilograms, kilograms of evaporated water, etc. per unit of time);

e.8) Processing method: static, dynamic, batchwise;

e.9) processed products: input water content, composition;

e.10) Processing parameters: inlet temperatures of the fluids, heat cycle, application velocities and temperatures of the fluid, provided power densities, etc., setting;

e.11) control / regulation;

e.12) measurement;

e.13) number of hours of operation;

e.14) annual consumption;

e.15) process-specific consumption.

f) Boiler house:

f.1) Description of the system, the installed capacity and the operational requirements matched data;
f.2) number of boilers;
f.3) Description of the operating conditions (cascade control, backup, shutdown, Additions, etc.);
f.4) operating mode;
f.5) Generator: date of commissioning, output, make, type, fluid (hot water, steam, superheated water, thermal oil, air, etc.), number of operating hours, nominal flow rate, thermal insulation;
f.6) Control and measuring equipment (fuel, heat transfer medium, flue gases), number of operating hours, return of condensate, condensate separator;
f.7) Burner: nature of the fuels, age, type, performance;
f.8) presence and performance of heat exchangers, superheaters, preheaters, hot air generators;
f.9) Volume and temperature of the water storage tank feeding the boiler;
f.10) disposal of combustion products;
f.11) Supply circuits and additional accessories (circulation pump, fan, etc.);
f.12) general condition of the equipment: recent adjustments, upkeep, recent repairs and changes;
f.13) Water treatment (nature and characteristics of the water types, model and flow velocity, processing);
f.14) Measurement of atmospheric discharges and power measurements based on the control book of the boiler house or the regular test report;
f.15) readings (including accuracy class);
f.16) annual consumption and production level.

g) Heat exchange:

g.1) Description of the system, the installed capacity and the operational requirements matched data; heat transfer parameters;
g.2) supplied buildings and property areas, heated room content;
g.3) exchangers, mixing pumps;
g.4) Function (heating, cooling, etc.);
g.5) primary fluid / secondary fluid;

g.6) number of hours of operation;
g.7) annual consumption.

h) Distribution networks for liquids:

h.1) nature of the fluid;
h.2) type of network (above, channels, tunnel);
h.3) distribution method and network scheme;
h.4) characteristics (length, diameter, flow rates, pressure [low, medium, high], Temperatures, system for return transport;
h.5) return of condensate, condensate separator;
h.6) thermal insulation, thermal bridges;
h.7) number of hours of operation;
h.8) losses;
h.9) Network health and maintenance.

i) Other generators for mechanical, thermal or electrical energy:

i.1) Description of the system, the installed capacity and the operational requirements matched data;
i.2) Type and number of machines: turbines, diesel engines, combined heat and power, compressors;
i.3) Make, type, date of commissioning;
i.4) energy source (electricity, steam, oil, distillate, gas, renewable energy, etc.);
i.5) Features of the generator (rated power, rotor speed, work cycle, exhaust gas temperatures or Vapor pressure and temperature, etc.);
i.6) Characteristics of the driven machine: characteristics (pressure, fluidity or current, electrical voltage), operating mode (compressor, alternator);
i.7) control device;
i.8) measurement;
i.9) number of hours of operation;
i.10) general condition of equipment;
i.11) Annual heat consumption as well as the amount of mechanical and electrical generation.

j) Electrical distribution and equipment:

j.1) List of the main components of the equipment and their characteristics: transformers, low voltage consoles, capacitor bank, power plant (turbines, power generators), inverters, Networks, machines;
j.2) Drives with adjustable speeds;
j.3) workflow (for each major piece of equipment);
j.4) Annual consumption per position and area;
j.5) Regulation (for each major piece of equipment).

k) Cooling towers:

k.1) Description of the system, the installed capacity and the operational requirements matched data; heat transfer parameters;
k.2) Type and number of systems (air-cooled, water-cooled, evaporative-cooled);
k.3) heat capacity;
k.4) temperatures;
k.5) control;
k.6) measurement;
k.7) general condition of equipment and distribution network (system, pump);

k.8) number of hours of operation;
k.9) annual energy and water consumption.

l) Chillers:

l.1) Description of the system, the installed capacity and the operational requirements matched data;
l.2) Type and number of machines (absorption or compression-based cooling unit, compressor, Condenser, air cooler, heat pump);
l.3) power (cooling, electrical);
l.4) type of coolant;
l.5) Secondary coolant inlet / outlet temperatures;
l.6) control;
l.7) measurement;
l.8) general condition of equipment and distribution network (system, pump);
l.9) number of hours of operation;
l.10) Annual consumption.

m) Compressed air:

m.1) Description of the system, the installed capacity and the operational requirements matched data;
m.2) type and number of compressors;
m.3) pressure;
m.4) performance;
m.5) inlet / outlet temperature;
m.6) flow rate;
m.7) air production and quality;
m.8) operation;
m.9) annual consumption;
m.10) control;
m.11) general condition of equipment and network (insulation, leaks, flaps, etc.).

n) Vacuum system:

n.1) Description of the system, the installed capacity and the operational requirements matched data;
n.2) type and number of vacuum systems;
n.3) suction lift;
n.4) performance;
n.5) flow rate;
n.6) operation;
n.7) annual consumption;
n.8) control;
n.9) general condition of equipment and network (insulation, leaks, flaps, etc.).

o) Any other industrial equipment; relevant description and corresponding parameters.

4.4 Additional Field Work

Check the current operating conditions (setpoints) for utility processes and manufacturing processes as well as confirm the effect on energy use and consumption.

4.5 Industrial Systems Analysis

In an energy audit in Industries the auditor shall analyze the energy saving potential according to the scope and aim of the audit.

The Auditor must:

a) Calculate the actual, energy-related performance in relation to the determined optimal performance. Assess the energy requirements of utility processes and manufacturing processes;

b) Calculate the actual energy performance of the equipment (manufacture and use);

c) Calculate the actual amount of equipment and energy required for manufacture and utility compare;

d) Assess the optimal amount of energy and resources for the manufacturing process.

4.6 Industrial Systems Energy Breakdown

During this phase, the energy auditor shall establish the existing energy performance situation -energy baseline- of the audited industrial processes.

It shall include:

a) A breakdown of the energy consumption precisely by source;
  a.1) breakdown of the delivered energy by energy carrier in terms of consumption, cost and emissions in consistent units (e.g. pie-charts);
  a.1) breakdown the energy consumption exactly according to processes, resources, shell and other in absolute numbers and break down into uniform energy units;

b) Energy balance between energy consumption and energy losses based on appropriate Illustrate procedures;

Example: Theoretical material and energy balance, Sankey diagram, static computer simulation.

c) If possible, determine energy consumption without manufacturing or activities.

The calculated industrial Systems baseline is to be included in the main SME baseline and accounted for in the main Energy breakdown of section 3.2.2 under "i. Process loads".

5. Energy efficiency and Renewable energy opportunities

Further considerations and methodology of analysis used in calculating the energy efficiency and renewable energy opportunities are mentioned in the Attachment B: MoW section 5.3.4.

5.1 Assess Potential Measures:

5.1.1 Considerations: Consider the following for each system:

- Comfort and maintenance problems
- Energy use, loads, proper sizing, efficiencies and hours of operation
- How the measures work together (i.e. lighting upgrades can introduce less heat which requires less space cooling)
- Current operating condition
- Remaining useful life
- Feasibility of system replacement and replacement costs
- Hazardous materials and other environmental concerns
- Owner's future plans for equipment replacement or building renovations
- Facility operation and maintenance procedures that could be affected
- Capability to monitor equipment or system performance and verify savings
- Thermal and electrical loads, Electrical metering configuration (for RE integration)

5.1.2. Checklists - Annex D

Examine all items in the Checklists of Annex D, marking the selected measures.
Annex D is to be filled and submitted with the Energy Audit Report.

5.1.3 Primary Measures List; List all potential opportunities, whether cost-effective or not.

List potential energy saving and renewable energy opportunities for each system included in the facility site survey (Fill Annex C for inspecting items/ Fill Annex D for EE & RE measures). Conduct necessary calculations to estimate the range of savings and costs in order to help guide decisions on which measures should be pursued for full analysis.

Summarize the results in the primary measures list. The list of measures shall be completed or, at a minimum, reviewed by the qualified energy auditor, and the calculations shall be conducted or reviewed by the qualified energy auditor.

Energy efficiency and Renewable energy measures list required for the SME are presented -but not limited to- in Annex D; D.2 Primary Measures Checklist for more details.

Examine all items in the Checklists of Annex D, table D2.
Annex D, table D2 is to be filled and submitted with the Energy Audit Report.

5.1.4 Industrial Measures List;

Further considerations and methodology of analysis used in the assessment of the industrial measures are mentioned in the Attachment B: MoW section 5.3.4.3.

The list of energy-efficiency measures for cross-cutting technologies that can be further analyzed by energy auditors if applicable to the industrial plant being audited is presented below and in a form of a checklist in Annex D, table D3.

Examine all items in the Checklists of Annex D, table D3.
Annex D, table D3 is to be filled and submitted with the Energy Audit Report.

5.2. Calculate Energy Savings;

- Follow the methodology of Work section 5.3.4.1 or other nationally-recognized Standard following the engineering principle(s) identified for each retrofit option.
- Utilize assumptions, projections and baselines which best represent the true value of future energy or operational savings. Include accurate costs for each unit of savings at the time the audit is performed, documentation of material and labor cost savings, adjustments to the baseline to reflect current conditions at the facility, calculations which account for the interactive effects of the recommended measures.
- Use best judgment regarding the employment of instrumentation and recording durations so as to achieve an accurate and faithful characterization of energy use.
- Provide analysis methodology, supporting calculations and assumptions used to estimate savings, and relevant technical documents used.
- Manual calculations should disclose essential data, assumptions, formulas, etc. so that a reviewer could replicate the calculations based on the data provided
- For savings estimates use computer simulations when necessary.
- Provide detailed calculations for any rate savings proposals
- Provide detailed supporting calculations for any proposed maintenance savings
- Estimate any environmental costs or benefits of the proposed ECMs (e.g. disposal costs, avoided emissions, water conservation, etc.)
- Specify Facility operations and maintenance procedures which will be affected by the installation/implementation of the proposed ECMs;

5.3. Estimate EE and RE Costs

Estimate the total expected cost of implementation for each practical measure. Cost estimates shall include the following factors, as applicable:

a. Material costs
b. Labor costs
c. Profit
d. Sub-Contractor Cost (if existent)
e. Overhead costs
f. Yearly operation and maintenance costs

g. Any additional adjustments that significantly impact the cost estimate of the EEM

Provide estimates of monthly costs associated with sustaining the project performance including breakouts for maintenance fees, monitoring fees, and training fees.

5.4 Financial Analysis

Based on the existing energy performance situation of the audited object, the energy auditor shall identify energy efficiency improvement opportunities. Each measure shall be assessed for financial benefits separately.

The energy auditor shall evaluate the impact of each energy efficiency improvement opportunity on the existing energy performance situation based on:

a) The financial savings enabled by the energy efficiency and renewable energy measures;
b) The necessary investments; and periodic costs.
c) The return on investment (RoI), Simple payback, and any other economic criteria agreed with ICU of each practical measure based on the total expected costs;
d) The other possible non-energy gains (such as productivity or maintenance);
e) The comparison in terms of both cost and energy consumption between alternative energy efficiency and renewable energy measures;
f) Technical interactions between multiple actions.

6. Report

6.1 General

The report provides an engineering and economic basis for assessing the potential Energy Savings of the SME.

When reporting the results of the energy audit, the energy auditor shall:

a) Ensure that the energy audit requirements agreed with ICU & the SME have been met;
b) Check the quality of the report before submission to ICU;
c) Summarise relevant measurements made during the energy audit, commenting on:
  c.1) Consistency and quality of data;
  c.2) Rationale for the measurements and how they contribute to analysis;
  c.3) Difficulties encountered in data collection and field work;
d) State whether the results of the analysis are on the basis of calculations, simulations or estimates;
e) Summarise the analyses detailing any assumptions;
f) State the limits of accuracy of estimates of savings and costs;
g) Report the ranking of the energy efficiency and renewable energy opportunities.

6.2 Content of report

The exact content of the report shall be appropriate for the scope, aim and thoroughness of the energy audit.

The report of the energy audit shall contain:

a) Executive summary:
  a.1) ranking of energy efficiency and renewable energy opportunities;
  a.2) suggested implementation programme.

b) Background:
  b.1) general information of the audited organisation, energy auditor and contact information;
  b.2) context of the energy audit;
  b.3) description of audited object(s);
  b.4) relevant standards and regulations.

c) Overview:
  c.1) description of the facility, measures evaluated, analysis methodology, results;
  c.2) summary table presenting the cost and savings estimates for each measure and for the project as a whole.
  c.3) summary table of recommended energy saving measures (EE and RE), including total and itemization for each measure of total design and construction cost, annual maintenance costs, simple payback and equipment service life

d) Energy audit:

d.1) energy audit description, scope, timeframe and boundaries;
d.2) information on data collection;
i) metering setup (current situation);
ii) statement about which data was used (and which is measured and which is estimated);
iii) copy of key data used and calibration certificates where appropriate;
iv) Include energy bill analysis (for utility and other sources);
d.3) Audit on the mechanical and electrical systems (describing the existing situation);
d.4) analysis of energy consumption;
i) summary of annual energy use and costs by source and costs of existing or base year condition; ii) description of the existing facility, mechanical and electrical systems; load inventory; tables, figures; iii) end-use energy breakdown; tables, figures;
d.5) data on baseline analysis and how the baseline was computed
i) description and itemization of current billing rates, including schedules; summary for all energy bills;
ii) identification and definition of baseline and description of how established;
iii) provide detail on baseline adjustments, if any;
iv) Reconciliation of estimated end use consumption (breakdown) (i.e. lighting, cooling, heating, fans, plug loads, etc.) with baseline (include discussion of any unusual findings)
d.6) conclusions and recommendations

e) Energy efficiency and Renewable energy opportunities:

e.1) Description of each operational, energy saving measure; Written description:
i) existing conditions
ii) description of equipment to be installed and how it will function
iii) assumptions used in calculating savings and the resulting accuracy of the recommendations;
iv) detailed descriptions for each measure including analysis method, supporting calculations (submitted in appendices, excels), results, proposed equipment and implementation issues, including a discussion of facility operations and maintenance procedures that will be affected by installation/implementation.
v) discussion of the conclusions, observations and caveats regarding cost and savings calculations.

e.2) Savings calculations
i) baseline energy use and cost
ii) post-retrofit energy use and cost
iii) savings calculations including analysis methodology, supporting calculations and assumptions used.
iv) annual savings calculations. The cost savings for all energy saving measures must be estimated for each year.
v) percent cost-avoidance projected
vi) description and calculations for any proposed rate changes
vii) explanation of how savings interactions between retrofit options are accounted for in calculations.
viii) operation and maintenance savings, including detailed calculations and description. Ensure that maintenance savings are only applied in the applicable years and only during the lifetime of the particular equipment.
ix) if computer simulation is used, include a short description and state key input data and software used. If requested by ICU, access will be provided to the program and all assumptions and inputs used, and/or printouts shall be provided of all input files and important output files and included in the Energy Audit with documentation that explains how the final savings figures are derived from the simulation program output printouts
x) if manual calculations are employed, formulas, assumptions and key data shall be stated.

xi) Conclusions, observations, caveats

e.3) Cost estimate
i) a detailed narrative of the cost estimate, suitable for cost estimating. Level of detail to be provided should be consistent with the Pilot Project Work Plan later on. Include all anticipated costs associated with installation and implementation.
ii) Environmental costs or benefits (disposal, avoided emissions, handling of hazardous materials, etc.)
iii) Conclusions, observations, caveats

e.4) appropriate financial analysis;
e.5) summary description of measures, including estimated costs and savings for each as detailed above
e.6) potential interactions with other proposed recommendations;

f) Appendices complete appendices that document the data used to prepare the analysis. Describe how data were collected.

g) Conclusions.

II. Project Development Proposal

In addition to implementing the Energy Audit and presenting the Energy Audit Report; the ESCO shall prepare a Project Development Proposal suitable to be executed under the ESCO Business Model.

1. Requirements of the Project Development Proposal

This proposal shall include the following.

a) A list of the EE and RE measures that will be implemented under the ESCO Business Model. This may be all of the EE and RE measures proposed in the Audit report or part of them.

b) A cash flow schedule that will show all the financial assessments and calculations for the selected EE and RE measures. The financial assessment shall be done after taking into account the subsidy from ICU (up to 70% of the total invested cost with a maximum of 110,000 Euros). The cash flow schedule shall present at minimum the following assumptions and results:

- The total investment cost
- The return on investment (RoI)
- Internal Rate of Return
- Simple payback
- Net present value
- The contract duration
- The expected payment calculation method and values (Monthly fees, shared saving, guaranteed savings, energy selling through energy meters etc….)
- Any other economic criteria

c) A Financing plan that will clarify the following:
   - The expected subsidized amount by REESTART project (up to 70% of the total invested cost with a maximum of 110,000 Euros)
     The financing method for the non-subsidized part (ESCO own cash, bank loan, subcontractor /suppliers payment facilities, etc..).

d) A time schedule to include the following:
   - **Negotiation Period up to the Energy Performance Contract** (EPC) signature

- **Design and Procurement Phase** (for each selected EE and RE measure)

- **Installation Phase** (for each selected EE and RE measure)

- **Measurement and Verification Phase** (for each selected EE and RE measure): to be elaborated in section 2.
  The measurement and verification methods to be used for post-implementation assessment of the recommended opportunities, following the current version of the International Performance Measurement and Verification Protocol (IPMVP), explaining how savings from each measure is to be measured and verified (description of Option A, B, C, or D will be implemented for the measure).

- **The Operation and Maintenance Phase**:
  Define O&M and repair reporting requirements. Detailed verification activities and reporting responsibilities of the SME and contractor on operations and maintenance items. Define reporting schedule.

2. The Measurement & Verification plan

Provide a detailed description of the measurement and verification plan (following the (IPMVP) International Performance Measurement and Verification Protocol) and the approach employed for each selected EE & RE measure to demonstrate realized savings that are sustainable over the useful life of the EE & RE Measures. The plan shall include definitions of terminology and the methods and procedures for reconciling the verified savings to the guaranteed savings.

2.1. Tables - Annex E

Annex E is to be filled and submitted with the Energy Audit Report.

2.2. EE & RE Measures-Selected M&V Plan and Savings Calculation

2.2.1 Develop M&V section for each selected EE & RE measure

- Summarize the scope of work, location, and how cost savings are generated. Describe the source of all savings including energy, O&M, and other (if applicable).
- Specify the M&V guideline and option used from the International Performance Measurement and Verification Protocol (IPMVP).
- Provide an overview of M&V Activities for the selected EE & RE measures. Explain the intent of M&V plan, including what is being verified.
- Provide an overview of savings calculations methods for The EE & RE Measures. Provide a general description of analysis methods used for savings calculations.

2.2.2 Proposed Energy Savings description

- Provide description of analysis methodology used. Describe any data manipulation or analysis that was conducted prior to applying savings calculations.
- Detail all assumptions and sources of data, including all stipulated values used in calculations.
- Provide post-acceptance performance period energy and rate adjustment factors.
- Detail proposed savings for this energy conservation measure for the post-acceptance performance period. Include table - Proposed Annual Savings for Each EE & RE Measure found in Annex E

2.2.3 Operations and Maintenance Cost Savings

- Provide justification for O&M cost savings. Describe how savings are generated. Detail cost savings calculations.
- Provide post-acceptance performance period and other cost savings adjustment factors.

2.2.4 Details of other savings (if applicable)

- Provide justification for cost savings. Describe how savings are generated. Detail cost savings calculations.
- Provide post-acceptance performance period and other cost savings adjustment factors.

2.2.5 Post-Installation M&V Activities

- Describe the intent of post-installation verification activities, including what will be verified.

- Describe variables affecting post-installation energy use. Include variables such as weather, operating hours, set point changes, etc. Describe how each variable will be quantified, i.e., measurements, monitoring, assumptions, manufacturer data, maintenance logs, engineering resources, etc.
- Define key system performance factors characterizing the post-installation conditions such as lighting intensities, temperature set points, etc.
- Define requirements for Institution witnessing of measurements if different than whole project data requirements.
- Provide details of post-installation data to be collected, including: Parameters to be monitored, Details of equipment to be monitored (location, type, model, quantity, etc.), Sampling plan, including details of usage groups and sample sizes, Duration, frequency, interval, and seasonal or other requirements of measurements, Monitoring equipment to be used, Installation requirements for monitoring equipment, Calibration requirements/procedures, Expected accuracy of measurements/monitoring equipment, Quality control procedures to be used, Form of data to be collected (.xls, .cvs, etc.), Sample data collection forms (optional)
- Detail data analysis to be performed.

2.2.6 Post-Acceptance Performance Period Verification Activities

- Describe the intent of post-acceptance performance period verification activities – what will be verified.
- Provide detailed schedule of post-acceptance performance period verification activities and inspections.
- Define requirements for Institution witnessing of measurements if different than whole project data requirements.
- Provide details of post-acceptance performance period data to be collected, including: Parameters to be monitored, Details of equipment to be monitored (location, type, model, quantity, etc.), Sampling plan, including details of usage groups and sample sizes, Duration, frequency, interval, and seasonal or other requirements of measurements, Monitoring equipment to be used, Installation requirements for monitoring equipment, Calibration requirements/procedures, Expected accuracy of measurements/monitoring equipment, Quality control procedures to be used, Form of data to be collected (.xls, .cvs, etc.), Sample data collection forms (optional)
- Detail data analysis to be performed.

III. Final meeting

At the final meeting the ESCO energy auditor shall:

a) Hand over the report on the energy audit;
b) Present the results of the energy audit in a way that facilitates decision making by the organization;
c) Be able to explain the results.

The need for follow-up shall be discussed and concluded.

ATTACHMENT B. Methodology of Work (MoW)

This document provides further analysis, considerations, and methodology for the items mentioned in the SoW. It applies to all forms of establishments and organizations, all forms of energy and uses of energy, excluding individual private dwellings.

This details of this document are not considered mandatory requirements for the energy audit approval, but nonetheless their inclusion is accounted for in the evaluation and selection of the **pilot project**.

1. Introduction

An energy audit is an important step for an organization, whatever its size or type, wanting to improve its energy efficiency, reduce energy consumption and bring related environmental benefits.

This document provides additional attributes for a good quality energy audit. It states the considerations, analysis and the methodology for energy audits having the scope of work of attachment A.

It recognizes that there are differences in approach to energy auditing and seeks to harmonize common aspects of energy auditing in order to bring more clarity and transparency to the market for energy auditing services.

The energy audit process of the SoW is presented as a simple chronological sequence, but this does not preclude repeated iterations of certain steps.

An energy audit can help an organization to identify opportunities to improve energy efficiency. It can be part of a site wide energy management system.

2. Terms and Definitions

For the purposes of this document, the following terms and definitions apply. Unless defined otherwise, the below terms apply in the energy audits.

2.1. Energy audit
Systematic inspection and analysis of energy use and energy consumption of a site, building, system or organization with the objective of identifying energy flows and the potential for energy efficiency improvements and reporting them.

2.2. Energy auditor
Individual, group of people or body carrying out an energy audit

Note 1: In REESTART project, the selected Energy Company should inform ICU if they wish to perform the energy audit by subcontractors.

2.3. Adjustment factor
Quantifiable parameter affecting energy consumption
Example: Weather conditions, behaviour related parameters (indoor temperature, light level) working hours, production throughput, etc.

2.4. Audited object
Building, equipment, system, process, or service which is the subject of the energy audit

2.5. Organization
Person or body who owns, operates, uses or manages the audited object(s)

2.6. Energy consumption
Quantity of energy applied
[SOURCE: EN ISO 50001:2011, 3.7]

2.7. Energy efficiency
Ratio or other quantitative relationship between an output of performance, service, goods or energy, and an input of energy
Example: Conversion efficiency; energy required/energy used; output/input; theoretical energy used to operate/energy used to operate.

Note 1: Both input and output need to be clearly specified in quantity and quality, and be measurable
[SOURCE: EN ISO 50001:2011, 3.8]

2.8. Energy performance
Measurable results related to energy efficiency (3.7), energy consumption (3.6), and energy use (3.11).

Note 1: In the context of energy management systems, results can be measured against the organisation's energy policy, objectives, targets and other energy performance requirements.
Note 2: Energy performance is one component of the performance of the energy management system.
[SOURCE: EN ISO 50001:2011, 3.12]

2.9. Energy performance indicator
Quantitative value or measure of energy performance, as defined by the organisation

Note 1: Could be expressed as a simple metric, ratio or a more complex model.
[SOURCE: EN ISO 50001:2011, 3.13]

2.10. Energy efficiency improvement measure
Amount of saved energy determined by measuring and/or estimating consumption before and after implementation of one or more energy efficiency improvement measures, whilst ensuring normalisation for factors that affect energy consumption.

2.11. Energy use
Manner or kind of application of energy.

Example: Ventilation; lighting; heating; cooling; transportation; processes; production lines.
[SOURCE: EN ISO 50001:2011, 3.18]

2.12. Building
Construction as a whole, including its envelope and all technical building systems, manufacturing machinery & equipment for which energy may be used to condition the indoor climate, provide domestic hot water, illumination and other services, and for manufacturing processes related to the use of the building and the activities performed within the building

Note 1: The term can refer to the building as a whole or to parts thereof that have been designed or altered to be used separately.
Note 2: The building could include its site location and related external environment.

2.13. System boundary
Boundary that includes within it all areas associated with the audited object (both inside and outside the audited object) where energy is consumed or produced

Note 1: Inside the system boundary the system losses are taken into account explicitly, outside the system boundary they are taken into account in a conversion factor.

2.14. Energy need
Energy to be delivered to or extracted from a building in a defined time period by a technical system to provide a building service

2.15. Energy carrier
Substance or physical phenomenon that can be used directly or indirectly to be transformed into useful energy

Note 1: The default energy content of fuels is gross calorific value.

2.16. Delivered energy (final energy)
Energy, expressed per energy carrier, supplied to the technical building systems through the system boundary, to satisfy the uses taken into account or to produce electricity

Note 1: Delivered energy can be calculated for defined energy uses or it can be measured.
Note 2: Energy uses include heating, cooling, ventilation, domestic hot water, lighting, appliances, etc.

2.17. Produced energy
Heat or electricity generated within the system boundary

Note 1: Produced energy can be used within the system boundary or exported.

2.18. Exported energy
Energy, expressed for each energy carrier, delivered by the technical building systems through the system boundary and used outside the system boundary

Note 1: It can be specified by generation types (e.g. CHP, photovoltaic, etc) in order to apply different weighting factors.
Note 2: Exported energy can be calculated or it can be measured.
[SOURCE: CEN/TR 15615, 3.19]

2.19. Building services
The services provided by the technical building systems and by appliances to condition the indoor environment (thermal comfort, air quality, visual and acoustic quality) and other services related to the use of the building

2.20. Technical building system
Technical equipment for heating, cooling, ventilation, domestic hot water, lighting and on-site energy production

Note 1: A technical building system can refer to one or a combination of building services (e.g. heating system includes heating, domestic hot water system and controls).
Note 2: A technical building system is composed of different subsystems and includes controls.
Note 3: On-site energy production can include heat or electricity.
Note 4: Manufacturing processes are excluded from this definition and are to be treated as a separate system.

2.21. Production method
All steps necessary to manufacture a product or to provide a service.

Note 1: The manufacturing process can include safety and health facilities as well as pollution control facilities.

2.22. Utility
Energy sources necessary for manufacturing processes and auxiliary processes.
Example: Steam, hot water, compressed air, etc.

Note 1: A resource can be generated on site or off site, or by acquired from a third party.

2.23. Utility process
Set of utility equipment and distribution

Note 1: If the resource was acquired from a third party, the resource process exists only in the distribution.

2.24. Utility equipment
Equipment that is used to convert an energy carrier into a useful medium.
Example: Boilers, compressors, cooling towers, refrigerators, etc.

2.25. Distribution of resources
Transport system to transport a resource from the place of production to the place of use.
Example: Electric cables, pipes, etc.

2.26. Industrial location
Manufacturing processes and utility processes as well as organizational shell.

Note 1: That allowed processes of dealing with environmental pollution, energy recovery as well as with waste products.

2.27. Shell
Systems, including building structure, air treatment and handling methods, and lighting.

2.28. Energy source
All forms of energy available on the market

Example: Electricity, natural gas (including liquefied natural gas), liquefied petroleum gas, any fuel for heating and cooling (including district heating and cooling), HFO, hard coal and lignite, peat, transport fuel (but not aviation fuels and bunker oils for shipping) as well as biomass.

3. Energy Audit Process

3.1 General:

The energy audit process shall be:

a) Appropriate to the agreed scope;
b) Complete: in order to define the audited object and the organisation;
c) Representative: in order to collect reliable and relevant data;
d) Traceable: in order to trace the origin and processing of data;
e) Useful: in order to include a cost effectiveness analysis of the energy saving opportunities identified;
f) Verifiable: in order to allow the organisation to monitor the achievement of the targets of implemented energy efficiency improvement opportunities.

Note 1: When a sampling method is used, any selected sample of spaces, systems or equipment shall be representative of the whole building or of a group of buildings.

3.2 Performing an Energy Audit:

The Energy audit process consists of the following stages, as illustrated in Annex A:

a. ICU - ESCO Agreement
b. Start of the audit; opening meeting
c. Collecting data
d. Field work
e. Analysis
f. Report
g. Project Development Proposal
h. Final Meeting

4. Considerations on the Elements of the energy audit process

4.1. Collecting data

4.1.1. Information Request Considerations

The energy auditor shall, in cooperation with ICU and the SME, collect the items mentioned in the SoW section 1 - Collecting Data.

The following considerations apply to the SoW:

a. The frequency of the data should be appropriate to the scope of the energy audit.

b. Building energy audits typically deal with ***monthly*** consumption data.

c. The energy related data should be recorded by the building and control system if available.

d. Adjustment factors affecting energy consumption that the auditor may use with justification:
   d.1) climatic data (e.g. temperature, degree-days, hygrometry, lighting) from the local building automation and control system (BACS), if available;
   d.2) occupancy patterns;

Information for quantifying the adjustment factors affecting energy consumption should be recorded by the building control system if available (e.g. occupancy times, degree-hours etc).

e. Operational history and past events that could have affected energy consumption in the period covered by the data collected;

f. Information on variation in supply schemes (e.g. drop of EDL supply from 18 hours a day to 12 hours a day)

g. Detailed characteristics of the audited object(s) including known adjustment factors and how the organisation believes they influence energy consumption;

h. Energy audits or previous studies related to energy and energy efficiency;

4.1.2. Review of the available data

The energy auditor shall review the information collected and provided by the SME.
The energy auditor shall judge whether or not the information provided by the organization allows the energy audit process to continue and the agreed objectives to be achieved.
Where there is missing data the client will be given a choice to produce the missing data or accept that the auditor will have to make assumptions (that will be clearly detailed by the energy auditor).

The energy auditor shall inspect the systems and items present in the Scope of Work (SoW). Review monthly utility bills (electricity, gas, fuel, etc.) for opportunities to lower costs. Consider taking advantage of different utility rate classes, accounting for electric demand patterns and charges. Consider potential advantages and disadvantages of optional rates such as time-of-use and real-time pricing. Consider load-shifting opportunities to reduce demand charges. Consider potential benefits of account or meter consolidation when many accounts or meters are in use.
The energy auditor must ensure that the information provided and recorded is consistent and suitable. The energy auditor must assess whether the information provided is sufficient to meet the agreed upon objectives. If requested data is not available, the energy auditor must follow the procedure for collecting the necessary information (e.g. measurements, forecasts, modeling).

4.1.3. Preliminary data analysis

The energy auditor shall carry out an analysis of the data collected to:

a) Undertake a preliminary analysis of the audited object's energy balance on the basis of energy data;
b) Establish the relevant adjustment factors;
c) Establish the relevant energy performance indicators;
d) Evaluate the distribution of energy consumption (consumption breakdown) if possible, depending on the measured data available;
e) If there is sufficient information, establish an initial energy reference (energy baseline) to be used for quantifying the impacts of energy saving interventions;
f) Plan further data collection and measurement to be carried out during field work.

The energy auditor should develop a preliminary list of energy efficiency improvement opportunities.

4.2. Considerations on the Field work

4.2.1 Aim of field work

The energy auditor shall take in mind the following aim, considerations, and instructions:

a) Inspect the site against the data received;

b) Evaluate the energy use of the audit object(s);

c) Evaluate for each significant building service the actual and future level of service (e.g. temperature, humidity, illuminance level, etc.);

d) Interview the owner or operator and occupants to identify current space use, special problems (especially relating to thermal comfort or indoor air quality), and planned improvements (such as equipment and/or controls upgrades, envelope upgrades) of the facility.

e) Determine the history of all commissioning that has been performed on the building, changes made at the site, and whether any maintenance problems and/or practices or occupant behaviors affect energy efficiency or indoor environmental quality.

f) Check that the technical systems are adequate for the intended purpose, i.e. can deliver the required level of service;

g) Evaluate the performance of the technical systems, taking into account the generation, storage, distribution and emission system and control;

h) Understand the operating routines, user behaviour, and their impact on energy consumption and efficiency;

i) Look for energy efficiency improvement opportunities and related constraints and restrictions.
i.1) Identify Low-Cost and No-Cost Energy Efficiency Measure (EEM) Recommendations; to the facility or to O&M procedures. Estimate the approximate level of economic return from savings that will result.
i.2) Identify Potential EEM Capital Recommendations; Identify potential capital-expensed EEMs (items not normally within the O&M budget), including a preliminary qualitative estimate of the level (high, medium, or low) of potential costs and energy cost savings, based on the qualified energy auditor's field observations.

j) List areas and processes for which additional quantitative data is needed for later analysis.

4.2.2 Conduct

The energy auditor shall:

a) Ensure that measurements and observations are made in a reliable fashion and in situations which are representative of normal operation and, where relevant, under appropriate weather conditions; it is accepted that it may be beneficial to make observations and measurements outside normal working hours, during shut-down periods, or when no climatic load is expected;

b) Promptly inform ICU of any unexpected difficulties encountered during the work.

4.2.3 Site visits

The energy auditor shall ask the SME to:

a) Nominate one or more individuals to act as guide and escort for the energy auditor's personnel during site visits as required; these individuals shall have necessary competences and authority to carry out direct operations on processes and equipment if required;

b) Give the energy auditor access to drawings, manuals and other technical documentation relevant to the installation together with the results of any commissioning tests that have been carried out.

c) Arrange access (read only) to building automation and control system (BACS) and electronic data sources;

d) Provide authorized assistance for any tests and operations required in the energy audit, e.g. switching on or off systems and equipment;

e) Arrange access to the parts of the building which are defined as relevant for conducting the energy audit.

4.3. Analysis

4.3.1 Overview of the energy use in a building

The building energy audit may cover all or some of the technical building systems and energy flows depending on the agreed scope of the energy audit (detailed in the SoW).

Energy use in a building is linked to:
a) The supply of comfort services (e.g. heating, domestic hot water, ventilation, etc.);
b) The activities in the building and the use of appliances to support activities (e.g. household appliances, computers, office machines, etc.);
c) Other energy uses;

Energy supply chain is detailed as:
a) Energy needs;
b) Comfort services are determined by the energy balance of the building envelope, taking into account losses, gains and interaction with technical systems;
c) For other services are determined by appropriate balance or accounting procedure (e.g. number, power and utilization time of devices, appliances, etc.);
d) Delivered energy is converted and distributed by the technical systems to fulfill the needs;
e) Energy is delivered to the building by energy carriers.

Technical systems are usually analysed as consisting of the following subsystems:
a) Generation;
b) Storage, to decouple time of generation and use, and optimize sizing and power of generation plant;
c) Distribution;
d) Room equipment (such as heat emitters, cooling elements and lighting) and their control that takes into account transfer of energy from systems into the serviced space.

4.3.2. General Methodology

In an energy audit in buildings the auditor shall analyze the energy saving potential according to the scope of the audit (Check the SoW for the detailed list).

The analysis of the audit shall include:

a) For each building service a comparison of actual against appropriate level of service (such as indoor environmental criteria, etc). The level of service (e.g. temperature, quality of air, illuminance) shall not be compromised by any proposed energy saving measures. Legislative

compliance notwithstanding, the level of service may, however, be changed if agreed with the client (e.g. change of indoor temperature to reduce heating or cooling demands);

b) Evaluation of the actual performance of the technical systems against a suitable reference;

c) Evaluation of different energy sources and provided average cost per kWh or MJ for each;

d) Evaluation of the performance of the building envelope;

Note 1: Levels of insulation, thermal bridges, air tightness etc.

e) Evaluation of the energy performance of the whole building, taking into account the potential interaction between technical systems and the building envelope.

When considering improvements, the energy auditor shall:

a) Consider the interaction between the technical building systems, with the building envelope, external environment and the activities performed within the building. EN 15603:2008 allows the quantification of this interaction;

b) Take into account all possible impacts for all delivered energy for different time periods (e.g. occupied and unoccupied) and different seasons, that could lead to adverse situations regarding energy savings. (For example, replacement of lighting may decrease internal heat gains, thereby increasing heating loads and reducing cooling loads);

c) Evaluate potential impact that energy saving interventions will have on the existing energy performance indicators.

The energy audit should include a review of contracts for the supply of energy and the requirements for the inspection and maintenance of technical equipment in terms of impact on energy efficiency and the cost.

4.3.3. Baseline and Energy Breakdown Considerations and Methodology

During this phase, the energy auditor shall establish the existing energy performance situation -energy baseline- of the audited object.

a) The existing energy performance situation -energy baseline- becomes a reference against which improvements can be measured. It shall include:

- a.1) A breakdown of the energy consumption by use and source;
  - a.1.1) breakdown of the delivered energy by energy carrier in terms of consumption, cost and emissions in consistent units (e.g. pie-charts);
  - a.1.2) breakdown the energy end-use by service and other use in absolute or specific numbers and in consistent energy units (e.g. pie-charts);
- a.2) Energy flows and an energy balance of the audited object; if applied, inventory of installed onsite energy production and export to third parties, in absolute numbers.

a.3) Pattern of energy demand through time;
a.4) Relationships between energy consumption and adjustment factors;
a.5) One or more energy performance indicators suitable to evaluate the audited object.

The energy breakdown shall be representative of the energy input and energy use. Also, it shall be clear which energy flows are based on measurements and which on estimations/calculations.

The calculation of the energy performance indicators (specific energy use) or building specific baselines shall be included in the analysis as appropriate.

4.3.2.1. Building System End-Use Categories

The energy consumption of end-use systems shall be determined in accordance with this section. Each system or unit of equipment that uses energy shall be assigned to one or more of the end-use system types listed in this section without double counting the energy use of any system or subsystem.
Each system or equipment that uses energy shall be further identified with its energy sources by type.
End-use system types shall be categorized as follows, *as described in Section 5.3.2.2*

a. Space heating
b. Space cooling
c. Air distribution (fans)
d. Water distribution (pumps)
e. SHW/DHW
f. Conveyance
g. Lighting
h. Plug loads
i. Process loads
j. Refrigeration
k. Information technology
l. Other

4.3.2.2. End-Use Systems

For the purposes of energy use assessments, in accordance *with Section 5.3.2.1*, and reporting of end-use breakdown, in accordance *with Section 5.3.2*, the following end-use categories shall apply (each to include all energy sources used to provide the end use):

a. "Space heating" for heating conditioned areas, including reheat. Air-handling unit fans shall be categorized as air distribution.

b. "Space cooling" shall include refrigeration associated with cooling spaces (including terminal cooling and variable-refrigerant flow systems), chilled-water condenser fans, and cooling tower fans. Air-handling unit fans shall be categorized as air distribution.

c. "Air distribution" shall include fan operation for ventilation, supply air, return air, exhaust, hoods, powered variable air volume (VAV), and energy recovery ventilation (ERV)/heat recovery ventilation (HRV) or other HVAC equipment pertaining to air distribution.

d. "Water distribution" shall include pumps for chilled water, condenser water, heating hot water, condensate return, or SHW/DHW circulation, and water pressurization.

e. "SHW/DHW" shall include hot water used for hand washing, showering/bathing, dishwashing, cleaning, and laundry.

f. "Conveyance" shall include elevators, escalators, and automated people movers.

g. "Lighting" shall include all indoor and outdoor lighting (including for parking, garage, and other unenclosed areas) for area and task lighting, including refrigerated case lighting.

h. "Plug loads" shall include loads that are normally served through electrical receptacles but do not include either task lighting or equipment used for HVAC purposes. Plug loads shall include office equipment, audio and video equipment, personal computers, printers, and reprographic equipment and appliances.

i. "Process loads" shall include loads on the building resulting from the consumption or release of energy consumed in support of a manufacturing, industrial, or commercial processes (not including loads listed in other parts of this section, such as SHW/DHW, or loads resulting from conditioning spaces). Process loads may include, but are not limited to, compressed air, process conveyors, lab equipment, food processing, manufacturing tools, refrigeration that supports manufacturing, or other mentioned in the SoW.

j. "Refrigeration" shall include compressors, condenser fans, condenser water pumps, walk-in coolers, freezers, refrigerated cases (self-contained or remote), refrigerated storage, household refrigerators, and process cooling.

k. "Information technology" (IT) shall include all centralized equipment for data storage, processing, uninterruptible power supplies (UPS), power conditioning, and IT related temporary power and access but does not include personal or desktop computers or office equipment.

l. "Other" shall include miscellaneous loads not listed above, including, but not limited to, distribution transformer losses and pumps or motors that are not included in categories above.

m. Ventilation is not included as an end-use category in *Section 5.3.2.1*, to the extent that its associated energy is included as part of space heating, space cooling, and air distribution categories. However, because ventilation levels can be a major factor in thermal loads, ventilation, including mechanical ventilation and/or ventilation via natural draft infiltration or exfiltration, shall be separately described and assessed. This evaluation shall be based on observation of building details, equipment ratings and operations, and testing as deemed appropriate by the qualified energy auditor.

4.3.2.3 End-Use System; Energy Use Assessment Methodology

Analyze the energy using systems using one of the following methods. Fuel and electricity consumption units shall be expressed in energy consumption units at the site energy value (not adjusted for power

generation and distribution efficiency). End-use system energy consumption shall be determined in accordance with one or more (or a combination) of the following methods:

a. A calculated method that estimates energy use according to the size, load, method of control, and efficiency of equipment, and its operating hours. Assumptions used in this analysis must be the same as those used for calculations of energy and demand savings.

b. A building energy model. The same simulation must be used for calculation of energy and demand savings.

c. Based on submetered energy use in the building.

4.3.2.4 Energy Use Further Analysis

The energy audit in a building will necessarily include some modelling or calculations to determine the current energy use profile and the energy efficiency improvement opportunities. The energy modelling or calculation should be at a level appropriate to the scope and thoroughness of the energy audit (Detailed in the SoW).
The modelled energy use should ideally be checked for consistency with actual measured energy consumption.
The calculation shall ideally reflect actual values and conditions (use, occupancy, indoor temperatures, climate, etc), not standardized ones.
For comfort services, once the building model is established and validated against actual energy use, energy performance indicators such as specific energy consumption (kWh/m2. y), efficiencies of systems and subsystems, shall be compared to appropriate reference values to generate preliminary ideas for energy saving opportunities.
The identified energy efficiency improvement opportunities shall be ordered where appropriate in a defined sequence to optimize the energy savings. The sequence will depend on how each opportunity (or measure) may impact on the saving potential of each of the others.

4.3.3. Energy efficiency and renewable energy opportunities; Analysis and Methodology

4.3.3.1. Calculate Energy Savings Methodology

a. Energy Use Impacts: For each measure or group of measures, identify key energy uses that will be impacted by the improvement, by energy source type (electricity, gas, etc.).

b. Calculation Method: Select the methodology of calculation: stipulated values, engineering calculations, building energy model, simulations or other.

c. Evaluation of Individual Measures: Using a preliminary cost estimate, provide a separate calculation (or building energy model run) for each individual measure. Measures may be grouped, if desired, in consultation with the building owner to best suit the owner's criteria. Maintain a record of these individual measures and group calculations for inclusion in the audit report. (see section 5.3.4.2)

d. Interactive Effects: Analysis of measures and/or measure groups shall include interactive effects. Identify interactions between measures or groups of measures and account for the interactions between the measures.

e. Requirements for All Calculation Methods: The same energy analysis method shall be used for base case and proposed case calculations. Energy savings shall be calculated as the base-case energy use minus the proposed-case energy use. Assumptions shall be noted, and any change in assumptions between base-case and proposed-case calculations shall be documented. Energy savings by end use shall be compared to estimated values for the same end uses in the end-use breakdown (see SoW Section 3.2) and the total of all savings to total building energy use to ensure that calculated savings are reasonable.

Weather data used for energy savings calculations shall be long-term (minimum ten year) average data.

Equipment performance characteristics shall take into account part-load or seasonal efficiencies where applicable. Full-load efficiencies shall not be used to represent efficiency across all load conditions for equipment with varying part-load or seasonal efficiencies.

Equipment operating schedules and hours of operation shall be based on building operations. Runtime meters shall be used if schedules cannot be established by other means.

For each metered or delivered energy source, a marginal unit energy price shall be calculated. Energy cost savings shall be based on the marginal costs and demand charges. Use of average unit cost (blended rates) is prohibited. For seasonal or time-of-use rates, an algorithm shall be developed to reflect the actual rate. For real-time commodity pricing, a seasonal algorithm shall be developed based on historical data.

4.3.3.2. Evaluation of individual measures

Based on the existing energy performance situation of the audited object, the energy auditor shall identify energy efficiency improvement opportunities. Each measure shall be assessed for financial benefits separately.

a) The energy auditor shall evaluate the impact of each energy efficiency improvement opportunity on the existing energy performance situation based on:

a.1) The financial savings enabled by the energy efficiency improvement measures;

a.2) The necessary investments;

a.3) The return on investment (RoI), Simple payback, and any other economic criteria agreed with ICU of each practical measure based on the total expected costs;

a.4) The other possible non-energy gains (such as productivity or maintenance);

a.5) The comparison in terms of both cost and energy consumption between alternative energy efficiency improvement measures;

a.6) Technical interactions between multiple actions.

Energy saving actions shall be ranked upon the agreed criteria.

b) In those cases where it is appropriate to the agreed scope aim and thoroughness of the energy audit, the energy auditor shall complement these results with:

b.1) requirements for additional data;

b.2) the definition of need for further analysis.

c) The energy auditor shall:

c.1) Evaluate the reliability of data provided and highlight defaults or abnormalities;

c.2) Use transparent and technically appropriate calculation methods;

c.3) Document the methods used and any assumptions made.

c.4) Subject the results of the analysis to appropriate quality and validity checks

c.5) Consider any regulatory or other constraints of the potential energy efficiency improvement opportunities.

Note 1: See Informative Annex D: Energy efficiency improvement opportunities.

The energy auditor must be responsible for each proposed way to improve energy efficiency. Calculate the expected energy savings taking into account the appropriate adjustment factors (before and after the introduction of the energy efficiency improvements). The energy auditor must take a possible tariff change into account for the purpose of lower energy costs.

4.3.3.3 Categorization and ranking

The energy auditor shall categorize the energy improvement solutions into:

a) no cost (set-point and time schedule adjustment, switching off lights, closing doors, etc.);

b) low cost (adding or improving controls, etc.);

c) high cost investments (thermal insulation of building envelope, major technical system modifications, renewable energy, CHP, etc).

In energy audits in buildings it is usual to rank the energy efficiency improvement opportunities by simple payback time but this does not exclude the use of other financial metrics.

The energy savings interventions should be ranked in order of an appropriate financial metric. In order of most informative (and complexity) these include:

a) Internal Rate of Return;
b) Net Present Value;
c) Simple Payback;

4.3.3.4. Specific Industrial Process Considerations

This section is exclusive for the SMEs that require industrial process audit only. The SoW of the respective SME will specify the inclusion of this section.

There are various energy systems that can be found in almost all industrial plants such as motor systems, steam systems, compressed-air systems, pumps, and fan systems. These are so-called “cross-cutting” technologies. In addition, each industrial sub-sector has its own unique production technologies and processes. Energy-efficiency improvement opportunities can be found in both cross-cutting as well as industry-specific areas. Since there are many industrial sectors with numerous types of technologies and machinery, it is beyond the scope of this SoW to discuss in detail the energy-efficiency opportunities for each technology, system, or industry.

The list of energy-efficiency measures for cross-cutting technologies that can be further analyzed by energy auditors if applicable to the industrial plant being audited is presented in the SoW Section 5.1.4

Check the specific SoW for the corresponding SME for details on the EE measures required to be added to the energy audit report.

Detailed explanation of specific energy-efficiency measures can be found in the below references for each section. For further details on the below see:

LBNL-3991E: Industrial Energy Audit Guidebook: Guidelines for Conducting an Energy Audit in Industrial Facilities in addition to ***Worrell et al. (2010)***

Finally, it is mentioned in the above references given; additional references for the publications are provided on sector-specific energy-efficiency measures for various industrial sectors so that they can be used by energy auditors to go beyond the cross-cutting technologies and identify the energy saving opportunity in the process. The cross-cutting technologies are the following:

a. Electrical Motors
b. Compressed Air Systems
c. Pumping Systems
d. Fan Systems
e. Steam Systems
f. Process heating systems

4.3.4. Operations and Maintenance (O&M) problems and needs

As identified, report operating problems, malfunctioning equipment, maintenance costs, and maintenance needs, including revisions to O&M procedures pertaining to major energy-using systems.
If, during this investigation, health or safety issues are observed or are identified by site staff, those issues shall be reported by the qualified energy auditor. Determine whether any maintenance issues or practices affect energy efficiency. Review potential sources for funding to determine what funds are available for O&M expenditures and for capital expenditures.

Bibliography

General standards and Guidebooks

- ISO 50002:2011, Energy audits — Requirements with guidance for use
- EN 16247:2012 - 1, General Requirements
- EN 16247:2012 - 2, Building Audits
- EN 16247:2012 - 3, Industrial Audits
- ISO 80000-1, Quantities and units — Part 1: General
- IEC 60027 (all parts), Letter symbols to be used in electrical technology
- ANSI/ASHRAE/ACCA Standard 211:2018, Standard for Commercial Building Energy Audits
- LBNL-3991E, Industrial Energy Audit Guidebook

Energy management standards

- EN ISO 50001:2011, Energy management systems — Requirements with guidance for use (ISO 50001)
- EN 15900, Energy efficiency services — Definitions and requirements
- CEN/CLC/TR 16103, Energy management and energy efficiency — Glossary of terms

Specific standards

General

- UNE 216501, Energy audit — Requirements (October 2009)

Buildings

- CEN/TR 15615:2008, Explanation of the general relationship between various European standards and the Energy Performance of Buildings Directive (EPBD) Directive — Umbrella Document (Annex C – definitions)
- EN 15378, Heating systems in buildings — Inspection of boilers and heating systems
- EN 15459, Energy performance of buildings — Economic evaluation procedure for energy systems in buildings
- EN 15232, Energy performance of buildings — Impact of Building Automation, Controls and Building

Management

- EN ISO 13790:2008, Energy performance of buildings — Calculation of energy use for space heating and cooling (ISO 13790)
- EN 15316 (all parts), Heating systems in buildings — Method for calculation of system energy requirements and system efficiencies
- EN 15217, Energy performance of buildings — Methods for expressing energy performance and for energy certification of buildings
- EN 15265, Energy performance of buildings — Calculation of energy needs for space heating and cooling using dynamic methods — General criteria and validation procedures
- EN 15603, Energy performance of buildings — Overall energy use and definition of energy ratings
- NF P03-310, Thermal analysis and energy balances for new housing

ATTACHMENT C. Notice of Acceptance of Energy Audit Agreement

Date of Notice

_____

Notice is hereby given that the SME accepts the ESCO to perform all the items of the Scope of Work (SoW), as contemplated in **the Energy Audit Agreement.**

Institution Name

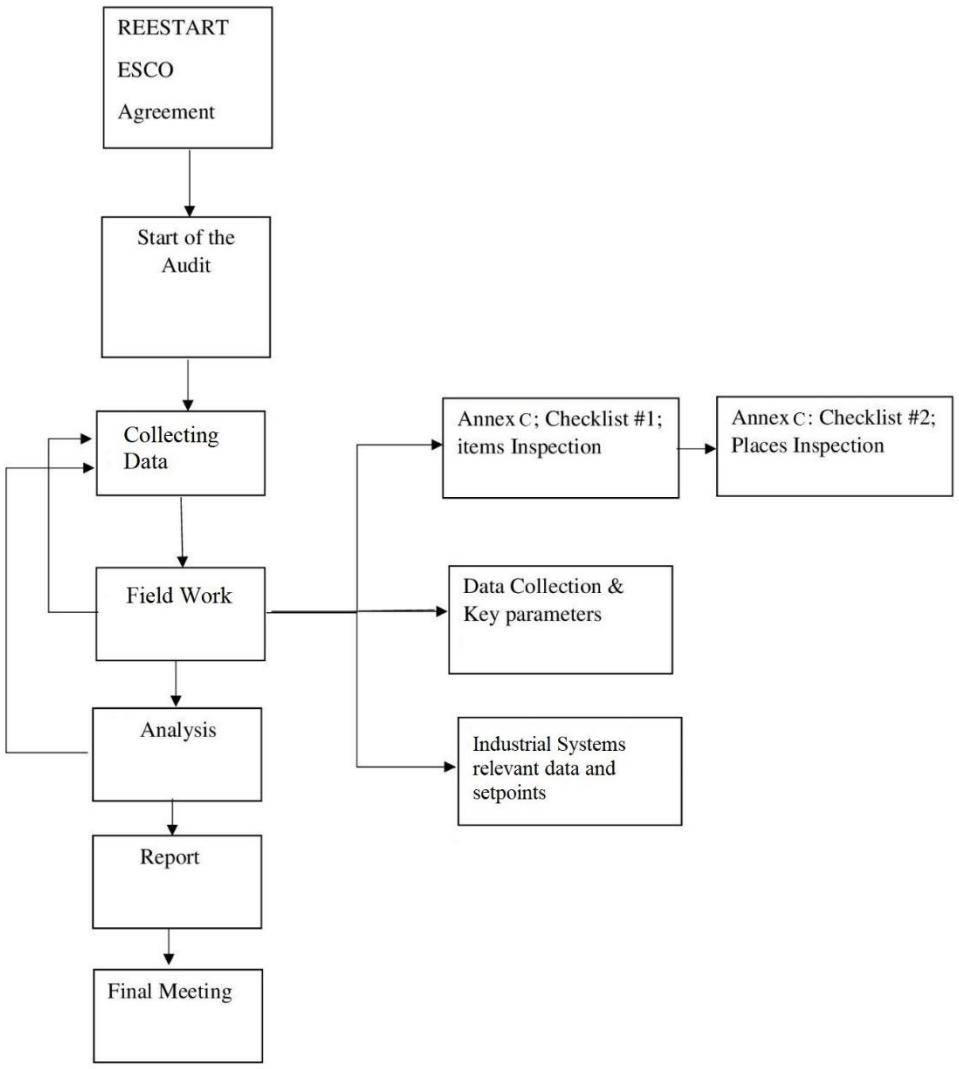
By _____

Date _____

When completely executed, this form is to be sent by certified mail to ICU and ESCO by Institution Name.

ANNEX A. Energy Audit Process Flow Diagram

The main steps of the energy audit process are shown below.



ANNEX B. Energy Performance Indicators

B1. General

Indicator reference values may include, as available:

a) Legal requirement for new buildings;

b) Legal requirement for renovations;

c) Best available technology;

d) Typical (statistical) values for existing or new buildings.

B2. Global Indicators

Yearly energy indicators:

a) kWh/(m2·year) or kWh/(m3·year) for heating, cooling, domestic hot water, ventilation, electricity and combinations thereof;

b) kWh/(m2·K·day) for heating;

c) kWh/m3 for domestic hot water;

d) kWh/(person.y), kWh/patient-day, etc.

e) Kwh/unit of production

Similar indicators can be used based on CO2 or costs.

B3. Detailed Indicators

Indicators for:

a) U-value of structures (may include the effect of thermal bridges);

b) kWh/m3 auxiliary energy for ventilation;

c) efficiencies of systems and subsystems;

d) expenditure factors of systems and subsystems.

ANNEX C. Checklists for Energy Audit Field Work

C.1 General

In visiting the building and systems, the energy auditor should gather suitable information to evaluate actual performance of the audited object and to assess feasibility of improvements.

C.2 Checklist #1: Items Inspection

Main Item	Sub-items to Inspect	Check
The Building Envelope	Heating related properties	●
	Permeability	●
	Cooling related properties	●
	Daylighting related properties including glazing type	●
The heating system(s) and control	Room equipment	●
	Distribution	●
	Generation and thermal storage	●
The domestic hot water system(s) and control	Fixtures	●
	Distribution	●
	Storage	●
	Generation and thermal storage	●

The cooling system(s) and control	Room equipment	●
	Distribution	●
	Generation and thermal storage	●
The ventilation and air conditioning system and control	Room equipment	●
	Air-handling units	●
	Heat recovery	●
The lighting system and control		●
Domestic appliances		●

Office appliances		●
Other appliances (e.g. medical)		●
Internal transport systems	Elevators, escalators, moving walkways	●
Freeze-protection systems and control	Heated areas, trace heating	●
Electric energy distribution	Transformers, UPS, reactive power correction	●
Other utilities	Steam, compressed air, medical gases	●
The building automation and control system (BACS)		●
Other energy using systems	Swimming pools	●

➔ Renewable Energy Systems are to be inspected if available

C.3. Checklist #2: Places Inspection

Main Item	Places to be visited	Check
The Building Envelope	Roof	●
	Walls	●
	Windows	●
	Basement	●
The heating system(s) and control	Boiler room	●
	Heat distribution rooms	●
	Distribution manifolds and channels	●
The domestic hot water system(s) and control	Boiler room	●
	Storage	●
	Individual domestic	●
The cooling system(s) and control	Chiller room or the roof where cooling equipment is located	●
The ventilation and air conditioning system and control	Mechanical rooms where air handling units are located	●
	Technical spaces	●
The lighting system and control	Sample rooms, by usage	●
	Common areas	●
	External illuminated areas	●
Domestic appliances	Sample residential dwellings	●

Office appliances	Sample rooms, by usage	●
	Data centers	●
Other appliances (e.g. medical)		●
Internal transport systems	Elevators, escalators, moving walkways	●
Freeze-protection systems and control	Power distribution panels	●
	Protected areas	●
	Heated areas, trace heating,..	●
Electric energy distribution	Transformer room	●
	power distribution rooms	●
	UPS room	●
Other utilities	Steam generation plant	●
	Steam distribution headers	●
	Condensate collection tanks and pumps Compressors room	●
	Compressed air headers and drains	●
	Swimming pool plant	●
	Other service production rooms	●
	Other distribution	●

The building automation and control system (BACS)	Electronic access	●
Other energy using systems	Swimming pools	●

ANNEX D. Analysis Checklist for Energy Audit

D.1 General

The following checklist includes aspects that can be considered in looking for energy saving opportunities. It is not exhaustive and the auditor should work on a case by case basis. Similar information may be found for heating, cooling and ventilation systems also in:

EN 15378:2007 — Annex E;

EN 15239:2007 — Annexes I and J;

EN 15240:2007 — Annex H;

EN 15232:2012 — Clause 5, Table 2.

D.2 Primary Measures Checklist

Main Item	Typical Energy Saving Measures	Check
Renewable Energy	Solar Photovoltaics (PV)	●
	Solar Water Heating (SWH)	●
	Biomass	●
	Biogas	●
	Wind	●
	Hydro	●
	Geothermal	●
The Building Envelope	Improving U-values	●
	Improving air tightness	●

	Reducing thermal bridges	●
	Improving solar shading (cooling load reduction)	●
	Adjustable solar shading adoption (to adapt for different seasonal heating/cooling/lighting balance)	●
The heating system(s) and control		
Room equipment	Single room control available?	●
	Zoning according to use (implies distribution modifications).	●
	Avoid stratification in high ceiling rooms	●
	Avoid summer time heating	●
	Avoid simultaneous heating and cooling of the same space	●
		●
Distribution	Zoning (is it possible to improve control with appropriate zoning?)	●
	Layout and location (external, unheated, heated…)	●
	Control mode (constant flow/variable flow) and temperature regime	●
	Pumping energy optimisation	●
	Piping insulation (type, thickness)	●
Storage (if any)	Dimensions	●
	Insulation	●
	Temperature regime	●

	Location	●
Generation	select generator type according to available energy	●
	carrier and distribution temperature requirement	●
	combustion or conversion efficiency improvement	●
	temperature control of generation	●
	appropriate capacity control	●
The domestic hot water system(s) and control	faucets and water flows (reduce needs)	●
	distribution: appropriate insulation	●
	temperature regime of storage and distribution ring	●
	generation source: generator type selection, thermal solar integration	●
	local generation for small loads	●
The cooling system(s) and control		
Room Equipment	Avoid simultaneous heating and cooling of the same space	●
	Suggest proper settings	●
	Introduce timing control or occupancy driven control	●
Distribution	Pumping auxiliary energy demand	●

	Control of temperatures: avoid mixing	●
Generation	Chilled water / cooling production	●
	Winter time cooling / free cooling	●
	Temperature control of generation	●
	Appropriate capacity control	●
Heat Rejection	Condenser water temperature	●
	Fan and pump energy	●
The ventilation and air conditioning system and control	Air flows	●
	Operation schedules/ventilation needs/demand based	●
	Ventilation	●
	Air flow and temperature control	●
	Heat recovery	●
	Efficiency of heat recovery	●
	Fan electricity	●
The lighting system and control	Lamp types change to higher efficiency (lumen/W)	●
	Lighting levels (lux / W/m2)	●
	Lighting control / schedules	●

	Daylighting	●
Domestic appliances	Energy efficient equipment	●
	Stand-by mode	●
	Appropriate use	●
Office appliances	Energy efficient equipment	●
	Stand-by mode	●
	Appropriate use	●
Other appliances (e.g. medical, ...)	Energy efficient equipment	●
	Stand-by mode	●
	Appropriate use	●
Internal transport systems	Energy efficient equipment	●
	Demand-based operation	●
Freeze-protection systems and control	Temperature setpoints	●
	Avoid unnecessary heating	●
Electric energy distribution	Transformer losses	●
	Reactive power /Compensation	●
Other Utilities		

Steam	Steam needs	●
	Minimize steam pressure	●
	Steam generator type	●
	Steam distribution headers	●
	Condensate traps	●
	Condensate recovery	●
Compressed Air	users' needs reduction	●
	users pressure minimisation	●
	system leaks	●
	compressor specific needs (kWh/m3)	●
	compressor control	●
	heat recovery from compressors	●
The building automation and control system (BACS)	Improving energy saving functions of the BACS	●
	Appropriate settings and operation	●
Other energy using systems		
Pool	Pool covers	●
	Water / air temperature difference	●
	Heat recovery	●

Kitchen	Energy efficient equipment	●
	Stand-by mode	●
	Appropriate use	●
Computer / server spaces	Energy efficient equipment	●
	Stand-by mode	●
	Appropriate use	●
Occupant behaviour	Change of occupant numbers or working patterns	●
	Change behaviour	●

D.3. Industrial Measures Checklist

This List is Exclusive for the Industrial Energy Audit Section.

Main Item	Typical Energy Saving Measures	Check
Electric Motors	Motor Management Plan	●
	Maintenance	●
	Energy-efficient Motors	●
	Rewinding of Motors	●
	Proper motor sizing	●
	Adjustable speed drives (ASDs) (VSD)	●
	Power factor correction	●

	Minimizing voltage unbalances	●
Compressed Air Systems	Reduction of demand	●
	Maintenance	●
	Monitoring	●
	Reduction of leaks (in pipes and equipment)	●
	Electronic condensate drain traps (ECDTs)	●
	Reduction of the inlet air temperature	●
	Maximizing allowable pressure dew point at air intake	●
	Optimizing the compressor to match its load	●
	Proper pipe sizing	●
	Heat recovery	●
	Adjustable speed drives (ASDs)	●
Pumping Systems	Maintenance	●
	Monitoring	●
	Controls	●
	Reduction of demand	●
	More efficient pumps	●
	Proper pump sizing	●
	Multiple pumps for varying loads	●
	Impeller trimming (or shaving sheaves)	●

	Adjustable speed drives (ASDs)	●
	Avoiding throttling valves	●
	Proper pipe sizing	●
	Replacement of belt drives	●
	Precision castings, surface coatings or polishing	●
	Improvement of sealing	●
Fan Systems	Minimizing pressure	●
	Control density	●
	Fan efficiency	●
	Proper fan sizing	●
	Adjustable speed drives (ASDs)	●
	High efficiency belts (cogged belts)	●
Steam Systems: Steam Generation	Demand Matching	●
	Boiler allocation control	●
	Flue shut-off dampers	●
	Maintenance	●
	Insulation improvement	●
	Reduce Fouling	●
	Optimization of boiler blowdown rate	●
	Reduction of flue gas quantities	●

	Reduction of excess air	●
	Flue gas monitoring	●
	Preheating boiler feed water with heat from flue gas (economizer)	●
	Recovery of heat from boiler blowdown	●
	Recovery of condensate	●
	Combined Heat and Power (CHP)	●
Steam Systems: Steam Distribution System	Shutting off excess distribution lines	●
	Proper pipe sizing	●
	Insulation related measures	●
	Checking and monitoring steam traps	●
	Thermostatic steam traps	●
	Shutting of steam traps	●
	Reduction of distribution pipe leaks	●
	Recovery of flash steam	●
	Prescreen coal	●
Process Heating Systems	Heat Generation Opportunities	●
	Heat Transfer Opportunities	●
	Heat Containment Opportunities	●
	Heat Recovery Opportunities	●

ANNEX E. Measurement & Verification Plan

E.1 Annual Savings Overview

[Include all applicable fuels/commodities for project, e.g., electric energy, electric demand, natural gas, fuel oil, coal, etc.]

ECM	Electric energy savings (kWh/yr)	Electric demand savings (kW/yr)*	Other energy savings (Kwh thermal/yr)**	Total energy cost savings, Year 1 ($/yr)	Other energy-related O&M cost savings, Year 1 ($/yr)	Total cost savings, Year 1 ($/yr)
Total savings						

E.2 Site Use and Savings Overview

	Electric energy savings (kWh/yr)	Electric demand savings (kW/yr)*	Other energy savings (Kwh thermal/yr)**

Total proposed project savings			
Usage for entire site**			
% Total site usage saved			
Project square footage (KSF)			
Total site square Meters (m^2)			
% Total site area affected			

E.3 M&V Plan Summary

ECM No.	ECM Description	M&V Option Used*	Summary of M&V Plan

*M&V options include A, B, C, and D of the International Performance Measurement and Verification Protocol (IPMVP).

E.4 Schedule of Verification Reporting Activities

Item	[a]Recommended time of submission	[a]Institution's review and acceptance period
Post-Installation Report	30 to 60 days after acceptance	30 days
Annual Report	30 to 60 days after annual performance period	30 days

[a]Times are recommended based on industry practice; modify as needed.

E.5 Proposed Annual Savings for Each ECM

[Include all applicable fuels/commodities for project, such as: electric energy, electric demand, natural gas, fuel oil, coal, etc.]

	Electric energy use (kWh/yr)	**Electric energy cost, Year 1 ($/yr)**	**Electric demand* (kW/yr)**	**Electric demand cost, Year 1 ($/yr)**	**Other energy use (Kwh thermal/yr)****	**Other energy cost, Year 1 ($/yr)**	**Other energy-related O&M costs, Year 1 ($/yr)**	**Total costs, Year 1 ($/yr)**
Baseline use								
Post-installation use								
Savings								