GUIDELINE FOR GENERAL REPORTING

This section applies to all three reports: preliminary (walkthrough) energy audit, detailed (investment-grade) energy audit and post-implementation reports. Note: Examples shown in this document serve only as a guide.

Content

- All calculations are to be checked for mathematical accuracy
- The report should be written in proper prose. The language should be clear, concise and understandable
- All numbers related to the results should be supported by information showing how they were derived. This includes all energy savings, cost savings, investment and payback information

Graphical presentation

- Key graphs and plots such as total cooling profile, total power consumption, etc, are to be presented in the report, and not given as appendices
- All graphs and plots are to be properly labelled and named, showing the dates when the readings were taken and highlighting the important points to take note
- Graphs and plots should be printed in colour for clarity
- Where possible and without sacrificing clarity, reduce the number of graphs by combining information into one
  Example 1: Flow rate, return temperature, supply temperature and temperature difference can be plotted in one graph
  Example 2: Cooling load, power consumption and efficiency can be plotted in one graph
- Duplicative graphs (graphs that show repetitive information) can be omitted. Example: Graphs showing the temperatures and humidity of AHUs are often numerous. A sample number of, say 4, graphs would be sufficient. Additional graphs can be given in soft copy

Table/Chart presentation

- Charts and tables must be clearly titled and units used must be identified

General

- SI units are to be used.
- The report should be printed on both sides to save paper.
- A CD, containing a soft copy of the report, the raw measurement data in a readable file format, photos and other relevant documents shall be sent to NEA.

GUIDELINE FOR PRELIMINARY ENERGY AUDIT REPORT

Each report should include, but not be limited to, the following:

1. Cover Page

- Report title
- Name of client (company for which facility or building has been audited)
- Name and location of facility or building
- Date of report
- ESCO: QuESS, project officers and their designations
- Contact numbers & emails of client's and ESCO's representatives

2. Introduction

- Date and objectives of preliminary audit
- Description of facility or building audited – numbers of floors, GFA, air-con area, type of usage, occupancy, hours of operation, age of building, etc.
- Information on tenants in facility or building audited – whether they are paying their own energy bills, tenanted floor area, data centres, etc.
- Past year's energy consumption and cost
- Breakdown of energy (electricity and fuel) consumption by fuel type and equipment in pie-chart

3. Overview of Current Systems in Place

- Technical and operational data collected
- Description of the present situation and shortcomings identified
- Initial findings, observations and assessment of the performance of systems and/or equipment

4. Scope of Work for Detailed Energy Audit

- Phases of work intended
- Brief description of what will be done at each stage of the energy audit and what will be achieved
- Proposed instrumentation plan in detail
- Measurement error analysis with proposed instrumentation
- Calibration certificates for the proposed instrumentation
  Note: Calibration labs must be accredited under SAC-SINGLAS.
- An isometric layout of the proposed installation location of instrumentation
- Layout plan of the facility or building

5. Summary of Recommendations

- Initial recommendations, estimated annual energy and cost savings, estimated investment cost and payback in table form
- Additional information and assumptions to support numbers given

GUIDELINE FOR DETAILED ENERGY AUDIT REPORT

Each report should include, but not be limited to, the following:

1. Cover Page

- Report title
- Name of client (company for which facility or building has been audited)
- Location of facility or building
- Date of report
- ESCO: QuESS, project officers and their designations
- Endorsement by QuESS and client's representative
- Statement by the company accepting the report and verifying that the ESCO's recommendations meet the company's technical and financial criteria

2. Executive Summary

- Name of client, location of facility or building audited
- Objectives of audit
- Key systems and equipment analysed
- Dates of audit
- Summary of recommendations, estimated annual energy and cost savings, estimated investment costs and payback in table form

No.	Recommended Measure	Estimated annual energy savings	Estimated annual cost savings	Estimated implementation cost	Payback period
1					
2					
Total					

3. Table of Contents

- Introduction
- Methodology and instrumentation
- Data analysis and findings (including graphs and plots for each system)
- Identified energy saving measures
- Conclusion
- Appendices
- CD containing the report, raw measurement data in a readable file format, photos and other relevant documents

4. Introduction

- Objectives of audit
- Client's financial criteria and technical/operational limitations
- Description of facility or building audited – number of floors, GFA, air-conditioned areas, type of usage, occupancy, hours of operation, age, etc.
- Information on tenants in facility or building audited
- Past year's energy consumption and costs, including tariff rates used for financial calculations
- Breakdown of energy (electricity and fuel) consumption in pie-chart

5. Methodology and Instrumentation

- Instrumentation table (see example below)
- Method statement detailing instrument installation and measurement procedure
  Pictures and maps showing the locations of the installed instruments and sensors
- Measurement error analysis

6. Data Analysis and Findings (in general)

- Dates of audit
- Baseline energy consumption and the methodology used to establish it
- Description of systems or equipment audited, e.g. their capacities and ratings, design and operating conditions, equipment schedules, information such as the type of systems, types of controls, VSD, auxiliary equipment, etc.
- Measurement and monitoring of the performance of systems or equipment, including data plots of performance of systems or equipment audited
- Energy efficiency of equipment compared against industrial benchmarks
- Findings and observations

6.1 Air-conditioning system (Chilled-water system)

- Period of audit (data logging)
- Baseline energy consumption and the methodology used to establish it
- Heat and mass balance for the entire logging period
  Note: Chilled water and condenser water measurements must be taken concurrently to calculate the heat balance.
- Measurement and monitoring of the performance of systems or equipment audited over at least a week, e.g. weighted average COP or kW/RT
  - Concurrent monitoring and logging at 1-minute interval
  - Chilled-water: supply temperature, return temperature and flow rate
  - Condenser water: supply temperature, return temperature and flow rate
  - Cooling profile, electrical power consumption and efficiency
  - Weather station for ambient dry-bulb temperature and relative humidity
  - Operation of equipment is encouraged to be scheduled so that all equipment can be audited for a holistic assessment of the system
- Data plots of performance of systems or equipment audited such as cooling profile, system and individual equipment efficiency, heat balance, etc.
- Measurement error analysis
  Note: The normative and recommended requirements specified in SS591:2013 "Code of practice for long term measurement of central chilled water system energy efficiency", except for the required range of measurement uncertainties, shall be adhered to. The system performance measurement error shall be within ±5% and the acceptable end-to-end measurement uncertainties of the measuring system(s) are listed in the table below

Measurement System	Acceptable end-to-end measurement uncertainty
Temperature	$\pm 0.03^{0}$C
Flow	±1%
Power	±1%

*The system performance measurement error shall be within ±5%.

ID	Point Description	Measurement Range	Sensor Type or Calculation Method	Installation Location	Input Type	Instrument Range	End-to-end Accuracy (% of reading unless noted)	Data Resolution	Refresh Interval (min)	Trend Interval (min)
Power Measurements										
kW01	Chiller 1 Power									
kW02	Chiller 2 Power									
kW03	Primary ChW Pump 1 Power									
kW04	Primary ChW Pump 2 Power									
kW05	Secondary ChW Pump 3 Power									
kW06	Secondary ChW Pump 4 Power									
kW07	Chiller 1 CW Pump Power									
kW08	Chiller 2 CW Pump Power									
kW09	Cooling Tower Fan 1 Power									
kW10	Cooling Tower Fan 2 Power									
Flow Measurements										
FT01	Chilled Water Flow									
FT02	Condenser Water Flow									
TT01	Chilled Water Supply Temperature									
TT02	Chilled Water Return Temperature									
TT03	Condenser Entering Water Temperature									
TT04	Condenser Leaving Water Temperature									
TT05	Ambient Dry-Bulb Temperature									
TT06	Ambient Wet-Bulb Temperature									
Calculated Values										
CC01	ChWPlant Thermal Cooling Output									
CC02	chilled-water plant Efficiency									
CC03	Plant Heat of Rejection									

6.2 Mechanical ventilation system

MV Fan No	Location and Description	Area served (m^2)	Operating hours	Air Flow (CMH)		Motor (kW)		Efficiency
				Design	Actual	Rated	Actual	W/CMH

* Description such as inlet/outlet, supply/exhaust, purpose, VSD, etc.

6.3 Lighting system

Location	Type of Lamp	Nos.	Rated Power (W)	Ballast loss (W)	Control gear (ballast type)	Operating Hours	Efficiency (W/m^2)

Location	Design range (SS531:2008) Nos.	Average lux level	Efficacy (lm/W)	Remarks

6.4 Lifts and escalators

Lift No.	Type (Common/Cargo/Fireman)	Power (kW)		Operating Hours	Description of energy saving features	Remarks (potential savings)
		Rated	Actual			

6.5 Air distribution system (AHUs and FCUs)

Age of AHU (Year)	Description (Serving location,VSD feedback, fixed speed at what Hz etc)	Cooling Capacity (Ton)	Area served (m2)	Air Flow (CMH)		AHU Motor (kW)		Fresh Air		Return Air		On-coil		Off-coil		Room temp		Efficiency	Remarks
				Design	Actual	Rated	Actual	DegC	RH (%)	DegC	RH (%)	DegC	RH (%)	DegC	RH (%)	DegC	RH (%)	W/CMH Or kW/RT	

6.6 Compressed air system

- Period of audit (data logging)
- Details of the type, number, capacity and rating of air compressors
- Baseline energy consumption and the methodology used to establish it
- Measurement and monitoring of the performance of systems or equipment audited over at least three working days
    - Determine the period of load/unload cycle based on records
    - Concurrent monitoring and logging of pressure, air flow and power at a suitable interval, depending on the duration of load/unload cycle, e.g. 0.1-second, 1-second, 6-second.

No.	Type of compressor	Power (kW)		Pressure (psig)		Operating Hours	Capacity (scfm)	Efficiency (kW/100scfm)
		Rated	Actual	Load	Unload			

6.7 Boiler system (inclusive of hot water system)

- Heat and mass balance for the entire logging period
  Note: Boiler and steam-condensate measurements must be taken concurrently to calculate the heat and mass balance.
- Measurement and monitoring of the performance of systems or equipment audited over at least three working days

Parameter	Design	Measured		
		Boiler 1	Boiler 2	Boiler 3
Steam capacity (kg/s)				
Water flow rate (kg/s)				
Operating pressure (Pa)				
Feedwater temperature (^{0}C)				
Blower fan (kW)				

Parameter	Boiler 1	Boiler 2	Boiler 3
CO_2 (%)			
CO (ppm)			
Excess air (%)			
Flue gas temperature (^{0}C)			
Temperature difference between flue gas and air intake (^{0}C)			
Estimated boiler efficiency (%)			

Parameter	Design	Feedwater pump 1	Feedwater pump 2	Feedwater pump 3	Total
Flow rate (kg/s)					
Head (m)					
Power (kW)					
Pump efficiency					

6.8 Hot water system

No.	Storage Capacity	Power (kW)		Temperature (^{0}C)		Efficiency (%)	COP
		Rated	Actual	Supply	Return		

6.9 Indoor environment quality

Location	Air Temp (^{0}C)	Relative humidity	CO_2 Level (ppm)	CO Level (ppm)	Etc.

7. Identified Energy Saving Measures

- Description of the present situation and shortcomings identified
- Recommended energy saving measures with detailed and clear calculations of the predicted annual energy and cost savings, investment cost and payback period for each measure

Example

Present Situation

Almost all of the lightings on site use 4 feet linear fluorescent lamps with conventional electromagnetic ballast. There are an estimated 2,275 fluorescent lamps and they are assumed to be in operation on average 12 hours a day

Proposed Improvement

It is proposed to replace the existing 4 feet 36 W fluorescent lamps with energy saving lamps that will use 16 % less power.

Estimation of Savings

Estimated nos. of 36 W fluorescent lamps on site = 2,275

Estimated power consumption of one fluorescent lamp and ballast= 40 W

Estimated power consumption of each T5 lamp = 22 W

Estimated power saved = 6 W

Assuming 5.5 days work week

kWh Savings = 0.006 x 2275 x 12 x 5.5 days x 52 wks x $ 0.142/kWh

= $6,656 /year

kW demand savings = 13.7 kW/month

= 13.7 x $7.04/kW x 12 months

= $ 1,157 /year

Total savings = $7,813 /year

8. Conclusions

- Summary of recommendations, projected annual kWh savings, estimated cost savings, projected investment cost and payback in table form
- Recommended action plan and implementation schedule

9. Appendices

Additional information of significant importance can be presented here, including:

- Schematics and layout drawings of facility or building audited
- Details of instrumentation used – parameters monitored and duration of monitoring for each parameter
- CD containing the report, raw measurement data in a readable file format, photos and other relevant documents

GUIDELINE FOR POST-IMPLEMENTATION REPORT

Each report should include, but not be limited to, the following:

1. Cover Page

- Report title
- Name of client (company for which facility or building has been audited)
- Location of facility or building
- Date of report
- ESCO or contractor: Project officers and their designations

2. Measures implemented

- Details of measures implemented
- Description of systems or equipment modified
- Milestone chart showing the timeline of implementation

3. Measurements and Calculations

- Details of the measurement and verification system adopted to measure and compare actual savings to savings projected in the detailed audit
- Formulae and key data used for calculations
- Detailed instrumentation plan
- Parameters monitored and duration of monitoring of each parameter
- Dates of data collection and logging
- Performance of systems or equipment (comparison between pre- and post-implementation)
- Other findings and observations

4. Summary of Implementation

- Summary of all the recommendations from energy audit, including comparison between the predicted and actual annual kWh and cost savings
- Summary of implemented recommendations, actual annual energy and cost savings, actual implementation cost and payback in table form

5. Appendices

- Data plots of performance of systems or equipment improved
- Data plots of energy consumed vs. time before and after implementation on the same graph, showing the improvement for each measure
- Energy efficiency of major equipment compared against benchmarks set
- Current energy bills and actual savings achieved
- CD-ROM containing the report and raw measurement data collected post-implementation