**CONTENTS**

1.0 GENERAL 2

1.1 DESCRIPTION 2

1.2 PURPOSE 2

1.3 RELATED DOCUMENTS 2

1.4 SCOPE 2

1.5 REFERENCES 2

1.6 DEFINITIONS 3

1.7 ORGANIZATIONAL CHART 3

2.0 MINIMUM METERING REQUIREMENTS 4

2.1 ENERGY AND WATER SYSTEMS 4

2.2 PRIMARY SIDE UTILITY METERS 4

2.3 SECONDARY SIDE BMS METERS 4

2.4 SYSTEMS OPERATION AND PERFORMANCE VERIFICATION 5

2.5 METERING AND TRENDING 6

2.6 DATA COLLECTION 6

2.7 METER AND SENSOR CALIBRATION 6

2.8 BMS TREND LABELLING 7

2.9 MBCX SYSTEM COMMISSIONING 7

3.0 MINIMUM INFORMATION REQUIREMENTS 8

3.1 MBCx system 8

3.2 DESIGN PERFORMANCE TARGETS 8

3.3 MONITORING PERIOD PERFORMANCE 9

4.0 REPORTING REQUIREMENTS 9

4.1 MBCX PLAN 9

4.2 REPORTING SCHEDULE 9

4.3 REPORTING FORMAT 10

5.0 RESPONSIBILTIY 10

5.1 MBCX DESIGN SPECIFICATION 10

5.2 DESIGN REVIEW 10

5.3 EVALUATION OF BUILDING PERFORMANCE 10

6.0 APPENDIX 1 11

7.0 APPENDIX 2 12

7.1 PRIMARY SIDE UTILITY METER SPECIFICATIONS 12

7.2 SECONDARY SIDE BMS METER SPECIFICATIONS 12

# General

## DESCRIPTION

### This document summarizes the minimum owner requirements to support the planning and implementation of monitoring based commissioning (MBCx) for new or renovated construction projects that exceed 2,500 m2 or 250,000 ekWh total annual energy consumption at UBC

## PURPOSE

### To monitor and verify system performance over time and identify opportunities for improving system performance.

### Confirm if system performance is as per the Owners Project Requirements and Basis of Design.

### Determine why systems are not performing as per design.

## RELATED DOCUMENTS

### UBC Technical Guidelines Section 01 91 00 – Commissioning

### UBC Technical Guidelines Section 20 00 06 – Mechanical Meters

### UBC Technical Guidelines Section 26 27 13 – Electrical Meters

### UBC Technical Guidelines Section 25 05 00 – Building Management Systems

## SCOPE

### Monitoring based commissioning is the responsibility of the MBCx consultant. MBCx activities include preparation of MBCx plan, review design drawings and control schematics for appropriate meters and trends, MBCx related construction administration, MBCx related commissioning, and MBCx reporting. Throughout the project, the MBCx consultant will lead the integration and coordination of MBCx related matters with the Design Team, Construction team, Controls team and UBC Energy and Water Services group. The MBCx consultant shall be independent of the work of design and construction. It is recommended that the MBCx and the independent project commissioning provider (CxP) services are provided by the same consultant.

## REFERENCES

### ASHRAE Guideline 0-2005, “The Commissioning Process”, or the latest version.

### LEED V4 Canada Commissioning requirements.

#### LEED 2009 Energy & Atmosphere (EA) credit 5: Measurement and Verification.

#### LEED v4 Water Efficiency (WE) Prerequisite: Building-Level Water Metering

#### LEED v4 WE Credit: Water Metering

#### LEED v4 EA Prerequisite: Fundamental Commissioning and Verification

#### LEED v4 EA Prerequisite: Building-Level Energy Metering

#### LEED v4 EA Credit: Enhanced Commissioning (Monitoring-based commissioning option)

#### LEED v4 EA Credit: Advanced Energy Metering

## DEFINITIONS

### **Monitoring Based Commissioning** - (MBCx) means utilizing energy performance metering and DDC trending for diagnosis of under-performing systems, for optimizing system performance, and for on-going performance monitoring.

### **MBCx Plan** - is a document which describes how energy and water consumption data and system performance data will be collected and analyzed for the purpose of evaluating short- and long-term system performance, system efficiency, energy consumption, water consumption, and opportunities for optimization of system operation and efficiency. Include details of who is responsible for each aspect of the MBCx process.

### **Owners Project Requirements** - (OPR) is a written document that details the ideas, concepts, and criteria determined by the owner to be important to the success of the project.

### **Basis of Design** - (BOD) is the information necessary to accomplish the owner’s project requirements, including system descriptions, indoor environmental quality criteria, design assumptions, and references to applicable codes, standards, regulations, and guidelines.

## ORGANISATIONAL CHART

Owner

Project Manager

Integrated Design Team

Cx Provider

MBXc provider

Construction Manager

General Contractors

Mechanical Contractor

Controls Contractor

Electrical Contractor

M&E Coord

Cx Manager

Documented Deliverables

Design

Document Flow

Cx Meeting/Coordination Flow

# MINIMUM METERING REQUIREMENTS

## Energy and water systems must be designed in such a way as to enable energy and water monitoring for the purpose of determining overall system performance.

## PRIMARY SIDE UTILITY METERS

### All new construction projects require primary metering for monitoring of the following energy and water sources:

#### Total building electricity consumption and demand.

#### Total building natural gas consumption and demand.

#### Total building district energy consumption and demand.

#### Total building water consumption and demand.

### Refer to Appendix 1 and 2 of this document and UBC Technical Guidelines Sections 20 00 06 & 26 27 13 for specific guidance on metering equipment requirements and cross-discipline coordination.

## SECONDARY SIDE BMS METERS

### New construction projects that exceed 2,500 m2 or 250,000 ekWh total annual energy consumption require dedicated metering and monitoring of the following energy and water end-uses:

#### Interior lighting.

#### Exterior lighting.

#### Space heating: electricity and/or natural gas consumed by heat pumps, electric boilers, natural gas boilers, and/or thermal energy from UBC’s District Energy System (DES).

#### Space cooling: electricity consumed by heat pumps, chillers, and/or cooling towers.

#### Domestic hot water heating: electricity and/or natural gas consumed by heat pumps, electric boilers, natural gas boilers, and/or thermal energy from UBC’s DES.

#### Fans and pumps: no meter required, refer to monitoring requirements in section 2.3.

#### Receptacle loads: can be excluded from the sub metered list if it is possible to calculate their energy consumption through subtraction of all other sub-metered electrical loads from the electrical Primary Side Utility Meter.

#### Water for irrigation and hose bibs.

#### Data centres >50 kW’s (data centres electrical load only, excludes associated cooling load).

#### Energy end-uses can be excluded from the sub metered list if the end-use represents less than 10% of total annual energy consumption, as determined from detailed design-phase energy modeling. Where multiple sources of energy make up an end-use, this criterion refers to the total end-use.

#### For (c), (d), and (e) above, excludes electricity used for circulation pumps.

#### Where more than one meter is required to measure a given end-use type, include a virtual meter point to represent the aggregate load. For heat pumps, include virtual meter points for energy consumption for space heating and for space cooling.

### Refer to Appendix 1 and 2 for specific guidance on metering equipment requirements and cross-discipline coordination.

## SYSTEMS OPERATION AND PERFORMANCE VERIFICATION

### For the following systems, monitoring is required through Secondary Side BMS Meters and systems level BMS trend-logs. Refer to section 2.4 for meter communications protocol and trend log configuration requirements.

### In addition to the Secondary Side BMS Meters required, include provisions for monitoring[[1]](#footnote-1) as follows:

#### Environmental parameters: monitor outdoor air temperature.

#### On-site renewable energy systems:

##### For Solar PV or Wind Turbine: Monitor cumulative power production (kWh).

##### For Solar Thermal or Biomass: Monitor cumulative thermal production (kWh).

#### On-site reclaimed water systems: monitor volume of water supplied by the system.

#### Gas-fired hydronic systems that exceed 200 KW capacity: monitor thermal output (kWh) via thermal energy meter, natural gas consumption (kWh), calculated system efficiency, supply and return water temperatures.

#### Heat pumps and chillers that exceed 100 tons of capacity: monitor thermal energy output (kWh) from both condenser and evaporator systems, system mode (heating/cooling), calculated coefficient of performance in each mode of operation (heating/cooling).

#### Active Ventilation heat recovery (i.e. exhaust coils for chilled water heat recovery) on air systems greater than 2000 liters per second (LPS): Monitor thermal load reclaimed via thermal energy meter (kWh).

#### Passive Ventilation heat recovery (i.e. glycol run around or heat wheel) on air systems greater than 2000 liters per second (LPS): monitor outside air temperature (t1), temperature of outside air leaving the heat exchanger (t2), temperature of inside air entering the heat exchanger (t3), calculated value for temperature transfer efficiency (µ = (t2 – t1)/(t3 – t1)).

#### Variable frequency drive (VFD) pumps and fans 5 HP or more: monitor via BACNet integration motor speed and average kW demand over 15 minute intervals and all corresponding control point values, e.g., duct static pressure or water differential pressure.

#### Air handling systems: monitor outdoor and mixed air damper positions, mixed and supply air temperatures, duct static pressure, and return air CO2 levels (when demand control ventilation strategy is implemented)

#### Variable Air Volume (VAV): monitor supply air temperatures, volumes, and valve positioning

### For all systems identified above, include additional monitoring of relevant DDC points to further characterize system performances as deemed appropriate.

## METERING AND TRENDING

### Secondary Side BMS Meters and system performance verification monitoring points must be configured to store trend log data in 15 minute intervals for a minimum of three years on UBC BMS archiver. Ensure compatibility with UBC BMS virtualized servers.

### Secondary Side BMS Meters (electric, natural gas, thermal energy, and water) and DDC monitoring points must be BACNet compliant for communications with UBC BMS.

### Use packaged and calibrated thermal energy meters for thermal output monitoring.

### For on-site renewable energy systems and reclaimed water systems, metering must be configured for real demand (not absolute value) to enable determination of direction of flow. If bi-directional flow is anticipated, set up trends for both directions.

### All inputs and outputs to energy systems are to be in metric units.

### For electric metering, monitor average demand (W or kW) for given trend log interval and energy consumption (Wh or kWh).

### Date and time stamps must be recognizable in Microsoft Excel. Use the following date/time format: dd/mm/yyyy h:mm:ss AM/PM

## DATA COLLECTION

### The MBCx monitoring system must be configured for collection of trend log data for all measured and calculated monitoring points (CSV or XLS file).

## METER AND SENSOR CALIBRATION

### Meters and sensors must be factory calibrated. Calibration records must be included in O&M manual.

### Meters and sensors must be installed in such a way as to facilitate periodic calibration without interruption of system operations. Frequency of calibration is per manufacturer requirement, or in the absence of manufacturer requirements, every two years. On-going calibration is the responsibility of UBC.

## BMS TREND LABELLING

### Adhere to the following convention for labeling monitoring points in the BMS

### Where applicable the **Haystack** naming convention should be used:

#### BLDG#\_SYS\_DES\_UNIT\_TL where:

##### BLDG#: First three numbers of building; e.g., 641 for University Services Centre, 529 for Life Sciences Centre.

##### SYS: device ID tag; e.g., HP1, B1, P4, AHU2.

##### DES: description of parameter being monitored, using acronyms and abbreviations; e.g., OAT for outdoor air temperature, MAD for mixed air damper position, SPD for speed.

##### UNIT: unit of measurement; e.g., KWH for electrical energy consumption, KWH for thermal output, C for degrees Celsius.

##### TL: suffix to denote Trend Log object in BMS.

##### Sample: Mixed air temperature sensor on AHU 1 in Alumni building is “797\_AHU1\_MAT\_C\_TL”.

#### For Secondary Side BMS Meters, monitoring points shall be integrated with the BMS and labeled according to the loads captured by the meter in the following format:

##### BLDG#: as above.

##### SYS: end-use; e.g., LTG\_IN for interior lighting, HTG for space heating, CLG for space cooling, DHW for domestic hot water, LTG\_EX for exterior lighting, PLUG for receptacle loads, IRR for irrigation.

##### DES: ELEC for electric, GAS for natural gas, DES for District Energy, THERM for Thermal Energy, and WTR for water.

##### UNIT: as above

##### TL: as above.

## MBCX SYSTEM COMMISSIONING

### Verification of the MBCx system shall be included in the project commissioning plan. Each monitoring point must be verified for correct units of measurement, reading over full operational range, correct calculated value, and adherence to monitoring point labelling convention. Includes Primary Side Utility Meters, Secondary Side BMS Meters and system performance verification monitoring points. BMS data and trending functionality must be demonstrated for each MBCx monitoring point.

### Provide records of installation for Primary Side Utility Meters, Secondary Side BMS Meters, and thermal energy meters of the MBCx monitoring system. Record of installation must include the following information at a minimum: device make and model number, configuration for units of measurement, configuration of multipliers, confirmation that meter is recording and trend is set up, cross-reference with monitoring point name. Specifically, required for Primary and Secondary Side metering, and metering required for system performance verification.

### Provide records of configuration for each system performance verification monitoring point. Record of configuration must include the following information at a minimum: configuration for units of measurement, equation for calculated values, confirmation that monitoring point is recording and trend is set up, cross-reference with monitoring point name.

# MINIMUM INFORMATION REQUIREMENTS

## MBCx system will be used to verify system performance against owner project requirements and over systems’ operational range during steady state operation.

## DESIGN PERFORMANCE TARGETS

### Provide the following documentation at project handoff:

### UBC energy performance target, provided by UBC and as stated in OPR.

### Summary of design system performance expectations (referenced baseline and proposed design system efficiencies) (PDF file), provided by Design Team and as stated in BOD.

### LEED EA Credit: Optimize Energy Performance annual and monthly energy consumption by end-use and by source (LEED letter template for annual consumption and XLS file for monthly consumption), average daily outdoor air temperatures for simulation year (XLS or CSV file, including time/date field and temperature field), and energy simulation files including executable and auto-generated model output files (or similar for non LEED projects), provided by LEED consultant or Design Team for non LEED projects.

## MONITORING PERIOD PERFORMANCE

### The MBCx monitoring system must enable collection and calculation of the following:

### Monthly and annual total energy consumption by source (electricity, natural gas, district energy) and peak electricity demand.

### Monthly and annual total water consumption.

### 15 minute interval data by end-use (interior lights, space heating electricity, space heating natural gas, space heating district energy, space cooling, domestic hot water heating electricity, domestic hot water heating natural gas, domestic hot water heating district energy, aggregate of VFD electricity, irrigation and hose bib water).

### 15 minute interval data for power production by on-site renewable energy system.

### 15 minute interval data for water supply by on-site reclaimed water system.

### 15 minute interval data for systems performance verification monitoring points, including calculated values.

# Reporting Requirements

## MBCX PLAN

### An MBCx plan that has been approved by UBC Energy and Water Services must be submitted at the time of the building permit application.

## REPORTING SCHEDULE

### A performance monitoring report shall be submitted to the Director, Energy Planning and Innovation, UBC Energy and Water Services eighteen (18) months following building occupancy. The report shall include annual and monthly total building consumption by energy and water source and by end-use, as required in section 3. The report shall include a summary of system performance findings and summary of actions taken or recommended by MBCx consultant to optimize system performance.

### Interim performance monitoring data for one month of system operation shall be compiled and submitted to UBC Energy and Water Services group within six (6) months of building occupancy. Specifically, one month of energy and water consumption data by source and by end-use, and calculated system performance parameters shall be submitted (trend log data, XLS file).

## REPORTING FORMAT

### MBCx report must provide a collated summary of system performance trends and energy and water consumption based on data collected over the monitoring period (e.g., 1 year timeframe). It is the responsibility of the MBCx consultant to compile and interpret the data and present information in a manner that clearly summarizes trends in short- and long-term system performance and recommends opportunities for corrective action and system optimization to improve system efficiency where warranted. It is the responsibility of UBC Energy and Water Services group to provide Building Management System (BMS) trend log data to the MBCx consultant.

# RESPONSIBILITY

## In addition to the responsibilities set out in section 3, the following applies:

## MBCX DESIGN SPECIFICATION

### During design phase, the MBCx consultant must develop a project specific specification for the MBCx monitoring system (the “MBCx specification”), including a comprehensive MBCx monitoring points list. The MBCx specification is to be included in Div 1 of the project specifications. The MBCx specification is to be written in standard contractor language.

### Primary Side Utility Meters, Secondary Side BMS Meters, and meters included for system performance verification must be shown in design drawings.

## DESIGN REVIEW

### The following design documents must be submitted to UBC Energy and Water Services group for review at schematic design, issued for tender, and 100% design stages (prior to submission of Issued For Construction (IFC) set):

#### MBCx specification.

#### Electrical single line diagram.

#### Electrical panel schedules.

#### Mechanical plumbing schematics, including hot water and district energy systems showing meters as required.

## EVALUATION OF BUILDING PERFORMANCE

### The building will be deemed to meet the owner project requirements and design performance target when actual performance at the end of the warranty period is within 20% of adjusted design performance target. The design performance target may be adjusted to account for weather normalization, changes in system operating schedules from design to operation, and loads that are not included in the design performance target.

# 

APPENDIX 1

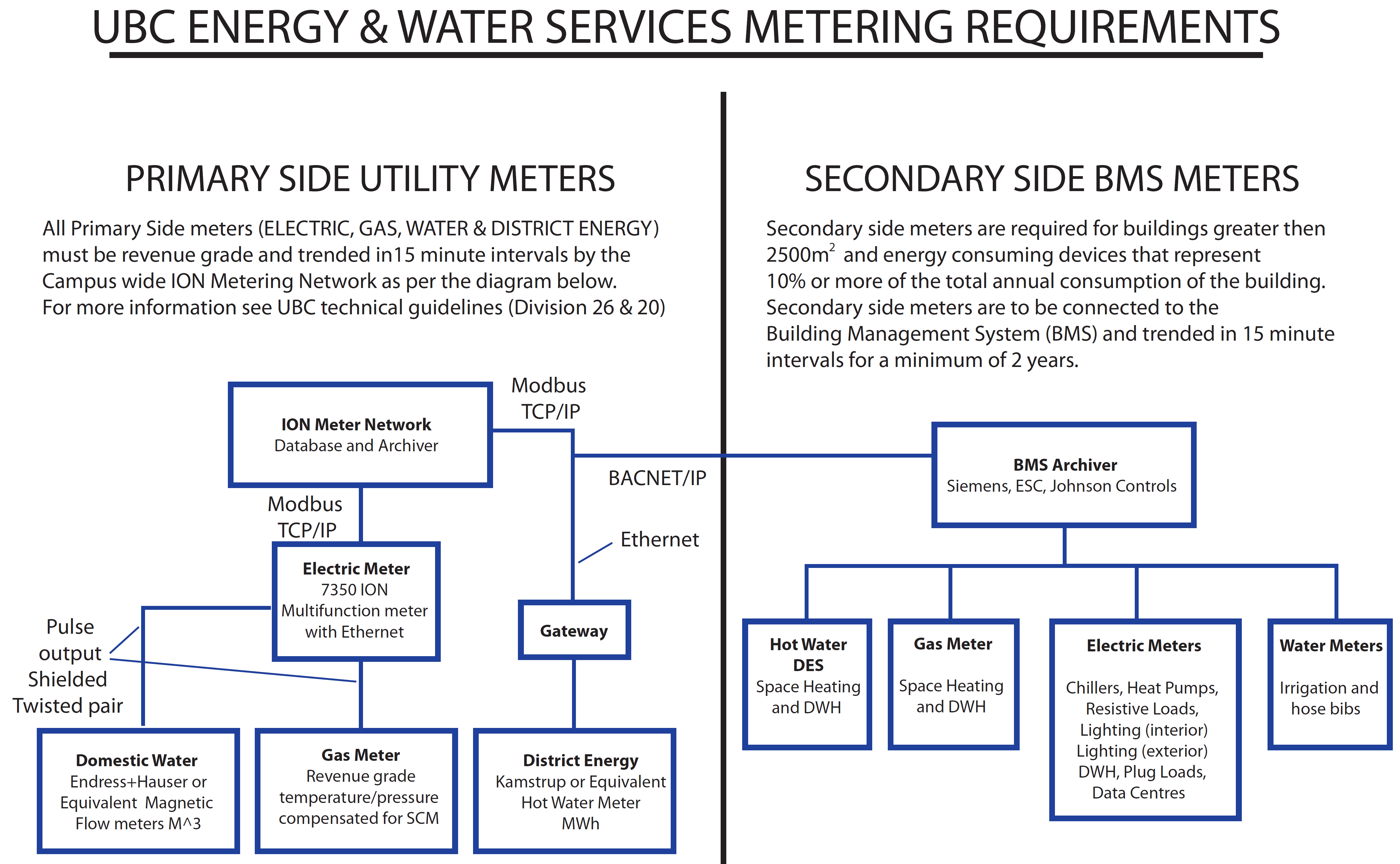


Figure 1 UBC Energy and Water Services Metering Requirements

APPENDIX 2

## PRIMARY SIDE UTILITY METER SPECIFICATIONS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Type of meter | Metric Output Units | Make/ Model | Database | Recording interval & duration | Protocol | Division of responsibility | UBC coordination |
| Electrical | KW, KWh, KVA | ION 7350 | ION Data Archiver | 15 minute  Ongoing | Modbus TCP/IP | Division 26 | IT and E&W services |
| District Energy | MWh’s, L/h, °C supply and return | Kamstrup or Endress & Hauser | BMS and ION Archiver | 15 minute  Ongoing | Bacnet MS/TP to Modbus TCP/IP gateway | Division 20 install & Division 26 wiring | IT and E&W services |
| Gas | Standard Cubic Meters (SCM) | Revenue grade | ION Archiver | 15 minute  Ongoing | Pulse output to Electrical meter | Division 20 install & Division 26 networking | E&W services |
| Water | Cubic Meters (M^3) | Endress & Hauser | ION Archiver | 15 minute  Ongoing | Pulse output to Electrical meter | Division 20 install & Division 26 networking | E&W services |

Table 2 Primary Side Utility Meter Specifications

## SECONDARY SIDE BMS METER SPECIFICATIONS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| System Type | Metric Output Units | Make/ Model | Database | Recording interval & duration | Protocol | Division | UBC coordination |
| Electrical | KWh’s | N/A | BMS Archiver | 15 minute  2 Year | Bacnet /IP | Division 26 | E&W services |
| Gas | SCM | N/A | BMS Archiver | 15 minute  2 Year | Bacnet /IP | Division 20 | E&W services |
| Thermal Energy | MWh’s, L/S °C supply and return | N/A | BMS Archiver | 15 minute  2 Year | Bacnet /IP | Division 20 | E&W services |
| Water | Cubic Meters (M^3) | N/A | BMS Archiver | 15 minute  2 Year | Bacnet /IP | Division 20 | E&W services |

Table 3 Secondary Side BMS Meter Specifications

**\*\*\*END OF SECTION\*\*\***

1. The term “monitor” or “monitoring” herein implies configuring trend logs in the BMS to support MBCx activities. [↑](#footnote-ref-1)