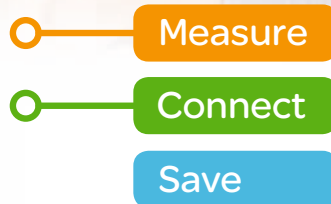


# Com'X 200

Energy management for  
small and mid size buildings

Data acquisition design guide



**Schneider**  
Electric

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# Smart Panels connect you to

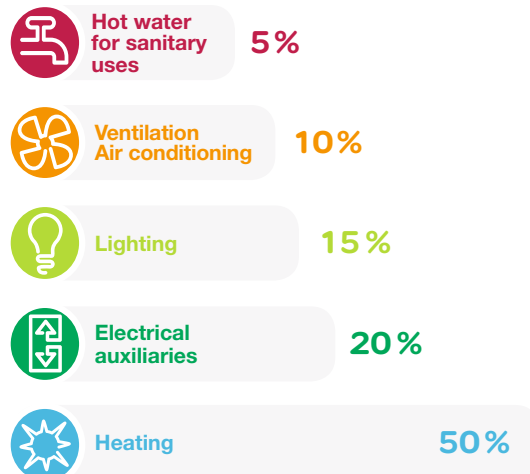
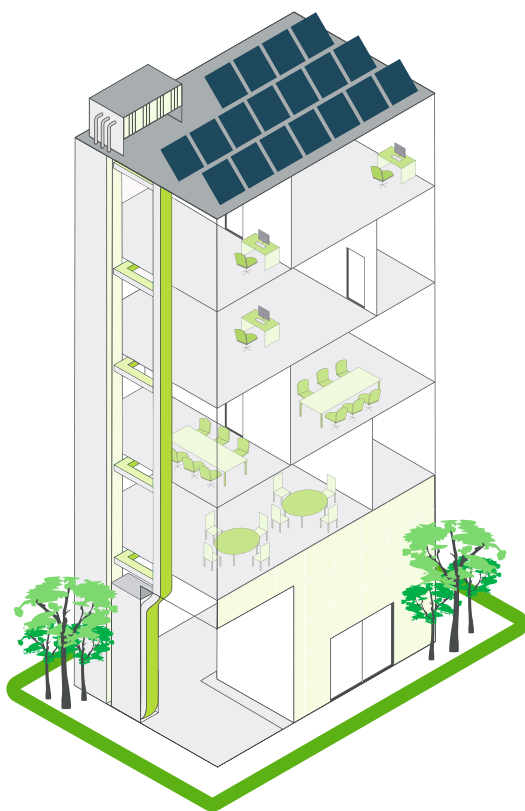
## Energy-efficient buildings is a must

By 2050, energy demand across the world is expected to double.

Within the same time frame, greenhouse gas emissions must be halved to mitigate climate change<sup>(1)</sup>. As buildings account for nearly 40% of energy use in most countries<sup>(2)</sup> and consume more energy than vehicles on the

road, climate policymakers have singled out buildings as a vast potential for improvement in energy efficiency.

Regulatory compliance aside, save energy use brings long-term financial benefits to buildings' owners and occupants.



# 52%

of energy use in commercial building is electricity<sup>(3)</sup>

### Getting building ready energy audits

- > Energy Performance Building Directive (EPBD) is the European Union framework for energy efficiency in buildings where each member country specifies the energy consumption limits for energy efficiency categories.
- > The EN15232 (Energy Performance of Buildings – Impact of Building Automation, Controls, and Building Management) provides guidelines for using building automation and control systems, and technical building management functions to measure a building's energy performance for loads, such as heating, cooling, and lighting.
- > Mandatory energy audits every four years for buildings where companies have more than 250 employees. This audit is exempted if the building has an energy management system compliant with ISO 50001.

(1) International Energy Agency, 20009 and Intergovernmental Panel on Climate Change.

(2) Energy Efficiency in Buildings, Business Realities and Opportunities, WBCSD, 2009.

(3) US Department of energy.

# energy savings

## Smart Panels for smarter energy use in 3 steps

### 1 MEASURE

- Embedded and stand-alone metering & control capabilities

### 2 CONNECT

- Integrated communication interfaces
- Ready to connect to energy management platforms

### 3 SAVE

- Data-driven energy efficiency actions
- Real time monitoring and control
- Access to energy and site information through on-line services

With our Smart Panels, you can **measure** your energy use and manage your electrical network, so you can understand the conditions that cause overconsumption and increase costs and malfunctions.

Now you **connect** your energy usage to information that allows you to analyze, control, and manage in order to identify areas for **saving** energy costs and meet environmental targets.

Designed for rapid deployment, Smart Panels are a comprehensive solution, simple to choose, and ideal for small to midsize buildings, such as public offices, commercial premises, and hotels.

Smart Panels digitized by

**Enerlin'X**



### 1 Measure

**Smart Panels mean visible information**

- **Energy management**
- **Network management:**  
Real time network monitoring, control and power quality.
- **Asset management:**  
Load monitoring, alarming and predictive maintenance.

### 2 Connect

**Enerlin'X communication system connects your measurements to insight data**

- Energy, network and asset monitoring and control.
- Simple to use, reliable and open to the future.

### 3 Save

**On-site real time monitoring and control**

- On a touch screen display connected to Ethernet.
- On a PC display with common browser.

**On-line Energy Management Services**

- **StruXureWare Energy Operation** automates data collection via an open, scalable, and secure energy management information system.

# 1 About the book

## At a glance

### Field of application.

This document provides instructions for designing a data acquisition system using a Com'X 200 as the system's main data aggregator.

The design guide includes three chapters:

- Guidelines for selecting a metering method
- Guidelines for selecting the right electricity meter
- Guidelines for selecting the right communication architecture – System limitations and recommendations (number of Modbus devices, ZigBee, etc.)
- Recommendations for IT network deployment
- Examples of typical architectures per segment: presentation of typical single- or multi-site architectures for a remote energy management solution, including the different information sources and flows

This guide is intended for design offices, electrical contractors and integrators that have been called upon to design an energy management solution.

# 2 Presentation of the data acquisition system



## 2.1 Presentation

The data acquisition system (DAS) is based on the Com'X 200, which enables WAGES data to be collected at a customer site and sent to a hosted platform such as Schneider Electric StruxureWare Energy Operation.

The Com'X 200 can collect:

- Power consumption data from meters with pulse signal outputs connected directly to the Com'X 200's digital inputs, via SIM10M, Smartlink (Modbus serial connection) or wireless emitter (868MHz wireless connection) modules.
- Information relating to the status of the contactors, the impulse relays or the Time-Of-Use signals of a main electricity meter.
- Data from devices connected to the Modbus RS485 network of the Com'X 200.
- Data from devices connected to the Modbus RS485 network of the EGX100 or EGX300 (for large buildings)

(Fig.1)

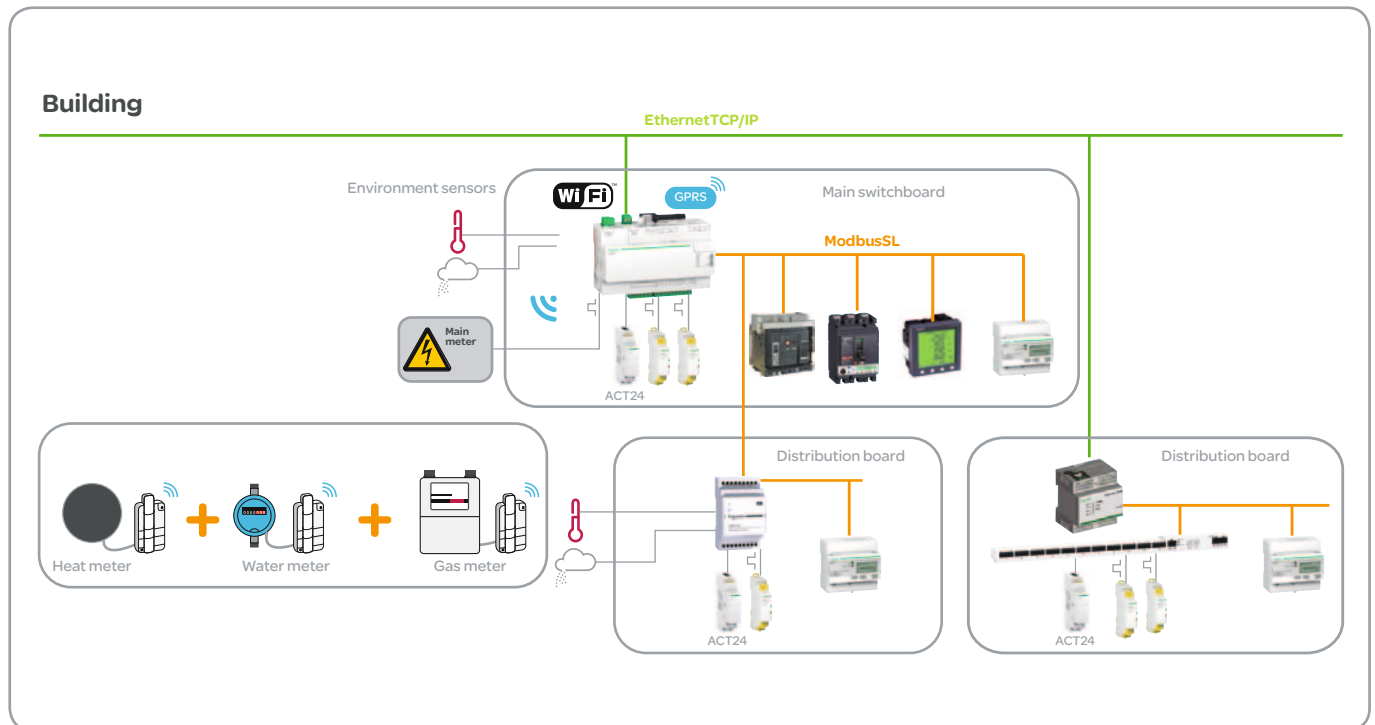
- Data from devices connected to an Ethernet TCP/IP network.
- Environmental data (temperature, humidity, etc.) from sensors connected to the Com'X 200's analog inputs via a SIM10M (Modbus serial line connection).

The Com'X 200 is able to log data at intervals ranging from 1 min to 60 min.

This data can then be sent to Schneider Electric StruxureWare Energy Operations via:

- An Ethernet network.
- GPRS in the case of isolated sites or sites where the IT administrator does not allow use of the network infrastructure.

Fig. 1



## 2.2 Characteristics and limits of the system

Here below are some recommendations to ensure good performances of the system.

Device	Interface	Characteristic/ limit description	Values
Com'X 200	Modbus port (master)	Max number of Modbus slaves	<b>5 to 20</b> (see page 21)
		Max bus length	1200 m in daisy chain
		Transmission speed supported	1200, 4800, 9600, <b>19200</b> , 38400, 57600 or 115200 bits/sec
		Parity	<b>Even</b> , Odd, or None
		Stop bits	<b>1</b> or 2 (if non parity)
	Ethernet ports	Auto-discovering address range	1 to 255 ( <b>1 to 10 by default</b> )
		Transmission speed	10/100 Mbits/s
		Ethernet ports configurations supported	<b>2 separated ports (1 IP address each)</b> or 2 switched ports (1 IP address for both)
		2 separated ports (1 IP address each)	Upstream network <b>DHCP client</b> or static IPV4 address Downstream network <b>DHCP server with fixed IPV4 address (10.25.1.1)</b> or static IPV4 address or DHCP client
		2 switched ports (1 IP address for both)	<b>DHCP client</b> or static IPV4 address
		Modbus TCP auto-discovering	Automatic or manual
	Modbus & Ethernet	Max number of devices attached through Modbus and Ethernet mixed	100 devices
	Analog inputs	Number of inputs	2
		Input types supported	0-10V, 4-20mA, PT100 and PT1000
	Digital inputs	Equipment types supported	«T° Sensor», «Humidity sensor», «CO2 sensor», «Level» and «Generic»
		Number of inputs	6
		Input type supported	Pulse, Square waves pulses and Status
Ethernet gateways	Modbus port (master)	Equipment types supported	Generic main meter, pulse meters, KYZ meters, contactor status, impulse relay status
		Max number of Modbus slaves	5 to 20 (see page 21)
		Transmission speed supported	2400, 4800, 9600, <b>19200</b> , or 38400 bits/sec
SIM10M	Analog inputs	Parity	<b>Even</b> , Odd, or None
		Stop bits	1 or 2 (if non parity)
	Digital inputs	Number of inputs	2
		Input types supported	0-10V externally powered
Acti9 Smartlink	Digital inputs	Number of inputs	6
		Input type supported	Pulse acquisition and On/Off detection by internal 3.6 V DC power and pull-up resistors
		Number of inputs	22 (2 x 11)
	Digital inputs	Input type supported	Pulse counter, Status and Run hours.

# 3 How to measure consumption

This chapter defines rules for designing a metering & data acquisition architecture taking into account customer requirements, cost, performance and security considerations.

### 3.1 Guidelines for selecting metering method

The metering method shall be selected according to the project's objectives (in particular, the level of accuracy required), estimated budget and operating conditions.

● **Direct metering:** measures consumption directly using electricity meters, gas meters, oil meters, heat meters or steam meters. Direct metering should be selected in the following cases:

- For major loads or overall building consumption.
- When it is necessary to sub-bill different tenants, as this requires class 1 or 0.5 accuracy.
- When other data, such as electrical power quality data, needs to be measured for the same energy use. That is why disruptive or interruption-sensitive loads must be identified at a very early stage when designing the metering system.

● **Hours-run meter:** for constant power loads, measuring the number of operating hours is one way to calculate consumption (e.g., fans without VFDs, lighting, etc.). This measurement can be performed by monitoring the status of a contactor or impulse relay and counting the time for which the status is "closed" or "open".

Knowing the power rating indicated on the identification plate is not always sufficient, as the load factor has to be taken into account to correctly estimate consumption. For existing buildings, the load factor can be determined by measuring power with a portable meter.

In cases where there is advanced load control (such as dimming for lighting) it is very difficult to estimate the load factor and this method is no longer valid.

● **Difference:** two direct meters can be used to determine a third measurement by difference. For example, the difference between overall consumption and the values at metering points can be used to calculate the consumption of an unmetered feeder.

● **Data Analysis:** using overall data and usage patterns (e.g., lighting during certain hours).

● **Indirect Metering:** using a formula to obtain the data required from the data measured, e.g., boiler gas use can be calculated based on hot-water flow rate and temperature.

● **Estimation:** estimate based on kWh/m<sup>2</sup> or the number of occupants.

The direct metering and hours-run methods are directly supported by the Data Logger.

The indirect metering, difference, data analysis and estimation methods can be performed in StruXureWare Energy Operations.

Detailed information can be found in the document entitled "Designing a metering system for small and medium-sized buildings".

## 3.2 Guidelines for selecting the right electricity meter

The diagrams and table below are intended to help select the right type of meter according to the electrical architecture, current ratings, and load or feeder sensitivity. Sensitive feeders require particular attention in terms of power quality and electrical distribution monitoring.

### 3.2.1 Requirements per electrical distribution level

The category of metering device generally depends on where it is installed in the electrical distribution system.

- Metering devices that are installed at the installation's main supply should allow:
  - Analysis of building electricity demand (load profile) and peak demand (value and duration)
  - Verification of energy bills and penalties (reactive consumption and overload).
  - Analysis of power quality such as harmonic distortion

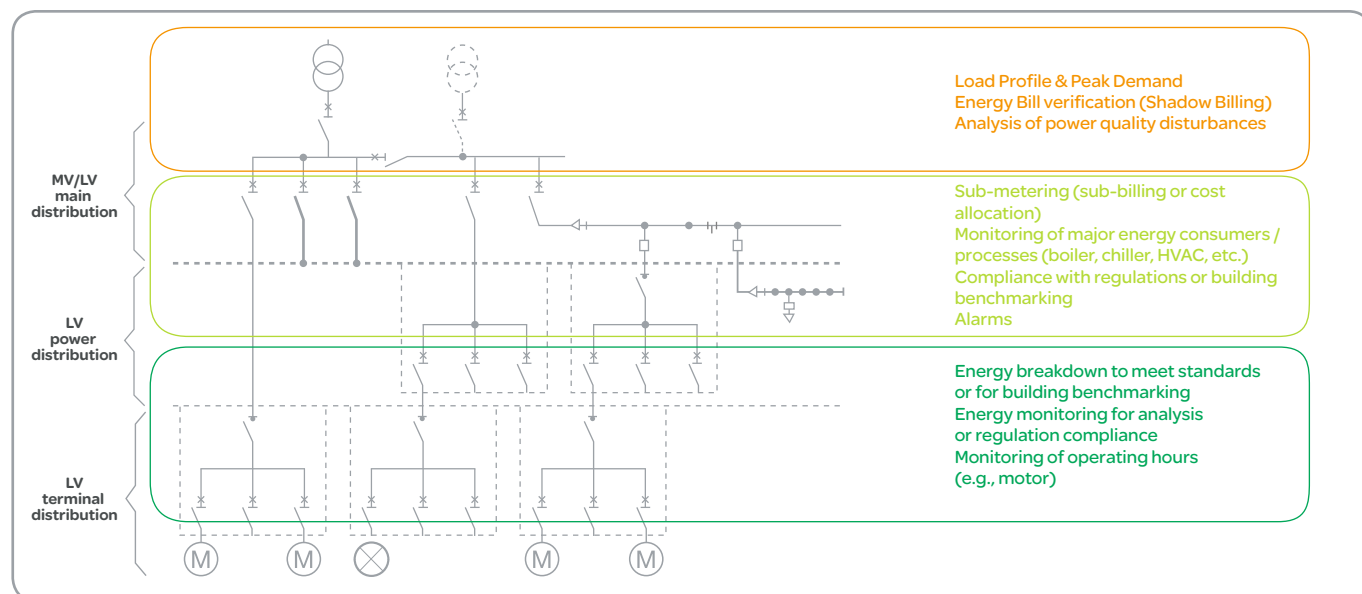
- Metering devices that are installed at the main low voltage switchboard feeder (or at the sub-distribution switchboard feeder) should allow:

- Sub-metering (consumption monitoring of building areas or processes) for cost allocation
- Consumption monitoring for building utilities such as Air Handling Units, boilers, chillers or other major energy usages, for:
  - Energy usage analysis
  - Building benchmarking
  - Standards or certifications
  - Building control optimization
  - To improve maintenance with alarms

- Metering devices that are installed closest to the point of consumption should allow:

- Energy use breakdowns to be produced so as to comply with certain standards and certifications, or to enable building benchmarking
- Energy consumption monitoring for:
  - Energy usage analysis
  - Building management optimization
  - The number of operating hours of a machine or motor to be counted for maintenance purposes. (Fig. 2)

Fig. 2



### 3.2.2 Meter characteristics

#### 3.2.2.1 Main electrical supply

##### ● Rating current < 630 Amps

Metering devices that are installed at the electrical installation's main supply should collect common data for the entire installation:

- Overall active and reactive energy consumption with the overall power factor
- Harmonic distortion (THD) to check network power quality
- Overload alarming and min/max Power/Voltage/Current to monitor overall energy consumption and maintenance parameters (Fig. 3)

##### ● Rating current > 630 Amps

In addition to the previous requirements, for this rating it is advisable to:

- Limit measurement uncertainty by selecting a meter with class 0.5 accuracy and one that allows the energy bill to be verified
- Be able to perform event analysis for the maintenance team, which means selecting a meter with event stamping
- Obtain the load profile and synchronize with the utility meter for contract optimization purposes
- In a hypermarket, due to significant lighting, IT and TV department consumption, harmonic distortion may be high; a detailed harmonics analysis should be performed to determine the filtering solution best able to reduce harmonics (Fig. 4)

#### 3.2.2.2 Renewable energy production

##### ● Photovoltaic

A simple energy meter is sufficient to measure energy production.

##### ● Wind

When wind speed is low, the generator can be used as a motor (for example, to help the blades start to turn). In such cases, the wind turbine consumes energy. It is therefore advisable to select a meter with four quadrants to enable production and consumption to be distinguished. (Fig. 5)

Fig. 3 - Schneider Electric devices



Fig. 4 - Schneider Electric devices

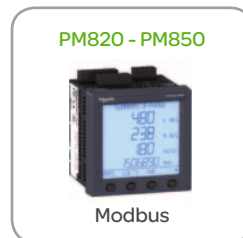
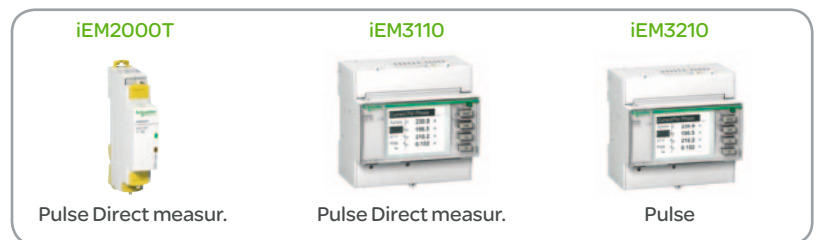


Fig. 5 - Schneider Electric devices



### 3.2.2.3 Back-up generator production

When the back-up generator is used for several hours a month due to poor utility reliability, it may be useful to measure the energy produced, as energy costs and related CO<sub>2</sub> emissions are significant when fuel oil is consumed. A simple energy meter is generally sufficient to measure energy production. However, data such as voltage and current can be useful for alarming.

### 3.2.2.4 Sub-distribution board feeders

#### ● Rating current < 630 Amps

Active and reactive power to more easily identify sources of reactive power consumption.  
Phase current/energy to detect unbalanced phases. (Fig. 6)

#### ● Rating current > 630 Amps

In addition to the previous requirements, for this rating it is advisable to:

- Limit measurement uncertainty by selecting a meter with class 0.5 accuracy
- Check harmonic distortion (THD). This will facilitate the analysis required to identify harmonics sources
- Measure neutral current to detect overloads in the neutral conductor (third-order harmonics due to non-linear single phase)
- Monitor energy consumption and maintenance parameters with overload alarming and min/max Power/Voltage/Current; this is especially important for a “process” that may evolve over time, e.g., implementation of new production line equipment in an industrial building.

Applications such as tenant sub-billing require an accuracy of 1% and data logging to avoid data loss in the event of power outages or problems with communication devices. For cost allocation, 2% accuracy is sufficient. (Fig. 7)

Fig. 6 - Schneider Electric devices



Fig. 7 - Schneider Electric devices



### 3.2.2.5 Special feeders on the main switchboard

Special feeders are those that supply:

- Critical loads that must not be interrupted or that can only withstand short interruptions, such as cash registers in a supermarket.
- Loads, such as motors with variable speed drives or lighting systems (e.g., a high-power feeder in a hypermarket), that may disrupt sensitive loads.

#### ● Rating current < 63 Amps

For these feeders, energy consumption metering should be combined with installation and power quality monitoring. This means measuring electrical parameters and analyzing harmonics and other data so as to reduce curative maintenance and enable preventive and predictive maintenance. (Fig. 8)

#### ● Rating current > 63 Amps

In addition to the previous requirements, it is advisable for this rating to collect the following data:

- Harmonic distortion (THD) for loads that produce harmonics (motors, lighting, IT servers); for motors in particular, harmonic distortion may also reveal problems, as the current is a direct reflection of the motor's health and can help to decide whether to carry out preventive maintenance on the motor
- Overload alarming and min/max Power/Voltage/Current to monitor energy consumption and maintenance parameters for sensitive loads
- For high-harmonic producing loads, the neutral current has to be measured to detect overloads in the neutral conductor. (Fig. 9)

#### ● Rating current > 630 Amps

In addition to the previous requirements, it is advisable for this rating to:

- Limit measurement uncertainty by selecting a meter with class 0.5 accuracy and one that allows the energy bill to be verified
- Be able to perform event analysis for the maintenance team, which means selecting a meter with event stamping
- Obtain the load profile to identify the source of peak demand for contract optimization. (Fig. 10)

Fig. 8 - Schneider Electric devices

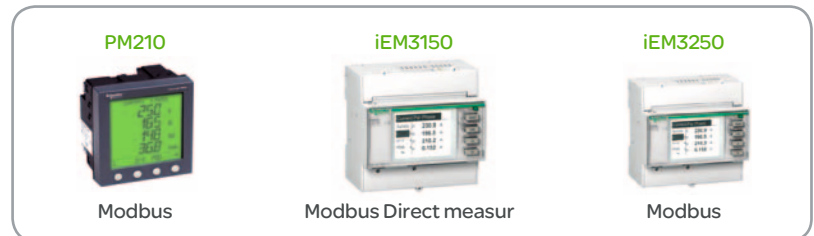


Fig. 9 - Schneider Electric devices



Fig. 10 - Schneider Electric devices





### 3.2.2.6 Special feeders in a sub-distribution board

- Energy consumption
- Main electrical parameters to check the load's performance and power supplies. (Fig. 11)

### 3.2.2.7 Common feeders (Main and sub-distribution boards)

#### ● Rating current < 63 Amps

A simple energy meter is sufficient to measure energy consumption.(Fig.12)

#### ● Rating current > 63 Amps

In addition to the previous requirements, it is advisable for this rating to gather:  
-Main electrical parameters (voltage, current) to check the load's performance and power supplies. (Fig. 13)

Fig. 11 - Schneider Electric devices

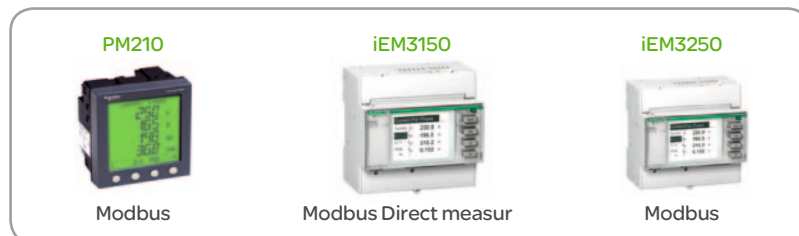


Fig. 12 - Schneider Electric devices



Fig. 13 - Schneider Electric devices



# 4 Guidelines for selecting networks for the collection and publication of data

This chapter presents the various communication networks that can be used to collect data and transfer this information to a remote data server. It also provides a guide to selecting a network.

The different types of network presented are based on the various possibilities offered by the Com'X 200 in terms of communication interfaces.

## 4.1 Communication interfaces of the Com'X 200

The Com'X 200 features the following communication interfaces:

- 1 RS485 serial port (Modbus)
- 2 Ethernet ports

### Options:

- GPRS via an external modem
- Wi-Fi via a USB key

The Com'X 200 also has a number of inputs allowing it to connect directly to pulse meters or sensors:

- 6 digital inputs (metering or state)
- 2 analog inputs

If the Com'X 200 has an on-board GPRS modem module:

This GPRS module is always used to publish data. If a Wi-Fi module is fitted, it can be used to connect to a PC, a tablet for the purpose of system configuration. The Wi-Fi module does not allow a permanent connection to be made. The two Ethernet ports can only be used to collect data and can only be set to "Switch" mode.

If the Com'X 200 has no on-board GPRS modem module:

A Wi-Fi module can be used to publish data. In this case, the two Ethernet ports can be set to "Switch" or "Separate" mode. If the Com'X 200 does not use a Wi-Fi module to publish data, the Ethernet ports can be configured separately. The following table lists each port's function according to the Com'X 200's configuration

An Ethernet port used for data acquisition can be configured.

- With a static IP
- As a DHCP client
- As a DHCP server

An Ethernet port used for data publication can be configured:

- With a static IP
- As a DHCP client

Options installed	Connection method	Interface	Function
GPRS option	Separate Eth/ GPRS	eth1	Data collection, Configuration
		eth2	Data collection, Configuration
		GPRS	Publication
		Wi-Fi	Configuration (temporary mode)
Wi-Fi option	Separate Eth/ Wi-Fi	eth1	Data collection
		eth2	Data collection
		GPRS	Not possible
		Wi-Fi	Publication
No options	Separate Eth1/ Eth2	eth1	Publication, Configuration
		eth2	Data collection, Configuration
No options	Switch	eth1	Data collection, Configuration and Publication
		eth2	Data collection, Configuration and Publication

## 4.2 Data collection and publication

A distinction must be drawn between two transmission networks:

- The “Data Collection” network is a transmission network used to acquire data about devices. The hardware required for this type of network can either be a serial connection or an Ethernet cable (or a Wi-Fi interface).
- The “Data Publication” network is a transmission network used to publish this data on the data analysis system. The hardware required for this type of network can either be an Ethernet cable (or a Wi-Fi interface) or a GPRS modem.

If an Ethernet cable (or a Wi-Fi interface) is used, both of the aforementioned network uses can be supported by the same physical network.

### 4.2.1 Data collection

Data collection devices can feature three different types of interface:

- Digital and analog inputs
- An RS485 Modbus serial interface
- An Ethernet interface with the Modbus-TCP protocol.

#### 4.2.1.1 Using the digital and analog inputs of devices

##### Pulse meters:

- If the meters are located on the same distribution board or close (<100 meters) to the Com'X 200, they can be connected directly to the Com'X 200's digital inputs (maximum of six connections with an acquisition frequency up to 25 pulses per second). To connect more than six meters, an additional communication interface must be added, such as an Acti9 Smartlink or a SIM10M (see chapter 4.2.2).
- If the meters are located further away from the Com'X 200:
- Connect the meters to a communication interface (Acti9 Smartlink, SIM10M), connect the latter to an EGX100 Ethernet gateway and use the site's Ethernet network to communicate with the Com'X 200 (see chapter 4.2.3).

When counting the pulses produced by a gas meter, a safety barrier must be placed between the meter and the electronic device that counts the pulses. This safety barrier must comply with ATEX 2G Ila standard.

##### Analog sensor

- If the sensors are located near (<15 to 20 meters) the Com'X 200, they can be connected directly to the Com'X 200's analog inputs (maximum of two connections). To connect more than two sensors, an additional communication interface must be added, such as a SIM10M.



#### 4.2.1.2 Using a Modbus serial network to collect data

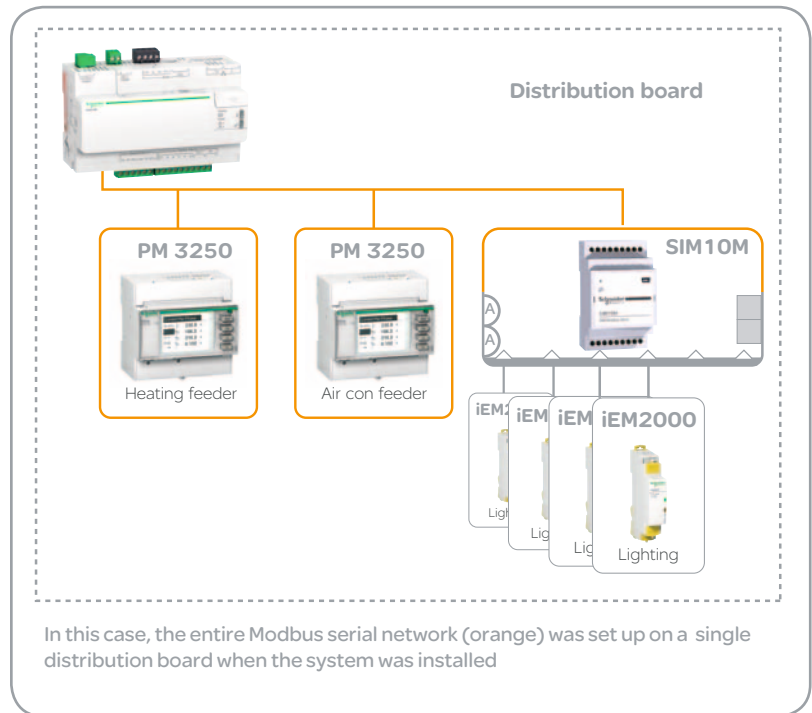
Most devices only offer an RS485 Modbus serial interface.

Setting up and using a Modbus serial network is technically the simplest method. However, because this type of network has only one purpose, it is unlikely that there will already be one in place and available at the customer site. In practice it will therefore be necessary to install all the communication cables required between the Com'X 200 and the various electrical devices.

**This solution is well suited to collecting data from devices grouped together in close proximity to the Com'X 200.**(Fig. 14)

One should not connect more than 20 Modbus slaves to a serial network (so as not to negatively impact the response times achieved via this network). Any additional meters should be connected to an EGX100 Ethernet gateway, which in turn should be connected to one of the Com'X 200's Ethernet ports (the Ethernet 2 port, by default).

Fig. 14



#### Number of Modbus slave devices connected to Com'X 200

- The maximum number of devices will depend upon the expected total response time for whole RS485 bus.
- Com'X 200 collects 5 to 7 Modbus frames per second, while 3 to 10 frames are required to collect all data (Modbus registers) from one slave. Therefore, as an average value, the number of connectable devices equates the required total expected response time in seconds.
- In energy management applications, where Com'X 200 will be used to transmit measurement data only, up to 20 devices can be connected, as a response time of 20 seconds is suitable.
- Where Com'X200 will be used also to transmit switching and control orders, implying a shorter response time, the number of connected devices should not exceed 10.
- If Modbus slaves are Masterpact breakers, they feature a frame return time around 500 ms, as data processing for tripping management and safety purposes is prioritized. The number of Masterpact breakers (Micrologic trip units) connected to on RS485 bus should not be in excess of 5.
- Disconnection of one slave (for maintenance purposes) may dramatically increase the response time, as the master will wait for a response from it until its time-out is completed.

#### 4.2.1.3 Using an Ethernet network to collect data

Setting up and using an Ethernet network is technically more complicated. However, the advantage of this type of network is that it can be used by several applications simultaneously. This means that if the customer already has such a network in place, it can be used without having to install new communication cables. In this case, Modbus-TCP <-> Modbus serial (EGX100) gateways will need to be added.

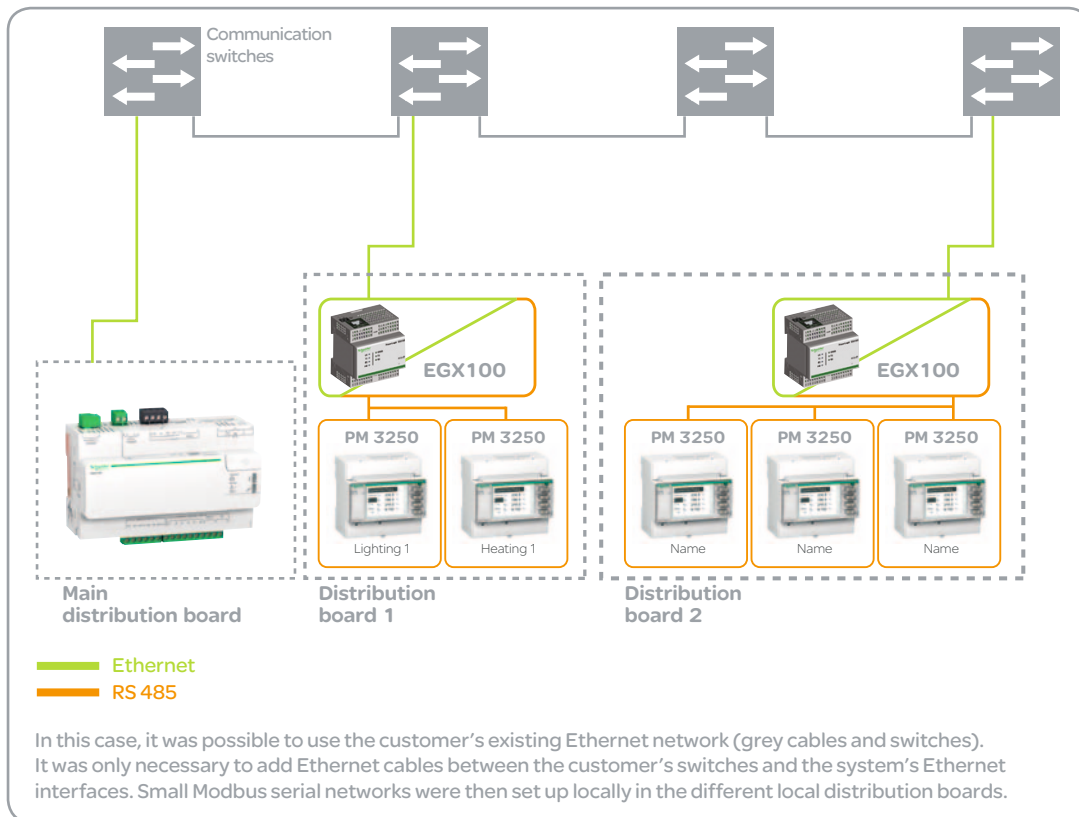
**This solution is ideal for collecting data from devices that are dispersed around the building.** (Fig. 15)

A Com'X 200 can communicate via the IP network with a maximum of 20 Modbus-TCP <-> Modbus serial gateways.

One must not connect more than 100 Modbus slaves to the various serial ports (this includes slaves of the Com'X 200's serial port and slaves of the serial ports of the different Modbus-TCP <-> Modbus serial gateways).

*NB: These two methods (Modbus serial and Modbus-TCP) can be used in parallel at a site.*

Fig. 15



#### 4.2.1.4 Ethernet connection of the Com'X 200 for data collection

The data collection network is also known as the “Downstream” network.

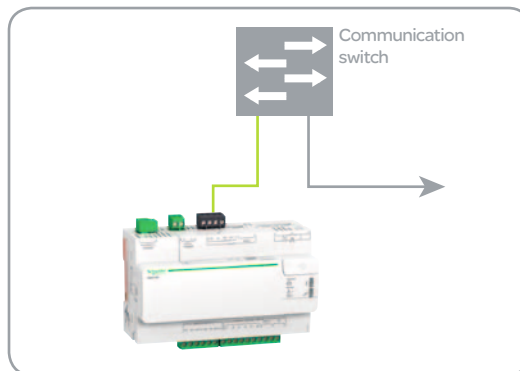
The Com'X 200 features two types of interface for connecting to the building's Ethernet network:

- A Wi-Fi interface (Radio)
- A RJ45 port (Wired)

##### **Implementation:**

- An Ethernet cable connects one of the Com'X 200's Ethernet ports to a switch on the customer's LAN. The customer's Ethernet network is then used. (Fig. 16)

Fig. 16



## 4.2.2 Data publication

The data publication network is also known as the “Upstream” network.

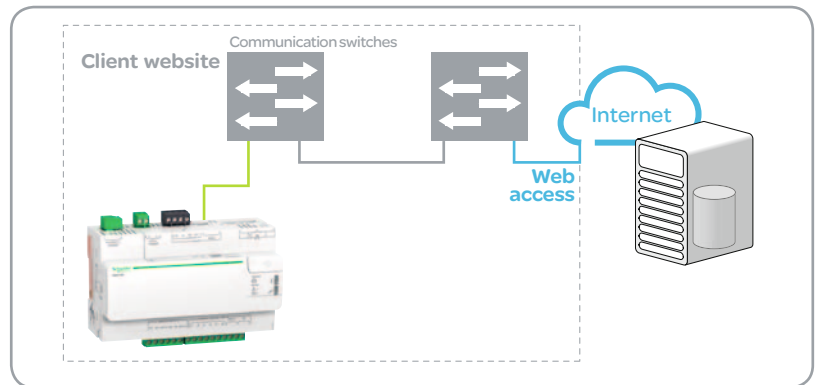
### 4.2.2.1 Data publication via the Ethernet interface

An Ethernet cable connects one of the Com'X 200's Ethernet ports to a switch on the customer's LAN. The customer's Ethernet network and internet connection are then used to transfer data to the data analysis system's server. (Fig. 17)

This solution (if it is achievable and approved by the customer) is the simplest to set up, the most secure and the cheapest to put in place. However, it may be impossible to use this solution for a number of reasons:

- The customer site does not have an Ethernet network.
- The customer site has an Ethernet network, but there is no switch near the location selected for the Com'X 200.
- The customer has refused to provide internet access.

Fig. 17





### 4.2.2.3 Data publication via the GPRS modem. (Fig. 18)

A GPRS radio connection is established between the Com'X 200's GPRS interface and a "base station" on the public GPRS network. The Internet is then used to transfer data to the data analysis system's server.

This solution is simple to implement and completely independent of the customer site's infrastructure, but it does require a GPRS subscription.

### 4.2.2.4 Comparison between these methods. (Fig. 19)

Fig. 18

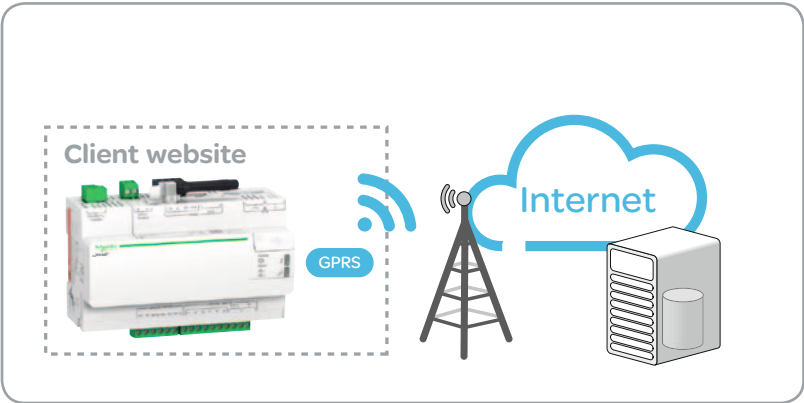


Fig. 19

	Advantages	Drawbacks
Ethernet interface	Less installation cost thanks to the use of the existing network	Access to a network switch is necessary
Wi-Fi interface	Useful when there's no Ethernet RJ45 socket available	Sensitive to radio disturbances
GPRS modem	Independent of the customer site's network	Cost of a GPRS subscription

NB (1): the Com'X 200 can only transfer data to one data analysis system at a time. It is therefore necessary to choose just one data publication method.  
 NB (2): the Com'X 200 does not offer a backup system for data publication. If the selected method is unavailable, it is not possible to define an alternative method.

# 4.3 Guide to selecting a network architecture

## 4.3.1 Introduction

This chapter provides decision trees to help select the right network interfaces. It is based on the information contained in the previous chapters. (Fig.20)

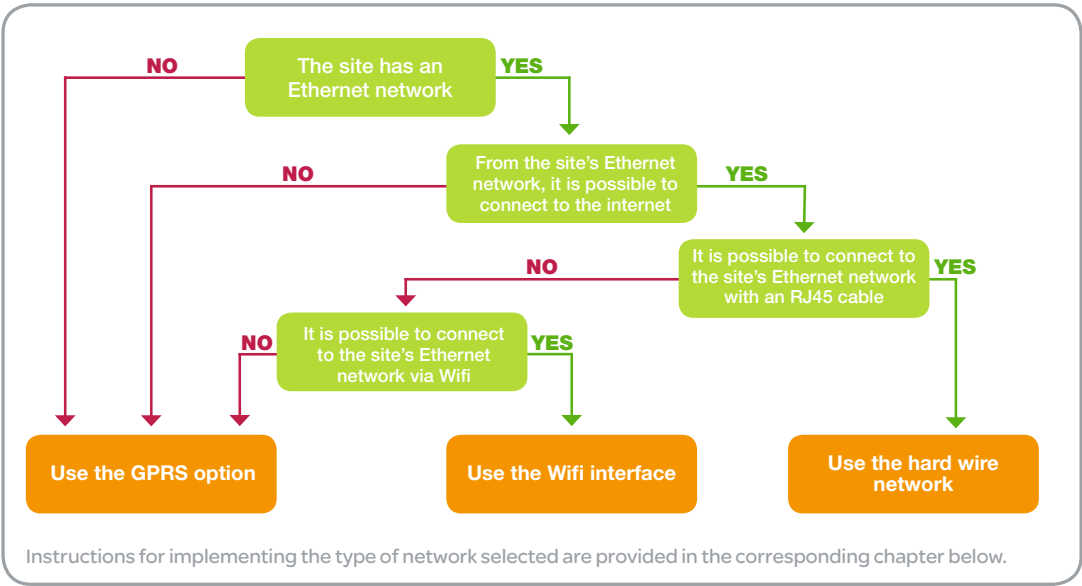
Fig.20 - The selection guide comprises

Example	Meaning
The site has an Ethernet network YES / NO	Questions, in green hexagonal boxes. Essentially, these are questions that need to be put to the administrator of the site's communication infrastructure.
Use the GPRS option	Explanations, in orange rectangles. More detailed explanations are provided in chapter 5.
Set interfaces eth1 and eth2 to DHCP client mode	Configurations required, in red rectangles. Details of these configurations are provided in chapter 5
Configure interfaces eth1 and eth2 with a static IP	Complicated configurations in grey rectangles. Details of these configurations are provided in chapter 5

— YES

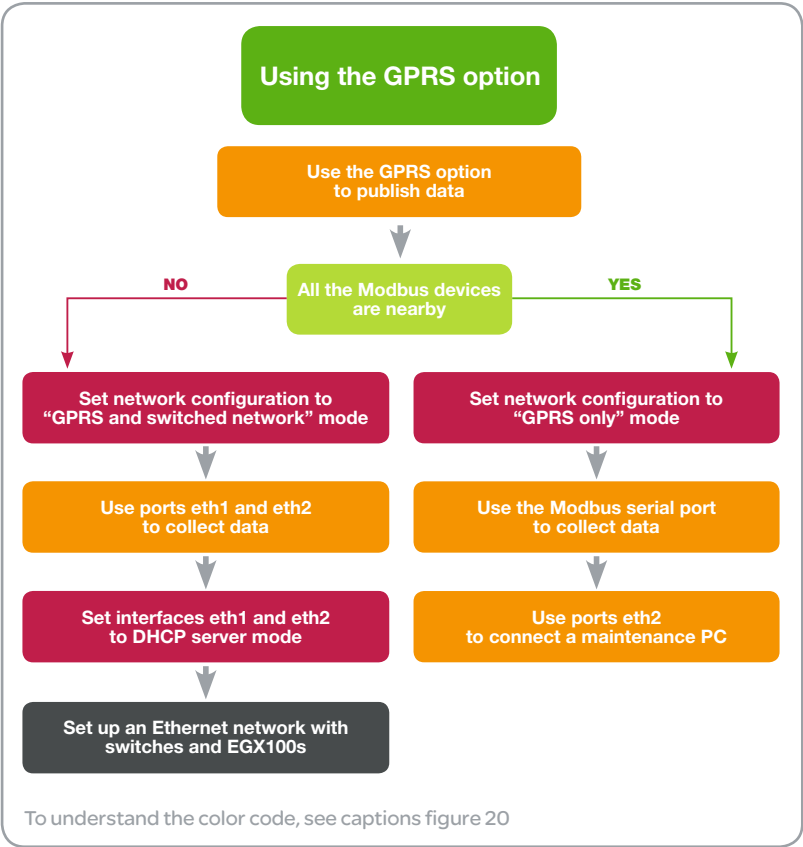
— NO

Fig. 21



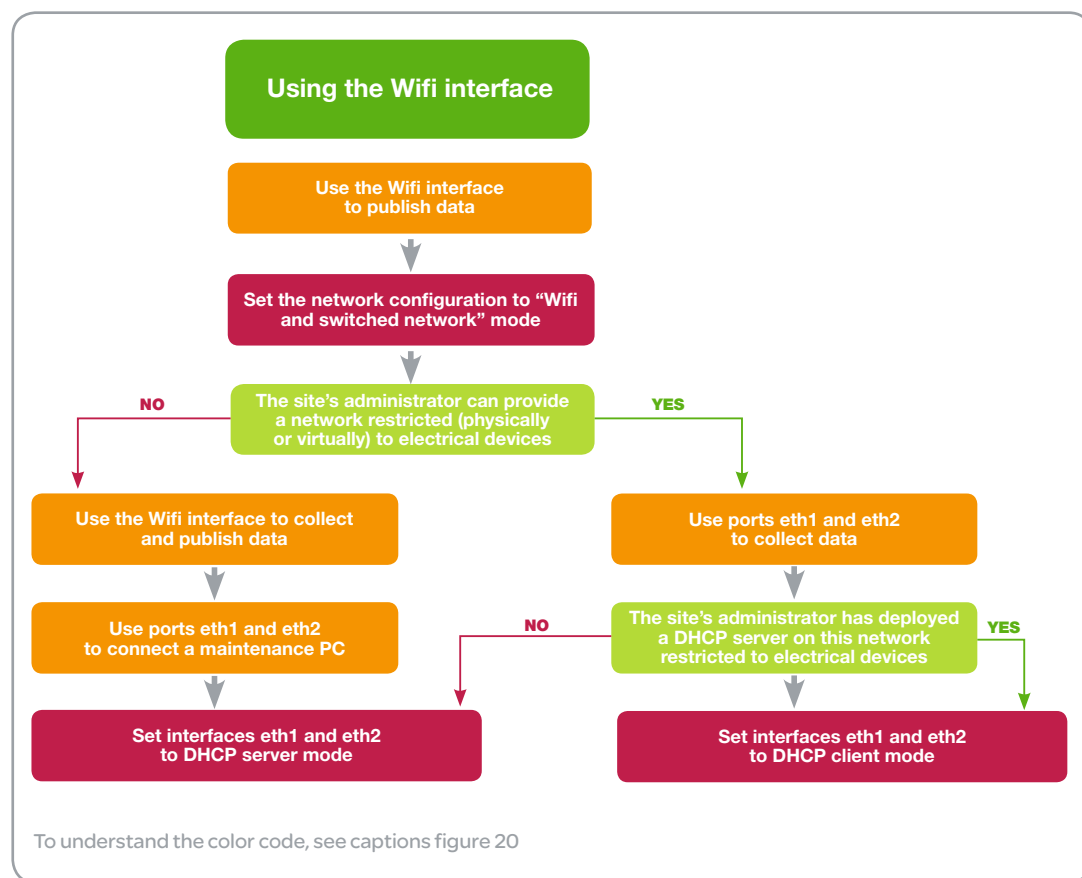
4.3.3 Network architecture  
based on the GPRS option

Fig. 22



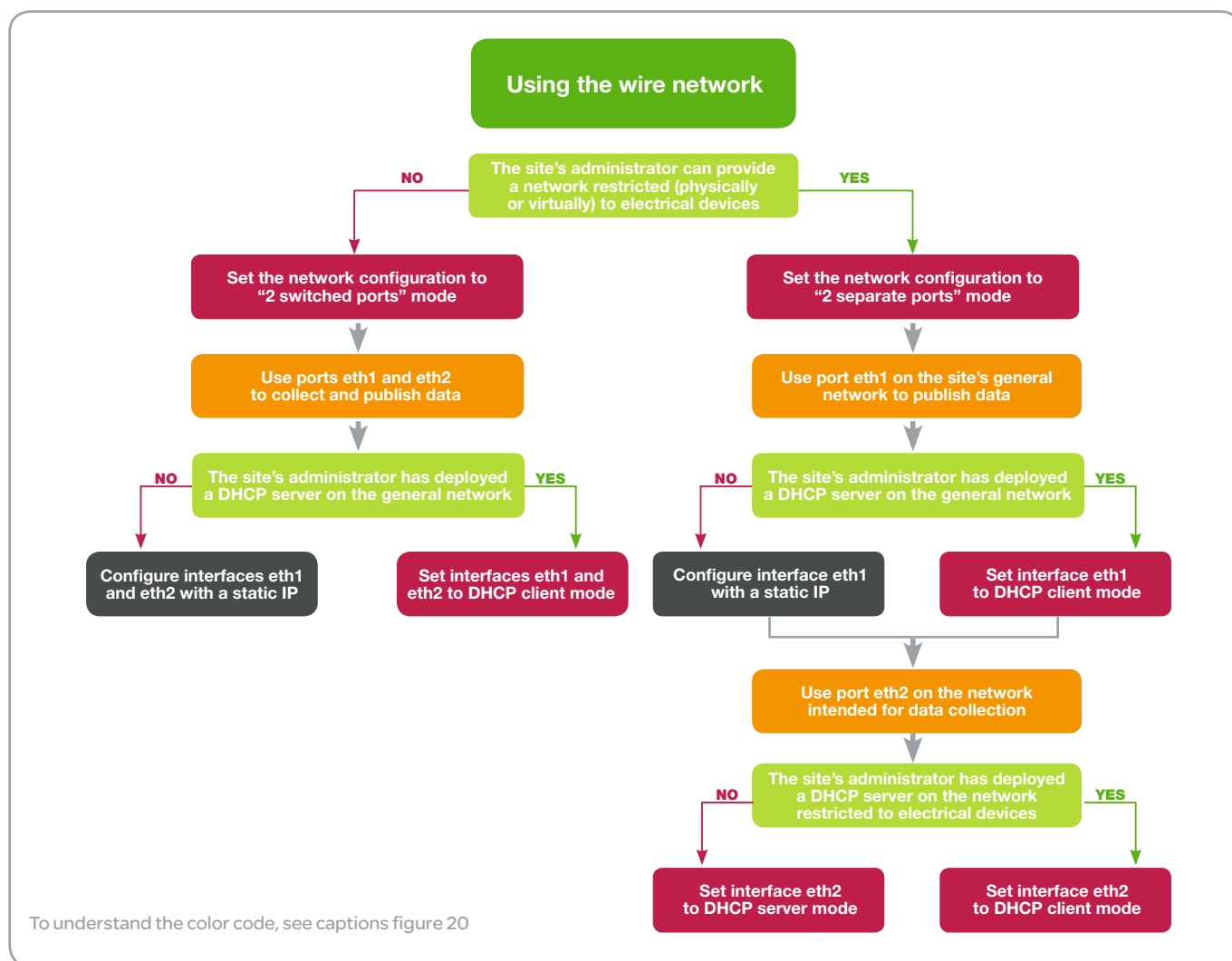
#### 4.3.4 Network architecture using the WIFI interface

Fig. 23



### 4.3.5 Network architecture with wired interfaces

Fig. 24



## 4.4 IP configuration of the Ethernet interfaces

### 4.4.1 Introduction

When different devices use the IP protocol on the same network, the IP configuration of these various Ethernet interfaces must be consistent.

- There are two ways of achieving this consistency:
- By using a DHCP server
- By setting up each device separately (static configuration)

### 4.4.2 Configuration using a DHCP server

The IP configuration may be obtained from a DHCP server set up on the network. This DHCP server ensures IP addressing consistency and prevents any errors from occurring. The DHCP server must be permanently available on this network. (Fig. 25)

### 4.4.3 Static configuration of each device

Users can define each device's IP configuration locally. In this case, it is important for each configuration to be consistent with that of the other devices on the network. (Fig. 26)

### 4.4.4 Possible configurations of the Com'X 200

The Com'X 200 offers three different operating modes for these IP interfaces.

**1. Static configuration:** The IP address (as well as the sub-network mask and the default gateway) to be used by an Ethernet interface can be defined in the Com'X 200. These values must be consistent with the site's network policy. This information should be requested from the site's IT administrator.

**2. DHCP client:** The Com'X 200 can be configured so that the IP address used by this interface is supplied automatically by the site's DHCP server. In this case, the site's IT administrator can be asked to ensure that this DHCP server always supplies the same IP address to the Com'X 200.

**3. DHCP server:** The Com'X 200 can be configured so that it provides all IP addresses for the network. In this case, the Com'X 200 configures the interface with the IP address 10.25.1.1. It also starts up an internal DHCP server, which enables it to automatically supply an IP address consistent with its own to any device on the network that is set to DHCP client mode. In this case, it is important to check with the site's IT administrator that the network is physically or virtually separate from the rest of the site's installations. In practice, this configuration can only be used if a GPRS or Wi-Fi interface is also activated on the Com'X 200 for data publication.

Fig. 25

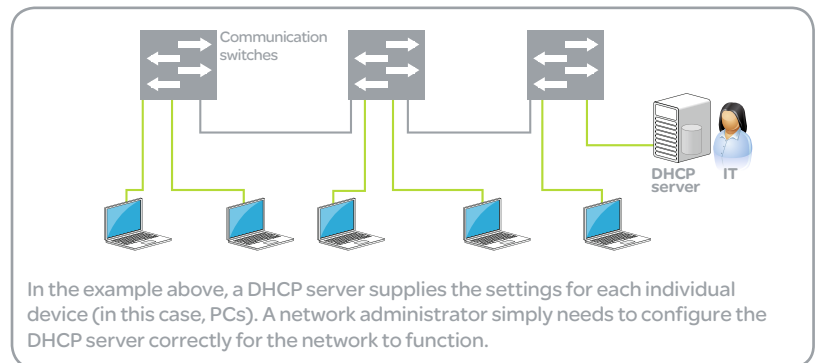
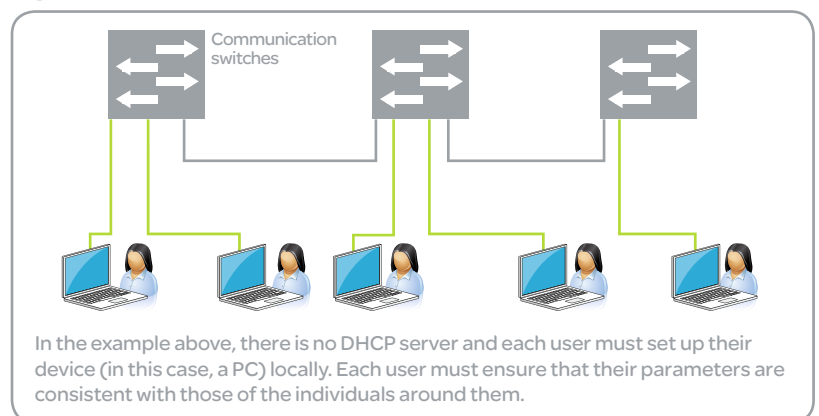


Fig. 26



## 4.5 Configuration of the two Ethernet ports

### 4.5.1 Introduction

The Com'X 200 has two Ethernet ports.

The Com'X 200 can be configured so that its two Ethernet ports are managed together ("2 switched ports" mode) or independently ("2 separate ports" mode).

*NB: If a GPRS interface is installed, network configuration can be set to «GPRS only» or «GPRS and switched network». If «GPRS only» mode is selected the 2 ethernet ports are also configured with the default values of the «2 separate ports» mode and their configuration cannot be changed. Eth1 is thus configured as DHCP client, and Eth2 is configured as DHCP server; in this case, the default gateway of the Com'X 200 is provided by the GPRS interface, (the default gateway received by the Eth1 interface is dropped).*

### 4.5.2 Configuring the Ethernet ports to "2 switched ports" mode

In Switch mode, the settings for the two Ethernet ports are the same. The fact that there are two ports simplifies cabling: one of the two ports can be connected to a switch on the local network, while the other can be used to connect a PC for configuration purposes or to connect directly to a data collection device also fitted with an Ethernet port.

In Switch mode these two ports have the same set of IP address configurations:

- The IP address (as well as the sub-network mask and the default gateway) to be used can be defined in the Com'X 200. These values must be consistent with the site's network policy. This information should be requested from the site's IT administrator.
- The Com'X 200 can be configured so that the IP address used by these two ports is supplied automatically by the site's DHCP server. In this case, the site's IT administrator can be asked to ensure that this DHCP server always supplies the same IP address to the Com'X 200.
- The Com'X 200 can be configured so that it provides all IP addresses for the network. In this case, the Com'X 200 configures these two ports with the IP address 10.25.1.1. It also starts up an internal DHCP server, which enables it to

automatically supply an IP address consistent with its own to any device on the network that is set to DHCP client mode. In this case, it is important to check with the site's IT administrator that the network is physically or virtually separate from the rest of the site's installations. In practice, this configuration can only be used if a GPRS interface is also activated on the Com'X 200 for data publication.

*NB: there is a physical difference between the two Ethernet ports: Port Eth1 can be used to supply power to the Com'X 200 using "Power Over Ethernet (POE)" technology. Port Eth2 does not offer this possibility.*

### 4.5.3 Configuring the Ethernet ports to "2 separate ports" mode

In "Upstream/Downstream" mode the two Ethernet ports are configured differently. One of the ports must be used to collect data, the other to publish data.

The port used to collect data can be set up in one of three ways:

- By configuring the Com'X 200 with the IP address (as well as the sub-network mask and the default gateway) to be used. These values must be consistent with the site's network policy. This information should be requested from the site's IT administrator.
- By configuring the Com'X 200 so that the IP address used by this port is supplied automatically by the site's DHCP server. In this case, the site's IT administrator can be asked to ensure that this DHCP server always supplies the same IP address to the Com'X 200.
- The Com'X 200 can be configured so that it provides all IP addresses for the network. In this case, the Com'X 200 configures these two ports with the IP address 10.25.1.1. It also starts up an internal DHCP server, which enables it to automatically supply an IP address consistent with its own to any device on the network that is set to DHCP client mode. In this case, it is important to check with the site's IT administrator that the network is physically or virtually separate from the rest of the site's installations. In practice, this configuration can only be used if a GPRS interface is also activated on the Com'X 200 for data publication.

The port used to publish data can be set up in one of two ways:

- By configuring the Com'X 200 with the IP address (as well as the sub-network mask and the default gateway) to be used. These values must be consistent with the site's network policy. This information should be requested from the site's IT administrator.
- By configuring the Com'X 200 so that the IP address used by this port is supplied automatically by the site's DHCP server. In this case, the site's IT administrator can be asked to ensure that this DHCP server always supplies the same IP address to the Com'X 200.

## 4.6 Cybersecurity recommendations

### 4.6.1 Introduction

Schneider Electric has established security rules:

- At the level of Com'X 200.
- At the level of communication between the various components of the complete solution.
- At the level of services made available on the web.

Cybersecurity must be dealt with on an overall basis: it must be ensured that no local weakness (e.g. a lack of confidentiality in password management) jeopardizes the other protection systems deployed.

Regarding this, in order to be valid, this protection plan must be supplemented by precautions that must be taken by the end user.

These cybersecurity rules which are the responsibility of the end user are described at the end of this chapter.

### 4.6.2 Cybersecurity measures during design of the Com'X 200

As of the Com'X 200 design stage, a FMECA analysis made it possible to analyse failure modes, their effects and their criticality in terms of confidentiality, integrity, availability and traceability.

This study analysed possible failures throughout the life of the Com'X 200, from installation and start-up, through upgrading to replacement. It made it possible to deduce the security countermeasures to be adopted.

The organization of the Com'X 200 development team complied with the following cybersecurity rules:

- The teams that performed the verification and validation tests are independent of the development teams.
- Confidentiality rules were applied within the development team (restriction of access to confidential information). The identifiers used during prototype development are different from those used subsequently in the end products. The following cybersecurity rules were complied with:
  - The Com'X 200 development team applied the encoding security rules during development.
  - All components of the program were traced, which prohibits the installation of hidden program parts.
  - The necessary privileges to run the application were reduced to a minimum (as of release V1.2).
  - The operating system of the Com'X 200 includes all recent updates which correct known security problems.
  - The Com'X 200 operating system and application can be updated to incorporate security countermeasures against new security problems occurring after start-up.
  - The Com'X 200 can accept only update files signed by Schneider Electric (as of release V1.2) (it is possible to apply several update, but each time, the update file must be signed by Schneider Electric).

The Com'X 200 communication interfaces apply the following cybersecurity rules:

- All unnecessary services have been deactivated, and unnecessary communication ports have been closed.
- The ICMP service (response to the ping test utility) has been deactivated so as not to facilitate detection and identification of the Com'X 200 by ill-intentioned persons.
- The DPWS service which allows detection and identification of the Com'X 200 is limited by nature to the IP sub-network in which the Com'X 200 is located. By default, the routers do not route DPWS messages from one sub-network to another. This makes it possible to control the discovery of Com'X 200 and to reduce detection by ill-intentioned persons.



- The Com'X 200 has two IP interfaces. It can be configured in order to separate data acquisition flows in electrical equipment from data publishing flows to the web. The protocol used for data acquisition (Modbus) cannot protect this data. By this separation of networks, access to the communication interfaces of electrical equipment can be physically restricted. It is thus possible to prevent all the users of the plant's network from obtaining access to electrical equipment data.
- The configuration protocol is HTTPS. This protocol allows encrypting of web page exchanges, and in particular entry of the name and password during authentication.
- An internal firewall, independent of the application, ensures the application of these rules. The Com'X 200 web application applies the following cybersecurity rules:
  - Access to the application is protected by a password, and each incorrect access attempt is recorded in a log.
  - There is no hidden "gold" password.

Satisfactory application of these Com'X 200 rules has been verified by outside organizations.

- The Com'X200 successfully resisted hacking attempts carried out by professional teams outside Schneider Electric within the framework of cybersecurity tests.
- The Com'X 200 has received the level-2 Achilles certificate.

#### 4.6.3 Cybersecurity measures adopted by Schneider Electric in design of the RSP

- When logging on to the RSP, the use of security certificates on the Schneider Electric servers ensures data confidentiality (no one can interpret them) and security of the destination (this information is indeed sent to the selected server).
- The servers used by RSP are placed in a highly secure and failproof environment. Access to these servers is controlled.

- RSP offers a remote monitoring procedure. This procedure allows Schneider Electric's Technical Support to be alerted in the event of malfunctioning of a Com'X 200 on a site. This procedure uses the TR-069 application protocol which is used extensively by companies specialized in the communications and information technologies sector. This protocol is used via HTTPS, which ensures the security of exchanges.
- RSP offers a remote upgrading procedure. This procedure allows Schneider Electric's Technical Support to maintain an optimal level of quality on the Com'X 200 systems already installed. This procedure uses the same TR-069 protocol as that for remote monitoring, with the same security system.
- RSP offers a remote control procedure. This procedure allows Schneider Electric's Technical Support to respond to customer requests for support. This procedure incorporates VPN mechanisms with authentication.

#### 4.6.4 Measures to be adopted by the end user at installation of the Com'X 200

However, the protection of a complete plant requires complying with certain rules on all the equipment in said plant.

- Install antivirus software and keep it up-to-date on each of the PCs connected to this network.
- If possible, prefer secure protocols (HTTPS instead of HTTP).
- On each of the PCs connected to this network, make sure that there are no unnecessary servers open.
- Change the default passwords.
- Choose complicated passwords: minimum length of 8 characters, presence of upper case, digits and special characters.
- Protect physical access to the Com'X 200, in order to prevent an unauthorized action on the front-panel buttons.
- If the plant's communication infrastructure allows data acquisition traffic and data publishing traffic to be separated, it is necessary to protect physical access to the port of the switches allowing access to electrical equipment.

#### 4.6.5 FAQ

##### I am unable to ping test my Com'X 200

That's normal, because the ping test utility uses the ICMP service, which is deactivated. Ill-intentioned persons frequently use this service to identify their targets. It is therefore very efficient to disable this service to combat these attacks.

##### Windows Explorer is unable to discover my Com'X 200

It is possible that the PC's firewall blocks discovery messages. This firewall may be either the Windows firewall or a firewall incorporated in the PC's antivirus software. It may be necessary to temporarily disable this service, to allow the PC time to discover the Com'X 200.

##### My browser displays a security warning message when I log in to the Com'X 200 (Fig. 27)

The browser indicates that:

1. Communication with the Com'X 200 is properly secure.
  2. However, Com'X 200 is not listed among the secure sites.
- > You can nevertheless continue.

**Communication is properly secure:** Even if an ill-intentioned person manages to intercept the messages, they will not be able to interpret them because these exchanges are encrypted. The password and all the values exchanged are properly protected.

**Com'X 200 is not listed among the secure sites:** By default, a browser cannot by itself ensure that the Com'X 200 website is indeed the one that it claims to be.

When a well-known company wants to open a secure website, it must register with a certification organization approved by browsers. This organization can then issue an encryption certificate which will be valid only for the address of that organization's website. In this case, the browser ensures that the secure messages indeed leave for the right destination defined by the server's domain name.

In the case of the Com'X 200, Schneider Electric cannot ask in advance for such a certificate for each Com'X 200, because it is not known where each Com'X 200 will be installed.

As a consequence, the browser can use the encryption certificate of the Com'X 200, but it cannot guarantee that the secure messages indeed leave for the right destination, and it therefore signals a security problem. It is the responsibility of the end user on site to declare at the level of its browser that the certificate presented by the Com'X 200 is trustworthy. \* It is also possible not to use the https protocol (by setting to "No" the "Enable HTTPS redirection" parameter in "Communication parameters" / "Proxy parameters"). (Fig. 28)

Fig. 27

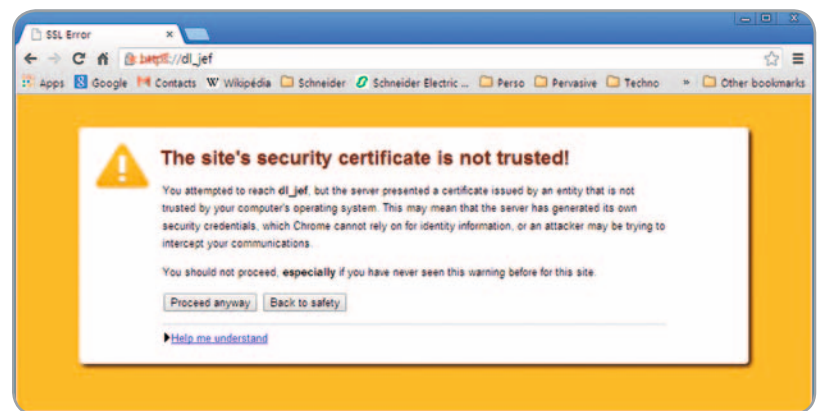
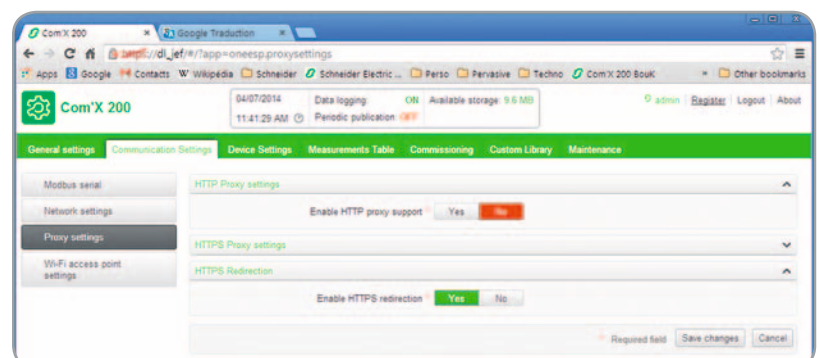


Fig. 28



## 4.7 Impact of the “Modbus Gateway” function on configuration of the Ethernet ports

### 4.7.1 Introduction

The “Modbus Gateway” function can translate Modbus-TCP requests (coming from a Modbus-TCP client on an IP network) into Modbus-RTU requests destined for a Modbus-RTU slave on an RS485 serial network.

This function requires no parameters setup. It is active from any IP port assigned to use for data collection or configuration.

Accordingly:

- The Modbus Gateway function is not operational from the GPRS modem (because the GPRS modem is used only for data publishing and not for data acquisition).
- The Modbus Gateway function is operational from the Wifi dongle in “access point” mode (because the Wifi dongle in “access point” mode is used for configuration of the Com’X 200).
- When the two Ethernet ports are configured in “switched” mode, the “Modbus Gateway” function is operational from any of these two ports because they can each be used for data acquisition.

- When the two Ethernet ports are configured in “separate” mode, the “Modbus Gateway” function is operational only from the Eth2 port because it can be used for data acquisition. On the other hand, the Eth1 port which is used only for data publishing does not offer the Modbus Gateway function.

All these rules make it possible, if necessary, to make a separation between a data acquisition network and a data publishing network.

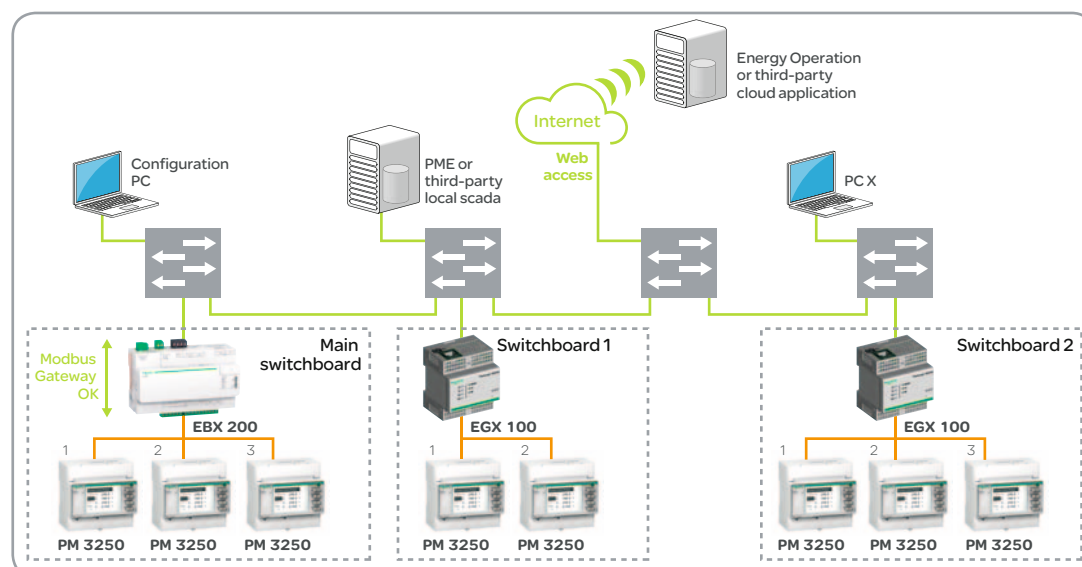
### 4.7.2 Example 1: There is only a single network which supports all the traffic (Fig. 29)

The Com’X 200 must be configured with its Ethernet ports in “Switched” mode.

The “Modbus Gateway” function allows any PC on this network to communicate with the devices on the serial link.

- The configuration PC can access the Com’X 200 but also downstream devices.
- The “Power Monitoring Expert” Server PC can access the devices downstream of the Com’X 200.
- PC X can access Com’X 200 and the downstream devices.

Fig. 29



### 4.7.3 Example 2: The site makes it possible to have 2 separate networks

These may be 2 physically different networks, or else 2 VLANs on the same physical network. The first network (in red on the diagram) is the “standard” network over which most of the traffic flows. It allows access to the web. The second network (in green) is the “technical” network over which only the technical equipment traffic flows.

There is no gateway between these two networks, so a person from the green network cannot obtain access to a device on the red network.

(Fig. 30)

The Com’X 200 must be configured with its Ethernet ports in “Separate” mode.

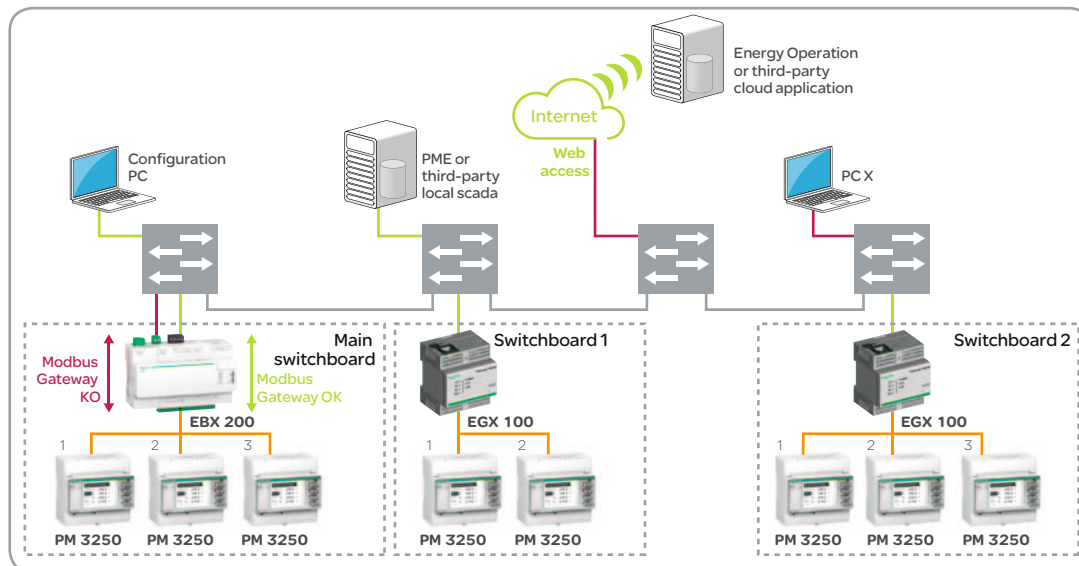
The “Modbus Gateway” function allows any PC on this red network to access devices on the serial link of the Com’X 200.

Accordingly:

- The configuration PC can access the Com’X 200 but also the Modbus devices connected to the serial link of the Com’X 200.
- The “Power Monitoring Expert” Server PC can access the Modbus devices connected to the serial link of the Com’X 200.
- PC X can access only the Com’X 200 configuration (this configuration is protected by its password). It cannot access the Modbus devices connected to the serial link of the Com’X 200.

This configuration makes it possible to stay consistent with the site’s security policy.

Fig. 30



# 5 Examples of architectures

## 5.1 Monitoring a main electricity meter

### 5.1.1 Constraints to be considered

The following key points must be considered with regard to the solution's architecture:

- The site's total electricity consumption needs to be monitored.
- The electricity meter is located in a delivery substation that may not have a communication network nearby.
- The electricity meter features a relay that generates pulses according to the amount of electricity used.
- The customer does not intend to facilitate access to its IP communication network.

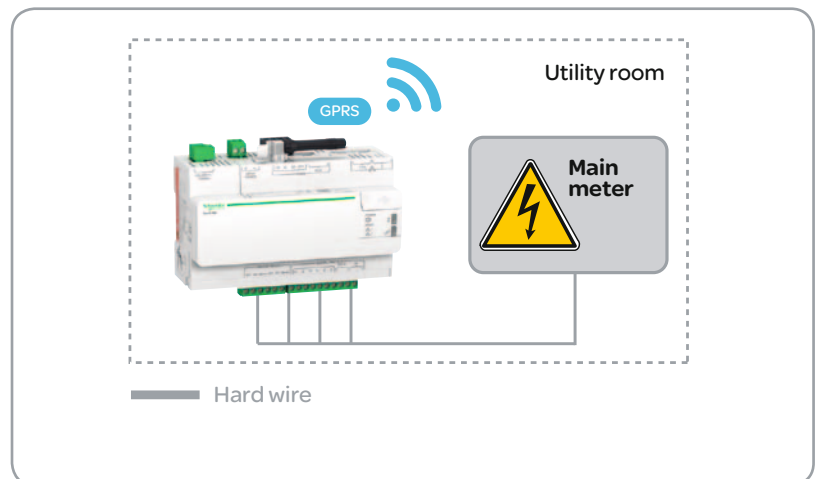
### 5.1.2 Proposed architecture

A fully autonomous solution is required.

The Com'X 200 is installed in the delivery substation. It is connected directly to the electricity meter to collect pulses generated by active and reactive power consumption. It can also collect dry contact signals from the electricity meter indicating peak and off-peak hours.

The Com'X 200 publishes its data via a GPRS modem. (Fig. 31)

Fig. 31



## 5.2 Monitoring main electricity, gas and water meters

### 5.2.1 Constraints to be considered

The following key points must be considered with regard to the solution's architecture:

- The site's total electricity consumption needs to be monitored.
- The electricity meter is located in a delivery substation that may not have a communication network nearby.
- Gas and fresh-water usage needs to be monitored.
- The gas metering equipment used must comply with the ATEX standard.
- The customer does not intend to facilitate access to its IP communication network.

### 5.2.2 Proposed architecture

A solution that is fully independent from the site's infrastructure is required.

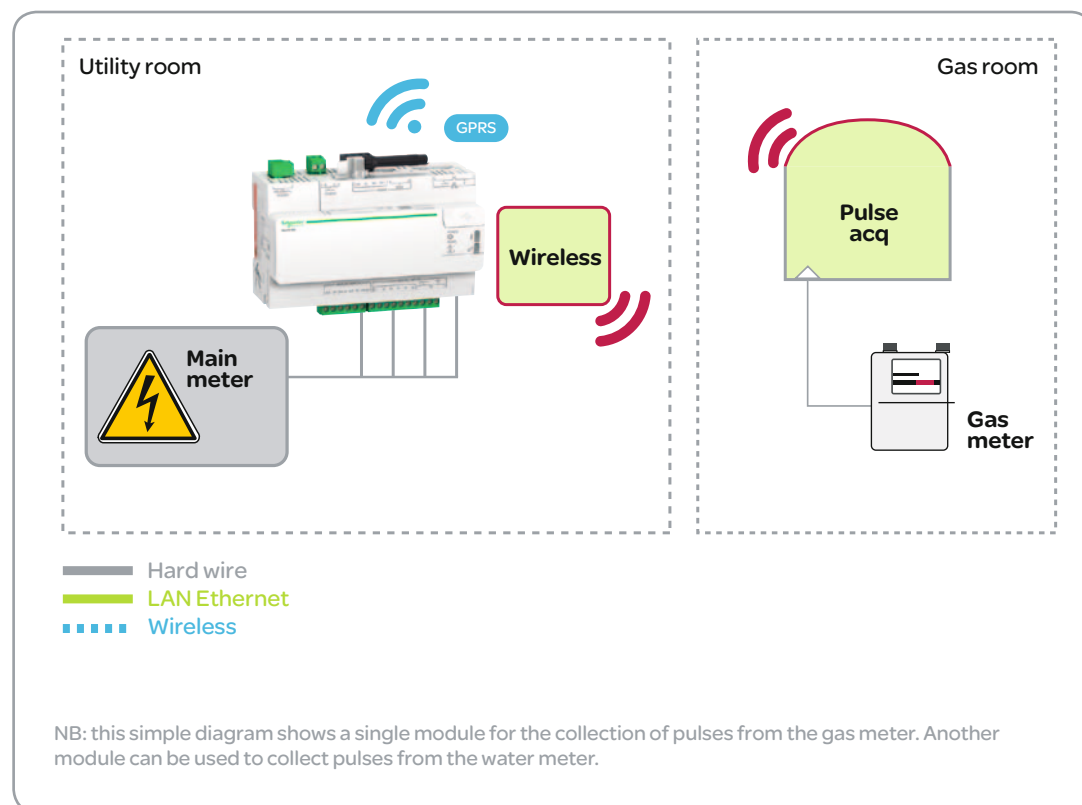
The Com'X 200 is installed in the delivery substation. It is connected directly to the electricity meter to collect pulses generated by active and reactive power consumption. It can also collect dry contact signals from the electricity meter indicating peak and off-peak hours.

A radio module allows gas and water metering information to be retrieved.

These meters are interfaced by a radio module that collects pulses.

The Com'X 200 publishes its data via a GPRS modem. (Fig. 32)

Fig. 32 - Trouver un titre au tableau



## 5.3 Bank Branch

### 5.3.1 Constraints to be considered

The following key points must be considered with regard to the solution's architecture:

- There is no gas supply to the premises.
- The consumption of drinking water does not need to be monitored (it is fairly low).
- The site is very small (1 counter and 5 offices).
- It is necessary to monitor the supply of electricity to a number of critical systems (e.g., uninterruptable power supplies).
- The main electricity meter is located next to the main electrical distribution board.

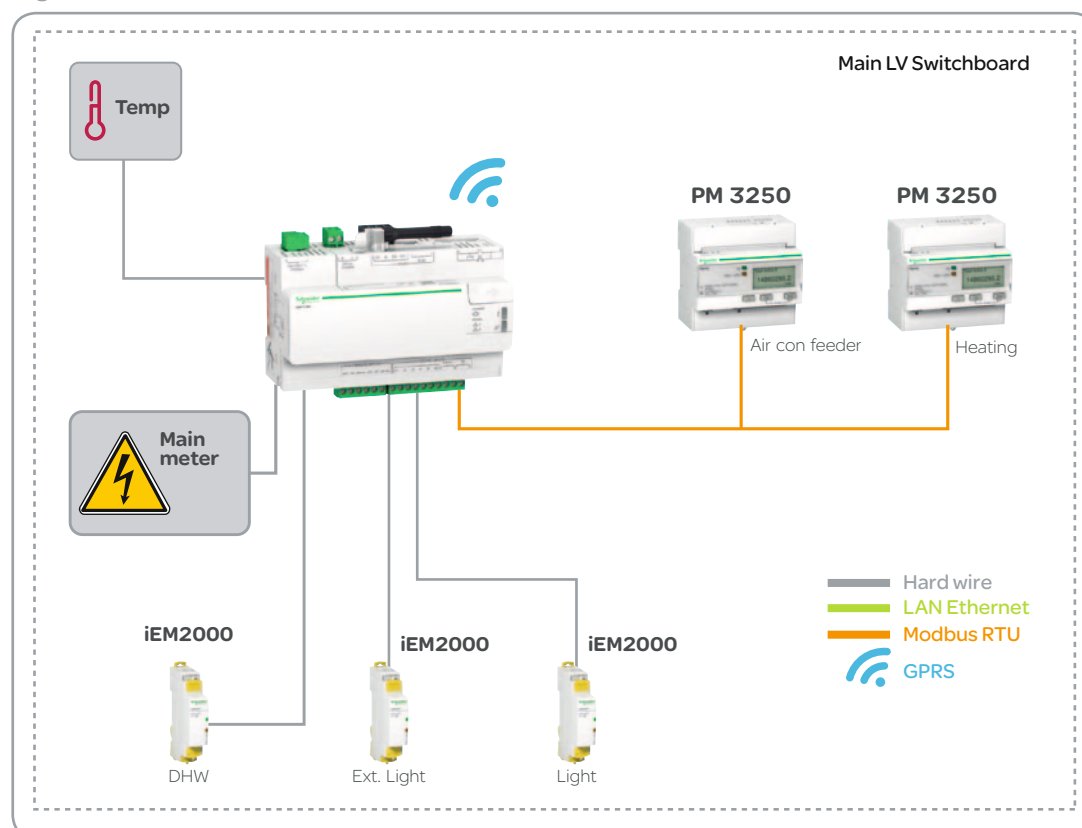
### 5.3.2 Proposed architecture

#### In this installation:

Depending on the availability of space for measurement cores, iEM3250 or iEM3150 meters are used for the three-phase circuits. iEM2000T meters are used for the single-phase circuits.

The Com'X 200 uses its RS485 Modbus interface to collect data, which is published using the GPRS option. (Fig. 33)

Fig. 33





## 5.4 High school

### 5.4.1 Constraints to be considered

The following key points must be considered with regard to the solution's architecture:

- Gas is used for two different purposes (heating and cooking), which need to be monitored separately.

- In this installation: The Com'X 200 uses its RS485 Modbus interface to collect local data and the school network to collect data from the other buildings. The data is published using the network's internet access.

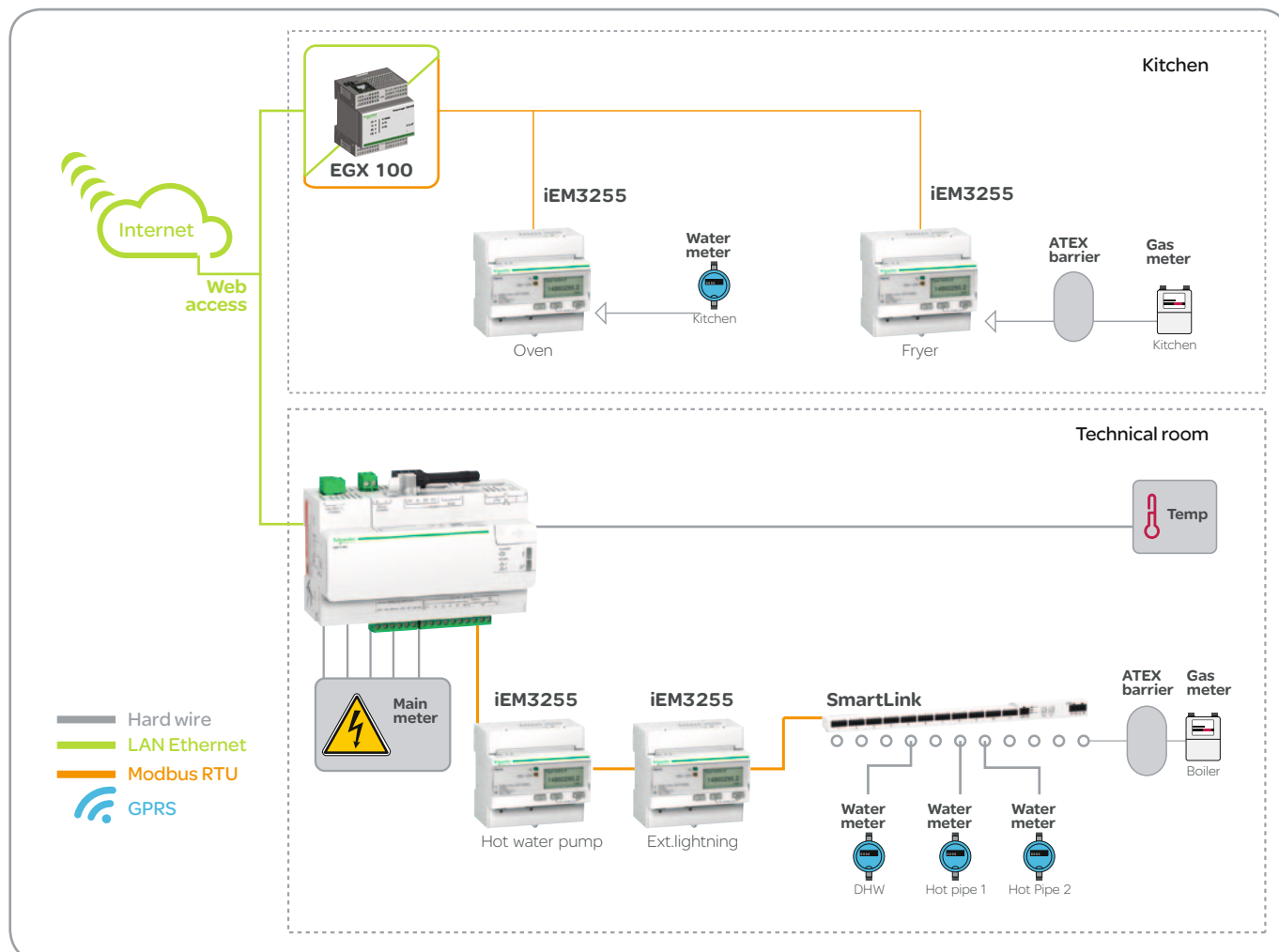
NB: In this real-life example, the distribution board does not allow us to differentiate between the different uses of electricity in auxiliary buildings.

- The Ethernet network is available in all administrative premises and in the classrooms.

### 5.4.2 Proposed architecture

Initially, because all the instrumentation is installed on the main distribution boards to reduce installation costs, the system will not provide specific information on the power used for room lighting. However, because the architecture is open, it will subsequently be possible to add a system to measure the power consumed by lighting in the remaining buildings (classrooms in particular). This open architecture will also allow additional monitoring systems to be deployed in the future. (Fig. 34)

Fig. 34



## 5.5 Medium-sized hotel

### 5.5.1 Constraints to be considered

The following key points must be considered with regard to the solution's architecture:

- Gas, fresh-water and hot-water usage needs to be monitored.
- The gas metering equipment used must comply with the ATEX standard.
- The total power consumption of the rooms needs to be monitored.
- The power supplied to critical systems must be monitored by detecting when electrical protection systems are triggered.

- The IP communication network is available everywhere.
- The main electricity meter is located near the main low-voltage distribution board

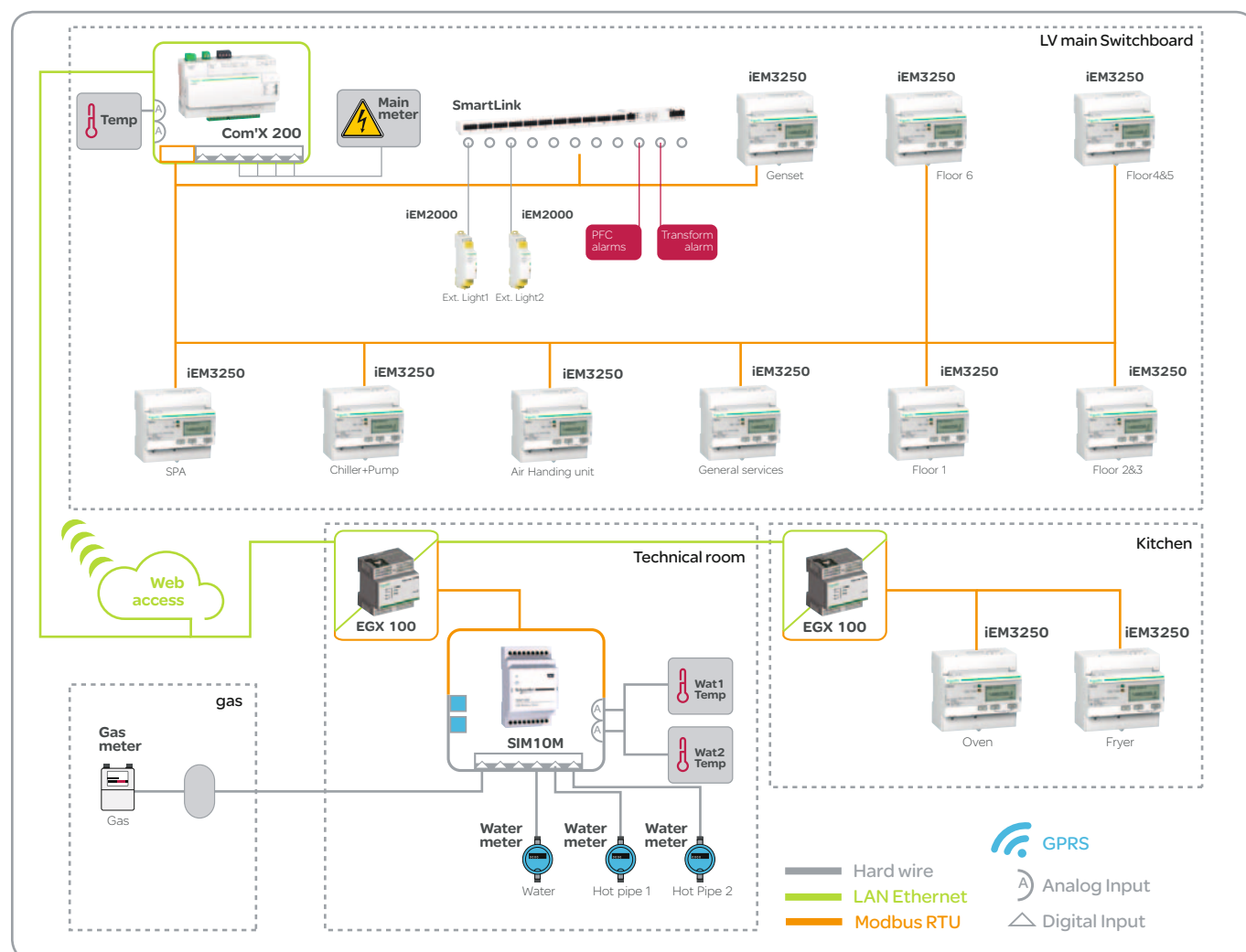
### 5.5.2 Proposed architecture

#### In this installation:

The Com'X 200 uses its RS485 Modbus interface to collect local data and the hotel network to collect data from the other floors. The data is published using the hotel's internet access.

The detection of PFC and transformer alarms allows over-consumption to be correlated against regulation faults. (Fig. 35)

Fig. 35



## 5.6 Existing offices at a site rented by a single tenant

### 5.6.1 Constraints to be considered

The following key points must be considered with regard to the solution's architecture:

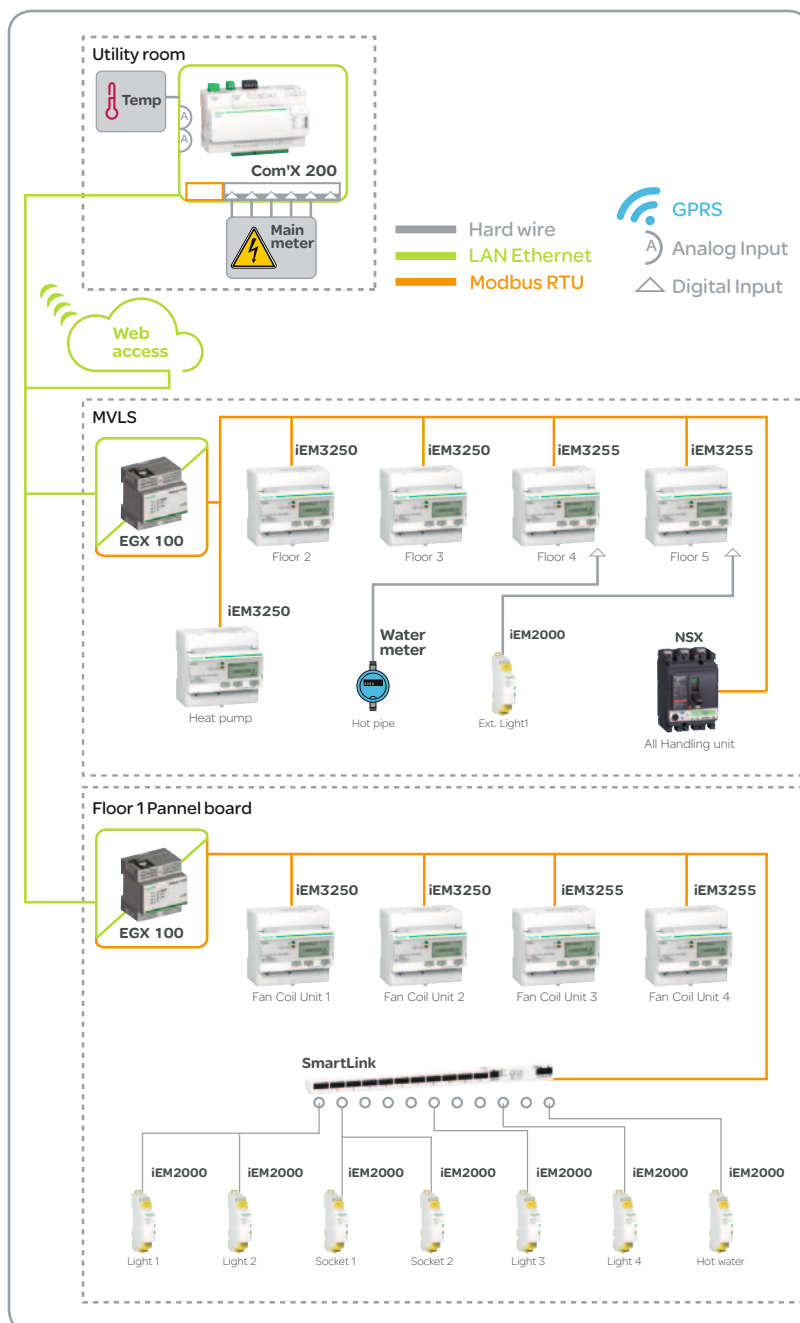
- There is no gas supply to the offices.
- The consumption of drinking water does not need to be monitored (it is fairly low).
- The building's electrical distribution boards are not far from its Ethernet network.
- The production of hot water for the heating system must be measured so as to monitor the efficiency of the heat pump.
- Power consumption must be monitored usage by usage, but the existing electricity distribution network is divided into zones rather than according to usage.
- Because the building is rented by a single tenant, the power consumption breakdown does not need to be too precise. We also assume that the breakdown of consumption usage by usage is the same on each floor.

### 5.6.2 Proposed architecture

With this architecture, the digital input of certain iEM3255 units is used to count the pulses produced by pulse meters.

To reduce the number of sub-meters that need to be installed, only the first floor is fully instrumented to measure consumption usage by usage. From this, one can deduce consumption ratios per usage for the entire first floor. A single sub-meter for each of the other floors is installed at each floor's feeder on the main distribution board. Formulas based on the ratios calculated for the first floor are used to deduce consumption usage by usage for each of the floors above. (Fig. 36)

Fig. 36



**Schneider Electric Industries SAS**

Head Office  
35 rue Joseph Monier  
92506 Rueil-Malmaison Cedex- France  
Tel.: +33 (0)1 41 20 70 00  
[www.schneider-electric.com](http://www.schneider-electric.com)