

1. What is Smart Metering?

Smart Metering is a system composed of monitoring equipment capable of communicating with a central data centre, receiving orders and taking action based on certain parameters.

Smart Meters are devices installed in or near the customer's premises, which allow bilateral communication between the utility centre and the customer.

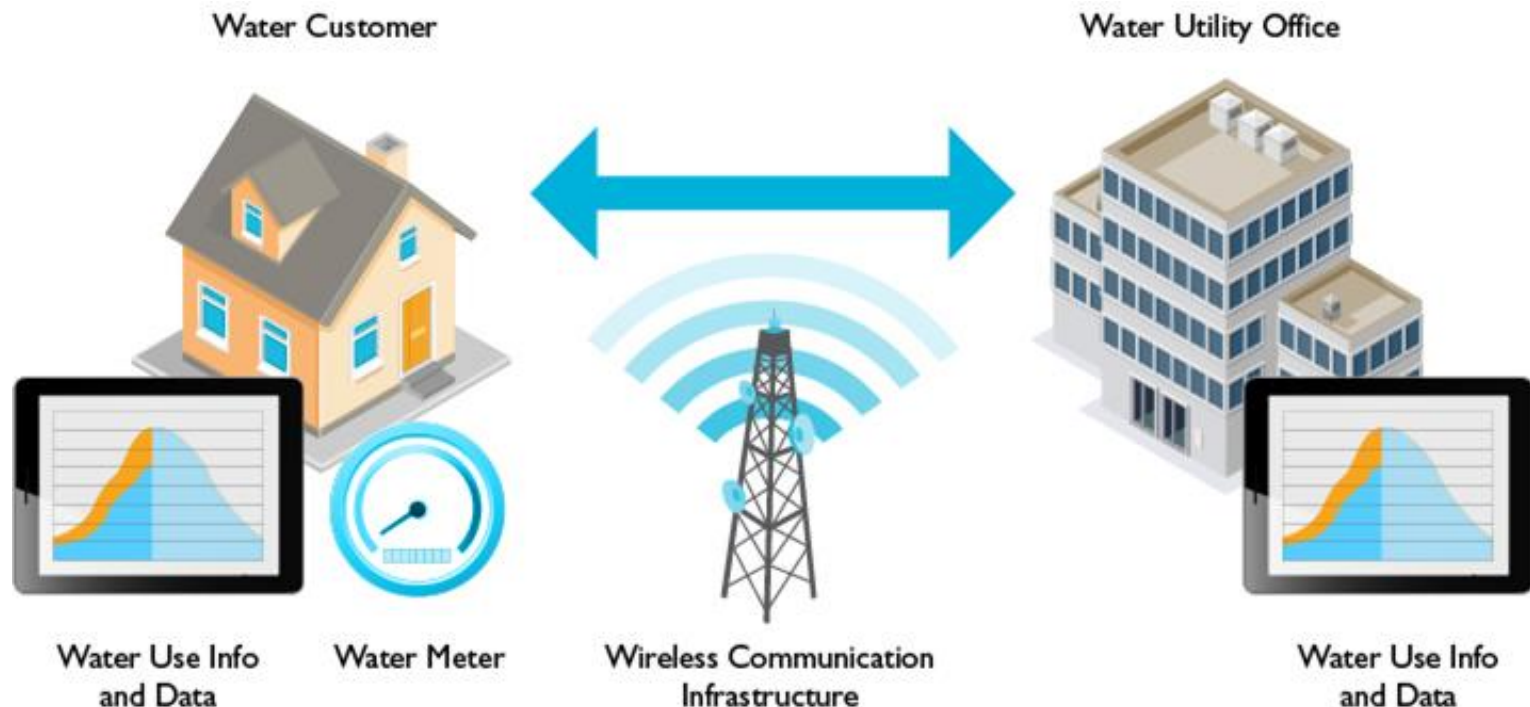


Figure 1. Automated Meter Infrastructure and Smart Water Metering.

Source: <https://www.metering.com>

2. Smart Meters

A **smart meter** is an electronic measurement device that collects energy/water data and sends it to the service or data centre.



Figure 2. Examples of smart meters. Source: <http://www.endesaeduca.com>, www.flickr.com

Conventional meters are mechanical devices, whose data needs to be collected manually; while smart meters allow reading and registering the information remotely.

In order to use smart meters it is necessary to understand the element itself as well as the communication protocol used.

2. Smart Meters

Depending on what is going to be measured, there are different types of smart meter technologies and systems.

- Power
- Water
- Gas
- Heat/Cooling



Figure 3. Measurements at home.

Source: <http://www.xatakahome.com>, <http://gcomercial.com>,
<http://aizeklima.com>, <http://guiah.net>

2. Smart Meters

Power meters

Measured parameters include:

- Reactive energy
- Instantaneous power
- Power factor
- Voltage
- Current
- Maximum demand
- Exported energy (active and reactive)
- Selected power quality characteristics



Figure 4. Meterus display. Source: <http://www.ikz.de>

2. Smart Meters

Water meters

Measured parameters include:

- Flow rate of cold water
- Flow rate of hot domestic water



Figure 5. Hydrometer CORONA-E. Source: www.lingg-janke.de

2. Smart Meters

Gas meters

Measured parameters include:

- **Energy** (if provided with a calorific value for the gas)
- **Instantaneous flow** (for ultrasonic and similar gas meters)
- **Maximum demand**



Figure 6. Gas Meter Itron. Source: www.lingg-janke.de

2. Smart Meters

Heat/Cooling meters

Measured parameters include:

- **Flow rate**
- **Temperatures** (supply, return and difference)
- **Maximum demand**
- **Instantaneous power**



Figure 7. Compact Heat Meter SensoStar 2. Source: www.engelmann.de

2. Smart Meters

The **metering point** is the location of each type of meter, which should consider the following aspects to optimize monitoring results:

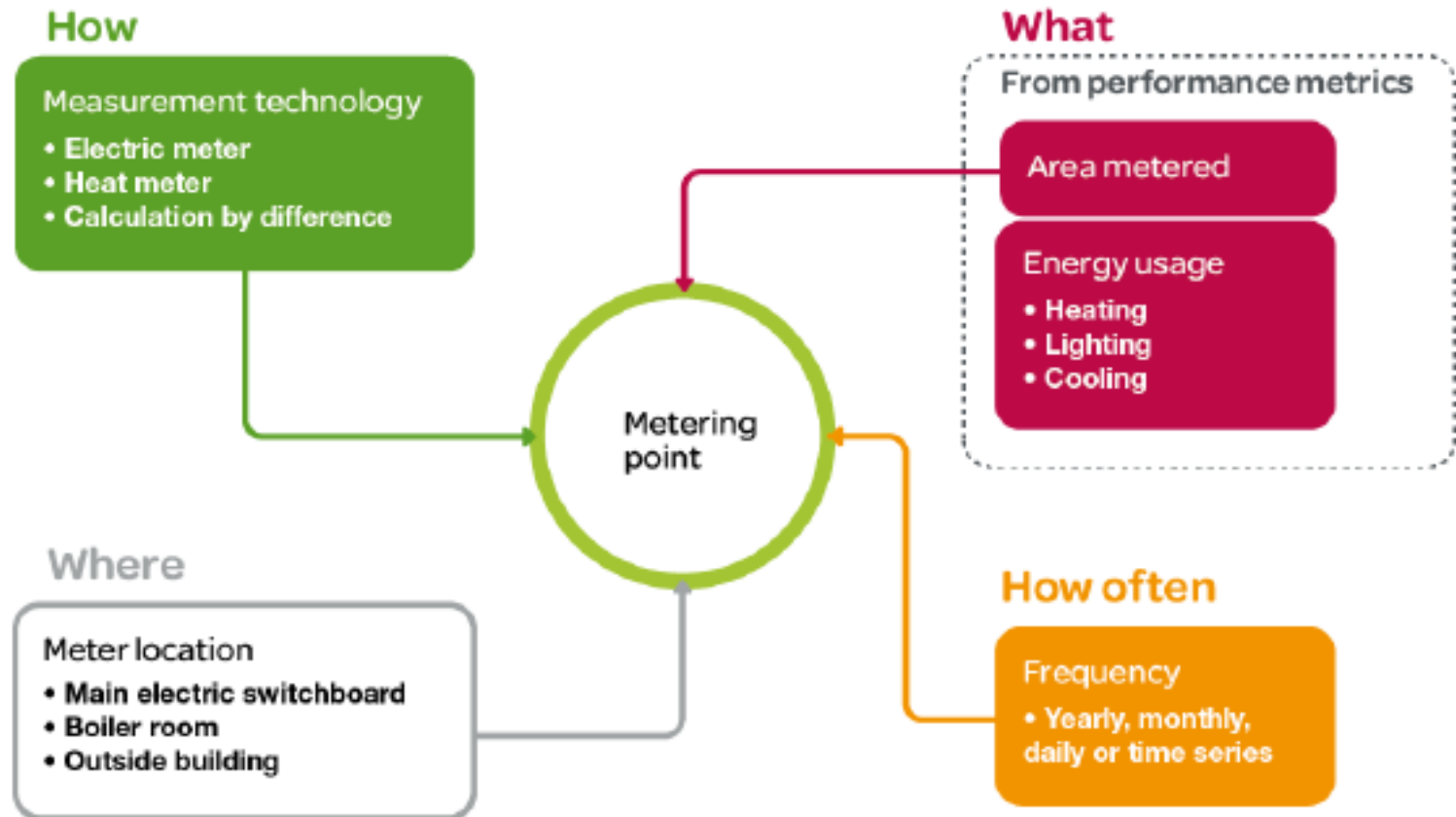


Figure 8. Metering points. Source: Reference [6]

3. Customer feedback

What can the customer do with a smart meter?

- Access real bills.
- Access real-time information measured by the meters.
- Better manage their resources (electricity, water, etc.), reducing consumption and increasing efficiency.
- Understand and choose an adequate tariff that suits them.
- Detect errors.
- Control renewable energy systems installed in the building.
- Understand their or the occupants' behaviour.



Figure 9. Electronic billing in Endesa. Source: <http://www.energia-info.es>

3. Customer feedback

Customer feedback is based on the measured data :

- Consumption, instantaneous and cumulative.
- Cost, instantaneous and cumulative.
- Prediction of the next bill.

Moreover, these devices provide additional information according to each application: electricity (disaggregated consumption data), gas (smoothed consumption data approximating to the steady heat output), heat/cooling (disaggregated by zones consumption data), water (leakage).

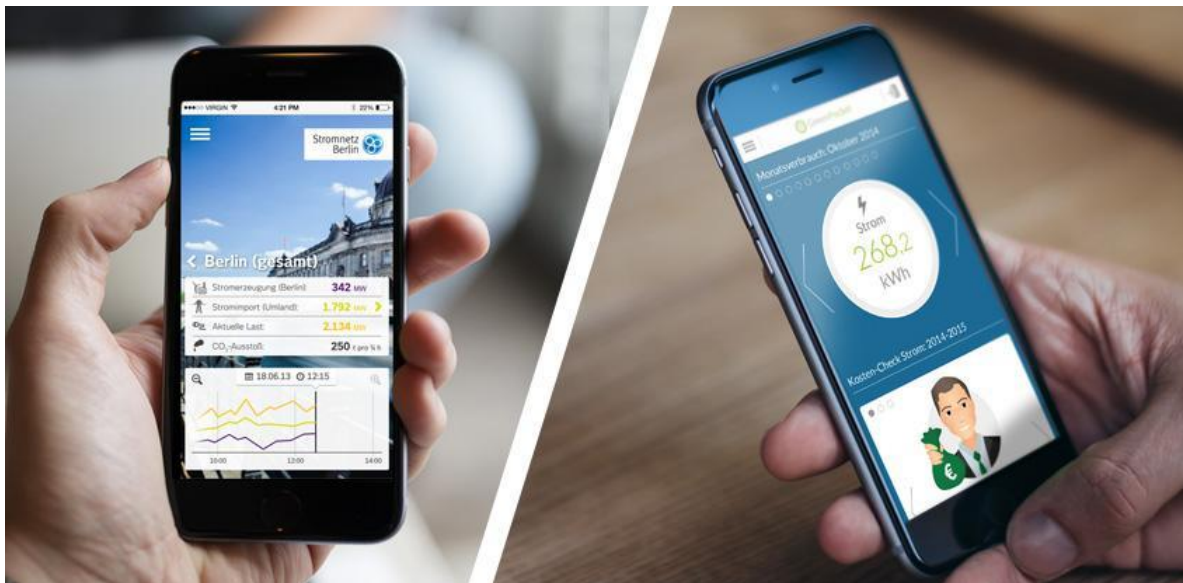


Figure 10. Example of app to consult all the information provided by the smart meter to the customer.

Source: <http://www.greenpocket.de>

3. Customer feedback

Benefits:

- No estimated bills.
- Historical data on bills.
- Possibility of achieving savings on energy bills.
- The ability to switch more easily between energy suppliers.
- The ability to adapt energy consumption patterns.
- The ability to install microgeneration measures.
- The possibility of prepaid or post-paid schemes and easier credit.



3. Customer feedback

Disadvantages:

- Smart metering is more vulnerable to criminals, vandals and hackers.
- Incorrect operation of smart meters may increment consumption and bills. It is necessary to understand measured data in order to improve the bills.



4. smart Metering

Additional **functionalities** for electricity:

Customer:

- Provide direct readings.
- Update the readings frequently enough to achieve energy savings.



Metering operator:

- Allow remote reading.
- Provide two-way communication for maintenance and control.
- Update remote readings frequently enough to allow network planning.

Commercial aspects of energy supply:

- Support advanced tariff systems.
- Allow remote on/off control of the supply and/or power limitation.

Distributed generation:

- Provide import/export and reactive metering.

Security and data protection:

- Provide secure data communications.
- Fraud prevention and detection.



4. smart Metering

Electronic devices can be connected with each other using different **communication** schemes:

Hard-wired

- Telephone networks
- Cable television
- Internet
- Fiber optic
- Waveguide (electromagnetism)

Wireless

- GSM
- GPRS
- 3G, 4G, 5G
- WiMax
- Low Power Radio
- WiFi
- Bluetooth
- Power Line Carrier (PLC)
- ADSL / Broadband
- ZigBee
- Z-Wave

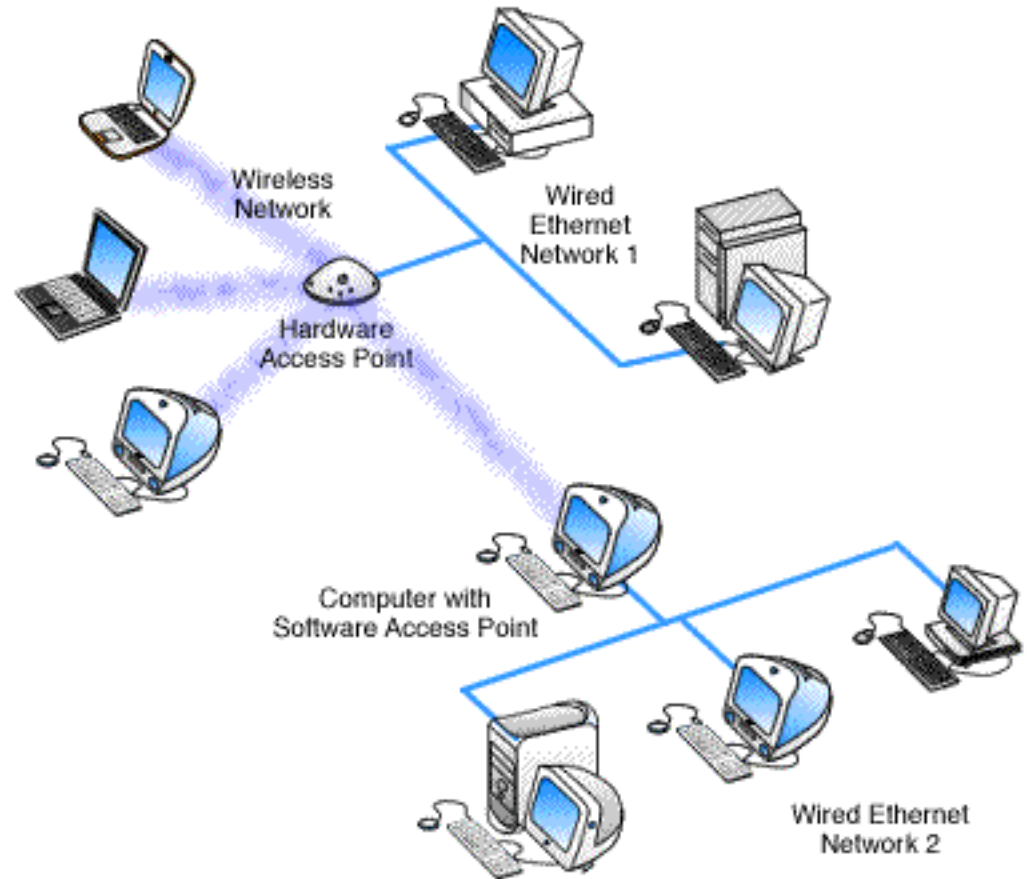


Figure 11. Office communication. Source: www.ourcyberoffice.com

4. smart Metering

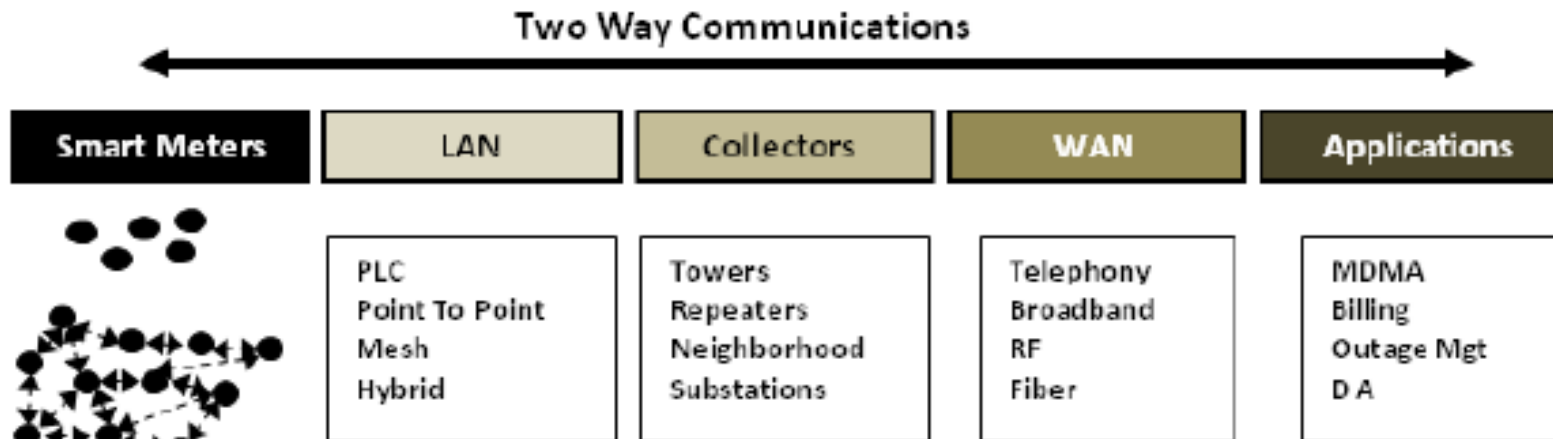


Figure 12. Smart Meter System Basic Architecture. Source: Reference [1]

Smart meters collect data locally and transmit it via LAN to a data centre.

Data is transmitted via WLAN to the utility data centre for processing. It can be used throughout business applications.

4. smart Metering



Figure 13. Sensors.

Source: <http://plcbangladesh.com>



Figure 14. Controller.

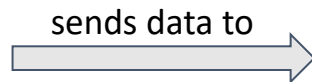
Source: <http://www.cates.com>



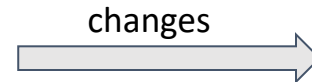
Figure 15. House.

Source: <http://inmobiliaria56.com>

Measuring equipment



Controllers



Environment

- Element for measurement.
- Data storage capacity.
- Set-up for data registering.

- Contains the control logic of the whole system.
- Collects and transmits only the necessary data.
- Compares data collected with measurements patterns for anomalies.

- CO₂ emissions avoided.
- Energy savings

5. Smart Buildings

A smart building is an automated building designed, installed and operated with advanced and integrated building technology systems.

Smart Buildings are critical in the rational use of resources (water and energy). Automated systems, such as HVAC and lighting control, power management and metering play a major role in determining the operational inefficiency of a building.



Figure 16. Smart buildings. Source: www.theonegroupputah.com, aptgadget.com

5. Smart Buildings

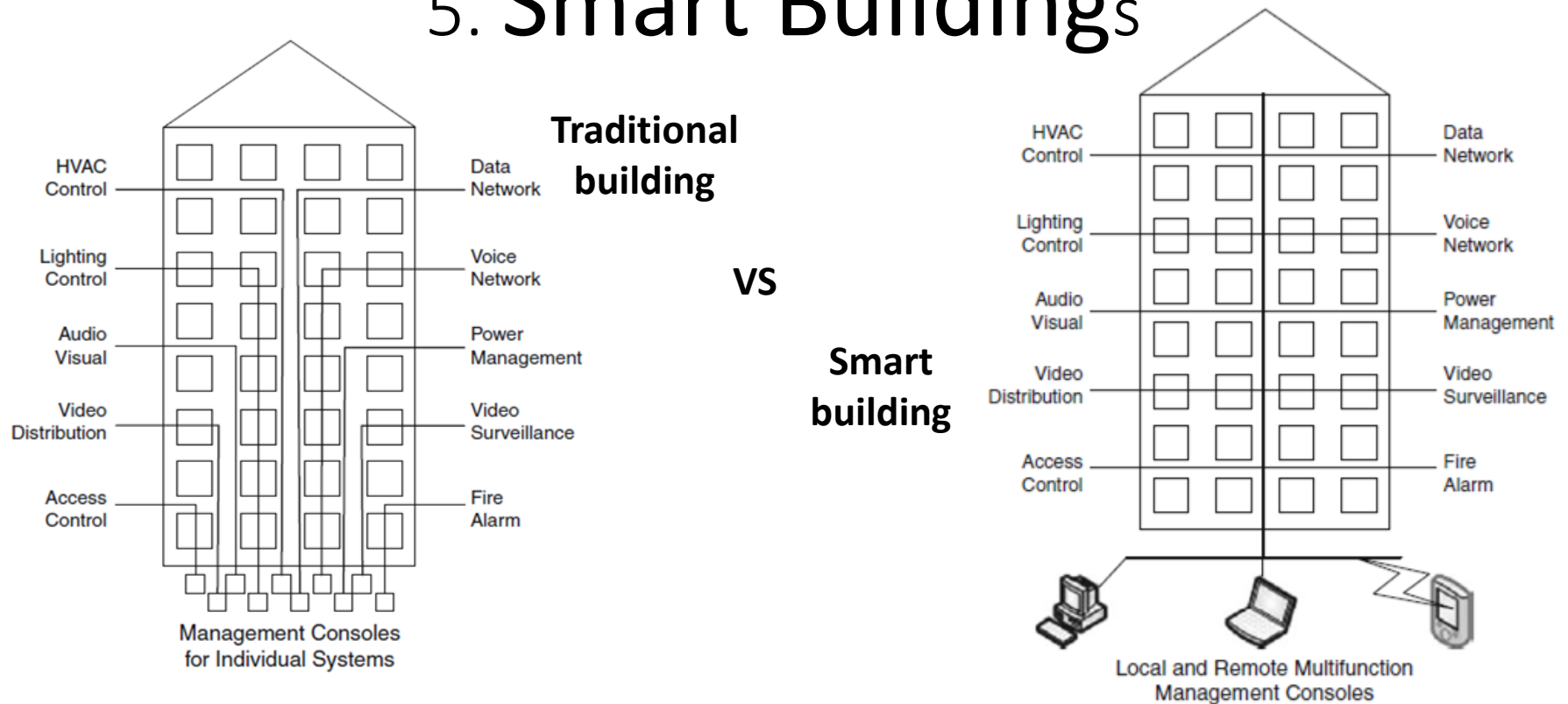


Figure 17. Multiple proprietary building systems vs Integrated building systems. Source: Reference [9]

Designing, installing, and operating each system separately.

Unified design of all building technology system and their interconnection.

5. Smart Buildings

Introducing advanced technology in buildings reduces costs not just in its operation period, but also in the construction stage.

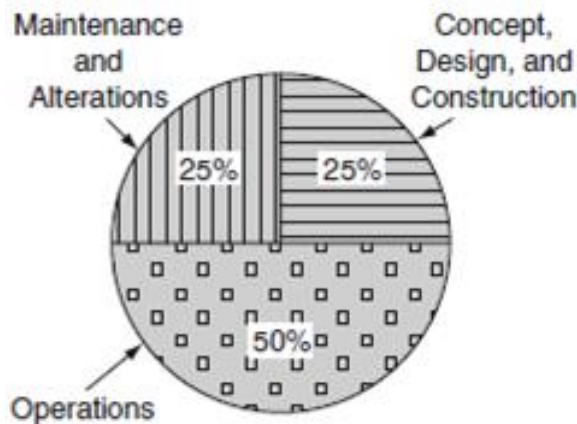


Figure 18. Life-cycle cost of a building.
Source: Reference [9]

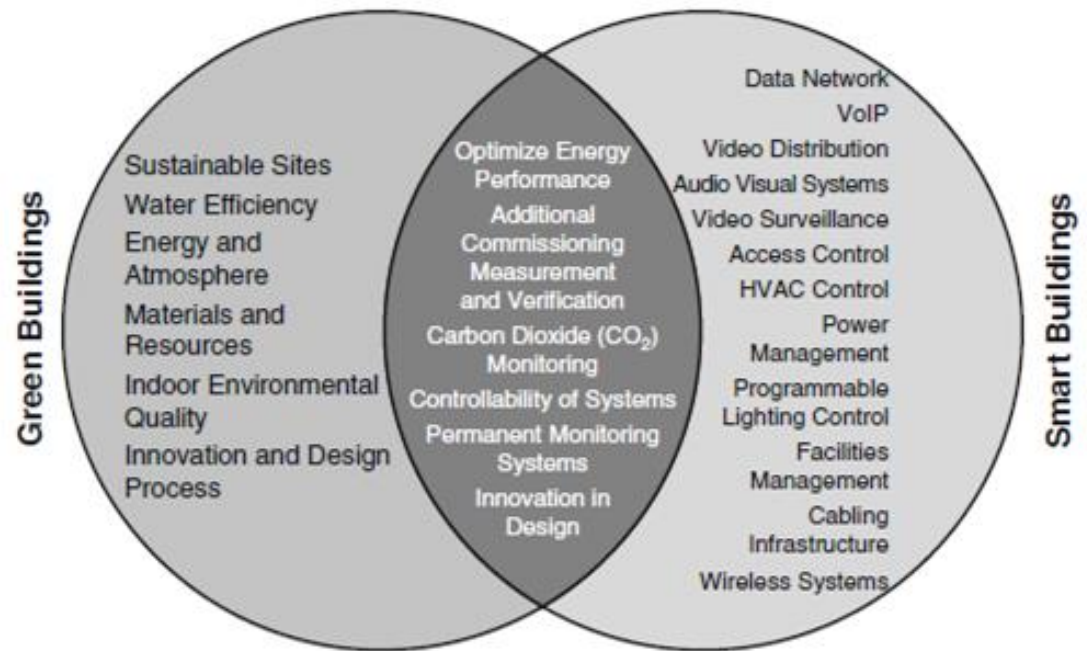


Figure 19. Commonality of smart and green buildings. Source: Reference [9]

5. Smart Buildings

Active vs. Passive energy efficiency

(There are two ways to manage energy more efficiently)

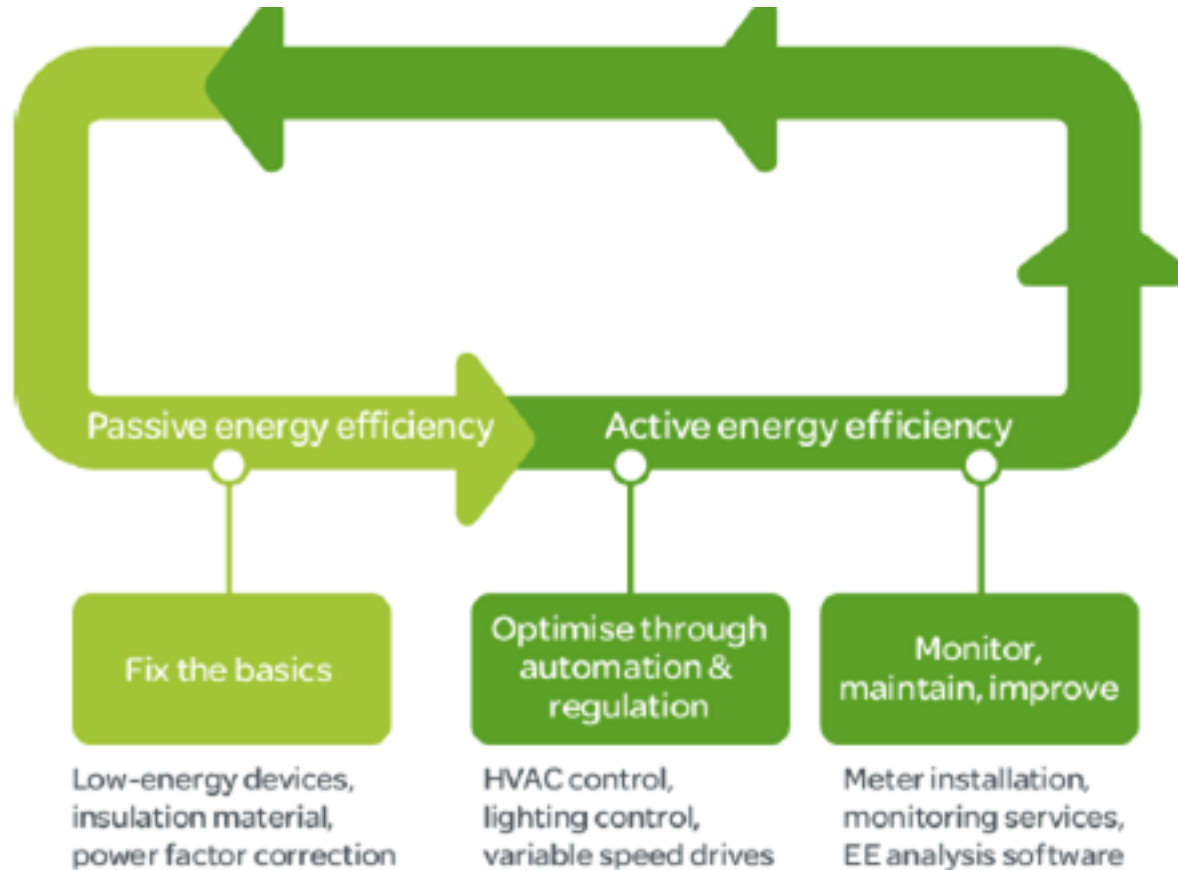


Figure 20. Energy Audit & Measurement. Source: <http://www.schneider-electric.es>

6. Environmental Impact

The only environmental impact is the **Electromagnetic Pollution**.
However, it is a topic not sufficiently studied.



Figure 21. Smart Meter radiation. Source: <http://www.wakingtimes.com>

6. Environmental Impact

Correct implementation and use of smart meters in buildings reduces the consumption of resources (power, water, gas, heating and cooling), avoiding CO₂ emissions due to use and resources production.



Figure 22. Green World. Source: www.news.lk

7. Videos



Video 1. The Smart home.

Source: https://www.smartgrid.gov/the_smart_grid/smart_home.html

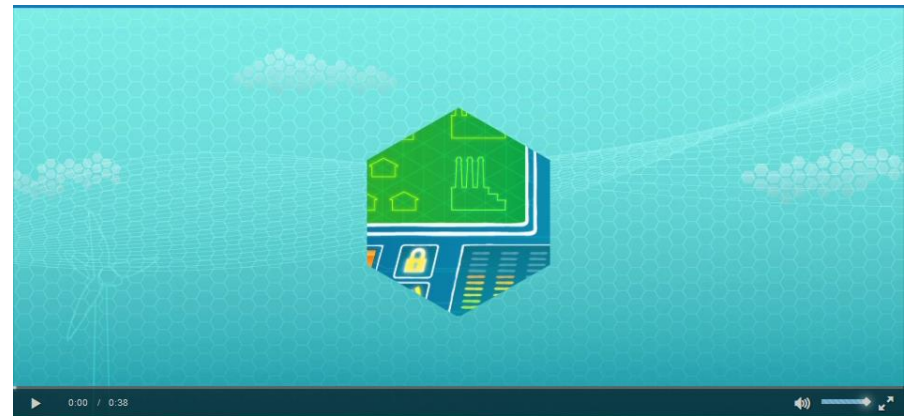


Video 2. The Smart Grid.

Source: https://www.smartgrid.gov/the_smart_grid/smart_grid.html

More videos:

https://www.smartgrid.gov/the_smart_grid/smart_home.html



Video 3. Operation centers.

Source: https://www.smartgrid.gov/the_smart_grid/operation_centers.html