enocean® alliance

No Wires. No Batteries. No Limits.

EnOcean Alliance – the batteryless wireless standard for smart buildings

Self-powered switches, sensors and control units save time and money during installation and guarantee higher energy efficiency.

Graham Martin, CEO & Chairman, EnOcean Alliance

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Introduction

EnOcean – the batteryless wireless standard for smart buildings

The **EnOcean Alliance** is a non-profit organization founded in 2008. Our mission: to supply standardized, interoperable solutions for intelligent buildings and Smart Homes based upon batteryless wireless technology.

Our **Aim**: to develop and market a broad range of interoperable batteryless wireless solutions for intelligent buildings, Smart Homes and IoT-applications.

Our **Vision**: to help create a better, safer, more energy-efficient and ecologically friendly world through the widespread use of intelligent, batteryless wireless sensor technology.

EnOcean in building automation

The Square, Frankfurt: 20.000 EnOcean-based products

- High flexibility & simplified planning
- Energy savings of up to 30%
- Cost and time savings
- No battery problems / no maintenance
- Interoperable products from different suppliers (international standard)

Networking with building automation systems

BACnet LonMark Modbus KNX

EnOcean in Smart Homes

EnOcean technology is already at home in 500.000 + buildings

- More comfort & security
- Simplified Installation
- Interoperable products from different suppliers (international standard)
- From senior citizens‘ homes to apartments and residential buildings
- No battery problems / no maintenance
- Seamless connection with different Smart Home standards and devices

Networking with Smart Home systems

HomeKit

OPEN CONNECTIVITY FOUNDATION

Wi Fi

Internet of Things – a connected world with batteryless wireless technology

enocean alliance
No Wires. No Batteries. No Limits.

OPEN CONNECTIVITY FOUNDATION

Business Partner IBM Ready for IBM Watson IoT

HomeKit

- Applications in the Internet of Things (IoT) make use of networked devices in buildings und Smart Homes
- Standardized wireless communication transmits sensor data and information to IoT-applications
- Batteryless wireless devices are the key to maintenance-free wireless sensor applications
- Seamless communication in the Smart Home of the future – a broad multi-supplier network independent of standards, technologies and devices

The benefits of EnOcean technology

Batteryless and wireless EnOcean devices

- High degree of flexibility
- High security
- Cost savings
- Reliable, future-oriented technology
- Energy efficiency
- Minimal / no maintenance
- No cabling / power supply for sensors
- Easy to commission

Benefits of batteryless wireless technology: for investors

Shorter build times

- Minimized contractor-to-contractor interaction
- Reduced building-site phase

Flexibility

- Properties can be rented out immediately upon completion
- Fit-out by the tenants

New areas of business

- Full-service offers
- with reduced costs (maintenance-free sensors/actuators)

Reduced costs

- 15 – 20% cost reduction for new buildings
- Up to 70% cost reduction for retrofits
- Up to 40% less energy consumption

Benefits of batteryless wireless technology: for specifiers

Smaller cable networks

- Cabling only in floors and ceilings.
- Reduced building-site phase.

Flexibility

- Initially „only“ the basics functions are required (lighting, HVAC per section/floor).
- Freely positionable sensors/actuators.

Reduced costs

- Approx. 20% reduction vs. conventional installation.

Benefits of batteryless wireless technology: for property users

Reduced energy costs

- Automated functions for minimal energy consumption without impaired comfort

Flexibility

- Flexible room configuration and easy / simple space conversion

Improved workplace environment

- Studies prove the positive effects of optimal building automation
- Higher productivity
- Less sick-leave / absence

Benefits of batteryless wireless technology: for contractors & system integrators

Simplicity

- No cabling necessary

Flexibility

- Quick and simple system adjustment to satisfy new requirements

Integration

- Easy integration in existing building automation systems via gateways

Benefits of batteryless wireless technology: for property owners

Comfort

- Enhanced comfort through automation

Security

- More security (window-/door-contacts, networked smoke sensors, liquid detection sensors, occupancy simulation)

Reduced costs

- 15 – 20% cost reduction for new buildings

Flexibility

- Easy restructuring of rooms, areas, floors
- Freely positionable sensors / actuators

Energy savings

- Maximal comfort with minimal energy consumption

Technical basics

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  - Signal absorption
  - Range planning
- Wireless data transmission in building automation
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  - Application examples
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EnOcean principle

- EnOcean wireless protocol
  ISO / IEC-Standard 14543-3-1X
- License-free frequency bands below 1 GHz
  - 868 MHz in Europe and China
  - 902 MHz in North America
  - 928 MHz in Japan
- Uni/bi-directional communication
- Standardized protocol and sensor profile (EEP)
- Each transmitter has its unique address (32Bit-ID)

EnOcean principle

Range

- Approx. 30m indoors
- Extended range with repeaters (Level 1 and Level 2)

Secure data transmission

- Burst telegrams ~ 1ms
- 3 - 5 asynchronous repeats
- Encoding with rolling code (authentification)

EnOcean is environmentally friendly – more so than all other wireless technologies


ECOLOG

INSTITUT FÜR SOZIAL - ÖKOLOGISCHE FORSCHUNG UND BILDUNG gGmbH

Messgutachten

Hochfrequenzemissionen von Funkschaltern der Fa. Enocean

Hannover, Juni 2003

Dr. H.-Peter Neitzke
Dr. Hartmut Voigt
Dipl. Ing. Christian Koeller

Full version: www.enocean.com

COMPARISON OF HIGH-FREQUENCY POWER FLUX VALUES

Device / System	W / m²	Distance (m)	Duration
EnOcean wireless switch	0,000013	1	when in use
Convent. lightswitch	0,0015	1	a few ms when in use
WLAN Access Point	0,01	2	during data transmission
Wireless LAN card	0,1	0,1	during data transmission
DECT telephone	1	0,1	during phone call
Mobile telephone	12-42	0,1	during phone call
GSM base station	0,00001	0,1	permanently

100 x

700 x

7.000 x

70.000 x

1,6 Mio.x average

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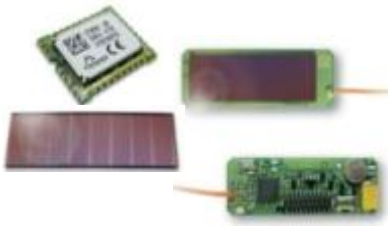
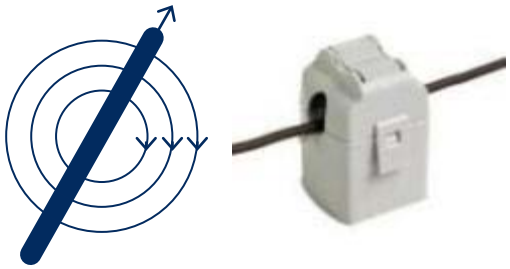
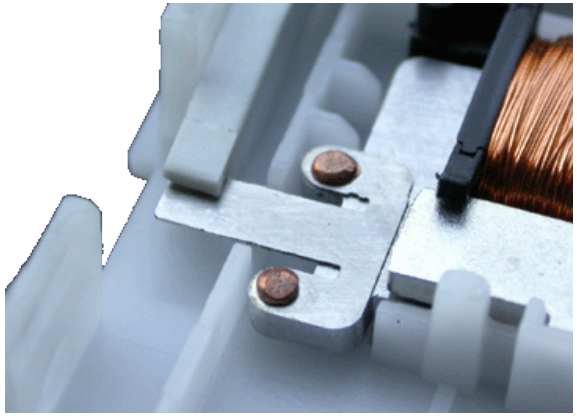
Energy harvesters and their applications

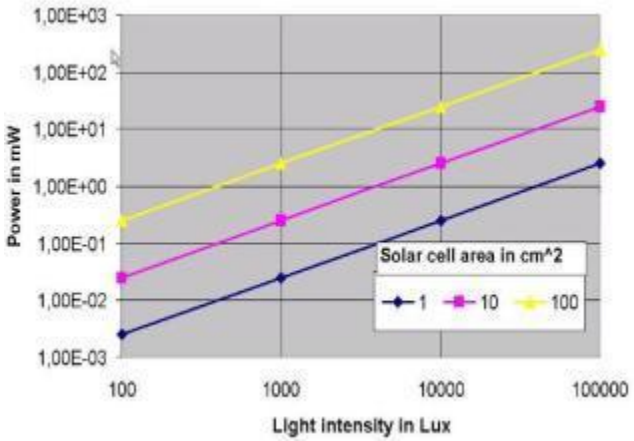
		Application
	**Kinetic energy** Electromechanical generator	Switch / push button
	**Solar energy** Module with energy reservoir	Temperature and humidity sensors, motion detectors, room control units
	**Thermal energy** Energy generation through temperature difference	Actuators for radiators, temperature sensors
	**Magnetic-field energy** Energy conversion from the magnetic field generated by the power cable to be monitored	Smart metering

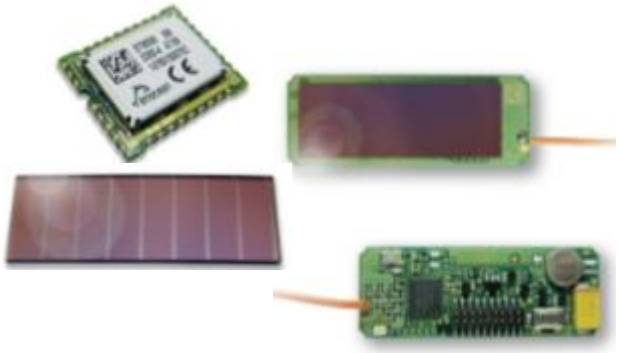
Energy harvesting through movement



- Linear movement (e.g. pressing a button) or rotary motion (e.g. turning a window handle) is converted into electric energy
- A minimal impulse (350 µWs) is sufficient to generate and encode a signal, and to repeat transmission 3-5 times
- Electrodynamic generator lifetime: up to 1.000.000 cycles

Energy harvesting through light



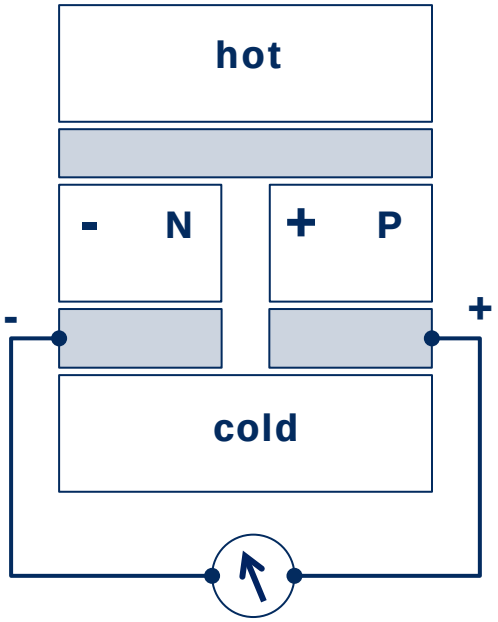


- Light intensity indoors: 50 - 1.000 lx
- Light intensity outdoors: 1.000 - 100.000 lx
- Devices function and charge from 50 lx up
- Fully charged devices function 3 -7 days in complete darkness
- Example: typical light intensity in hotels
  - Reception 300 - 700 lx
  - Restaurant 150 - 300 lx
  - Staircase 50 - 150 lx
  - Room – daylight 200 - 900 lx
  - Room – illumination 100 - 500 lx

Background information: customary light levels in buildings

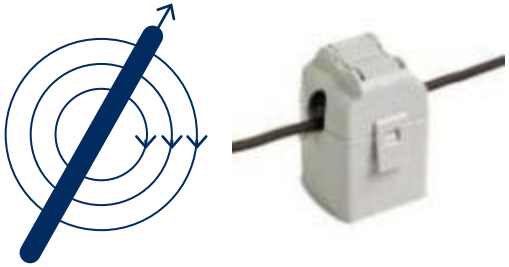
Schools	
Classroom blackboard area	500 – 1.000 lx
Typical classroom	300 – 500 lx
Office buildings	
PC workplace	200 – 500 lx
Conference room	300 – 700 lx
Corridor	50 – 100 lx
Hotels	
Reception	300 – 700 lx
Restaurant	150 – 300 lx
Staircase	50 – 150 lx

Energy harvesting through temperature difference – Peltier/Seebeck effect



- A thermoelectric element generates tension at the junction between two metals having different temperatures. This effect was discovered in 1821 by Thomas Johann Seebeck
- On the other hand, whenever a current is applied to a thermoelectric element a temperature difference occurs (discovered in 1834 by Jean Charles Athanase Peltier)
- Many such elements are available at low cost and constitute ideal sources of energy

Energy harvesting through magnetic fields



- Energy conversion from the magnetic field generated by the power cable to be monitored
- Minimally invasive – smart metering without cutting the power cable.

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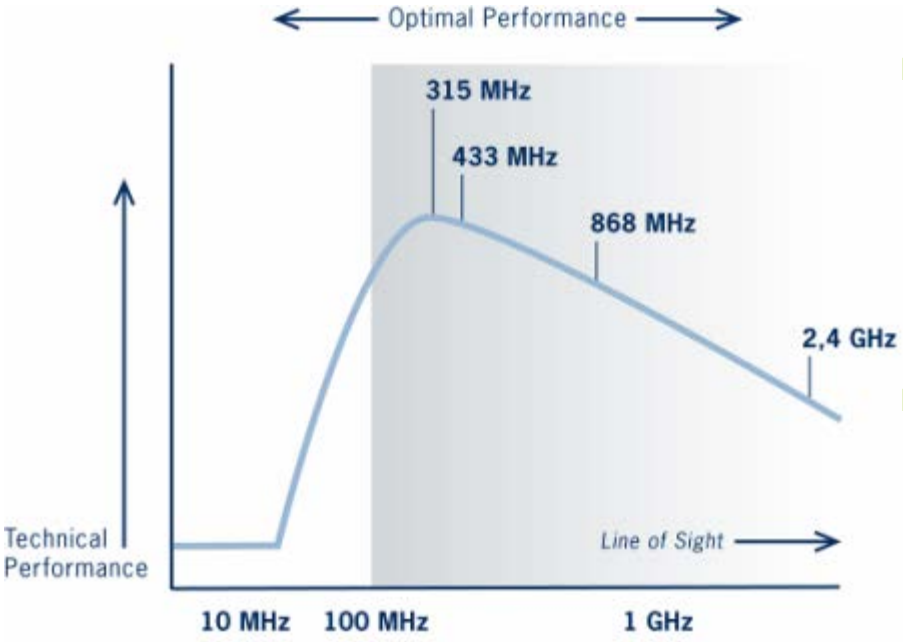
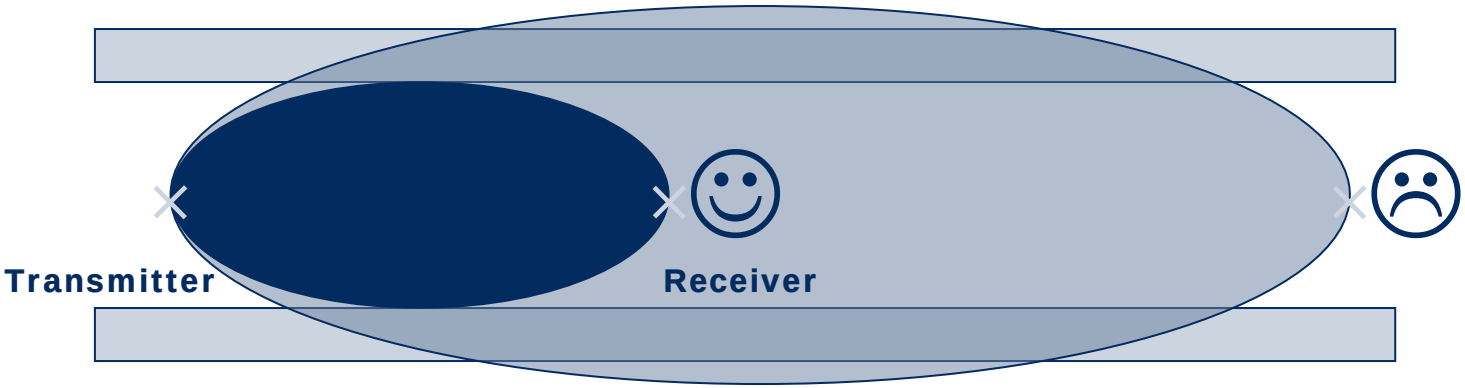
Technical basics: data transmission



- **Frequency**
  - Use of license-free frequency bands
- **Range**
  - Low frequency, high reach
  - Locate receivers within recommended range
  - Consider absorption / penetration angles
- **Signal absorption**
  - Metal and concrete can block most signals
  - Other materials can also reduce signal range

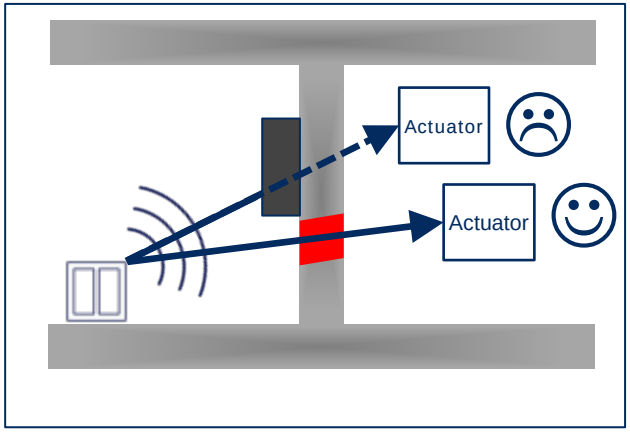
Technical basics: data transmission

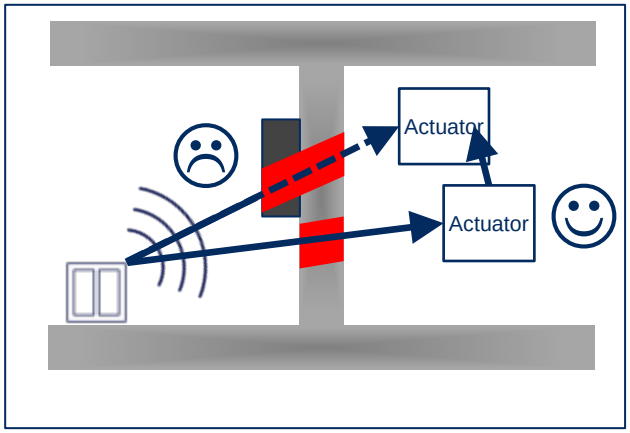
Wireless transmission displays elliptic properties. Evaluation of maximum range therefore requires more than line-of-sight appraisal.



This must be borne in mind. For example, a maximum range of 30m means that the ellipse only measures 10m in the middle. Therefore, narrow corridors with massive concrete walls are not ideal.

Technical basics: signal absorption





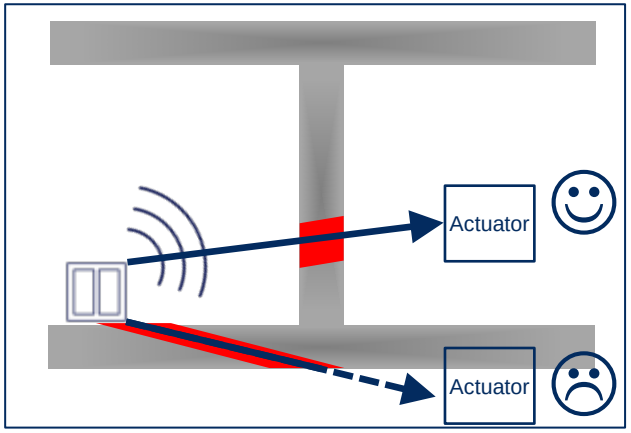
Signal absorption

Radio signals can penetrate walls – however, the signals may be weakened . The degree of signal absorption depends upon the material in question.

Examples

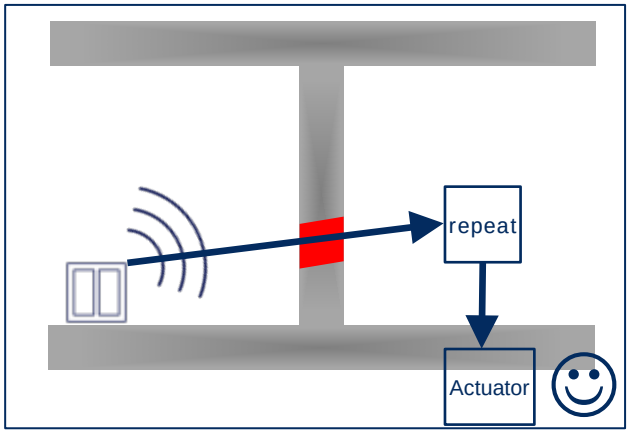
- Wood, plaster, uncoated glass, without metal
  0 – 10%
- Brick, chipboard
  5 – 35%
- Ferroconcrete
  10 – 90%
- Metal, aluminium lamination
  90 – 100%

Technical basics: penetration angles



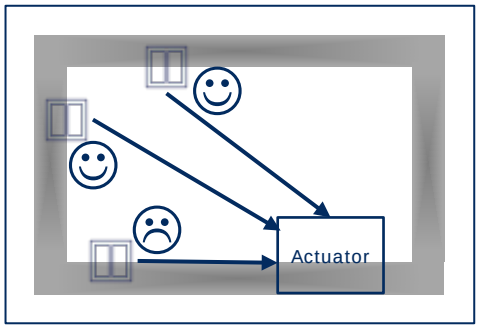
- The angle affects the signal‘s path due to varying thickness of the material in its way – and, therefore, impacts the signal strength.

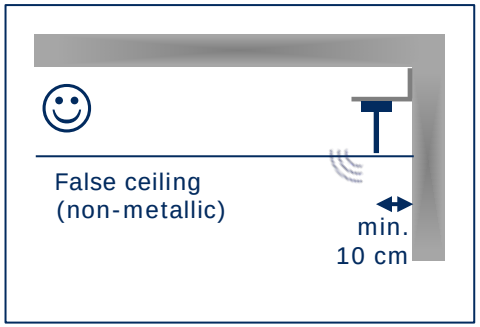
- Signals should ideally be routed perpendicularly through masonry, and niches should be avoided.

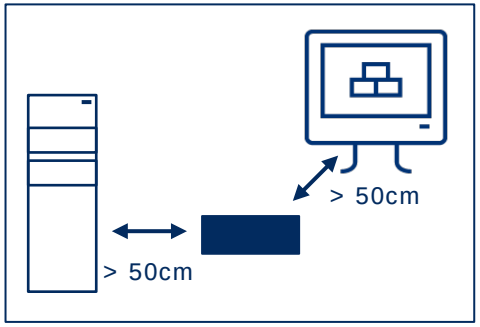


- If oblique signal paths cannot be avoided, we recomment using a repeater and/or changing the transmitter and/or receiver‘s position.

Technical basics:
antenna installation & sources of interference



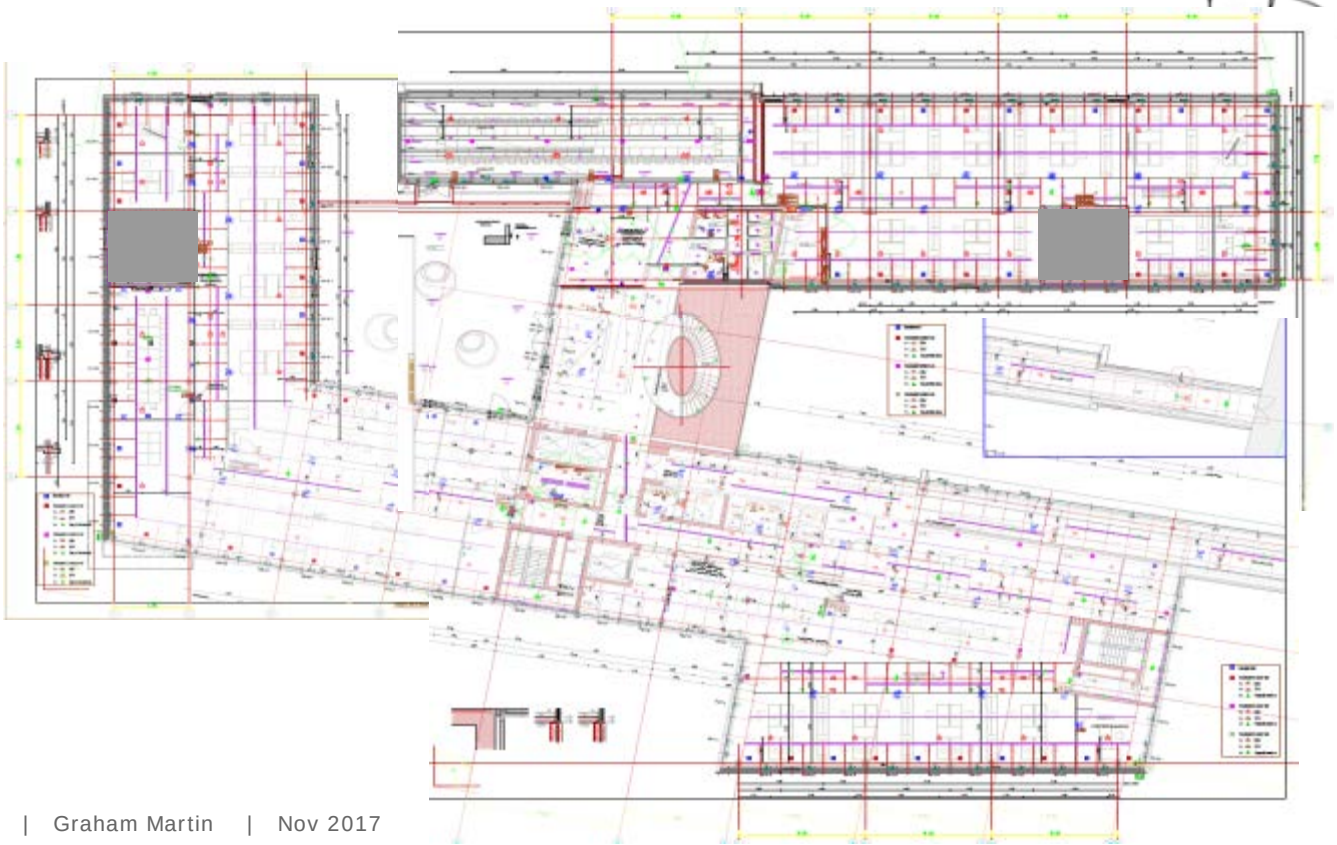




- Routing signals along a wall is not recommended (e.g. in a long corridor).
- When laying a shielded antenna cable, be sure to avoid kinking (and irreparably damaging) it.
- The EnOcean receiver should not be placed within 50cm of high-frequency transmitters. Placing of EnOcean transmitters is uncritical.868 MHz-RFID technology should not be employed in the vicinity.

Range planning: step 1

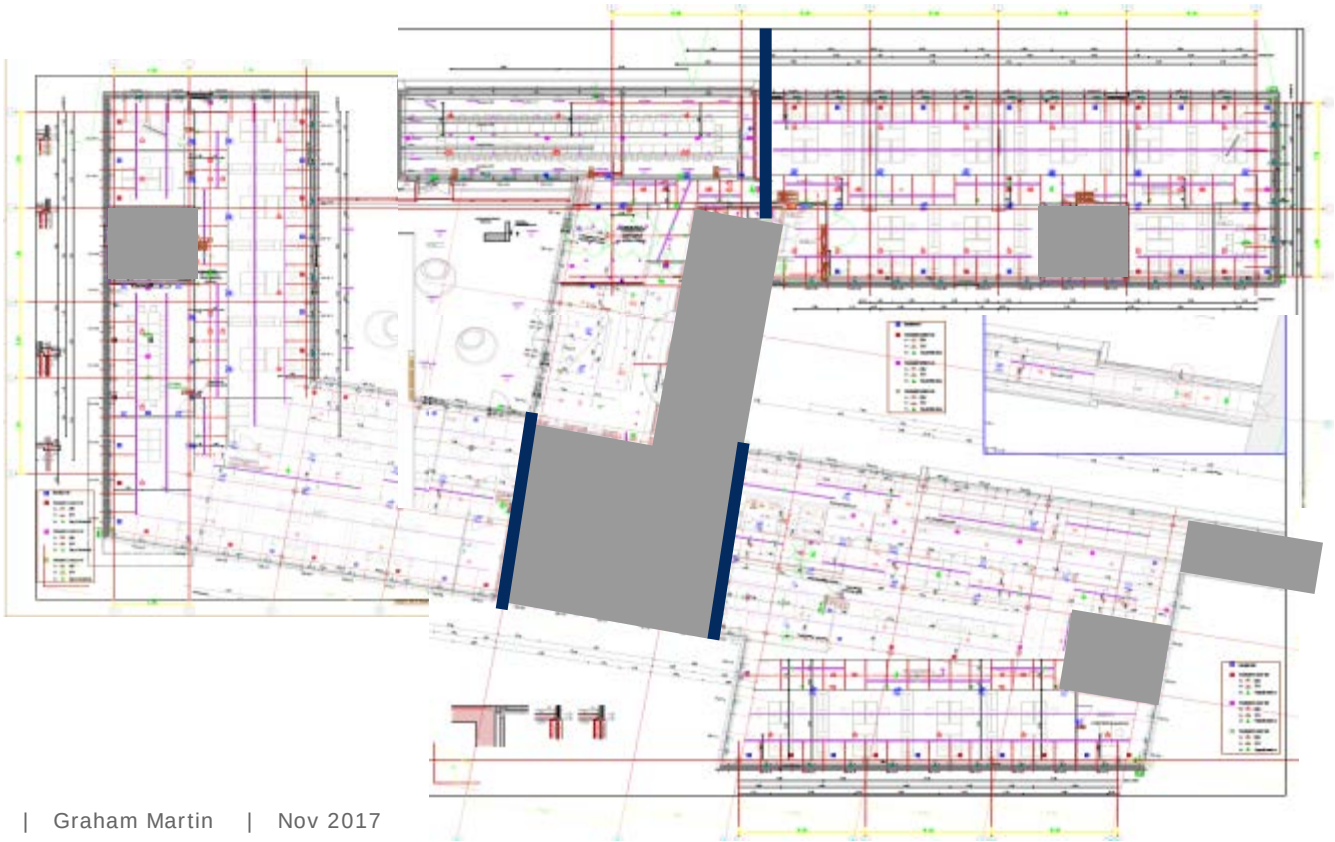
You will need the floor plan and a compass



Range planning: step 2

Mark the signal-shielding areas on the floor plan

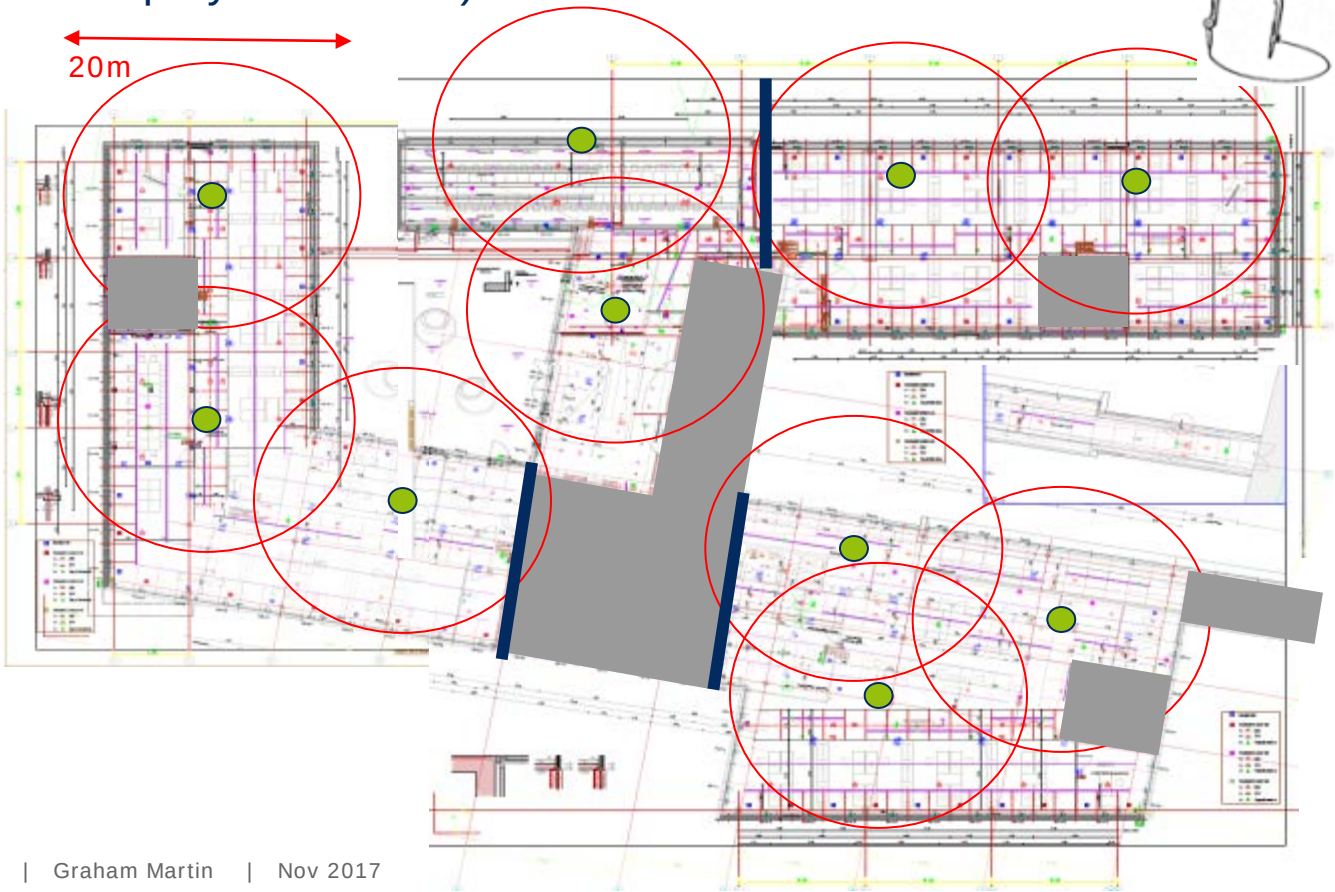
- firewalls, elevators, stairwells, laundry rooms, service areas ….



Range planning: step 3

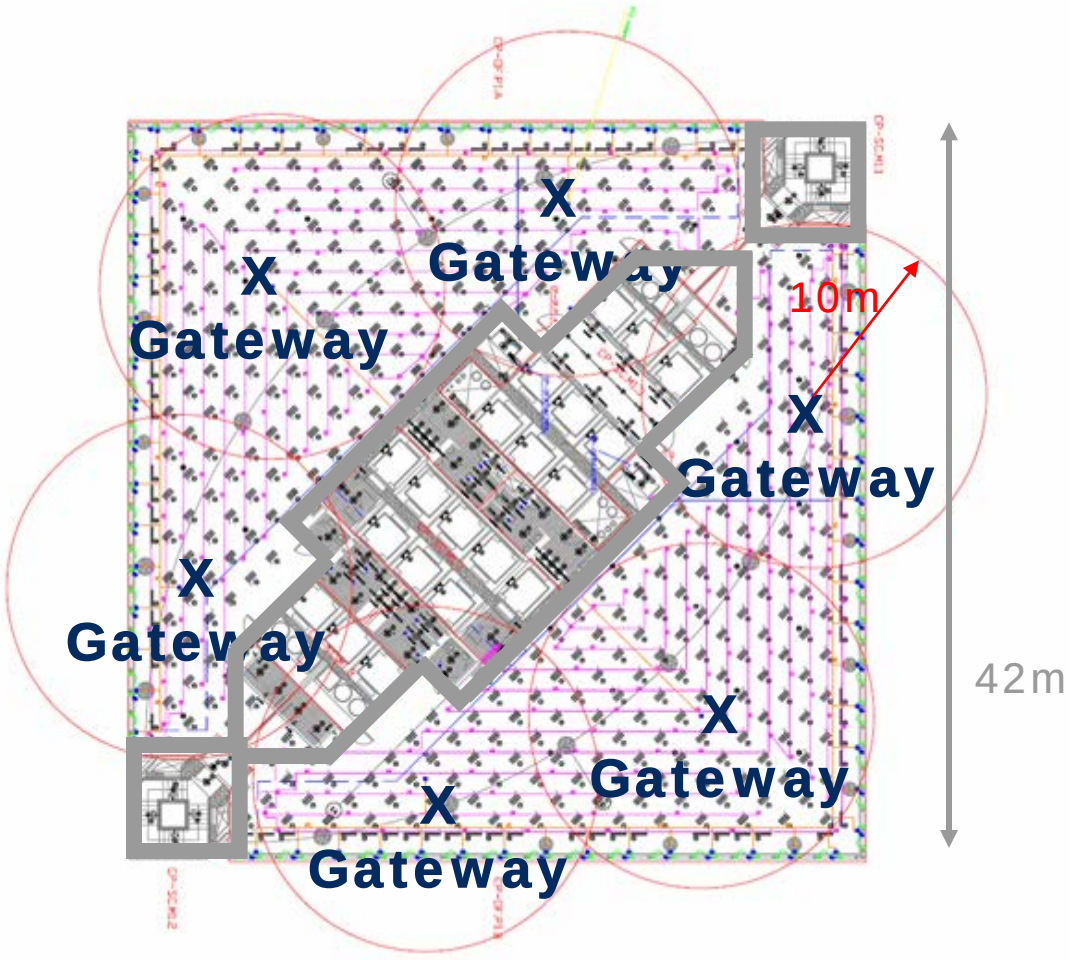
Mark 10-15m diameter areas on the plan

- 10m diameter areas guarantee adequate safety margins
- The center of the circle = receiver position
  (1m tolerance plays little role)



Planning example: SAP Headquarters, Walldorf

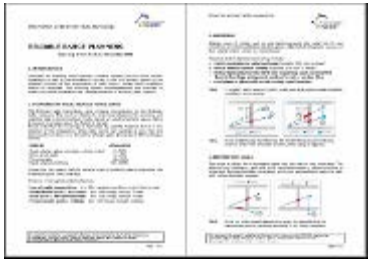
Planning example: Torre Espacio, Madrid



Range planning – equipment / measures

- Rangefinding instruments for indoor and outdoor use available.
- Prudent use of level 1 and/or level 2 repeaters recommended.
- Optimize systems,
  connect transmitters/sensors with 2 gateways.
- Download the information brochure
  „Reliable range planning”.

  https://www.enocean.com/range-planning/



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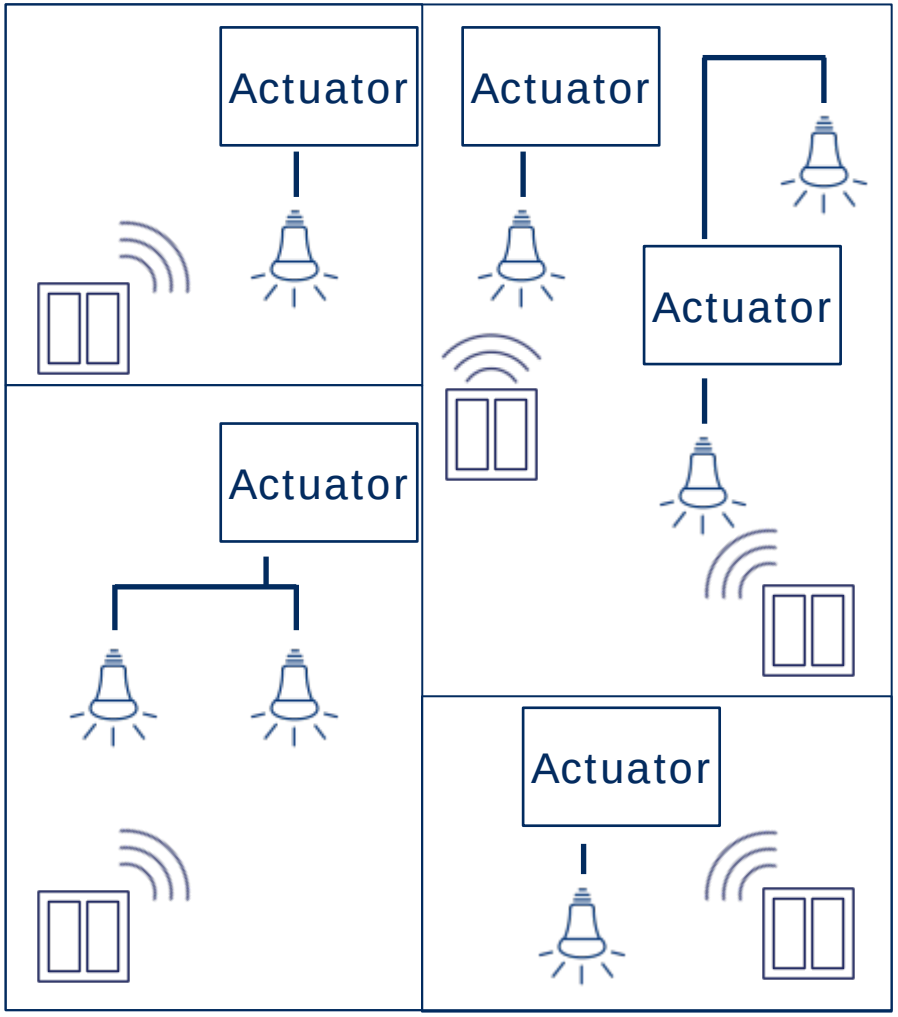
Wireless technology – when does it make sense?

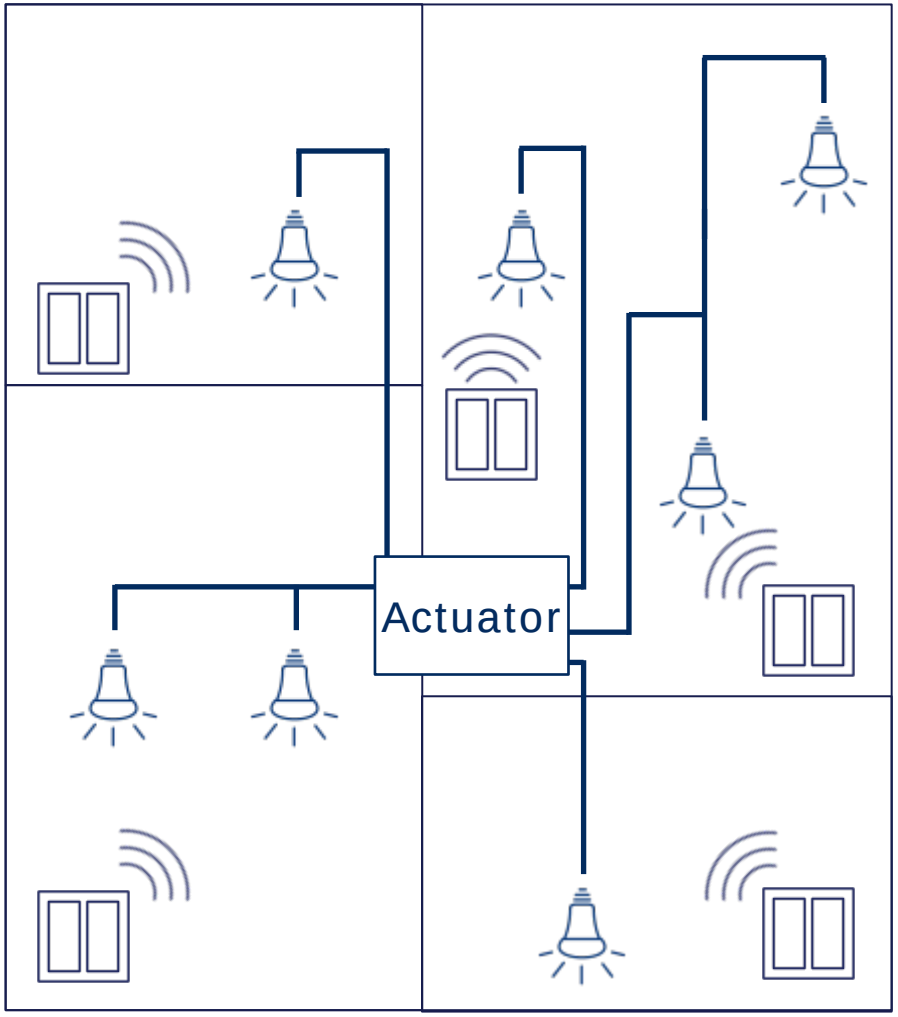
- Whenever building automation systems are involved (energy savings, central control systems, energy monitoring, legal & regulatory requirements)
- Whenever furniture and/or partition walls need to be periodically rearranged, or whenever glass walls are to be used
- In open-plan offices or multi-purpose buildings
- Whenever renovation calls for extensive re-cabling work (avoiding or reducing costs, time, drilling and noise/dust/dirt)
- Whenever timelines are of critical importance
- Whenever ecological certification is called for (green / sustainable building certificates)

Decentralized control system: example lighting



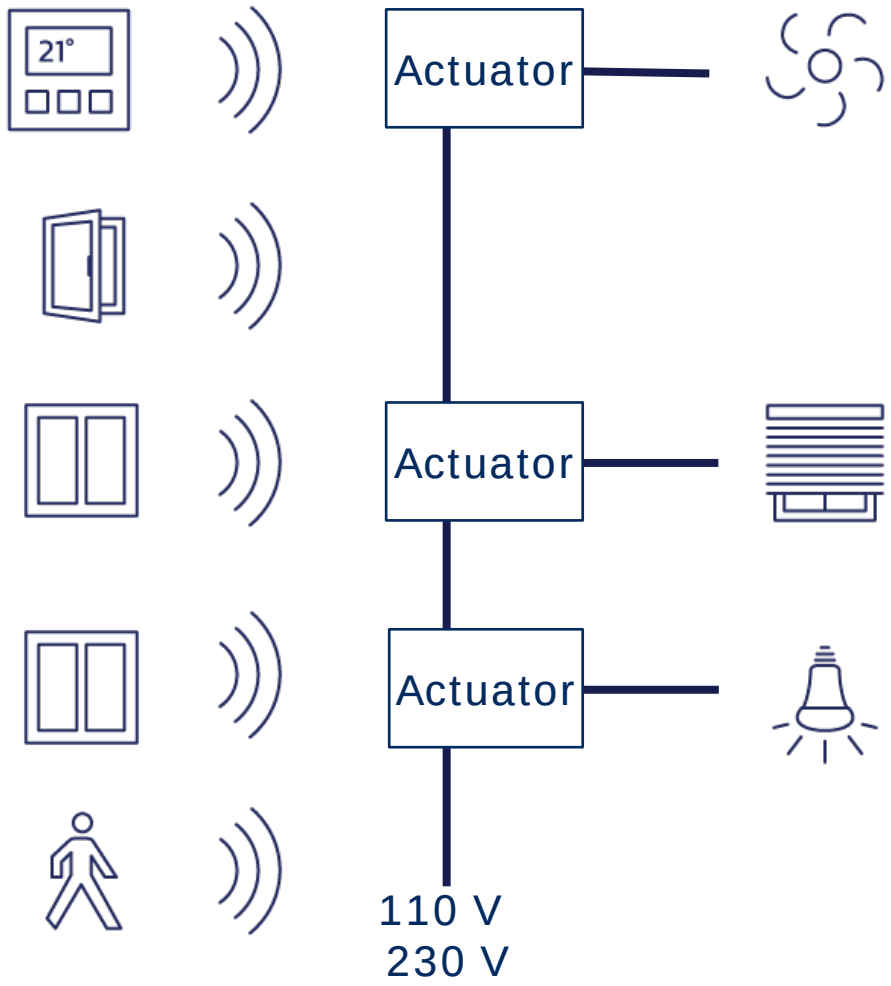
- Wireless actuators for each light, or group of lights, are required
- They are installed between the lights and their power supply
- Wireless light switches are individually connected with the actuators (pairing)
- Ideal for small-scale installations and restructuring/modernization projects

Centralized control system: example lighting

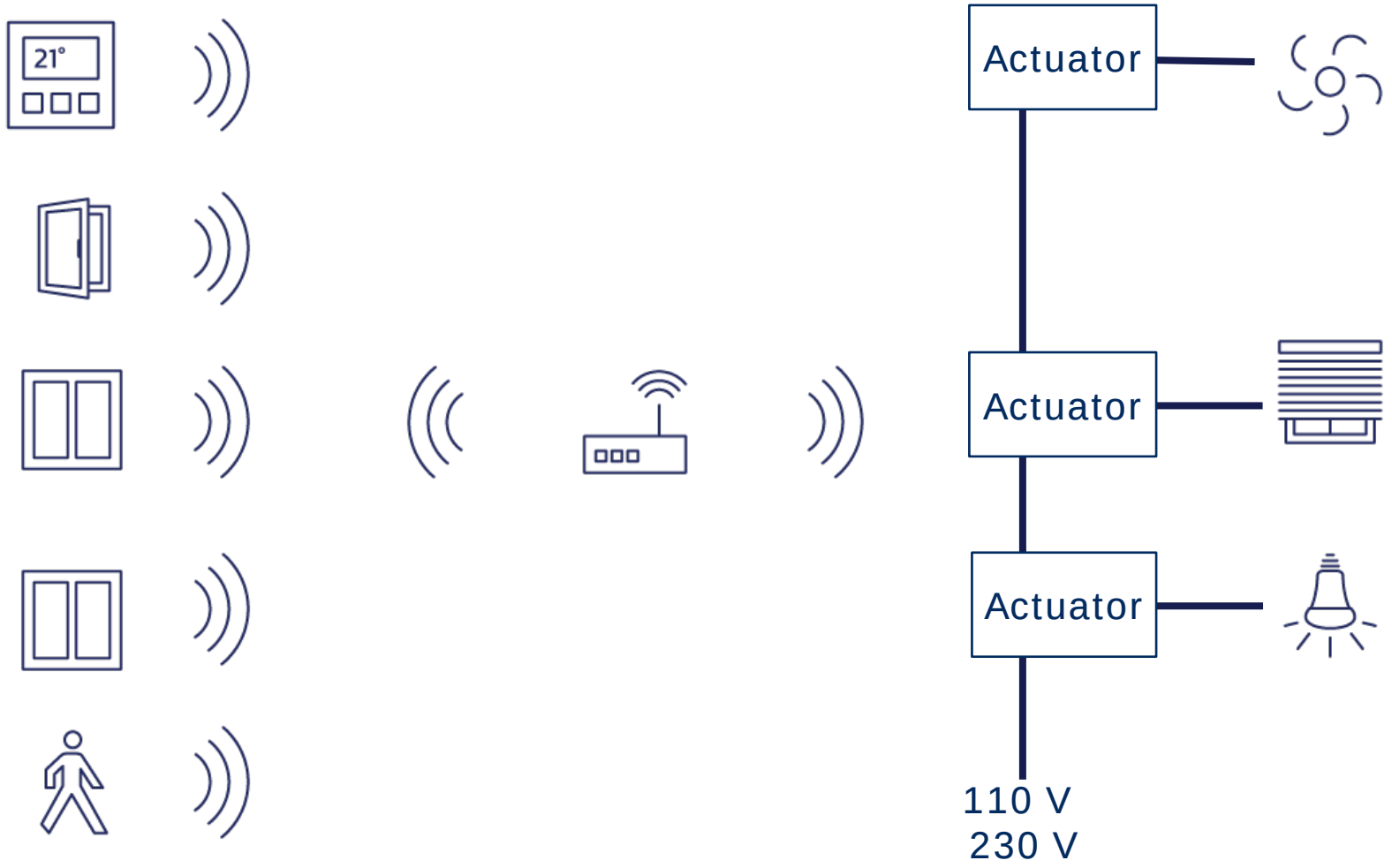


- Normally, one central control unit is employed for each storey (or section of a large open-plan office)
- Can also be operated as a stand-alone system (without gateway)
- Can be connected with the central building automation system (TCP/IP)
  - In smaller buildings with up to two storeys this can be achieved through wireless batteryless technology
  - In larger buildings a connection employing an Ethernet cable is recommended
- This solution can also be adopted for HVAC applications

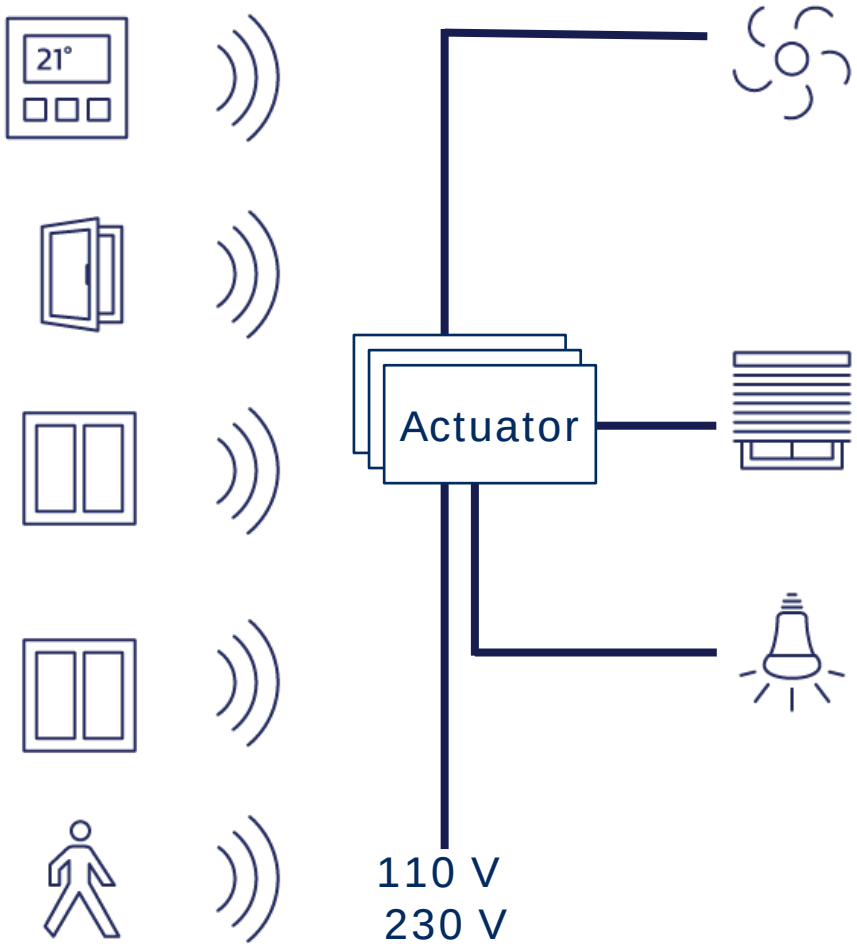
Decentralized control for HVAC, shading and lighting



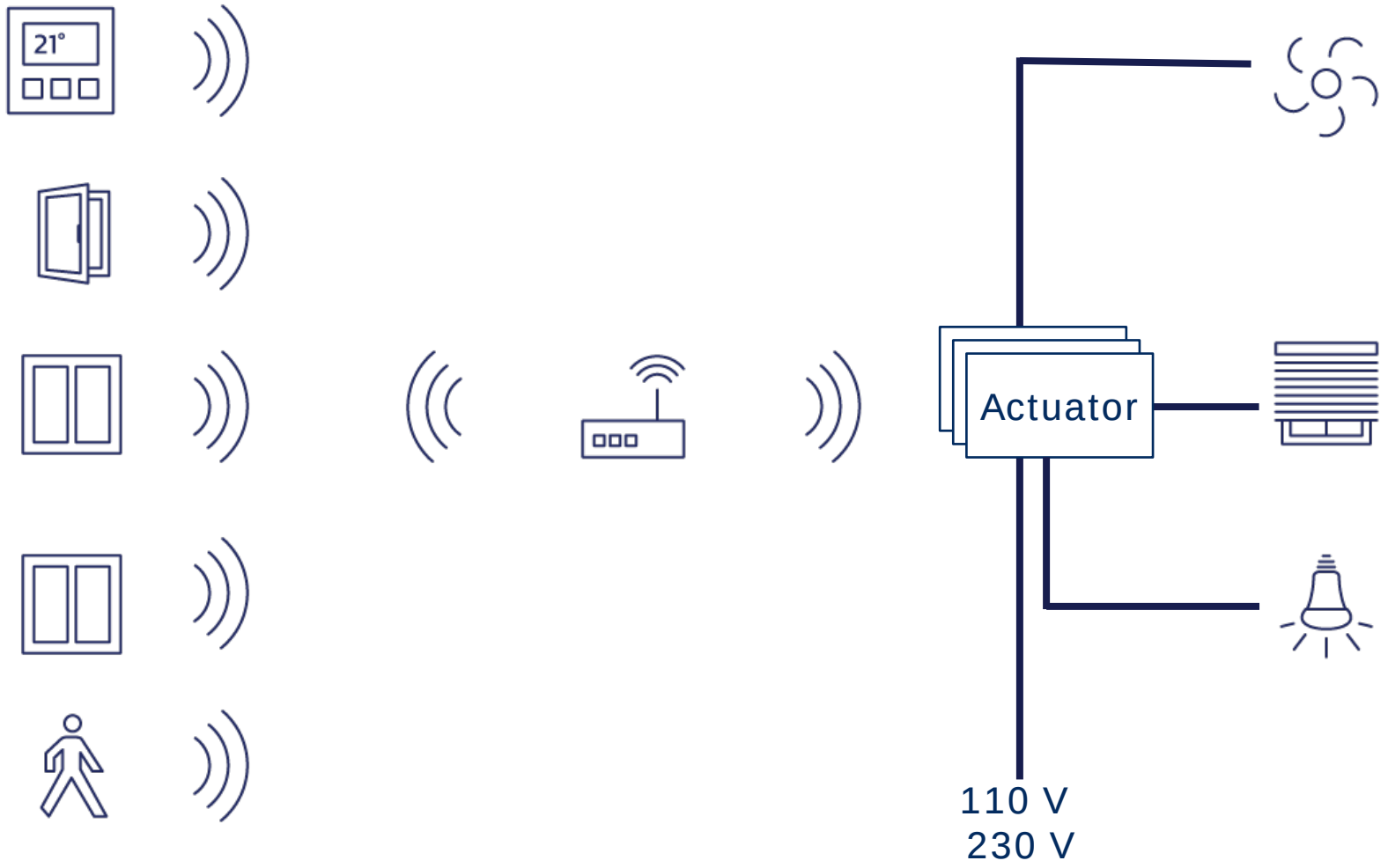
Decentralized control for HVAC, shading and lighting with gateway



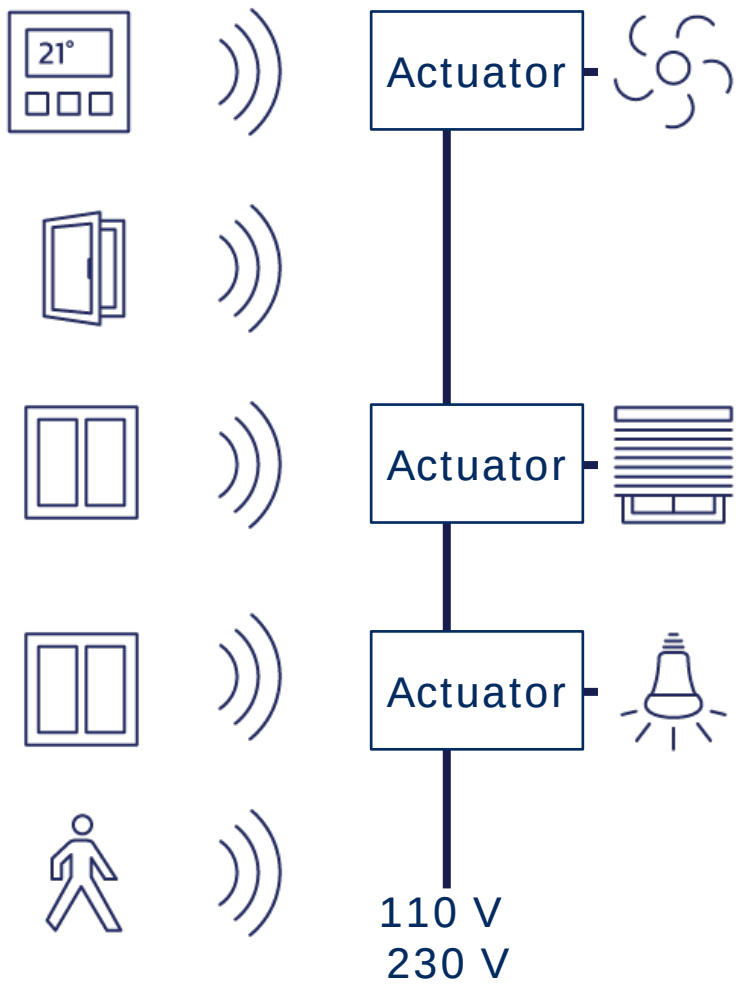
Centralized control for HVAC, shading and lighting

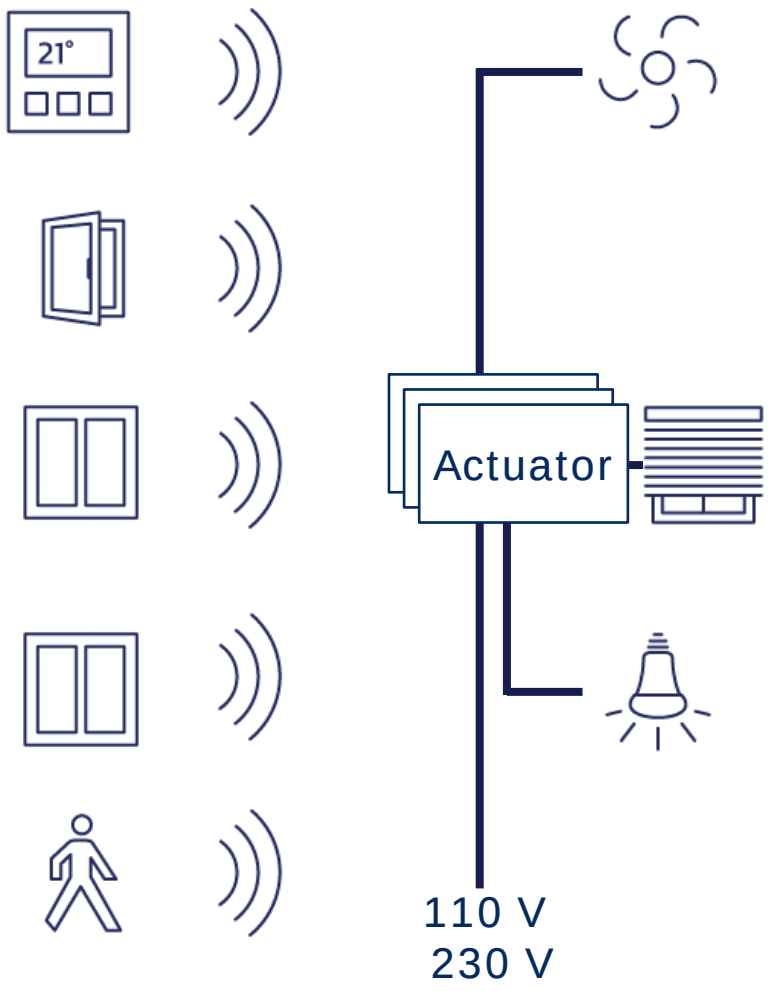


Centralized control for HVAC, shading and lighting



Decentralized / centralized control for HVAC, shading and lighting





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- Interoperability / Certification

Hardware security

- One-off, clear 32bit ID for each and every EnOcean module
  - ID cannot be changed
- Special-purpose ID
  - Preliminary, factory-programmed baseID
  - 128 Ids can be assigned (BaseID+0 ..BaseID+127)
  - BaseID can be reassigned up to ten times

Secure data transmission

- Rolling Code* protects against
  - copy & paste attack
  - copy & change attack
- Encoding* protects against
  - „eavesdropping“
  - encoded data is not legible for the „eavesdropper“

* Depending on product and manufacturer

„EnOcean security layer“ integrated into the protocol stack

Wire	Air
Application	
EnOcean Equipment Profiles (EEP)	
Remote Management	
Smart Acknowledge	
Security	
EnOcean Serial Protocol	EnOcean Radio Protocol
RS232 – UART	868.3, 315, 902, 928 MHz (Radio)

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Interoperability

Standardized sensor profiles ensure interoperability between products from various different manufacturers and make interoperable system solutions possible.

Certification: interoperability for diverse solutions

Standardized test procedures

- in accordance with EnOcean Alliance test parameters

Interoperability in the physical sense

- „Air Interface“ specification

Interoperability in terms of communication

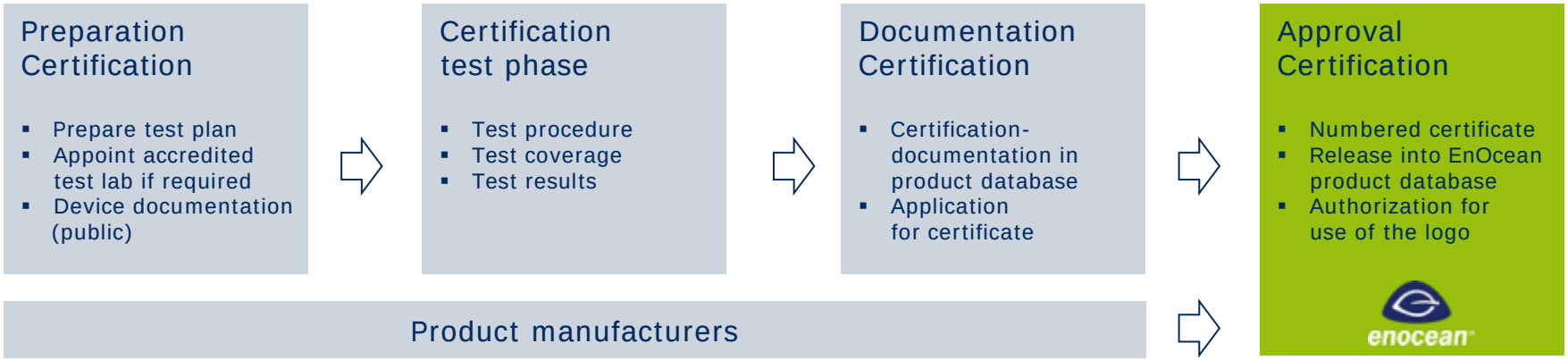
- „Communication Profiles“ specification

Guidelines and documentation

- EnOcean Alliance Certification Handbook

Certification: interoperability for diverse solutions

enocean alliance
No Wires. No Batteries. No Limits.

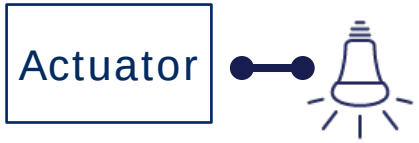


System start-up & troubleshooting

- **Standard**
- „Remote commissioning“
- Troubleshooting

System start-up – standard

Step 1
Connect appliance (lighting, sunblinds, heating) with the actuator.



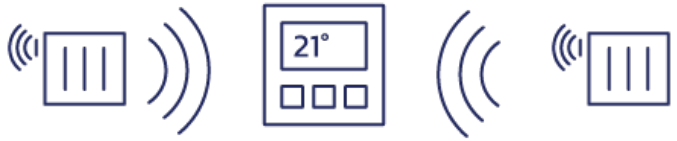
Step 2
Initialize switches and sensors once using a simple learn mode (pairing) connecting them with the actuators.

Step 3
Sensors and actuators interact without gateway (simple solutions).

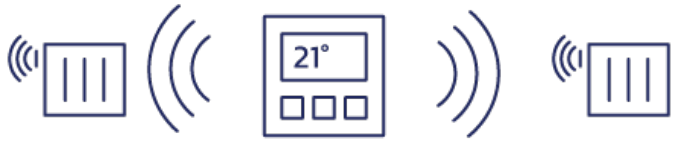
System start-up – standard with room controller

Step 1
Fit actuators to the radiators

Step 2
Initialize actuators once using a simple learn mode (pairing) connecting them with the room controller

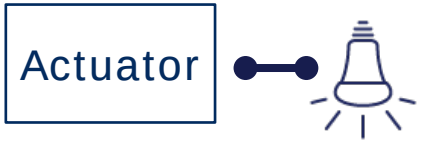


Step 3
Actuators and the room controller interact (e.g. individual room control)



System start-up – standard with gateway

Step 1
Connect appliance (lighting, sunblinds, heating) with the actuator



Step 2
Initialize sensors and actuators once using a simple learn mode (pairing) connecting them with the gateway

Step 3
Sensors and actuators interact via gateway (complex solutions)

System start-up & troubleshooting

- Standard
- **„Remote commissioning“**
- Troubleshooting

System start-up – „remote commissioning“

Step 1
Scan the switch (product-ID, EnOcean-ID).

Step 2
Add the switch to the connection list of the actuator via wireless connection. Adjust parameters if needed (e.g. mode, dimming rate).

Step 3
Switch can control the actuator straight away.

System start-up & troubleshooting

- Standard
- „Remote commissioning“
- **Troubleshooting**

Problem solving – questions & answers

System start-up

Sensor and actuator are not communicating – why?

- Establish sensor–actuator connection according to device instructions
- Delete „old“ connections (see device instructions)
- Check transmission range limit before installation (using tester, mock-up)
- Follow range-planning guidelines
- Charge sensors with solar module **prior** to installation (as per instructions)

Problem solving – questions & answers

System start-up

Sensor, actuator and gateway are not communicating – why?

- Establish sensor–actuator, sensor–gateway, gateway–actuator connections according to manufacturer‘s instructions.
- Delete „old“ connections (see device instructions).
- Check transmission range limit before installation (using tester, mock-up).
- Follow range-planning guidelines.
- Charge sensors with solar module **prior** to installation (as per instructions).
- Check gateway documentation to ensure that your sensors/actuators are supported. If not, use alternative sensors/actuators.

Problem solving – questions & answers

Logic / Parameterization of scenes

Why doesn‘t the parameterized scene „work“ as intended?

- Conduct a plausibility check for the parameterized triggers (system status, events, times).
- Ensure that the desired parameterization is compatible with the gateway (manufacturer hotline, internet forums etc.).
- Exclude contradictory parameterization with the same devices, but with other triggers (events, times).
- Parameterize and test the scenes step by step.

Sources of interference

Why does interference occasionally disturb wireless communication between devices?

- „simple“ devices which also transmit/receive on 868 MHz may disturb EnOcean-signal reception, e.g.
  - wireless thermometer
  - wirelessly networked smoke detectors (e.g. when triggered)

Problem solving – questions & answers

Indoor / outdoor

Why are sensors/actuators malfunctioning?

- Some devices are not intended for outdoor use by the manufacturer. They may function outdoors for a short time but are not weather-resistant and therefore subject to internal corrosion etc. Please select your devices with this in mind.

Manufacturers / suppliers

Where can I find further information?

- In the manufacturer‘s documentation, webpage and online resources including video tutorials and user forums.

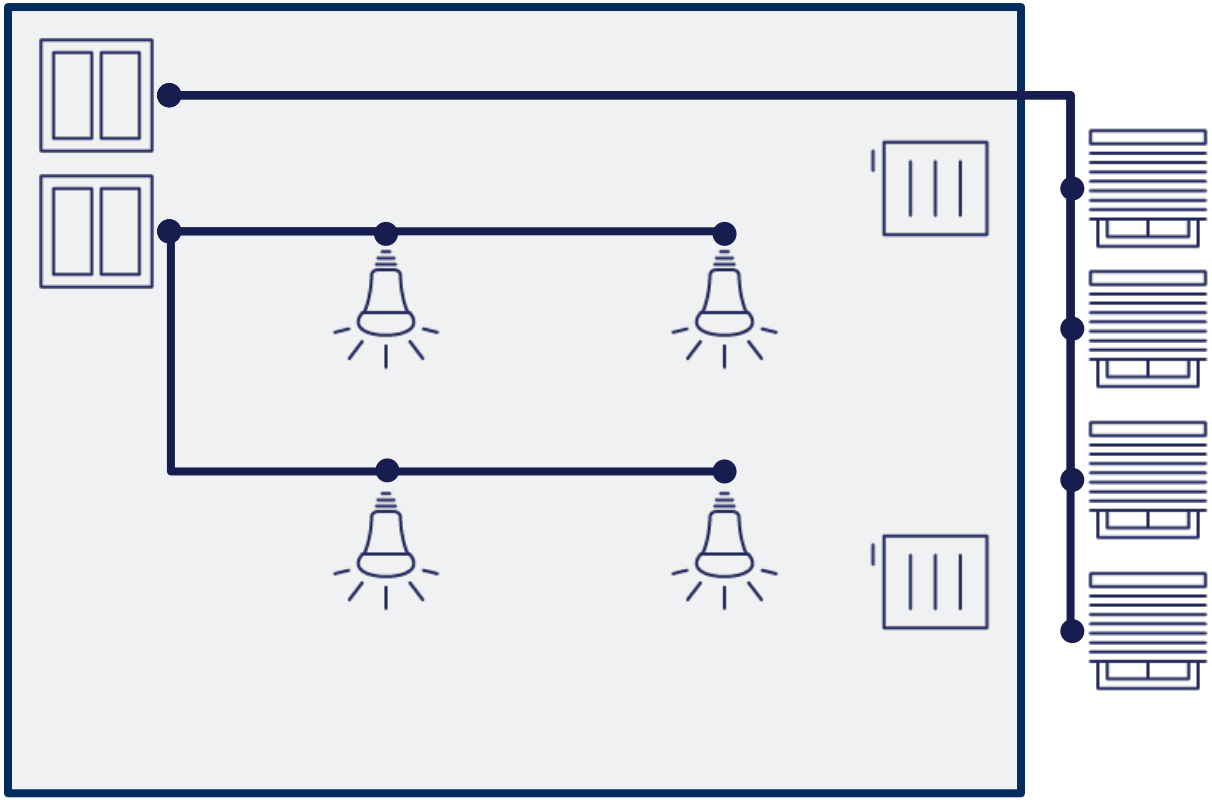
Calculation examples

- Time savings during installation (commercial building)
- Time savings during installation (general)

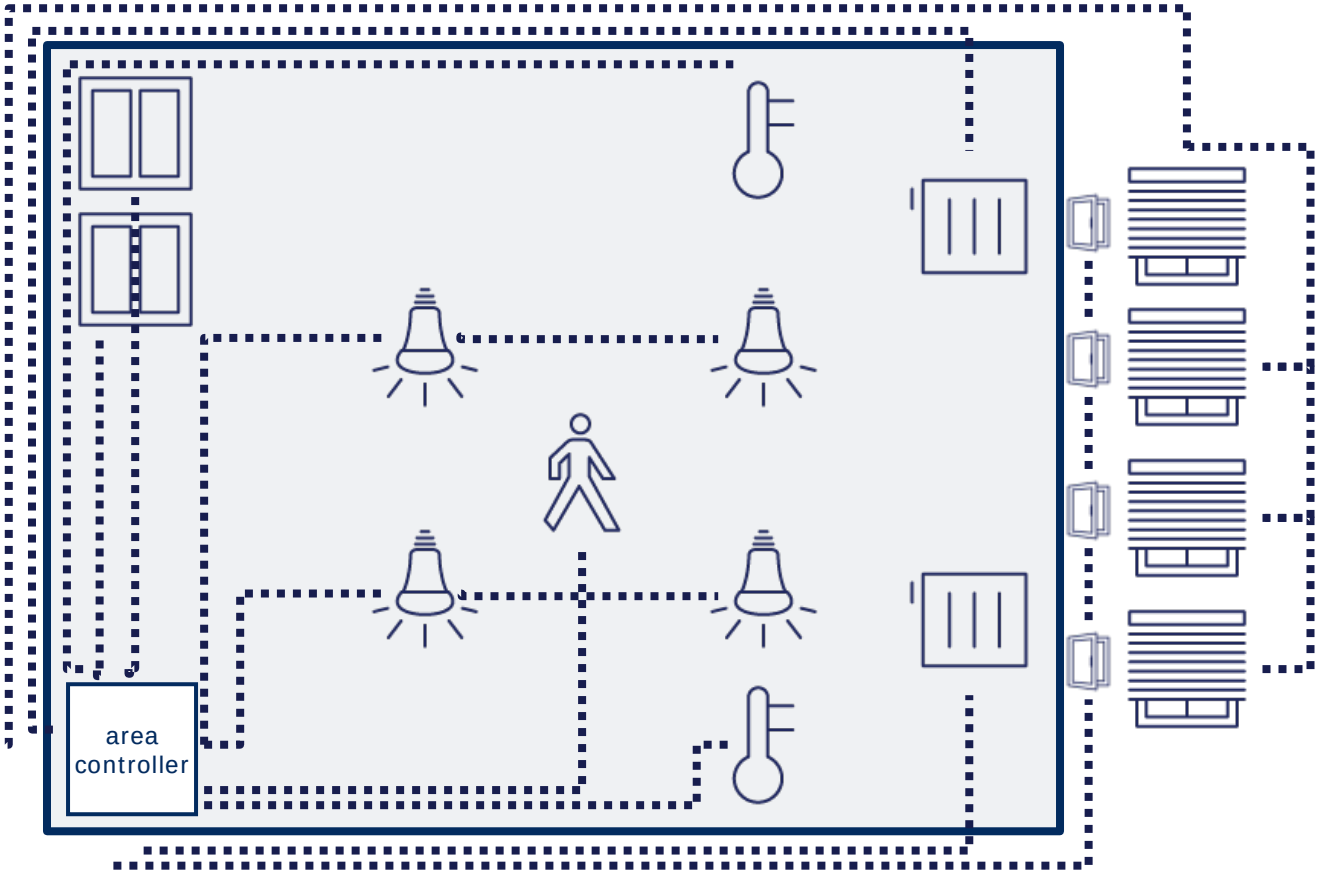
Conventionally cabled office – no automation

No automation = 100% energy consumption

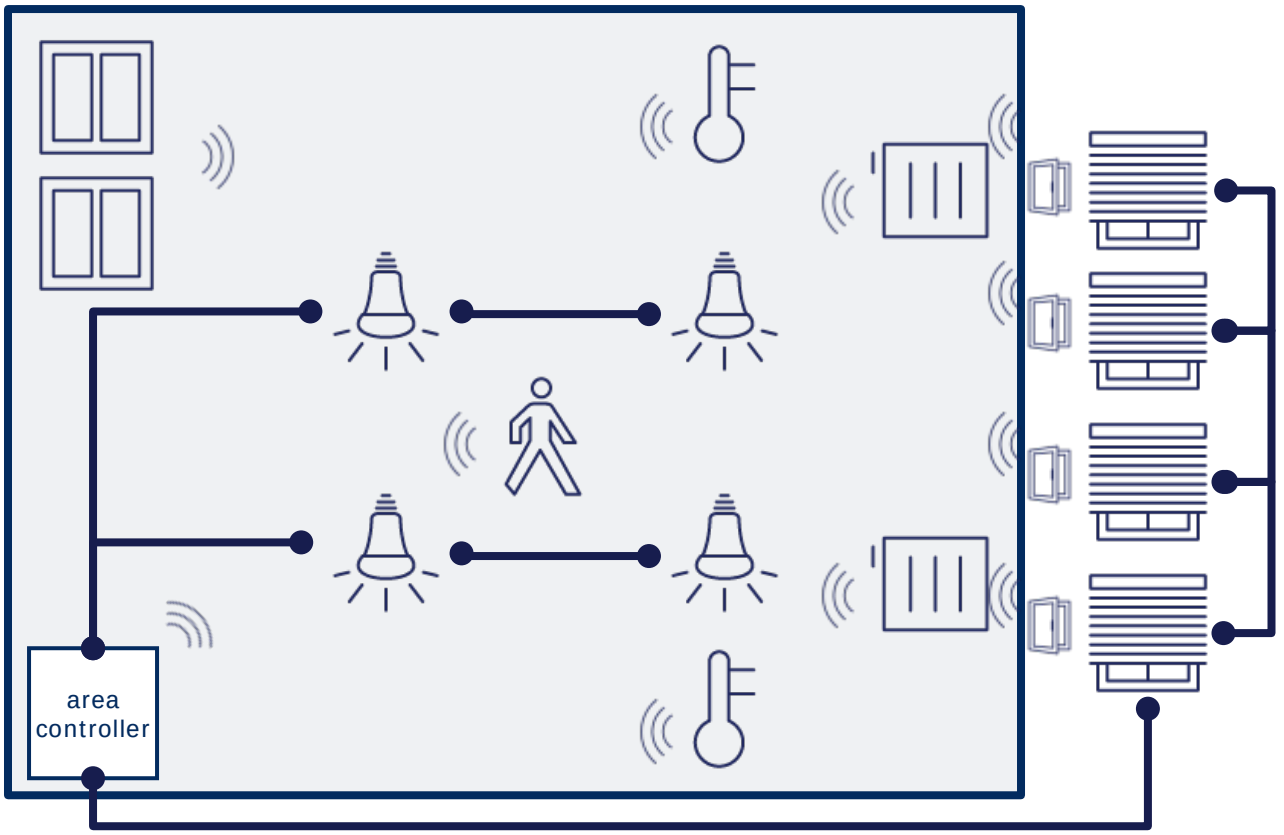
Standard office: 4 lights, 4 windows, 2 radiators



Cable-based building automation – 30%...40% less energy consumption



Automation system with wireless sensors – energy savings **and** 70% less cables



Time savings during installation

Office area [m²]	Time savings [hours]		Time savings [man-days]
	lighting & shading	lighting, shading & temperature control	
5.000	408	583	51 - 73
10.000	817	1.167	102 - 146
20.000	1.633	2.333	204 – 292
50.000	4.083	5.833	510 - 729

Source: ZVEH

Assumptions

- Average installation time 2.8 minutes/1m cable
- Approx. 1.8m cable per m² office space (lighting and shading)
- Approx. 2.5m cable per m² office space (lighting, shading and temperature control)

Time savings during installation (general)

Saving
20 – 30%

	Step #1	Step #2	Step #3	Step #4	Step #5	Total
	Preparation installation plan	Laying cables	Installing junction box	Connecting	Plastering & painting	
	Conventional technology					
Materials	-	€	-	€	€	€
Labour	€	€	€€	€	€€€€	€€€€€€€€
	Batteryless wireless technology					
	Installation receiver					
Materials	€€€	**n / a**	**n / a**	€€€	**n / a**	€€€€€€
Labour	€	**n / a**	**n / a**	€	**n / a**	€

Internet of Things (IoT)

IoT applications with EnOcean

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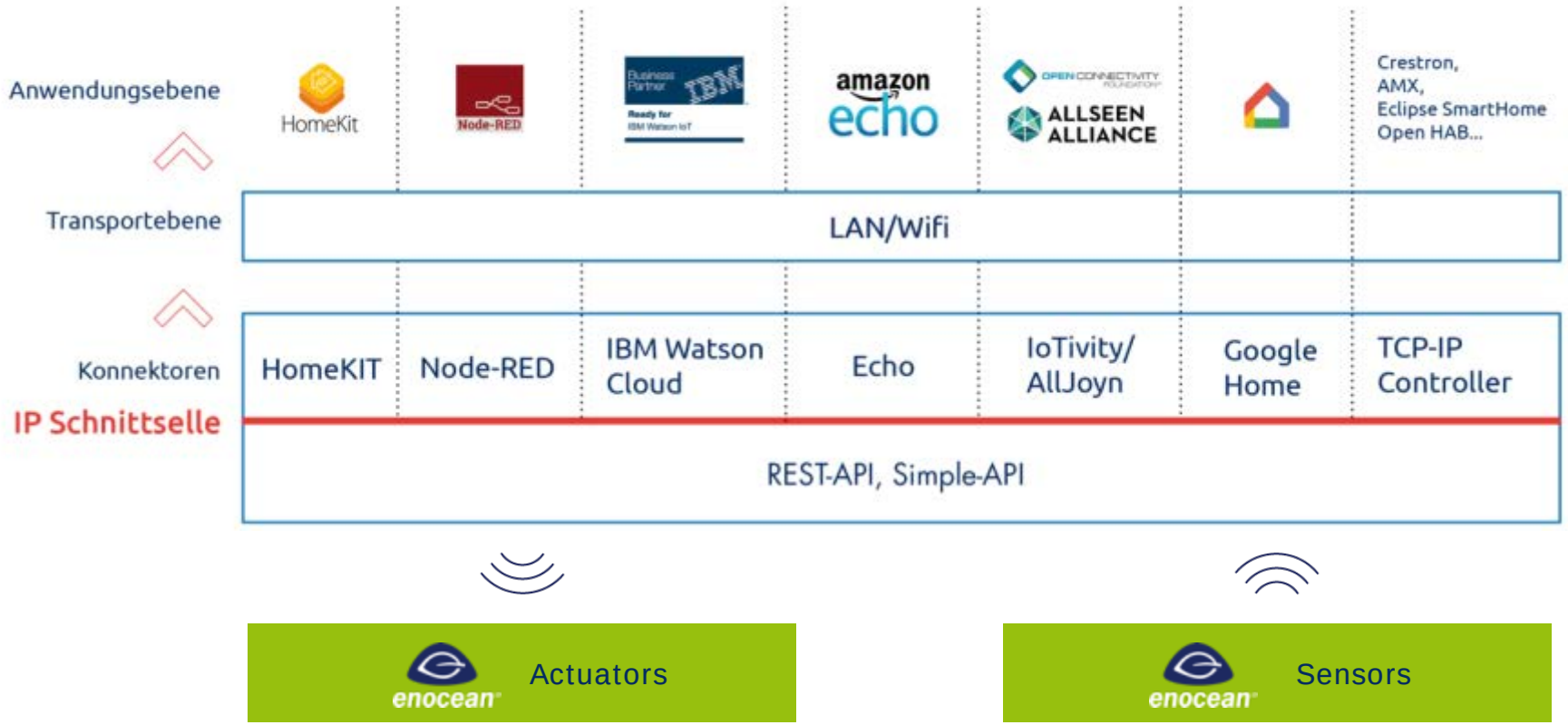


Source: www.enocean-gateway.eu

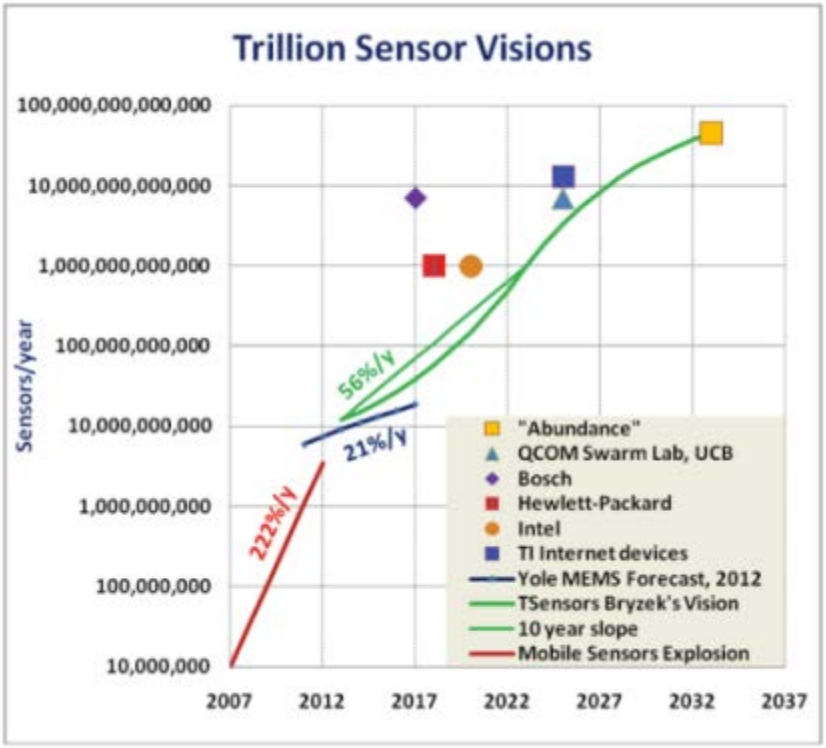
Internet of Things (IoT) – Market overview

Gartner 2015:
>20 billion permanently networked devices by 2020

TSensor Summit (October 2013)**:**
50 trillion networked sensors by 2032

Category	2014	2015	2016	2020
Consumer	2.277	3.023	4.024	13.509
Business Cross-Industry	632	815	1.092	4.408
Business Vertical-specific	898	1.065	1.276	2.880
Grand Total	**3.807**	**4.902**	**6.392**	**20.797**

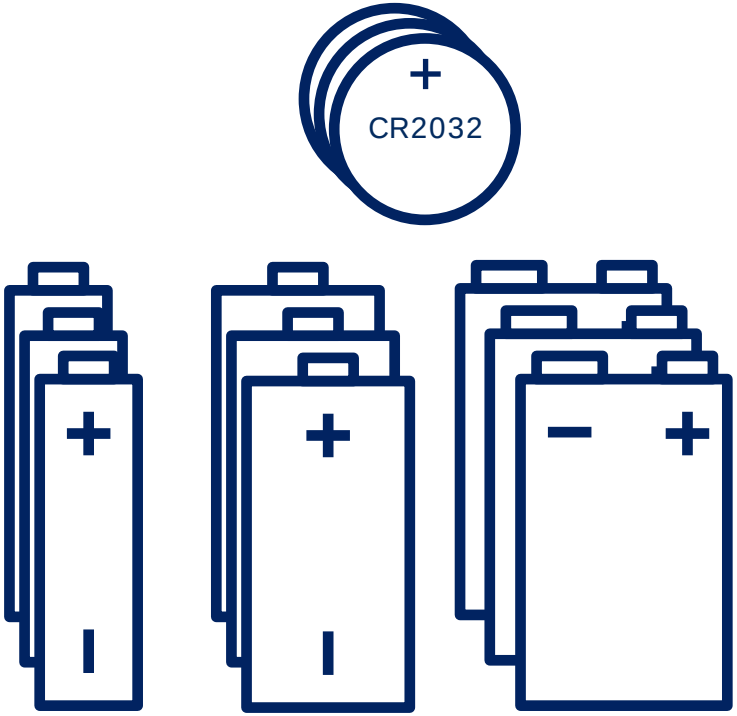
Internet of Things Units Installed Base by Category [Millions of Units], Gartner (November 2015)



How can 50 trillion sensors be powered and connected?

Energy for the Internet of Things (IoT): trillions of sensors

Batteries – not always practical or useful



Manufacturing 10 trillion CR 2032 batteries takes 1 million tons of lithium

- Current global yearly lithium production - approx. 20.000 tons*
- Total global lithium reserves - estimated 11 million tons*

Batteries can fail and require substitution, stocking and disposal

Discharged batteries mean inactive devices and system failures requiring service calls (Hotline) and, perhaps, onsite technical support

* Source: www.rohstoff-welt.de

Internet of Things (IoT)

enocean alliance
No Wires. No Batteries. No Limits.

Wireless sensors – sensory organs for the IoT

- Sensors connected by cables and/or powered by batteries can be excluded due to practical, ecological and economic reasons
- Batteryless, wireless technology is the only way forward

SmartHome – one of countless IoT applications

- In a few years‘ time, SmartHome technology will be the norm
- The demand for retrofits in older properties will become huge

Outdoor applications

- IoT applications for outdoor use will also play an important role
- Parking and traffic management
- Smart Agriculture
- Water management (supply and disposal, flood management)

Cognitive (learning) buildings

Evolution:
from automated to cognitive (learning) buildings

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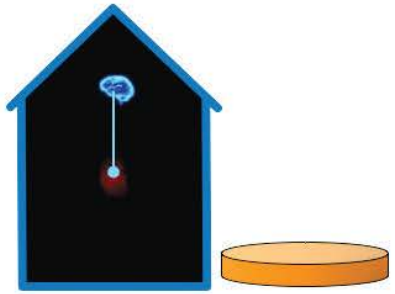
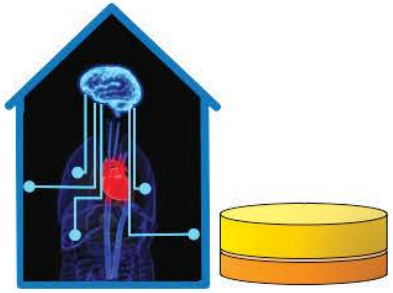
Automated buildings
(1980 – 2000)



Control & visualization

+ Good for manual monitoring
+ Recognizes serious problems
- No information concerning inefficient use of energy

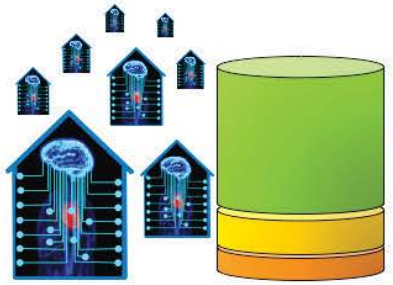
Intelligent buildings
(2000 – 2015)



Energy management

+ Monitors energy consumption of central systems and rooms
- Only monitors the main parameters

Cognitive buildings
(> 2015)



Learning behaviour

+ Model-based control at individual workplace level
+ Understands energy flow in the building and its allocation/utilization
+ Learns user behaviour (comfort) and the influence of context, e.g. the weather
- Requires analytic tools capable of elaborating a large quantity of data

Source: IBM Global Business Services 2016

Cognitive building: example hotel/campus

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Problem
Most hotel rooms and student rooms are unoccupied more than 2/3 of the time whilst HVAC and other appliances are left to run – and waste vast amounts of energy.

Consequence
Higher running costs and unnecessary environmental impact (CO_2).

Solution
Existing spaces can easily be modernized with maintenance-free wireless batteryless sensors - without disturbing ongoing operation of the facility. Energy costs can be reduced by up to 30-40% room by room.

Solution in detail

Batteryless wireless occupancy sensors adjust room temperature and turn off the lights when the room is not in use.

Batteryless wireless switches govern lighting and shading.

Batteryless wireless window contacts turn off the HVAC system when the windows are open.

CO_2 and humidity sensors monitor air quality.

Batteryless wireless card-readers activate/deactivate the lighting and HVAC system whenever someone enters or leaves the room.

Batteryless wireless room controllers guarantee high comfort and low energy consumption.

Source: IBM

Cognitive building: example office

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Problem
Today, office space has almost become a luxury. Many rooms are used for less than 70% of the time (meeting rooms, canteen spaces, warehouse space, special workspace areas).

Consequence
Unnecessarily high running costs (HVAC, lighting, maintenance).

Solution
Easy-to-fit maintenance-free wireless sensors collect raw data which is then processed by the automation system, putting the building's management in the picture with valuable information on usage patterns and potential for optimization.

Solution in detail

Batteryless wireless occupancy sensors adjust room temperature and turn off the lights when the room is not in use.

Batteryless wireless switches govern lighting and shading.

Batteryless wireless door contacts turn on lighting and HVAC system upon entering the room.

Wireless batteryless seat occupancy sensors govern AC power supply and IT systems for individual workstations.

Source: IBM

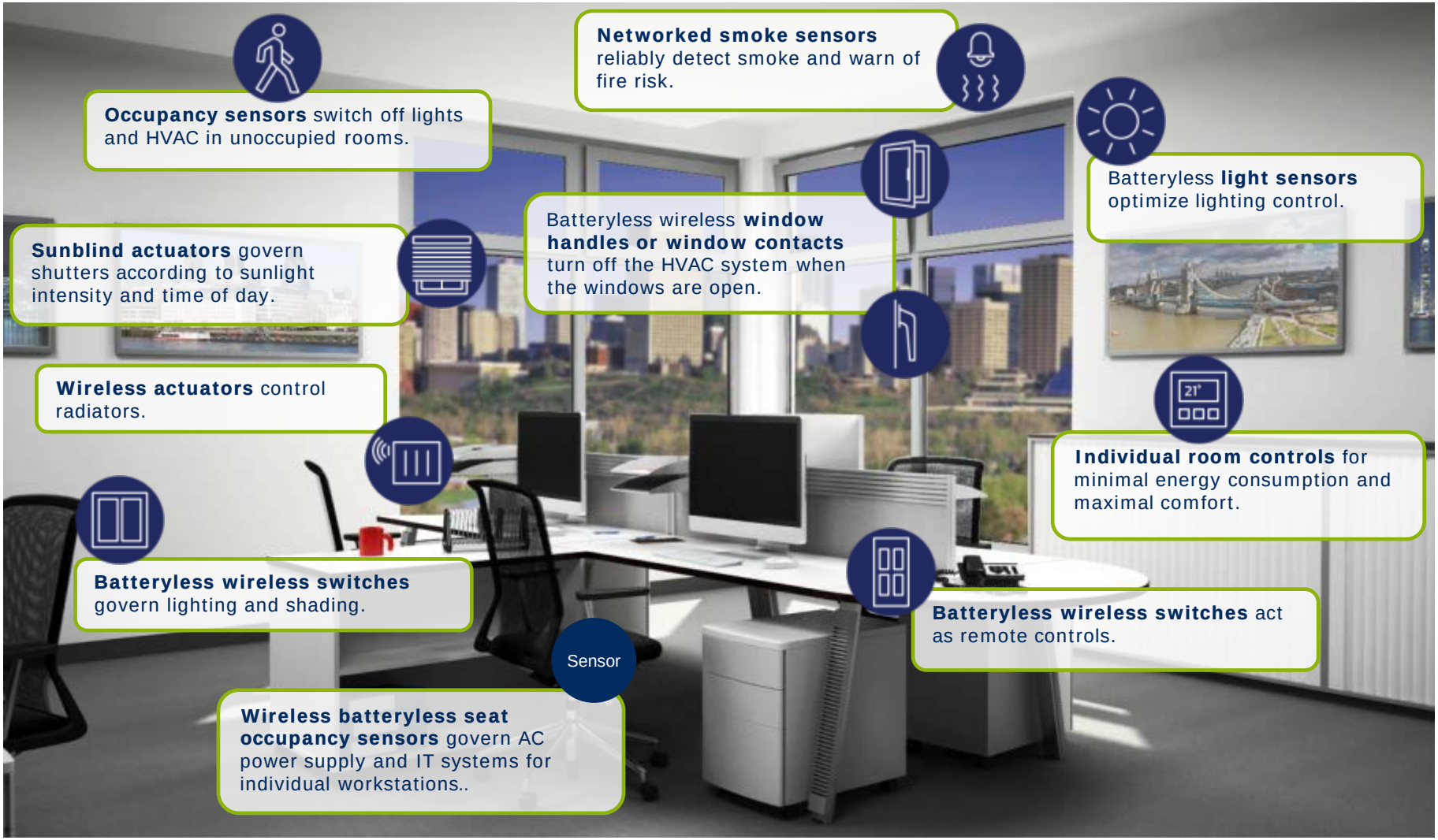
EnOcean applications

- Office building
  - Office / open-plan office
  - Administration building
- School
- Hospitality
  - Hotel room
  - Student's room
- Hospital
- Ambient Assisted Living (AAL)
- Residential building
  - Living room
  - Kitchen
  - Bedroom
  - Children's room
  - Bathroom
  - Detached house
  - Apartment building
- Retail facility
- Historic building
- Industrial facility

Office / open-plan office

Office / open-plan office

Office / open-plan office



Office / open-plan office

Benefits

Architects

- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers

- Simplified planning and high flexibility through freely positionable sensors
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors

- Speedy, flexible installation / system start-up
- No cabling, no drilling, no noise/dust/dirt
- Simple retrofit during undisturbed operation

Investors / Property Owners

- Reduced cost of installation and operation
- Flexible space planning and easy restructuring
- Fast space conversion for quick tenant turnaround
- High energy savings
- Higher productivity

Facility Managers

- Flexibility and freedom from maintenance
- Optimized servicing
- Effective manpower use
- Less noise/dust/dirt
- Increased safety levels
- Faster reaction to system faults
- Interoperable and scalable standard solutions

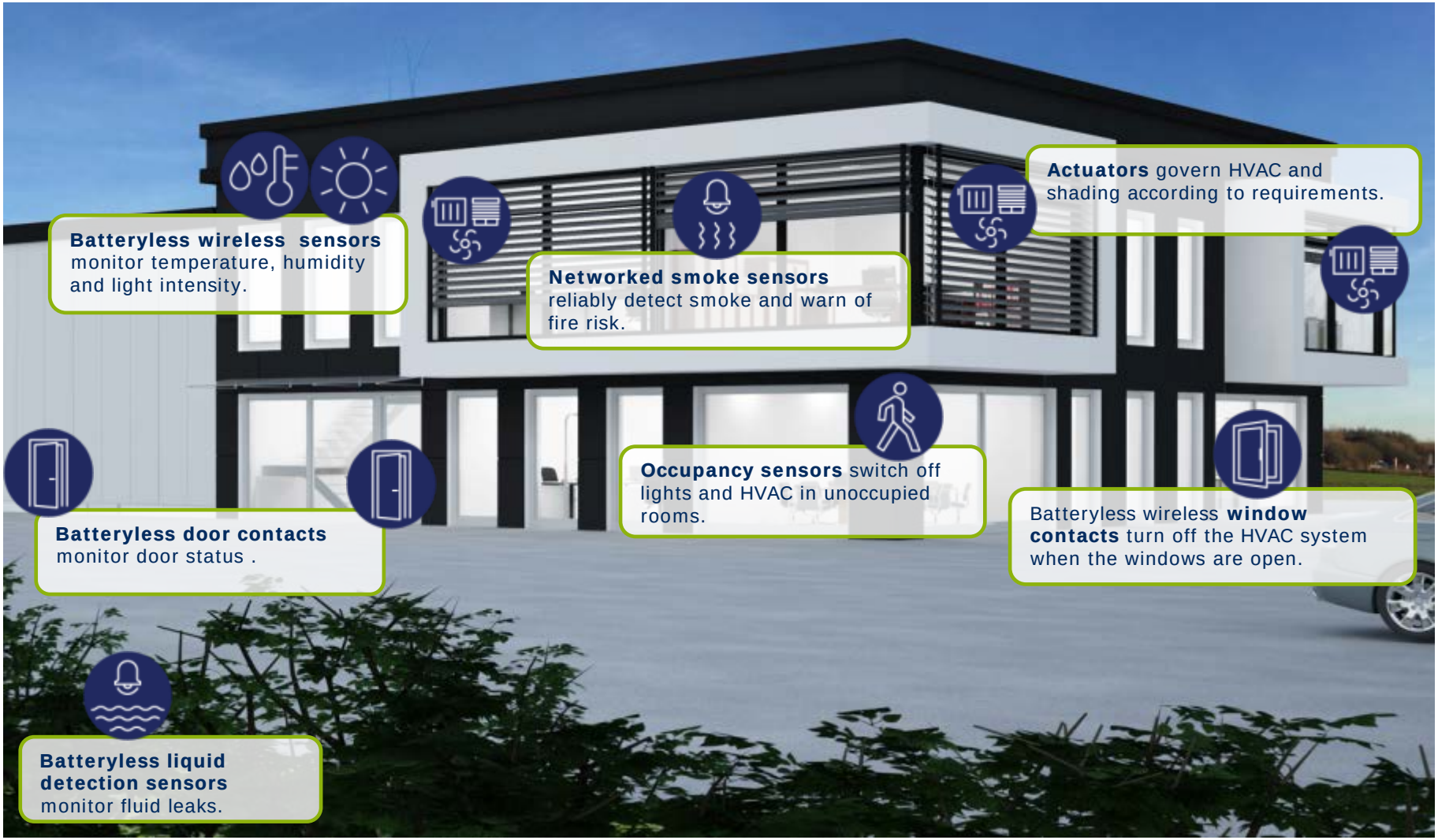
Facility users

- Enhanced comfort
- Pleasant, productive working environment

Administration building

Administration building

Administration building



Administration building

Benefits

Architects
- Maintenance-free, interoperable wireless sensors
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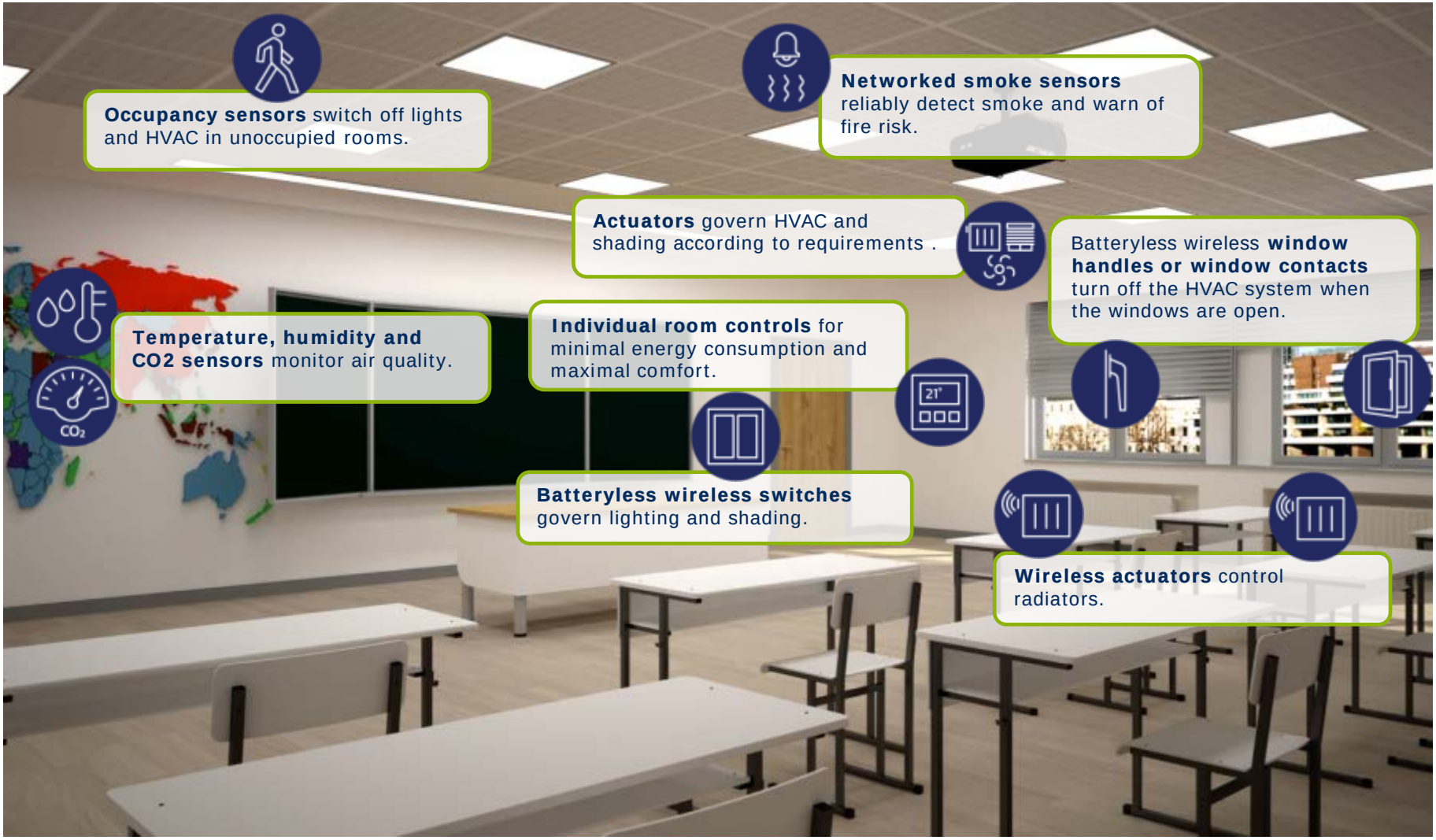
- Faster reactions to system faults
- Interoperable and scalable standard solutions

Facility users
- Enhanced comfort
- Pleasant, productive working environment

School

School

School


Occupancy sensors switch off lights and HVAC in unoccupied rooms.
Networked smoke sensors reliably detect smoke and warn of fire risk.
Actuators govern HVAC and shading according to requirements .
Batteryless wireless **window handles or window contacts** turn off the HVAC system when the windows are open.
Temperature, humidity and CO2 sensors monitor air quality.
Individual room controls for minimal energy consumption and maximal comfort.
Batteryless wireless switches govern lighting and shading.
Wireless actuators control radiators.

School

Benefits

Architects

- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers

- Simplified planning and high flexibility through freely positionable sensors
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors

- Speedy, flexible installation / system start-up
- No cabling, no drilling, no noise/dust/dirt
- Simple retrofit during undisturbed operation

Investors / Property Owners / School Authorities

- Reduced cost of installation and operation
- Flexible space planning and easy restructuring
- High energy savings
- Interoperable and scalable standard solutions

Facility Managers

- Flexibility and freedom from maintenance
- Optimized servicing
- Effective manpower use
- Increased safety levels
- Faster reaction to system faults
- Interoperable and scalable standard solutions

Facility users

- Enhanced comfort
- Pleasant, productive learning environment

Hotel room

Hotel room

Hotel room


Networked smoke sensors reliably detect smoke and warn of fire risk.
Occupancy sensors switch off lights and HVAC in unoccupied rooms.
Actuators govern HVAC and shading according to requirements.
Batteryless wireless card-reader activates/deactivates the lighting and HVAC system whenever someone enters or leaves the room.
Individual room controls for minimal energy consumption and maximal comfort.
Batteryless wireless **window contacts** turn off the HVAC system when the windows are open.
Batteryless wireless switches govern lighting and shading.
Wireless actuators control radiators, **room controllers** govern underfloor heating.
Batteryless liquid detection sensors monitor fluid leaks.

Hotel room

Benefits

Architects
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers
- Simplified planning and high flexibility through freely positionable sensors
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors
- Speedy, flexible installation / system start-up
- No cabling, no drilling, no noise/dust/dirt

Investors / Property Owners
- Reduced cost of installation and operation
- Flexible space planning and easy restructuring
- Less downtime during renovation
- High energy savings
- Interoperable and scalable standard solutions

Facility Managers
- Flexibility and freedom from maintenance
- Optimized servicing
- Effective manpower use
- Increased safety levels
- Faster reaction to system faults
- Interoperable and scalable standard solutions

Facility users
- Enhanced comfort

Student room

Student room

Student room

Student room

Benefits

Architects

- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers

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Facility Managers

- Flexibility and freedom from maintenance
- Optimized servicing
- Effective manpower use
- Increased safety levels
- Faster reaction to system faults
- Interoperable and scalables standard solutions

Facility users

- Enhanced comfort
- Increased safety levels

Hospital room

Hospital room

Hospital room

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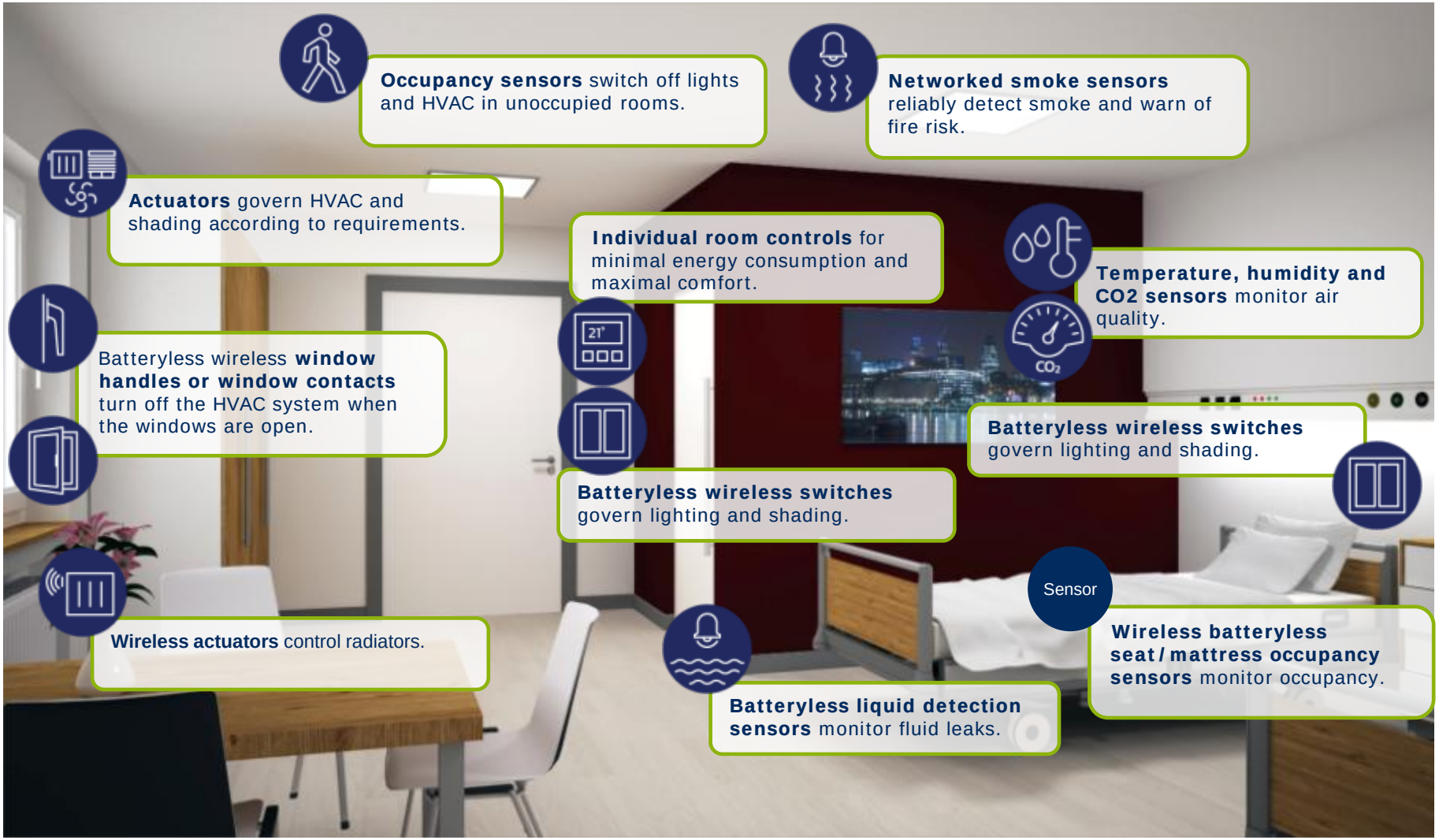

Hospital room

Benefits

Architects

- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers

- Simplified planning and high flexibility through freely positionable devices
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors

- Speedy, flexible installation / system start-up
- No cabling, no drilling, no noise/dust/dirt
- Simple retrofit during undisturbed operation

Investors

- Reduced cost of installation and operation
- Less downtime during renovation
- High energy savings
- Interoperable and scalable standard solutions

Facility Managers

- Flexibility and freedom from maintenance
- Optimized servicing
- Effective manpower use
- Increased safety levels
- Faster reaction to system faults
- Interoperableaund scalablee standard solutions
- Flexible space reallocation (patient room, therapy room or staff room)
- Combinable with nurse call systems

Facility users

- Enhanced comfort
- Better air quality

Ambient Assisted Living (AAL)

Ambient Assisted Living (AAL)

Ambient Assisted Living (AAL)

enocean alliance
No Wires. No Batteries. No Limits.

Ambient Assisted Living (AAL)

Benefits

Architects
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers
- Simplified planning and high flexibility through freely positionable devices
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors
- Speedy, flexible installation / system start-up

Investors / Property Owners
- Simple retrofit
- Reduced cost of installation and operation
- Flexible space reallocation
- High energy savings
- All-encompassing solutions

Facility users
- Increased safety levels
- Enhanced comfort
- Simple retrofit
- Freely positionable products
- Cost-effective SmartHome solutions
- No cabling, no drilling, no noise/dust/dirt

Ambient Assisted Living (AAL)

Ambient Assisted Living (AAL)

Ambient Assisted Living (AAL)

enocean alliance
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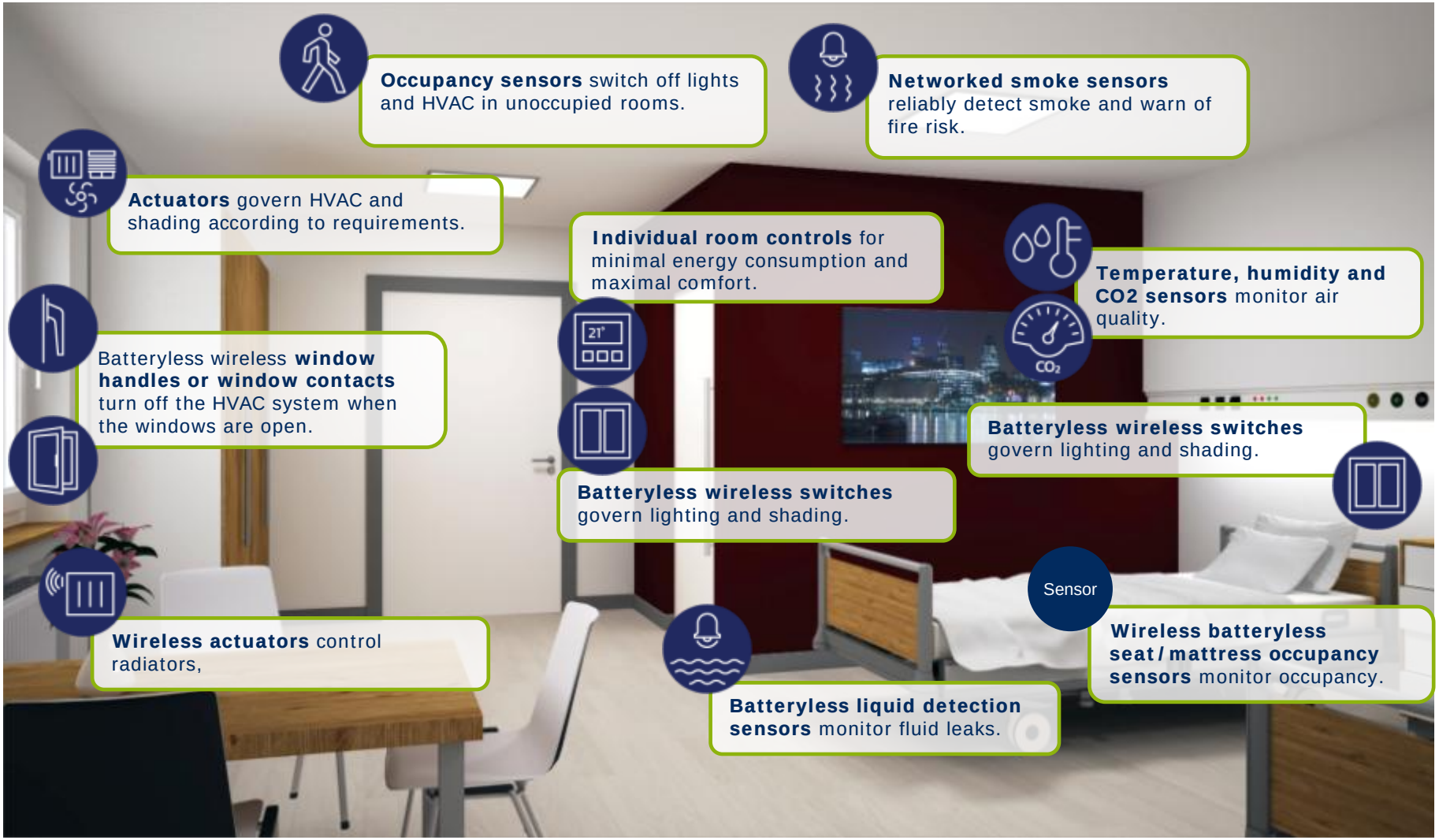


Ambient Assisted Living (AAL)

Benefits

Architects
- Maintenance-free, interoperable wireless sensors
- Freely positionable products can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers
- Simplified planning and high flexibility through freely positionable devices
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors
- Speedy, flexible installation / system start-up
- No cabling, no drilling, no noise/dust/dirt
- Simple retrofit during undisturbed operation

Facility users
- Enhanced comfort
- Freely positionable and retrofittable products e.g. emergency call button, mattress sensors

Investors
- Simple retrofit
- Reduced cost of installation
- Less downtime during renovation
- High energy savings
- Interoperable and scalable standard solutions

Facility Managers
- Flexibility and freedom from maintenance
- Optimized servicing
- Effective manpower use
- Increased safety levels
- Faster reaction to system faults
- Interoperable and scalable standard solutions
- Flexible space reallocation (patient room, therapy room or staff room)
- Combinable with nurse call systems

Living room

Living room

Living room

enocean alliance
No Wires. No Batteries. No Limits.

Living room

Benefits

Architects

- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers

- Simplified planning and high flexibility through freely positionable sensors
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors

- Speedy, flexible installation / system start-up

Investors / Property Owners

- Reduced cost of installation and operation
- Simple retrofit
- Flexible space planning and easy restructuring
- High energy savings
- Interoperable and scalable solutions
- All-encompassing solutions

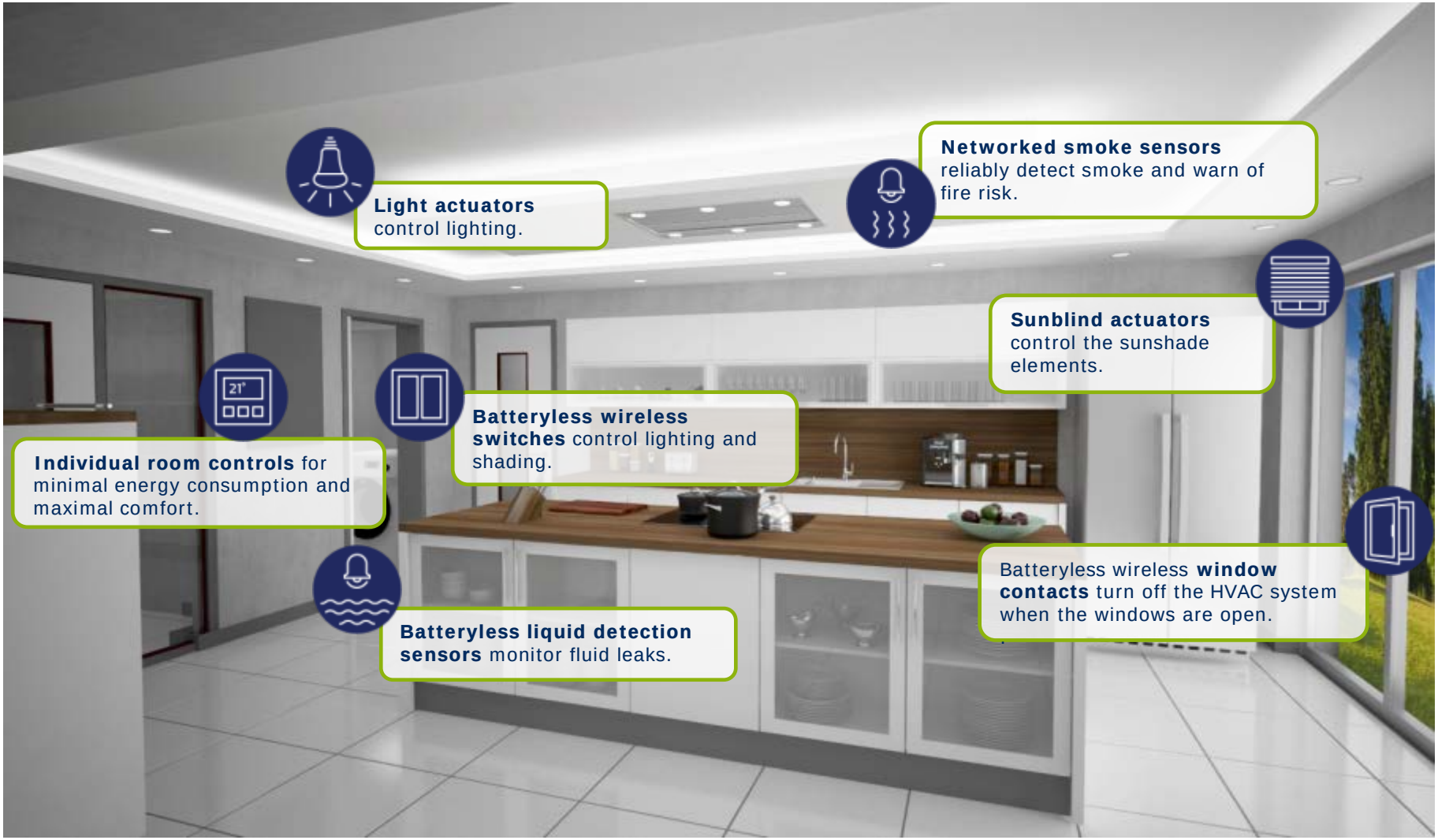
Facility users

- Increased safety levels
- Enhanced comfort
- Simple retrofit
- Freely positionable products
- Cost-effective SmartHome solutions
- No cabling, no drilling, no noise/dust/dirt

Kitchen

Kitchen

Kitchen


Light actuators control lighting.
Networked smoke sensors reliably detect smoke and warn of fire risk.
Sunblind actuators control the sunshade elements.
Batteryless wireless switches control lighting and shading.
Individual room controls for minimal energy consumption and maximal comfort.
Batteryless wireless **window contacts** turn off the HVAC system when the windows are open.
Batteryless liquid detection sensors monitor fluid leaks.

Kitchen

Benefits

Architects
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers
- Simplified planning and high flexibility through freely positionable sensors
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

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- Interoperable and scalable solutions
- All-encompassing solutions

Facility users
- Increased safety levels
- Enhanced comfort
- Simple retrofit
- Freely positionable products
- Cost-effective SmartHome solutions
- No cabling, no drilling, no noise/dust/dirt

Bedroom

Bedroom

Bedroom


Networked smoke sensors reliably detect smoke and warn of fire risk.
Sunblind actuators govern shutters according to sunlight intensity and time of day.
Individual room controls for minimal energy consumption and maximal comfort.
Batteryless wireless **window contacts** turn off the HVAC system when the windows are open.
Batteryless wireless switches control lighting and shading.
Wireless connectors control and monitor household appliances.
Wireless actuators govern underfloor heating.

Bedroom

Benefits

Architects
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers
- Simplified planning and high flexibility through freely positionable sensors
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors
- Speedy, flexible installation / system start-up

Investors / Property Owners
- Simple retrofit
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- High energy savings
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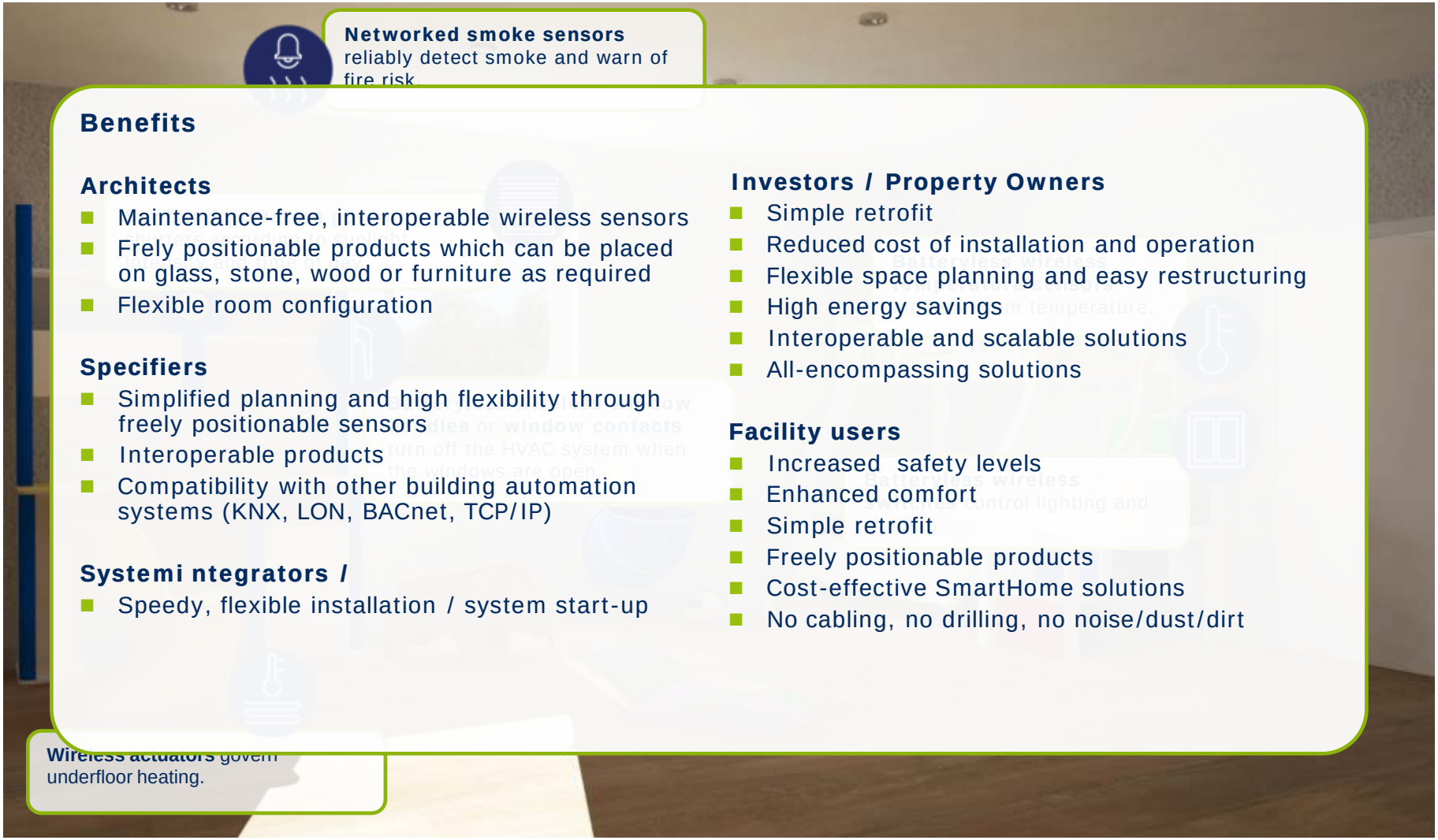
Facility users
- Increased safety levels
- Enhanced comfort
- Simple retrofit
- Freely positionable products
- Cost-effective SmartHome solutions
- No cabling, no drilling, no noise/dust/dirt

Children‘s room

Children‘s room

Children‘s room

Children‘s room



Benefits

Architects

- Maintenance-free, interoperable wireless sensors
- Frely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers

- Simplified planning and high flexibility through freely positionable sensors
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

Systemi ntegrators /

- Speedy, flexible installation / system start-up

Investors / Property Owners

- Simple retrofit
- Reduced cost of installation and operation
- Flexible space planning and easy restructuring
- High energy savings
- Interoperable and scalable solutions
- All-encompassing solutions

Facility users

- Increased safety levels
- Enhanced comfort
- Simple retrofit
- Freely positionable products
- Cost-effective SmartHome solutions
- No cabling, no drilling, no noise/dust/dirt

Bathroom

Bathroom

Bathroom


Sunblind actuators govern sunblinds or shutters.
Batteryless wireless window handles turn off the HVAC system when the windows are open.
Batteryless wireless temperature / humidity sensors monitor temperature and humidity.
Wireless actuators govern radiators.
Batteryless wireless switches control lighting and shading.
Batteryless liquid detection sensors monitor fluid leaks.

Bathroom

Benefits

Architects
- Maintanance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers
- Simplified planning and high flexibility through freely positionable sensors
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors
- Speedy, flexible installation / system start-up

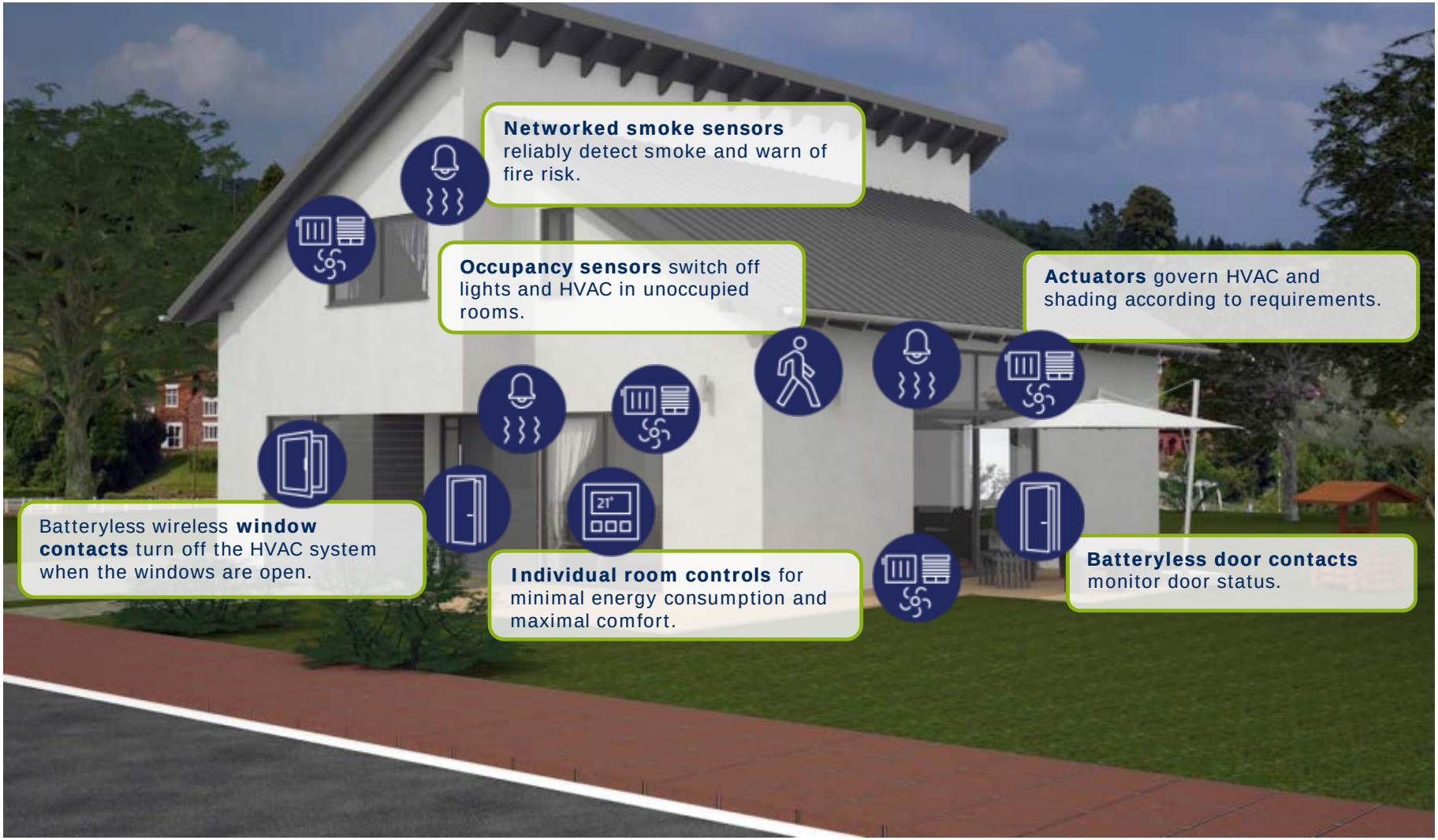
Investors / Property Owners
- Simple retrofit
- Reduced cost of installation and operation
- Flexible space planning and easy restructuring
- High energy savings
- Interoperable and scalable solutions
- All-encompassing solutions

Facility users
- Increased safety levels
- Enhanced comfort
- Simple retrofit
- Freely positionable products
- Cost-effective SmartHome solutions
- No cabling, no drilling, no noise/dust/dirt

Detached house

Detached house

Detached house



Detached house

Benefits

Architects
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers
- Simplified planning and high flexibility through freely positionable devices
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors
- Speedy, flexible installation / system start-up

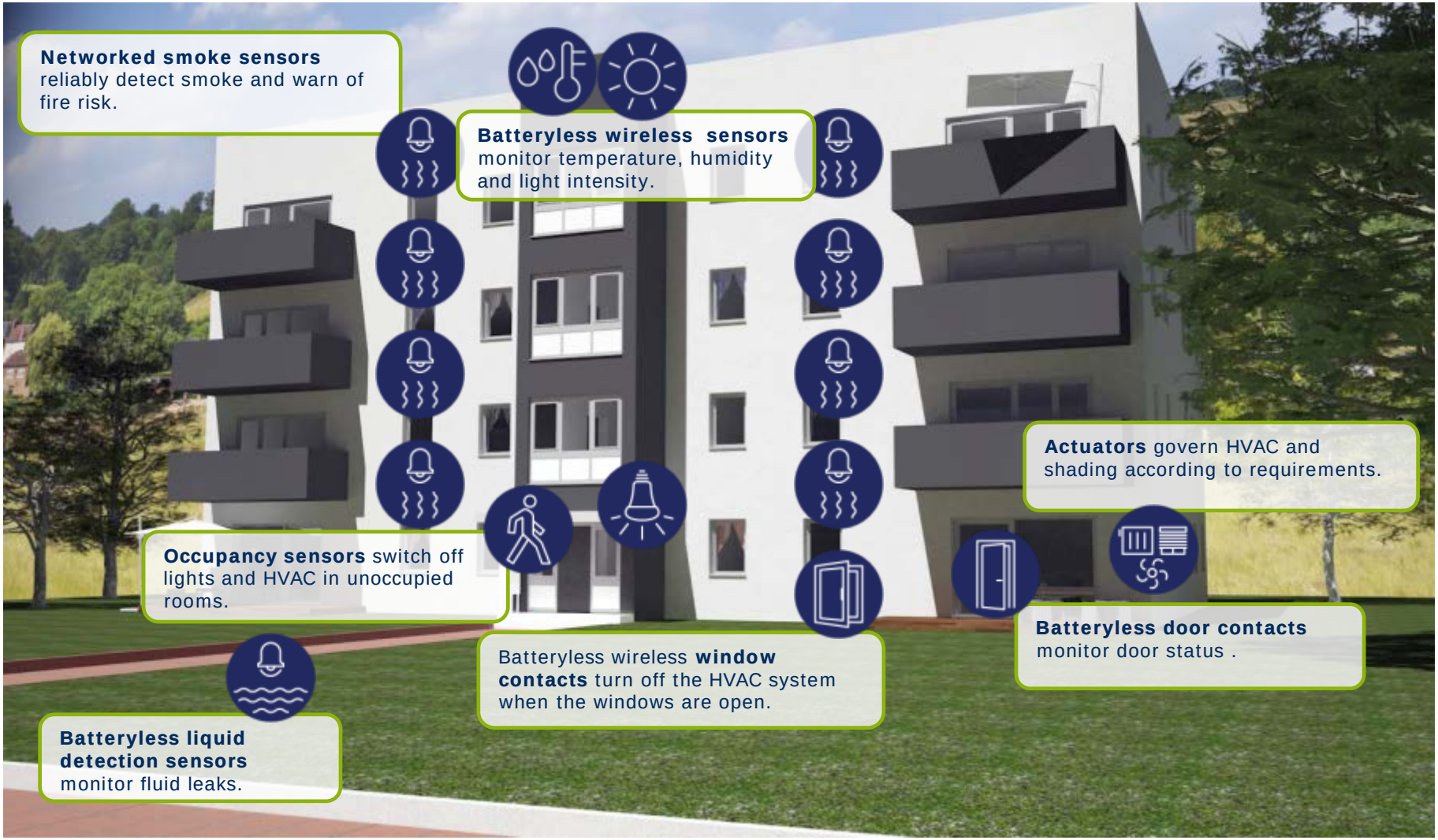
Investors / Property Owners
- Simple retrofit
- Reduced cost of installation and operation
- Flexible space planning and easy restructuring
- High energy savings
- All-encompassing solutions
- More attractive purchase proposition

Facility users
- Increased safety levels
- Enhanced comfort
- Pleasant living environment
- Simple retrofit
- Freely positionable products
- Cost-efficient SmartHome solutions
- No cabling, no drilling, no noise/dust/dirt

Apartment block

Apartment block

Apartment block



Apartment block

Benefits

Architects

- Maintenance-free, interoperable wireless sensors
- Freelyy positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers

- Simplified planning and high flexibility through freely positionable devices
- Interoperable products
- Compativility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors

- Speedy, flexible installation / system start-up
- No cabling, no drilling, no noise/dust/dirt

Investors / Property Owners

- Reduced cost of installation and operation
- Flexible space reallocation
- Easy modernization
- High energy savings
- Interoperable and scalable standard solutions

Facility Managers

- Flexibility and freedom from maintenance
- Optimized servicing
- Effective manpower use
- Increased safety levels
- Faster reaction to system faults
- Interoperable and scalable standard solutions
- No cabling, no drilling, no noise/dust/dirt

Facility users

- Extensive energy savings
- Enhanced comfort

Retail facility

Retail facility

Retail facility

Retail facility

Benefits

Architects

- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers

- Simplified planning and high flexibility through freely positionable devices
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors

- Speedy, flexible installation / system start-up
- No cabling, no drilling, no noise/dust/dirt
- Simple retrofit during undisturbed operation

Investors / Property Owners

- Reduced cost of installation and operation
- Flexible space reallocation and easy restructuring
- Less downtime during renovation
- High energy savings
- Better sales figures

Facility Managers

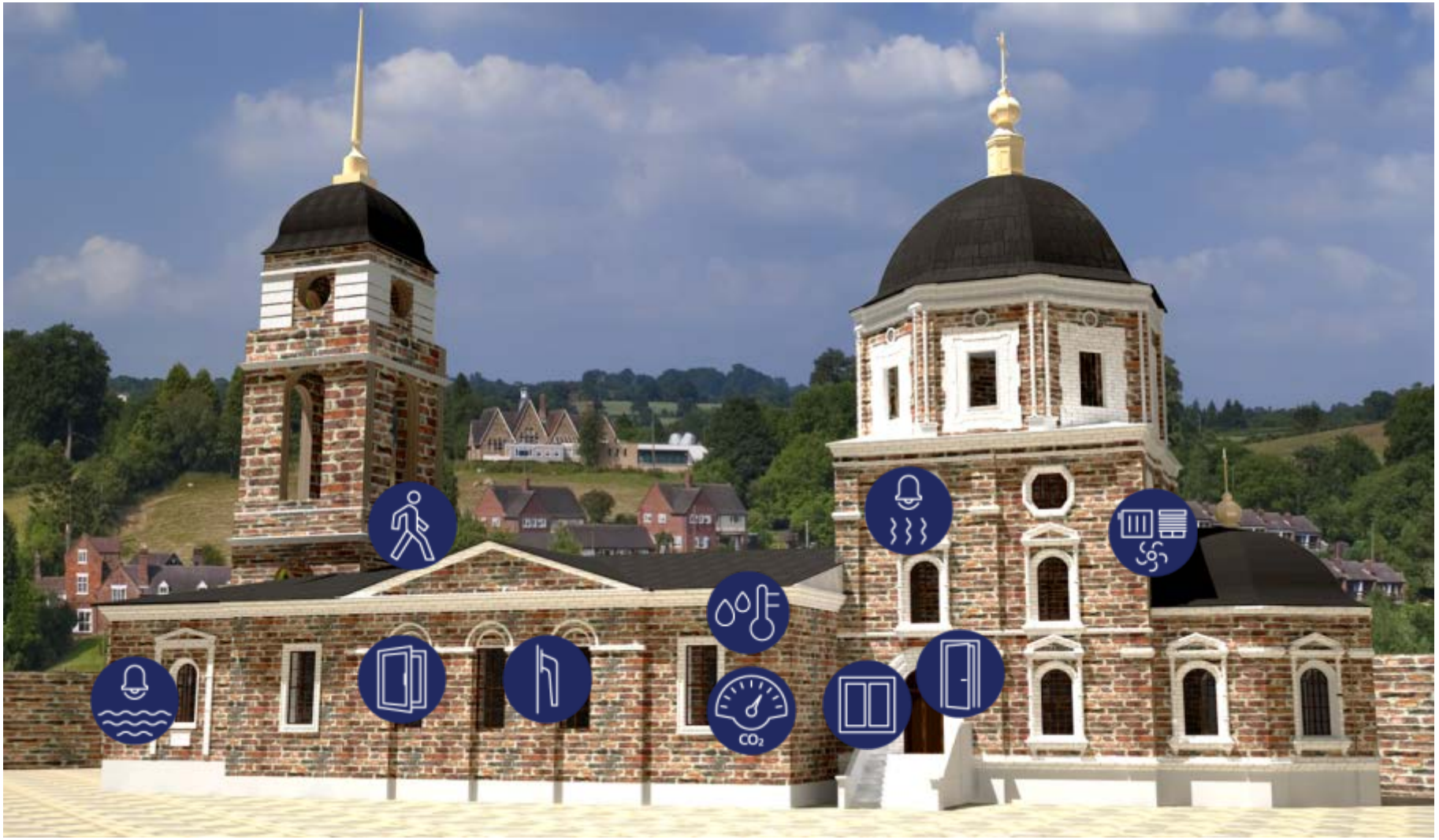
- Flexibility and freedom from maintenance
- Optimized servicing
- Effective manpower use
- Increased safety levels
- Faster reaction to system faults
- Interoperable and scalable standard solutions
- No noise/dust/dirt

Facility users

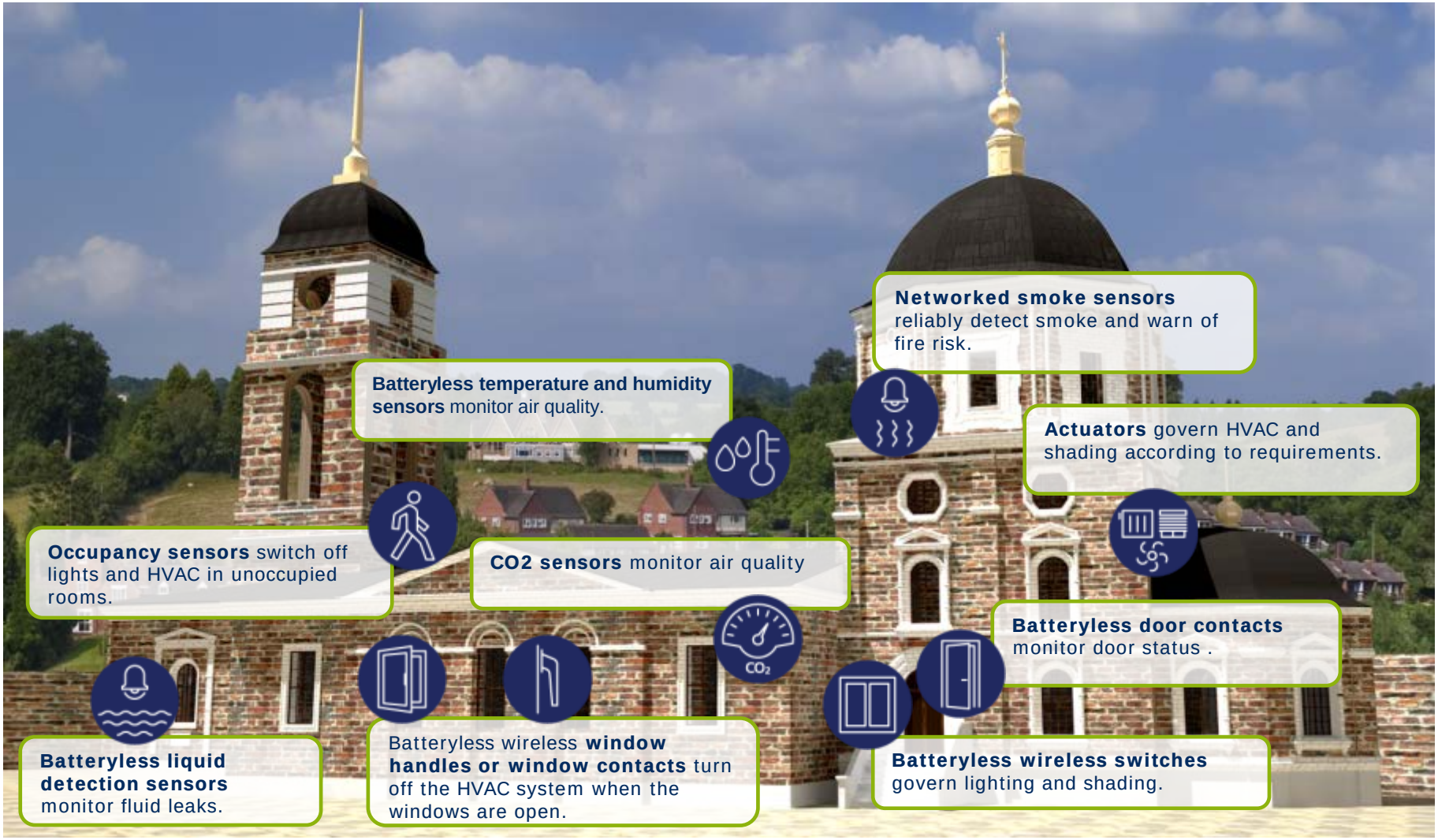
- Enhanced comfort
- Easy analysis of floorspace usage

Historic building

Historic building



Historic building



Historic building

Benefits

Architects
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers
- Simplified planning and high flexibility through freely positionable devices
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors
- Speedy, flexible installation / system start-up
- No cabling, no drilling, no noise/dust/dirt

Investors / Property Owners
- Reduced cost of installation and operation
- Flexible space reallocation
- Easy modernization
- High energy savings
- Interoperable and scalable standard solutions

Facility Managers
- Flexibility and freedom from maintenance
- Optimized servicing
- Effective manpower use
- Increased safety levels
- Faster reaction to system faults
- Interoperable and scalable standard solutions
- No cabling, no drilling, no noise/dust/dirt

Batteryless liquid detection sensors monitor fluid leaks.

Batteryless wireless **window handles or window contacts** turn off the HVAC system when the windows are open.

Batteryless wireless switches govern lighting and shading.

Industrial facility

Industrial facility

Industrial facility

Industrial facility

Benefits

Architects
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers
- Simplified planning and high flexibility through freely positionable devices
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors
- Speedy, flexible installation / system start-up
- No cabling, no drilling, no noise/dust/dirt
- Simple retrofit during undisturbed operation

Investors / Property Owners
- Reduced cost of installation and operation
- Flexible space reallocation and easy restructuring
- Less downtime during renovation
- High energy savings

Facility Managers
- Fewer cables thanks to maintenance-free wireless sensors
- Flexibility and freedom from maintenance
- Reduced cost of installation and operation
- Interoperable and scalable standard solutions
- No noise/dust/dirt

Impact of building automation and of EnOcean upon the certification of buildings

EnOcean‘s role in building automation and certification (e.g. DGNB)

Topic	Criteria group	N.	Criteria	Share of overall score
Ecological Quality (ENV)	Effect on global and local environment	**ENV 1.1**	**Ecological balance – emission-based environmental impact**	**7,9 %**
		ENV 1.2	**Risk for the local environment**	**3,4 %**
		ENV 1.3	Ecologically friendly material procurement	1,1%
	Resource impact and waste management	**ENV 2.1**	**Ecological balance – primary energy**	**5,6 %**
		ENV 2.2	Drinking water and waste water balance	2,3%
		ENV 2.3	Space requirement	2,3%
Economic Quality (ECO)	Lifecycle costs	**ECO 1.1**	**Building-related lifecycle costs**	**9,6 %**
	Value development	**ECO 2.1**	**Flexibility and reutilization potential**	**9,6 %**
		ECO 2.2	**Marketability**	**3,2 %**

Relevant criteria for EnOcean technology is **highlighted**

Excerpt „Bewertungsmatrix für Neubau Büro und Verwaltungsgebäude Version 2012 in Anlehnung an DGNB (Teil 1/2)“

EnOcean‘s role in building automation and certification (e.g. DGNB)

Topic	Criteria group	N.	Criteria	Share of overall score
Socio-cultural and functional quality (SOC)	Health, comfort and user satisfaction	**SOC 1.1**	**Thermic comfort**	**4,3 %**
		SOC 1.2	**Indoor air quality**	**2,6 %**
		SOC 1.3	Acoustic comfort	0,9%
		SOC 1.4	Visual comfort	2,6%
		SOC 1.5	**User‘s influence**	**1,7 %**
		SOC 1.6	Outdoor air quality	0,9%
		SOC 1.7	Safety and risk of malfunction	0,9%
	Functionality	SOC 2.1	Barrier-free access	1,7%
		SOC 2.2	Public access	1,7%
		SOC 2.3	Bicycle comfort	0,9%
	Creative qualities	SOC 3.1	Procedure for urban and artistic concept	2,6%
		SOC 3.2	Artistic building	0,9%
		SOC 3.3	Layout quality	0,9%

Excerpt „Bewertungsmatrix für Neubau Büro und Verwaltungsgebäude Version 2012 in Anlehnung an DGNB (Teil 1/2)“

EnOcean‘s role in building automation and certification (e.g. DGNB)

Topic	Criteria group	N.	Criteria	Share of overall score
Technical quality (TEC)	Quality of the technical execution	TEC 1.1	Fire protection	4,1%
		TEC 1.2	Sound insulation	4,1%
		TEC 1.3	Heat and dampness protection qualities of the building‘s cladding	4,1%
		TEC 1.4	**Adaptability of the technical systems**	**2,0 %**
		TEC 1.5	Ease of cleaning and maintenance of the building‘s structure	4,1%
		TEC 1.6	Ease of dismantling	4,1%
		TEC 1.7	Immission protection	0,0

Excerpt „Bewertungsmatrix für Neubau Büro und Verwaltungsgebäude Version 2012 in Anlehnung an DGNB (Teil 1/2)“

Integrated building automation impacts the following topics: ecological quality (ENV), economic (ECO), socio-cultural and functional quality (SOC) and technical quality (TEC). 11 out of 29 DGNB criteria are positively and sustainably affected*. The application of **EnOcean technology** influenced **10 out of 29 criteria**.

* Source:
„Peer Schmidt, Nachhaltigkeit durch Gebäudeautomation am Beispiel der DGNB-Kriterien (Gebäudeautomation, Jahrbuch 2015)“

EnOcean‘s role in building automation and certification (e.g. DGNB)

Topic	Criteria group	N.	Criteria	Share of overall score
Process quality (PRO)	Planning quality	PRO 1.1	Quality of project preparation	1,4%
		PRO 1.2	Integral planning	1,4%
		PRO 1.3	Proof of optimization and complexity of the planning approach	1,4%
		PRO 1.4	Safeguards for sustainability in the tender and award process	1,0%
		PRO 1.5	Creation of preconditions for an optimal utilization and management	1,0%
	Execution quality	PRO 2.1	Building site, building process	1,0%
		PRO 2.2	Quality assurance for the building process	1,4%
		PRO 2.3	Orderly system start-up	1,4%

Excerpt „Bewertungsmatrix für Neubau Büro und Verwaltungsgebäude Version 2012 in Anlehnung an DGNB (Teil 1/2)“

An optimized planning process, and the resulting construction with a systematic start-up phase and an implemented quality assurance system, can significantly improve process quality (criteria PRO 1.1 to PRO 2.3).

Source:
Peer Schmidt, Nachhaltigkeit durch Gebäudeautomation am Beispiel der DGNB-Kriterien (Gebäudeautomation, Jahrbuch 2015)

EnOcean‘s role in building automation and certification (e.g. DGNB)

The application of **EnOcean technology,** together with an adapted planning and execution process, positively and sustainably affected **18 out of 37 DGNB criteria**. These 18 criteria account for more than 2/3 of the overall ranking.

Gesamter-füllungsgrad	Mindester-füllungsgrad	Auszeichnung
ab 35 %	— %	Bronze*
ab 50 %	35 %	Silber
ab 65 %	50 %	Gold
ab 80 %	65 %	Platin

*Diese Auszeichnung gilt nur für Bestandsgebäude

Quelle
www.dgnb-system.de

Case studies / References

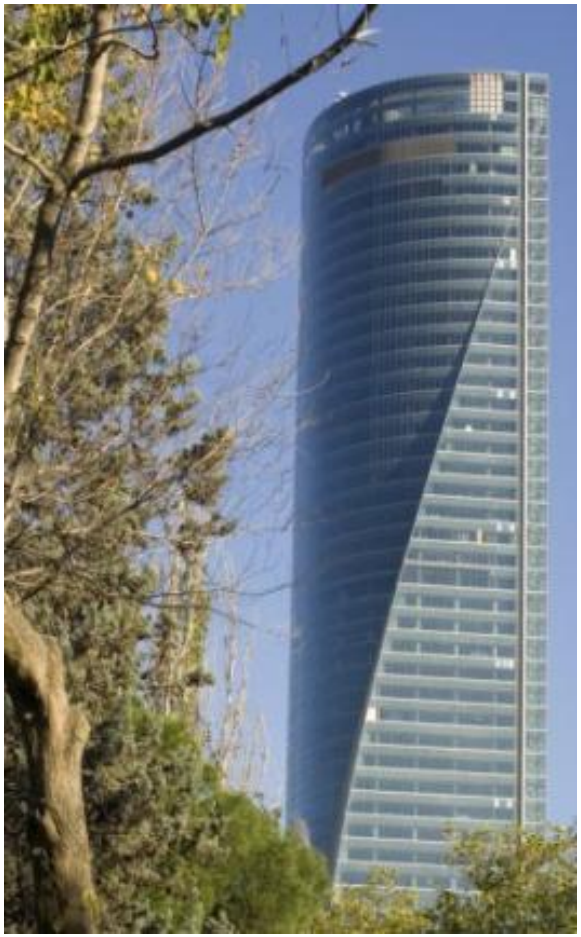
Case study: multi-purpose building
The Squaire – Frankfurt Airport

Basic facts

- Length: 660 metres (2 x Eiffel Tower)
- Width: 65 metres
- Height: 45 metres (9 storeys)
- Usable area: 140.000 m^2
- Project costs: 1.4 billion €
  - 21 million € threof spent on automation
- More than 20.000 EnOcean sensors and actuators in place

Devices	quantity
EnOcean terminals	1.838
EnOcean switches	12.000
EnOcean room sensors	6.000
PLC for Plants and Room Automation	899
PLC for BACnet communication	56
PLC for DALI	25
MP Bus-Terminal	2.119
DALI terminal	89
EIA422/485 terminal	6
KNX terminal	20

Case study: lighting in office building
Torre Espacio - Madrid



- **4.200 batteryless wireless devices**
  - Light switches
  - Occupancy sensors
  - Light sensors

- **Savings***
  - 30% to 40% of the cost of lighting
    - Ambient-light-dependent interior lighting
    - Occupancy-sensor-triggered light shutdown
  - 32 km cables, saving
    - 1.2 t copper / 4.5 t CO_2
    - 2.8 t PVC / 7.5 t CO_2
    - Many man-years in installation time
  - 42.000 batteries (over 25 years)
  - Thereafter: 80% of restructuring costs

* own calculation

References: office buildings

Schneider Electric Research and Development, Montreal (Canada)

NYC Department of Sanitation (USA)

Vossloh-Schwabe Office Shanghai (China)

ADAC Headquarters Munich (Germany)

References: hotels

Energy Saving Hotels (USA)

Platzl Hotel, Munich (Germany)

Springhill Suites, Natomas (USA)

Hainan Airline Hotel (China)

References: hospitals and AAL

Senior citizens home, Asslar (Germany)

VA Medical Center, Dayton, OH (USA)

Institut de Cardiologie (Kanada)

Müritz Clinic (Germany)

References: residential buildings

Empowerhouse, Washington D.C. (USA)

B10 Active House (Germany)

Shanghai Villa (China)

Weberhaus (Germany)

References: retail facilities

Changi City Point (Singapur)

Morrisons Distribution Center (UK)

Toys R Us (UK)

Xtramart Convenience Store (USA)

References: schools

Center for Virtual Engineering ZVE (Germany)

Sir Isaac Newton Academy (UK)

Georgia Institue of Technology (USA)

University of Western Ontario (Canada)

References: industrial facilities

Wayne County Airport Authority Maintenance Facilities (USA)

BMW production plant (Germany)

Aggreko Factory (UK)

Cardboard production plant (Canada)

References: historic buildings

Taimadera Buddhistischer Temple (Japan)

Semperoper, Dresden (Germany)

Queen Annes Gate (UK)

St. Andrews Cathedral (Canada)

References: further projects

Entega Loge
(Germany)

Imtech Arena
(Germany)

SCHEIBER Boats

Yacht "Feretti 830"
(Brazil)

Case study:
green building certifications

enocean alliance
No Wires. No Batteries. No Limits.

Leggat MacCall Properties, Boston

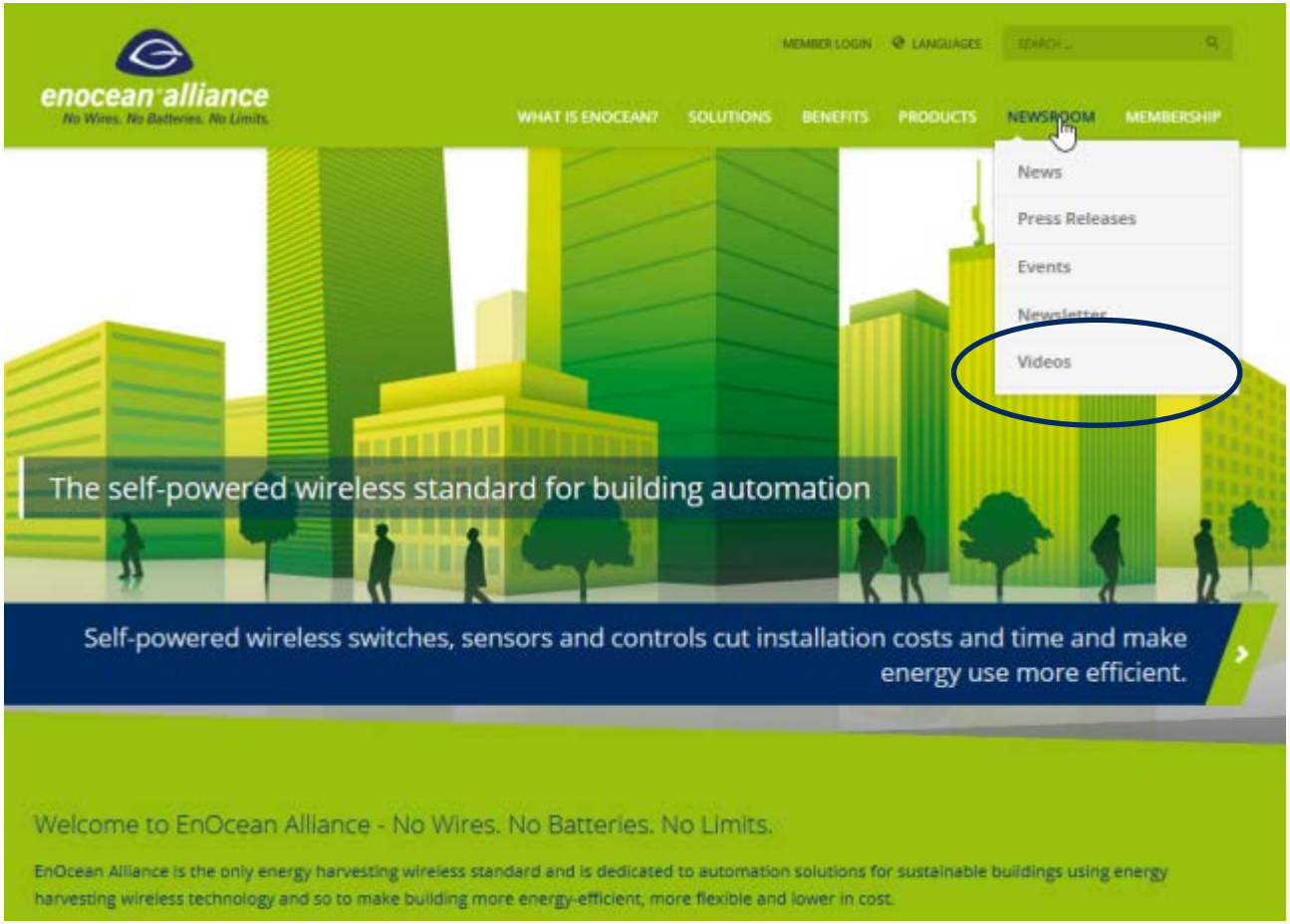
Promutuel Insurance Company, Quebec

“Tower 185” PWC Frankfurt

Videos

Videos

www.enocean-alliance.org
www.youtube.com/user/EnOcean



Videos

EnOcean YouTube channel: EnOcean technology for intelligent and green buildings

Any questions?

Contact
Please get in touch if you
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enocean alliance
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