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Smart Buildings Seminar

Module 6: Modern Technologies and Systems Integration

What We Will Work On and What You Should Pay Attention To

GRADUATE SEMINAR | BUILDING ENERGY MANAGEMENT

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Why Smart Buildings Matter

A building is not smart simply because it has many devices. It is smart when its systems work together to improve performance, comfort, and sustainability. Smart buildings connect four goals that are increasingly central to modern energy policy and practice.

Lower Energy Consumption

Reduce demand through integrated monitoring and adaptive control

Comfort & Indoor Quality

Maintain optimal thermal, visual, and air quality conditions

Grid Flexibility

Enable demand response and active participation in the energy system

nZEB / ZEB Goals

Support nearly zero and zero-emission building policy targets

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Your Seminar Task

Before and during the seminar, active engagement with the course materials is essential. The goal is not memorization — it is understanding how systems connect and how technologies serve energy management objectives.

Review All Uploaded Documents

Go through every topic section carefully and identify the main ideas presented in each area.

Identify Key Technologies

Recognize which smart building technologies are described and understand what problem each one solves.

Connect Technologies to SRI & Energy Management

Link each technology to the SRI domains it affects and the energy management function it supports.

Reflect on Your Own Environment

Examine the smartness of a building you live, study, or work in — and come prepared to discuss it.

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Seminar Roadmap: Four Main Themes

The seminar is structured around four interconnected themes that build upon each other. Understanding this logical progression will help you follow the discussion and see how each topic leads naturally into the next.

1

1. Concept of Smart Buildings

What defines a smart building and what technologies are involved

2

2. Smart Readiness Indicators

The EU framework for assessing how smart-ready a building is

3

3. Energy Management

Tools, processes, and methods for managing building energy use

4

4. New Technologies & Human Factor

Emerging systems and the critical role of people in performance

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THEME 1

Concept of Smart Buildings

What Systems Are Managed

- Heating, ventilation and air conditioning (HVAC)
- Lighting and shading
- Security and access control
- Energy distribution and storage
- Indoor comfort and air quality

Core Enabling Technologies

- IoT sensors and connected devices
- Building Management Systems (BMS)
- Artificial intelligence and machine learning
- Data analytics platforms
- Communication networks and protocols

Pay attention to the difference between isolated smart devices and a fully integrated smart building.

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From Automation to Intelligence

A smart building does more than follow programmed rules. It collects data, interprets conditions, and responds in ways that reduce waste and maintain comfort — sometimes without human intervention.

Automation

Follows predefined rules regardless of context. Example: lights switch off at 18:00 every evening.

Intelligence

Uses real-time data to adapt. Example: lights switch off when the room is empty *and* daylight is sufficient.

True smartness means a building can **collect data**, **analyze conditions**, **respond automatically**, and **adapt to changing occupancy, weather, and grid signals** — continuously optimizing across all systems simultaneously.

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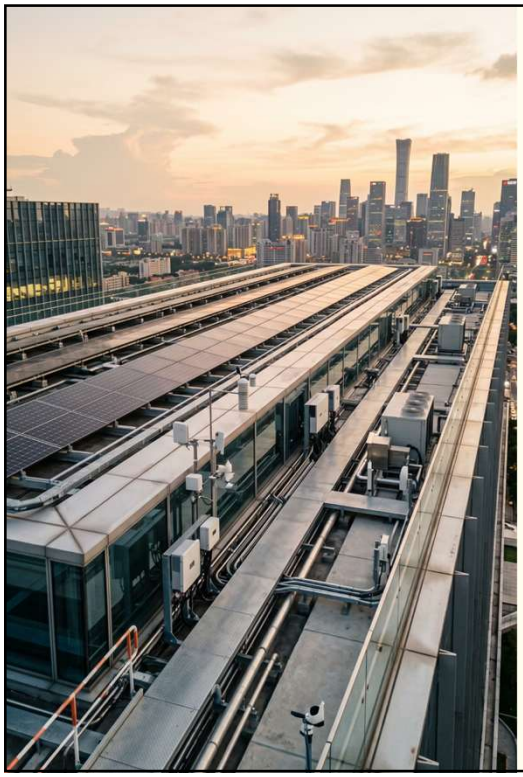

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Smart Buildings: Benefits and Barriers

Advantages

- Improved energy efficiency and lower operating costs
- Better occupant comfort and productivity
- Enhanced safety, security, and access control
- Easier integration of renewable energy sources
- Reduced carbon footprint and regulatory compliance

Challenges

- High initial capital investment
- Cybersecurity risks and data privacy concerns
- Complexity of integrating legacy and new systems
- Need for skilled technical personnel
- Dependence on reliable communication infrastructure

Every smart solution has a technical, financial, and human dimension. None can be evaluated in isolation.

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THEME 2

Smart Readiness Indicators (SRI)

The Smart Readiness Indicator is an EU assessment framework that evaluates how prepared a building is to use smart technologies effectively. It goes beyond energy consumption to evaluate the building's capacity to **adapt, respond, and interact**.

Optimize Energy Performance

Assess how well building systems can reduce energy demand and improve efficiency automatically

Adapt to Occupant Needs

Evaluate how well the building responds to changing user preferences, schedules, and behavior

Interact with the Energy Grid

Measure the building's ability to support demand response, flexibility, and storage integration

SRI does not only ask: "Is the building efficient?" It also asks: "Can the building actively adapt and participate in the grid?"

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SRI and EPC: Complementary Tools

Energy Performance Certificates (EPC) and the Smart Readiness Indicator serve different but complementary purposes. Together they provide a more complete picture of a building's performance and potential.

Energy Performance Certificate (EPC)

- Describes current energy consumption levels
- Based on physical building characteristics
- Reflects thermal performance and installed systems
- Focuses on static energy use

Smart Readiness Indicator (SRI)

- Describes smart-readiness of building systems
- Based on available smart functions and capabilities
- Reflects ability to adapt and respond dynamically
- Focuses on flexibility and interaction potential

Key message: EPC tells us about energy performance. SRI tells us about smart readiness. A high-efficiency building may still have a low SRI score if it lacks adaptive capabilities.

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The 9 SRI Technical Domains

SRI evaluates smart-ready services across nine distinct technical domains. Smartness is assessed system by system — not only at the whole-building level — which means even partial upgrades to individual systems can improve a building's SRI score.

1. Heating
2. Cooling
3. Domestic Hot Water
4. Ventilation
5. Lighting
6. Dynamic Building Envelope
7. Electricity
8. EV Charging
9. Monitoring & Control

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How SRI Evaluates Smartness: Impact Criteria

Within each domain, smart functions are scored based on their impact across seven criteria. A single smart technology can contribute to multiple impact categories simultaneously — which is why integration matters.

Energy Efficiency

Reducing energy demand through smart control and optimization

Maintenance & Fault Prediction

Detecting faults early and scheduling proactive maintenance

Comfort & Well-being

Maintaining optimal thermal, visual, and acoustic conditions

Energy Flexibility & Storage

Supporting demand response and interaction with the grid

Example: CO_2-based ventilation control improves both energy efficiency *and* indoor air quality — contributing to multiple impact criteria at once.

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SRI Calculation: Method A vs. Method B

Two calculation methods are available depending on the building's size, complexity, and the depth of assessment required. Choosing the right method ensures the SRI result is both accurate and practical.

Method A — Simplified

- Evaluates **27 smart functionalities**
- Requires less input data
- Suitable for smaller or less complex buildings
- Provides a quick, indicative overview of smart readiness
- Lower assessment effort and cost

Method B — Detailed

- Evaluates **54 smart functionalities**
- Requires more detailed building data
- Suitable for large or complex buildings
- Delivers a more precise and comprehensive assessment
- Better suited for investment decisions and certification

The chosen method depends on building size, complexity, available data, and the goals of the assessment.

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SRI Depends on Context

The value and relevance of smart technologies is not universal. Different building types have different priorities, and climate zones significantly influence which SRI domains carry the most weight.

Residential Buildings

- Focus on occupant comfort and convenience
- Simple, user-friendly controls
- Low-complexity automation

Commercial Buildings

- BMS-driven centralized automation
- Smart metering and sub-metering
- Energy reporting and compliance

Industrial Buildings

- Real-time process monitoring
- Fault detection and diagnostics
- High reliability and uptime requirements

Climate also matters: heating dominates in colder climates; cooling dominates in warmer ones. The same technology can have very different value depending on context.

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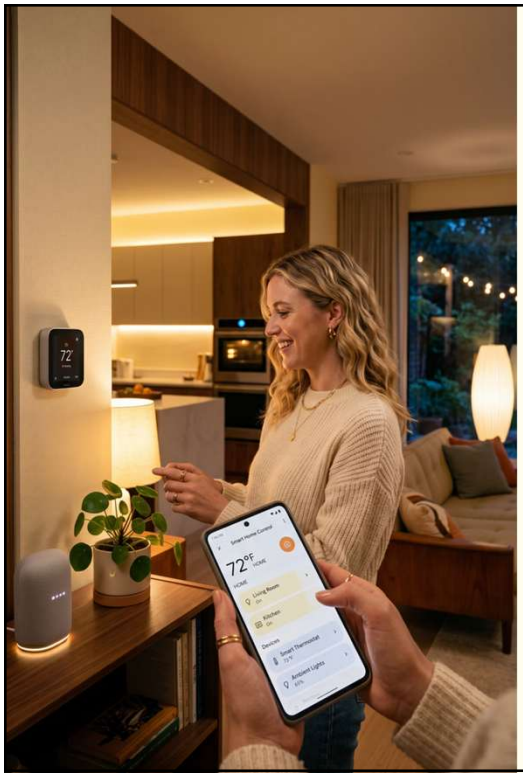

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Apply SRI Thinking to Your Own Home

Use the nine SRI technical domains to assess the smartness of your own living or working environment. This exercise will prepare you for the seminar discussion and sharpen your ability to evaluate real buildings critically.

01

Heating & Cooling

Is temperature control manual, timer-based, or fully automated with occupancy sensing?

02

Ventilation & Air Quality

Does ventilation react to CO_2 levels, occupancy, or is it always running at a fixed rate?

03

Lighting & Electricity

Are lights manual, sensor-triggered, or dimmable? Is energy consumption monitored?

04

Reflect and Improve

Identify what exists, estimate the smartness level, and propose at least one realistic improvement.

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THEME 3

Energy Management in Buildings

Energy management is the systematic, continuous process of monitoring, analyzing, and optimizing energy use across all building systems. It is not a one-time project — it is an ongoing cycle of improvement that forms the operational backbone of any truly smart building.

1. **Monitoring**
   Continuously collecting real-time data from meters, sensors, and systems
2. **Analysis**
   Identifying patterns, anomalies, and opportunities for improvement
3. **Optimization**
   Adjusting setpoints, schedules, and control logic to reduce waste
4. **User Engagement**
   Informing and involving occupants in energy-saving behavior
5. **Implementation**
   Applying changes and verifying that savings are achieved and sustained

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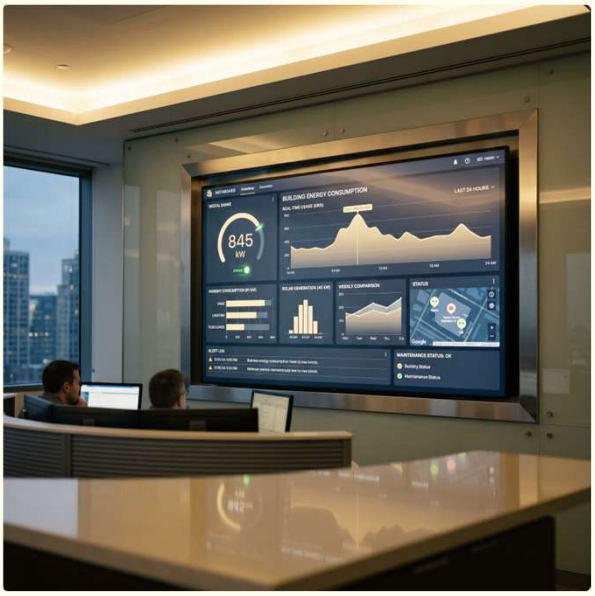
Why Energy Management Is Important



What Energy Management Enables

- Significant reduction in energy costs and utility bills
- Lower CO_2 emissions and improved environmental compliance
- Better occupant comfort through optimized system operation
- Smooth integration of on-site renewable energy generation
- Reliable data for investment decisions and reporting
- Regulatory compliance with EU energy directives

A building cannot be truly smart if it does not understand and actively manage its own energy use. Monitoring without action has no value.

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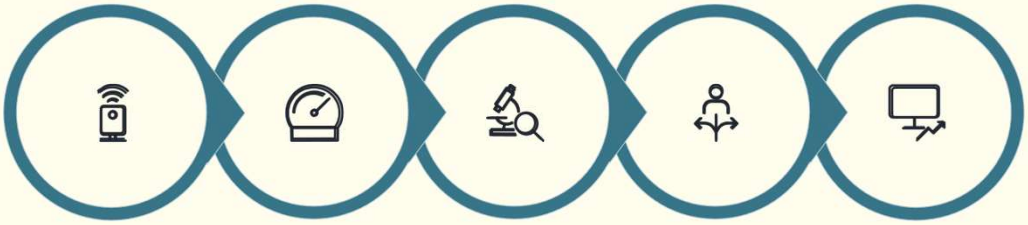
Digital Tools That Support Energy Management

Effective energy management relies on a connected ecosystem of digital tools. Each layer in the data flow serves a specific role — from raw sensing to intelligent decision-making and automatic control.



Sensor | Smart Meter | Analytics | Decision Support | Control Action

Smart Meters
Real-time consumption tracking

BMS
Centralized system control

Analytics Platforms
Pattern detection and insights

Digital Twins
Virtual building simulation

Predictive Algorithms
Forecast and pre-emptive control

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BMS: The Brain of the Building

A Building Management System (BMS) is the central platform that monitors, controls, and automates the core technical systems of a building. Its effectiveness depends entirely on the quality of data flowing through it, the reliability of its control logic, and consistent maintenance.

Systems Managed by BMS

- HVAC — heating, ventilation, air conditioning
- Lighting and blind/shading control
- Security and access systems
- Energy distribution and metering
- Indoor air quality and comfort systems

Core BMS Components

- **Sensors** — collect temperature, CO_2, occupancy data
- **Controllers** — process information and issue commands
- **Actuators** — physically execute control actions
- **Networks** — connect all devices and subsystems
- **User Interface** — allows operators to monitor and override

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Smart Metering and Data Collection

Smart meters provide real-time or near real-time information about resource consumption. Unlike traditional meters, they communicate data automatically — enabling monitoring, analysis, and faster response to inefficiencies or faults.

Electricity Meters

Monitor power demand, consumption profiles, and peak loads

Gas Meters

Track gas consumption for heating and hot water systems

Water Meters

Detect leaks and monitor water use patterns across the building

Heat Meters

Measure thermal energy delivered to HVAC and DHW systems

Smart meters do not save energy by themselves. They provide the data needed for smarter decisions — the real value lies in how that data is used.

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Measurement and Verification: No Measurement, No Management

Measurement and Verification (M&V) is the systematic process of determining whether energy-saving measures have actually delivered the expected results. Without M&V, claimed savings remain assumptions — not facts.

Verify Real Energy Savings

Compare actual consumption against a pre-intervention baseline to confirm that savings are genuine and attributable to the measures taken.

Adjust for External Factors

Account for changes in weather, occupancy, or building use that could inflate or mask the true impact of energy-saving actions.

Support Investment Decisions

Provide credible, data-backed evidence for future energy projects, retrofits, and capital expenditure justifications.

Key message: Energy savings should be measured and verified — not assumed.

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THEME 4

New Technologies and the Human Factor

Modern smart buildings deploy a powerful set of emerging technologies. But technology alone is not enough — smart systems only perform well when people understand, accept, and maintain them.

- IoT Sensors
- AI Optimization
- Predictive Maintenance
- Cloud Platforms
- Edge Computing
- Digital Twins
- Demand Response

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Human Behavior Shapes Building Performance

Even the most sophisticated smart building system will underperform if occupants do not understand it, trust it, or interact with it appropriately. Designing for **real users** — not ideal users — is a fundamental principle of smart building practice.

How People Influence Performance

- Thermostat overrides and manual adjustments
- Window opening behavior disrupting HVAC control
- Lighting and equipment habits
- Response to energy feedback and alerts
- Acceptance or rejection of automated control

Principles for Human-Centered Design

- Design interfaces that support — not frustrate — real behavior
- Provide clear, meaningful feedback to occupants
- Allow appropriate levels of user control and override
- Avoid overly complex interfaces that discourage engagement
- Build trust through transparency and reliability

Key message: Design for real users, not ideal users. The best technology fails if no one uses it correctly.

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Reading Strategy for the Seminar Materials

When reviewing the uploaded documents, avoid reading passively. Instead, apply this structured set of questions to every technology, system, or concept you encounter. This approach will help you engage critically and prepare for the seminar discussion.

1

What is its purpose?

What problem does this technology solve? What function does it perform in the building?

2

Which system does it affect?

Is it related to HVAC, lighting, metering, the envelope, or another domain?

3

What benefit does it provide?

Does it improve energy efficiency, comfort, maintenance, or grid flexibility?

4

What are its limitations?

Is it suitable for all building types? What data, skills, or infrastructure does it require?

Connect every technology to a function, a benefit, and a limitation. This three-part framing will guide your seminar contributions.

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Questions for Group Discussion

Come to the seminar prepared to engage with these questions. There are no single correct answers — the goal is to reason through trade-offs, connect concepts, and challenge assumptions.

What makes a building truly smart?

Is it the number of devices, the level of integration, or the quality of decisions the building can make?

Which SRI domains offer the easiest wins in existing buildings?

Where can smartness be improved with relatively low cost and effort?

Where can smart technologies create the biggest energy savings?

Which systems have the highest potential for efficiency gains through smarter control?

What are the biggest barriers: cost, data, integration, or people?

How do these barriers differ between residential, commercial, and public buildings?

How do we balance automation and user control?

At what point does automation improve outcomes, and when does it create resistance?

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Key Takeaways

As you leave this seminar, these five ideas should form the core of your understanding. Return to them when reviewing your notes or discussing smart buildings in practice.

Human Behavior Decides Real Performance

Technology sets the ceiling; people determine how close we get to it.

Metering and BMS Provide Data and Control

Without reliable data, neither optimization nor verification is possible.

Energy Management Is the Operational Backbone

Continuous monitoring, analysis, and improvement keep buildings performing.

SRI Measures Adaptability and Grid Interaction

It complements the EPC by assessing smart-readiness, not just efficiency.

Smart Buildings Unite Technology, Data, and People

Integration across systems and stakeholders is what creates true smartness.

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Your Preparation Before the Seminar

Please review all uploaded materials carefully before attending. Come with a concrete example from a building you know — your home, your campus, or your workplace. The final question of the seminar will be: How smart is the building you live in, study in, or work in?

01

Smart Buildings Booklet

Core concepts, definitions, and the framework for understanding integrated smart building systems

02

SRI Slides and Self-Assessment Guide

Nine technical domains, two calculation methods, and the self-assessment exercise for your own environment

03

Energy Management Materials

Five pillars of energy management, digital tools, BMS architecture, and the data-to-decision workflow

04

Smart Metering and M&V Materials

Meter types, data collection principles, and how savings are measured and verified with evidence

05

New Technologies and Human Factor Section

Emerging systems, AI, digital twins, demand response, and the role of occupant behavior in real performance

Come prepared with one example from your own environment and a view on where it sits on the smartness spectrum.

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