
SMART BUILDINGS IN SMART SYSTEMS
Smartness of the Built Environment on Building, District and City Scale
SMART?
WHY
HOW
Concerted Action Barcelona
CA RES, CA EED, CA EPBD Joint Workshop
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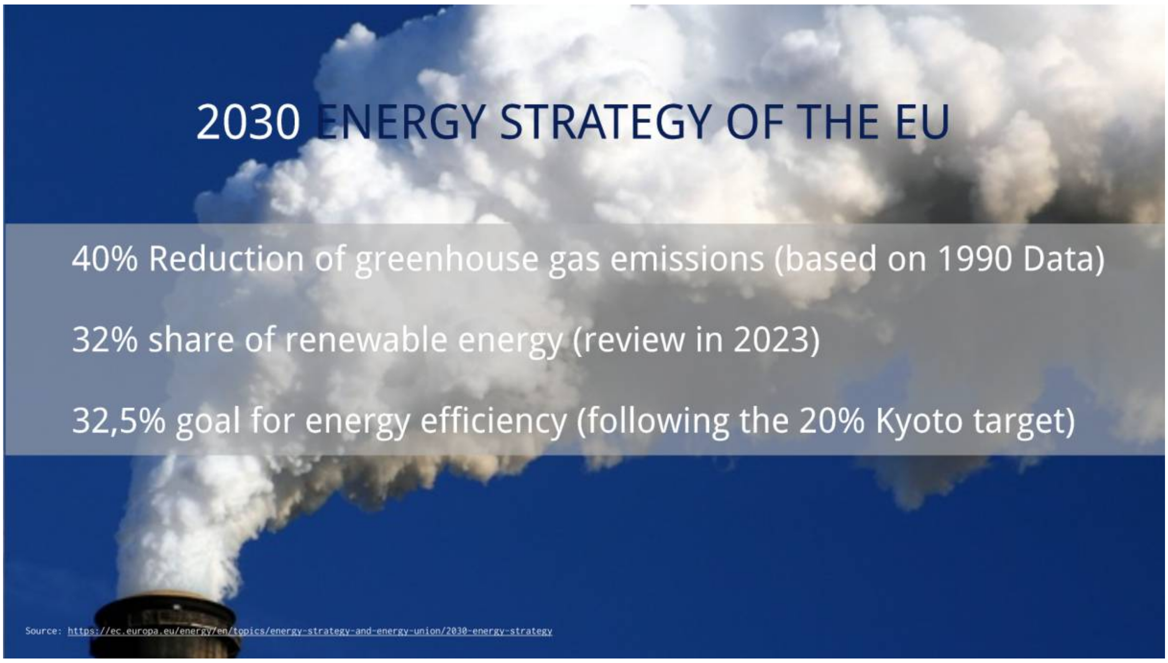
31.01.2020
Image Source: Aspern 3420 Development

1.


WHY
CLIMATE + ENERGY
EFFICIENT
RENEWABLE
FLEXIBLE

2.



Legislative Framework:

Source: Energy Performance Certificate based on OIB RL 6; B8110; EPBD Energy Performance of Buildings Directive

THE SRI

SRI = Smart Readiness Indicator

"…. . . The **smart readiness indicator** should be used to measure the **capacity of buildings** to use **information and communication technologies** and electronic systems to **adapt the operation of buildings to the needs of the occupants and the grid and to improve the energy efficiency** and overall performance of buildings. The smart readiness indicator should **raise awareness** amongst building owners and occupants of the value behind building automation and electronic monitoring of technical building systems and should give confidence to occupants about the actual savings of those new enhanced-functionalities . . . …"

Source: Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings Directive 2012/27/EU on energy efficiency; L156/75; Off. J. Eur. Union 2018

How do we measure the smartness of a building?

We can count the number of gadgets.

We can analyze, how many **technical systems** are controlled with a **building management system** (BMS).

We can calculate, if and how the building systems support the larger **network and energy management**.

We can assess how many systems actively contribute to the **indoor environmental comfort** of the users.

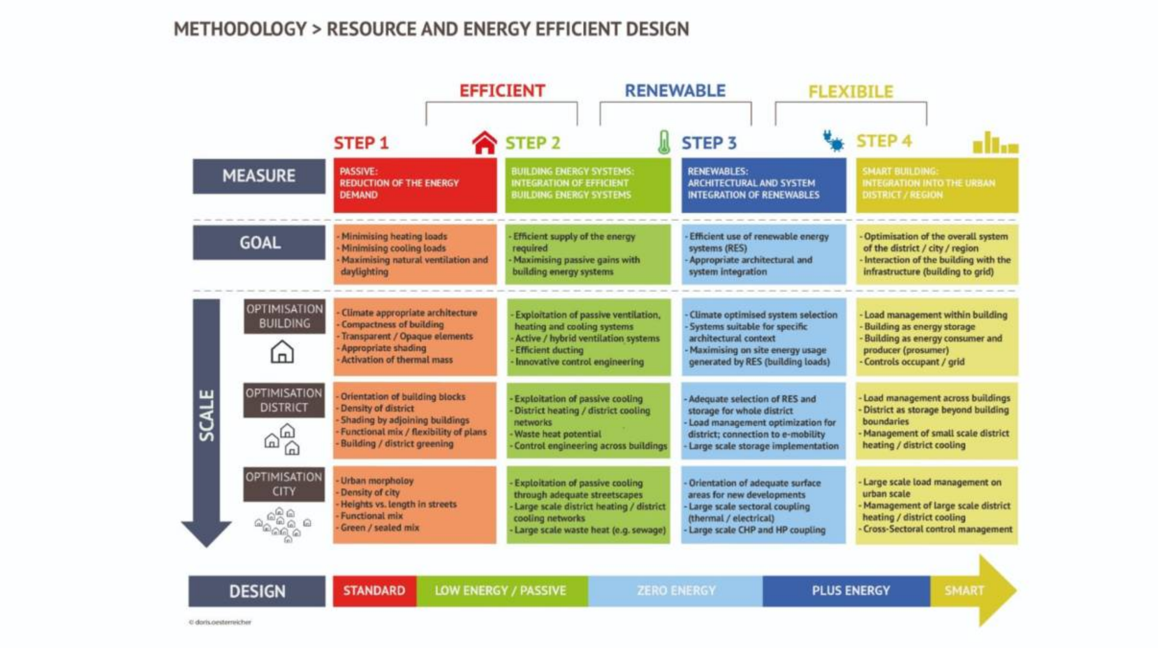
...?

How do we measure the smartness of a building?

We can assess the **load management potential of** a building by calculating **how much** of the thermal and electrical energy **can be stored and shifted over a certain period of time** whilst maintaining comfortable indoor temperatures.


What this is actually about...
ENERGY + RESOURCES


ENERGY EFFICIENT DESIGN ON ALL SCALES


METHODOLOGY > RESOURCE AND ENERGY EFFICIENT DESIGN
EFFICIENT
RENEWABLE
FLEXIBILE
STEP 1
STEP 2
STEP 3
STEP 4
MEASURE
PASSIVE: REDUCTION OF THE ENERGY DEMAND
BUILDING ENERGY SYSTEMS: INTEGRATION OF EFFICIENT BUILDING ENERGY SYSTEMS
RENEWABLES: ARCHITECTURAL AND SYSTEM INTEGRATION OF RENEWABLES
SMART BUILDING: INTEGRATION INTO THE URBAN DISTRICT / REGION
GOAL
- Minimising heating loads - Minimising cooling loads - Maximising natural ventilation and daylighting
- Efficient supply of the energy required - Maximising passive gains with building energy systems
- Efficient use of renewable energy systems (RES) - Appropriate architectural and system integration
- Optimisation of the overall system of the district / city / region - Interaction of the building with the infrastructure (building to grid)
SCALE
OPTIMISATION BUILDING
- Climate appropriate architecture - Compactness of building - Transparent / Opaque elements - Appropriate shading - Activation of thermal mass
- Exploitation of passive ventilation, heating and cooling systems - Active / hybrid ventilation systems - Efficient ducting - Innovative control engineering
- Climate optimised system selection - Systems suitable for specific architectural context - Maximising on site energy usage generated by RES (building loads)
- Load management within building - Building as energy storage - Building as energy consumer and producer (prosumer) - Controls occupant / grid
OPTIMISATION DISTRICT
- Orientation of building blocks - Density of district - Shading by adjoining buildings - Functional mix / flexibility of plans - Building / district greening
- Exploitation of passive cooling - District heating / district cooling networks - Waste heat potential - Control engineering across buildings
- Adequate selection of RES and storage for whole district - Load management optimization for district; connection to e-mobility - Large scale storage implementation
- Load management across buildings - District as storage beyond building boundaries - Management of small scale district heating / district cooling
OPTIMISATION CITY
- Urban morpholoy - Density of city - Heights vs. length in streets - Functional mix - Green / sealed mix
- Exploitation of passive cooling through adequate streetscapes - Large scale district heating / district cooling networks - Large scale waste heat (e.g. sewage)
- Orientation of adequate surface areas for new developments - Large scale sectoral coupling (thermal / electrical) - Large scale CHP and HP coupling
- Large scale load management on urban scale - Mamagement of large scale district heating / district cooling - Cross-Sectoral control management
DESIGN
STANDARD
LOW ENERGY / PASSIVE
ZERO ENERGY
PLUS ENERGY
SMART
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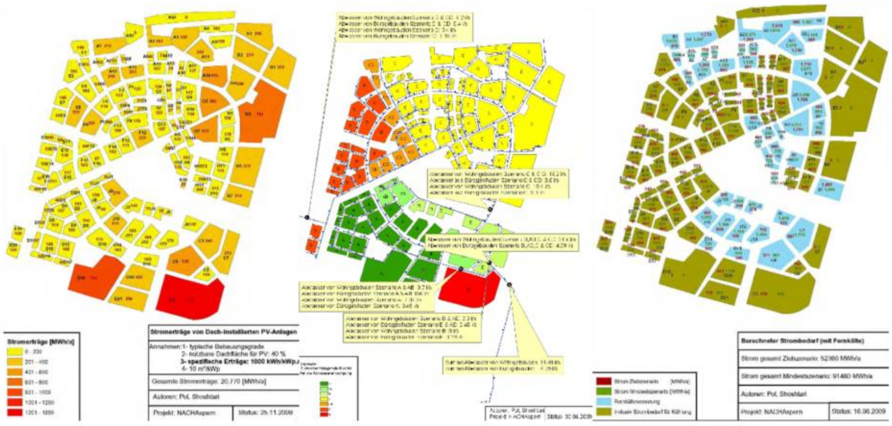
Source: Pertlwieser BMLV GZ S 90986/28-RechtB/2003

early stage energy assessment

PV Potential (roofs)

Potential of waste water heat

Power demand including cooling considering district cooling networks



Source: https://nachhaltigwirtschaften.at/resources/edz_pdf/nachaspern_gesamtenergiekonzept.pdf

Study for the implementation of the SRI

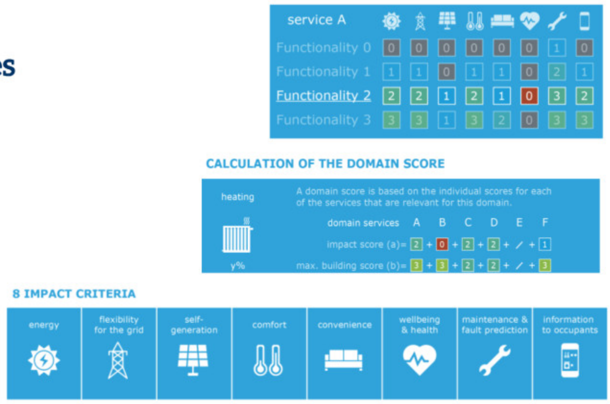
Proposal for the **Assessment Methodology** of the SRI (Study commissioned by the EC)

The goal is a **roughly similar approach** for the calculation of the SRI in all member states

Source: https://www.rehva.eu/fileadmin/Pau_Garcia_-_v2-SRI.pdf

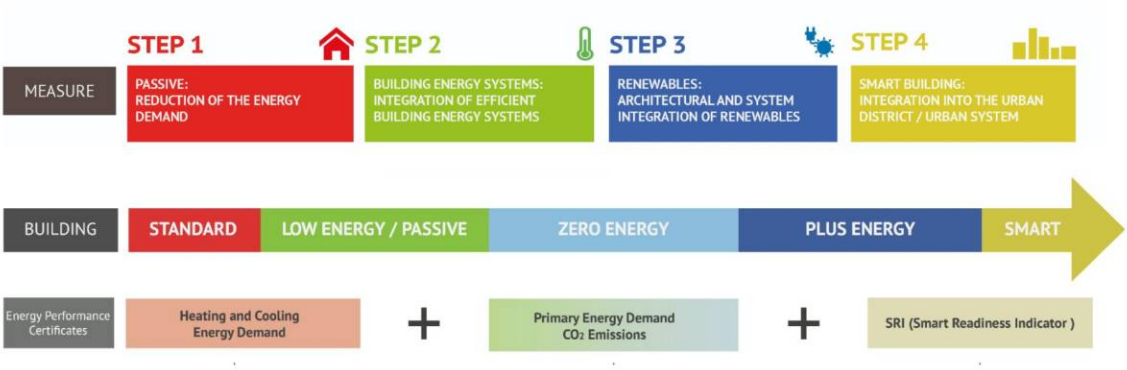
Study for the implementation of the SRI

Assessment based on a **series of indicators**, that are grouped in domains, individually rated and aggregated by a certified assessor.



Source: https://www.rehva.eu/fileadmin/Pau_Garcia_-_v2-SRI.pdf

Sustainable Building Design



Source: Märzinger, T., Österreicher, D.: „Supporting the Smart Readiness Indicator A Methodology to Integrate A Quantitative Assessment of the Load Shifting Potential of Smart Buildings",Special Issue: Energy Performance and Indoor Climate Analysis in Buildings; Energies, 2019, 12(10), 1955; https://doi.org/10.3390/en12101955

SRI Methodology: Input Parameter

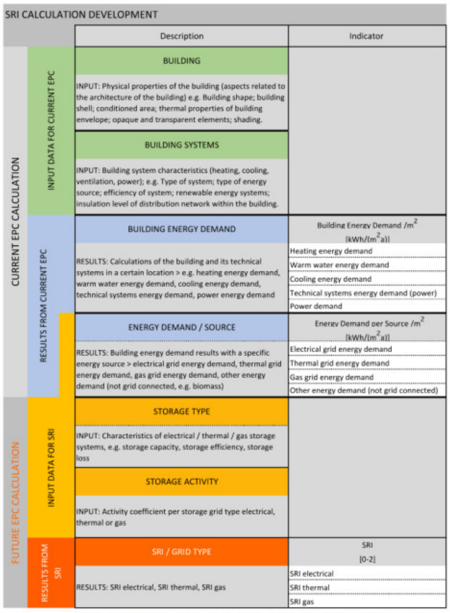
The input parameters can mostly be based on the current results form the energy performance certificate.

Additional Input Parameters:

Storage Type (capacity, efficiency, losses)

Storage Activity (no grid, no interaction with grid, passive interaction with the grid, active interaction with the grid)

Grid Type (thermal, electrical, gas)



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SRI Methodology: Calculation Framework

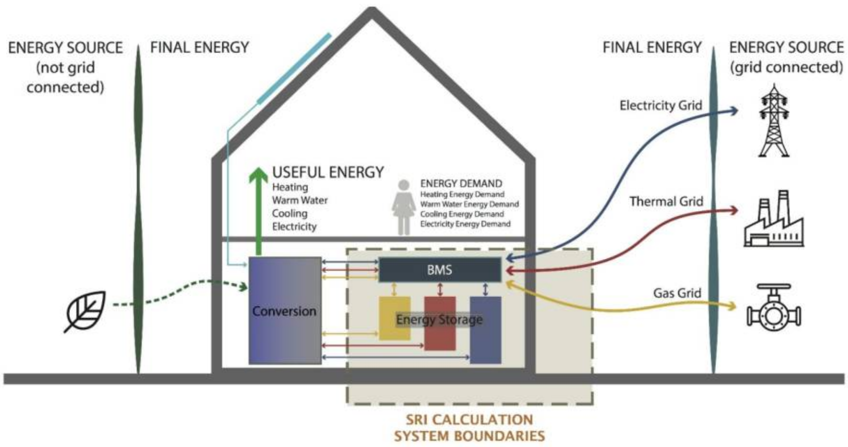
Focus on the basic questions >
Is there an **energy network**? If so, to what extent can the building **communicate** with this network?

The methodology for the calculation of the SRI delivers an answer to the following question:

"What is the potential of the building to get energy from the network, store it over a certain period of time and dispatch it again into the network?"

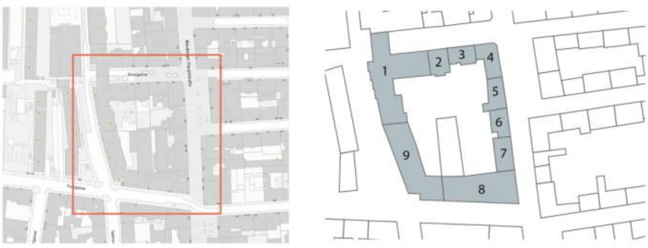
Source: Märzinger, T., Österreicher, D.: „Supporting the Smart Readiness Indicator A Methodology to Integrate A Quantitative Assessment of the Load Shifting Potential of Smart Buildings",Special Issue: Energy Performance and Indoor Climate Analysis in Buildings; Energies, 2019, 12(10), 1955; https://doi.org/10.3390/en12101955

SRI Calculation Framework



Source: Märzinger, T., Österreicher, D.: „Supporting the Smart Readiness Indicator A Methodology to Integrate A Quantitative Assessment of the Load Shifting Potential of Smart Buildings",Special Issue: Energy Performance and Indoor Climate Analysis in Buildings; Energies, 2019, 12(10), 1955; https://doi.org/10.3390/en12101955

SRI Methodology: case study



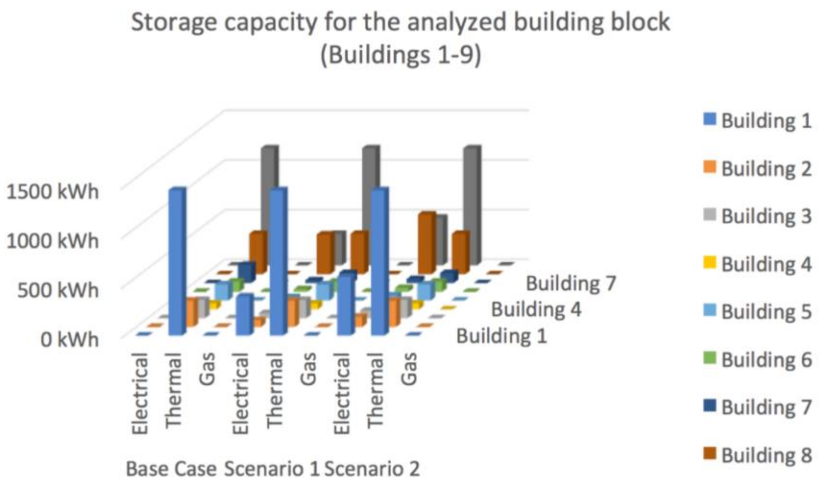
Typical mixed-use building block in the city of Vienna

Analyzed with >
- Base case
- Scenario 1 (standard refurbishment)
- Scenario 2 (Advanced refurbishment)

	Building Envelope	Electrical storage / grid	Thermal storage / grid	Gas storage / grid
Base Case	Un-refurbished	No active storage one-directional connection	No active storage no thermal grid	No active storage one-directional connection
Scenario 1	Improved 50%	Active storage bi-directional connection	No active storage one-directional connection	No connection
Scenario 2	Improved 90%	Active storage bi-directional connection	Active storage bi-directional connection	No connection

Source: Österreicher, D.; Märzinger, T.: „ Assessing the load shifting potential in buildings Application of a methodology for the Smart Readiness Indicator on a theoretical use case in the city of Vienna "; SBE 19 Malta Sustainable Built Environment; Proceedings Sustainability and Resilience, International Conference, S.100; ISBN 978-99957-1-613-4 (ebook), November 2019

SRI Methodology: case study



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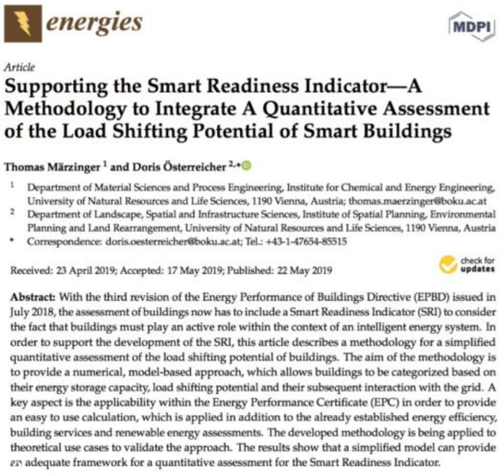
SRI Methodology: Advantages

- **Simple, quantitative** methodology independent of subjective assessors views (objective).
- Calculation is solely focused on **energy.**
- It is based on data from the **Energy Performance Certificate (EPC).**
- It allows for an easy **comparison.**
- Analyzes **exclusively the potential of the building** for storage and load shifting.
- **Each grid is calculated individually**, i.e. there is no negative assessment if there is no grid available.
- **Expandable** (any network is possible).
- The calculation is **adaptive**, time periods can be defined dependent on the energy source (e.g. 1 day for electricity, 1 week for thermal, 1 year for gas).

Source: Märzinger, T., Österreicher, D.: „Supporting the Smart Readiness Indicator A Methodology to Integrate A Quantitative Assessment of the Load Shifting Potential of Smart Buildings",Special Issue: Energy Performance and Indoor Climate Analysis in Buildings; Energies, 2019, 12(10), 1955; https://doi.org/10.3390/en12101955

SRI Methodology: Publication



energies

MDPI

Article

Supporting the Smart Readiness Indicator—A Methodology to Integrate A Quantitative Assessment of the Load Shifting Potential of Smart Buildings

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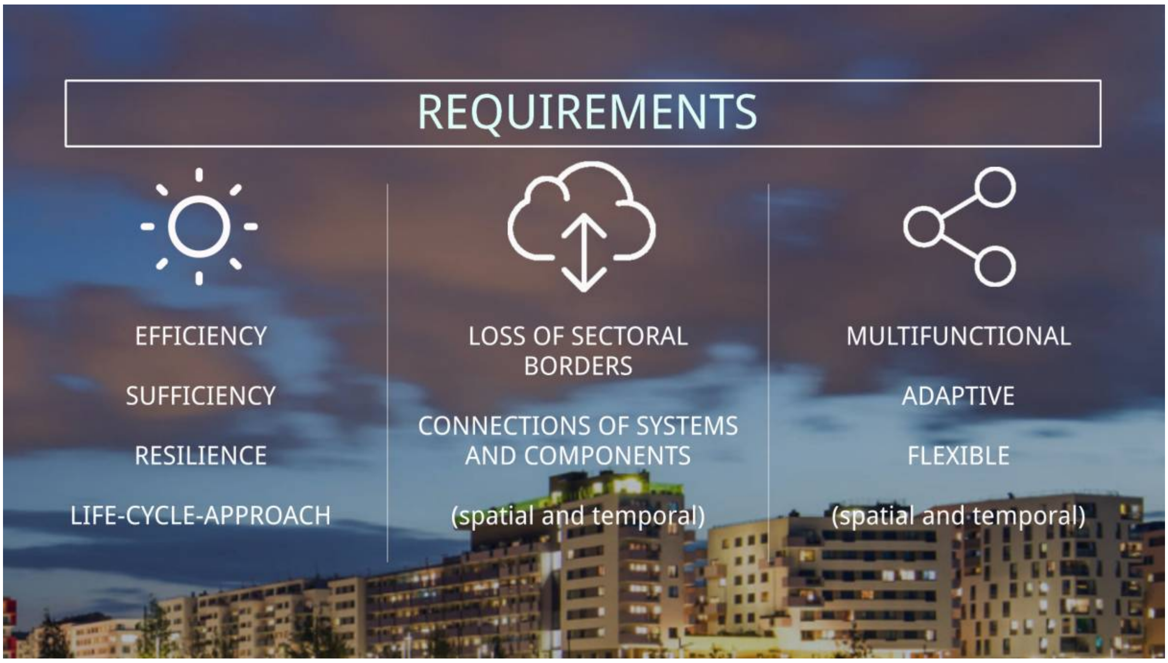
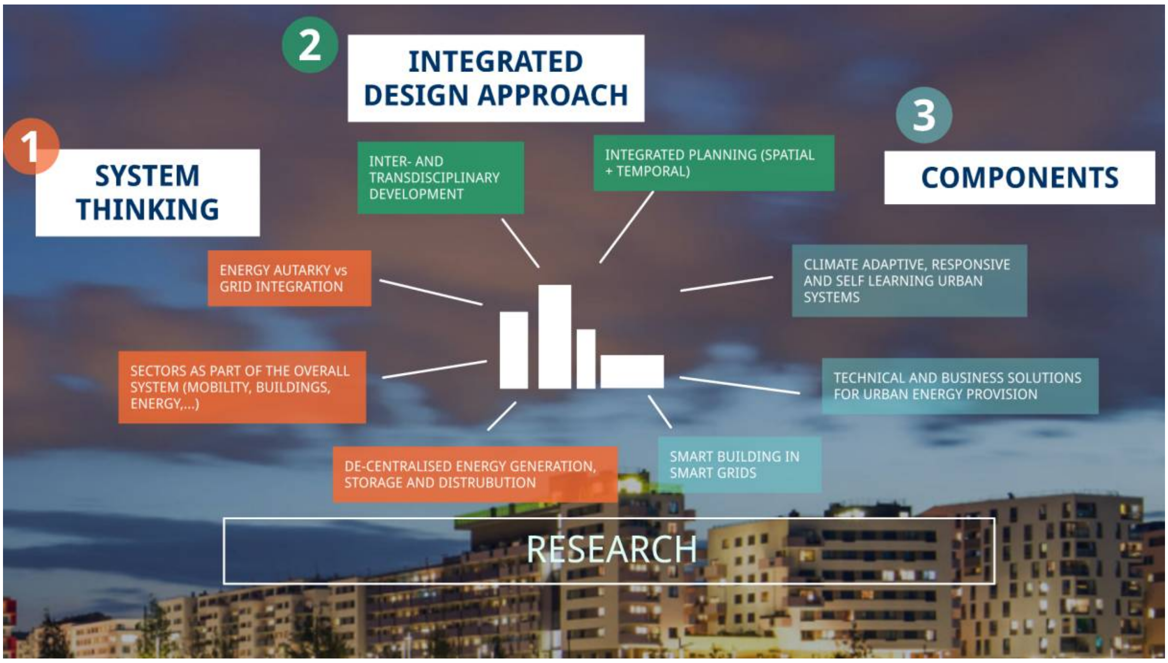
check for updates

Abstract: With the third revision of the Energy Performance of Buildings Directive (EPBD) issued in July 2018, the assessment of buildings now has to include a Smart Readiness Indicator (SRI) to consider the fact that buildings must play an active role within the context of an intelligent energy system. In order to support the development of the SRI, this article describes a methodology for a simplified quantitative assessment of the load shifting potential of buildings. The aim of the methodology is to provide a numerical, model-based approach, which allows buildings to be categorized based on their energy storage capacity, load shifting potential and their subsequent interaction with the grid. A key aspect is the applicability within the Energy Performance Certificate (EPC) in order to provide an easy to use calculation, which is applied in addition to the already established energy efficiency, building services and renewable energy assessments. The developed methodology is being applied to theoretical use cases to validate the approach. The results show that a simplified model can provide an adequate framework for a quantitative assessment for the Smart Readiness Indicator.

Source: Märzinger, T., Österreicher, D.: „Supporting the Smart Readiness Indicator A Methodology to Integrate A Quantitative Assessment of the Load Shifting Potential of Smart Buildings“,Special Issue: Energy Performance and Indoor Climate Analysis in Buildings; Energies, 2019, 12(10), 1955; https://doi.org/10.3390/en12101955


SOCIETAL DRIVERS
CLIMATE CHANGE AND LIMITED RESOURCES
COMMUNICATION AND INFORMATION TECHNOLOGY
SHARING SOCIETY + SHARING ECONOMY


REQUIREMENTS
EFFICIENCY
SUFFICIENCY
RESILIENCE
LIFE-CYCLE-APPROACH
LOSS OF SECTORAL BORDERS
CONNECTIONS OF SYSTEMS AND COMPONENTS
(spatial and temporal)
MULTIFUNCTIONAL
ADAPTIVE
FLEXIBLE
(spatial and temporal)



PLANNING

Integral planning with a high share of **renewable energy**

Building management systems (BMS) and **smart meters** are prerequisites

Building Integration: planning with **load shifting potentials** in buildings

Connection with **e-mobility** (use of storage capacity)

OPERATION

Flexible building management in operation (energy cost optimum)

Integration of the user to **visualize the benefits** of load management

Building integrated **cost models** (RES optimization for building use)

Energy relevant **business models**

Legislative Framework:

[Source: Energy Performance Certificate based on OIB RL 6; B8110; EPBD Energy Performance of Buildings Directive]

EFFICIENT

1

Building **intelligently** means building **according to the climate** and exploiting passive architectural measures in order to **increase energy efficiency** in an integral approach.

RENEWABLE

2

The next steps after the exploitation of passive measures is the **adequate integration** of technical services and **renewable energy systems**.

FLEXIBLE

3

Building optimization is the primary goal. **System optimization** by means of exploitation of synergies with **interconnections and load shifting** opens up new potentials to increase the energy efficiency of **larger entities** (district, cities, regions)

RECOMMENDATIONS

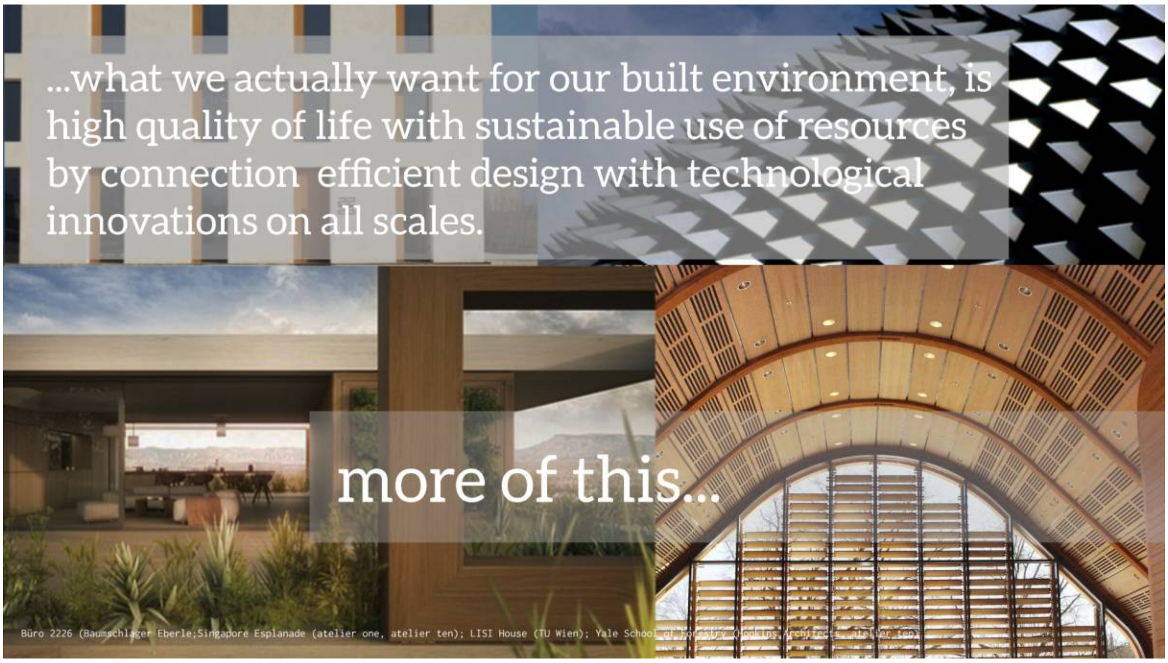
User Acceptance will be key to implement smart services across all domains.

Only cross-sectoral **interoperability and accessibility** to systems and control mechanisms can ensure a wide-spread implementation

Legal obligations and **business models** for smart readiness should be transformed from "can" to "must"

§ + €

Integrated energy planning starts at an urban / regional scale


...what we actually want for our built environment, is high quality of life with sustainable use of resources by connection efficient design with technological innovations on all scales.
more of this...
Büro 2226 (Baumschlager Eberle;Singapore Esplanade (atelier one, atelier ten); LISI House (TU Wien); Yale School of Forestry (Hopkins Architects, atelier ten)


less of this !