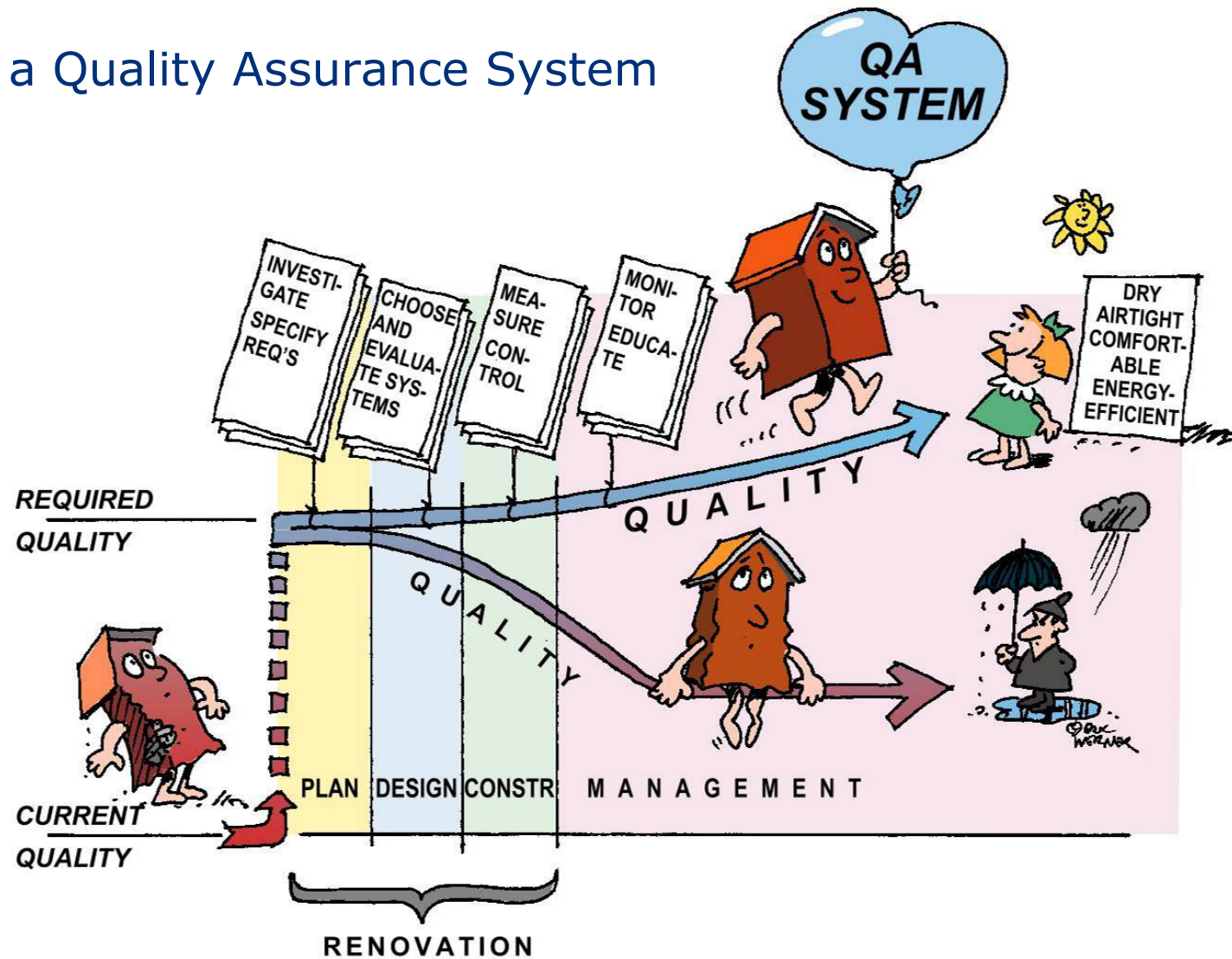


A Quality Assurance System for Improvement of Indoor Environment and Energy Performance when Retrofitting Multifamily Houses



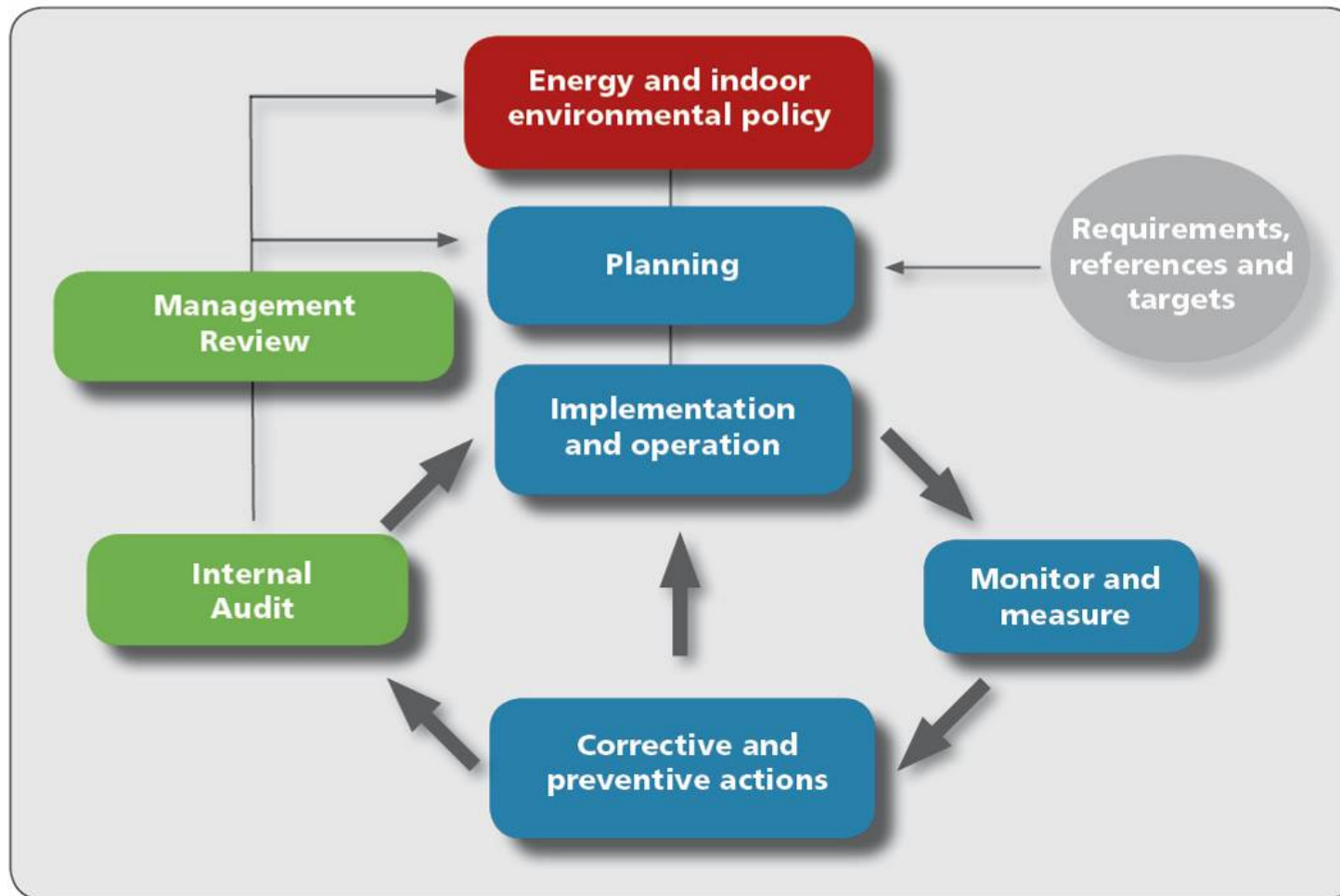
Renovation of Multifamily Houses

using a Quality Assurance System





Quality Assurance System - Outline





Five Good Reasons...

...to use a Quality Assurance system for improvement of indoor environment and energy performance are:

1. Economic and environmental savings
2. Avoidance of sub-optimisations
3. Improved communication within the project
4. Improved feedback within the organisation
5. More satisfied customers/tenants



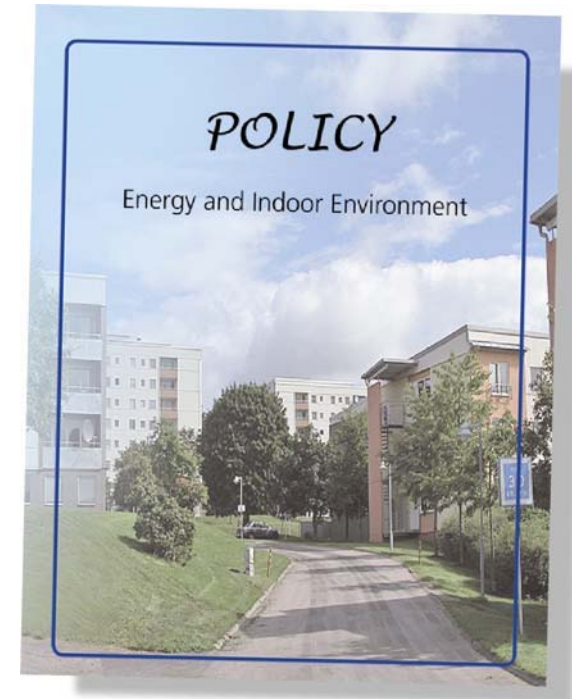


Energy and Indoor Management Policy

The Quality Assurance system must build upon an Energy and Indoor Management Policy

The Policy shall

- Provide a framework for setting and reviewing targets
- Ensure availability of information and resources needed to reach targets
- Commit to comply with applicable requirements
- Be documented, implemented, maintained and communicated to “all”
- Be regularly reviewed and updated





Establish the Quality Assurance System

Issues to consider when the QA system for indoor environment and energy performance is established

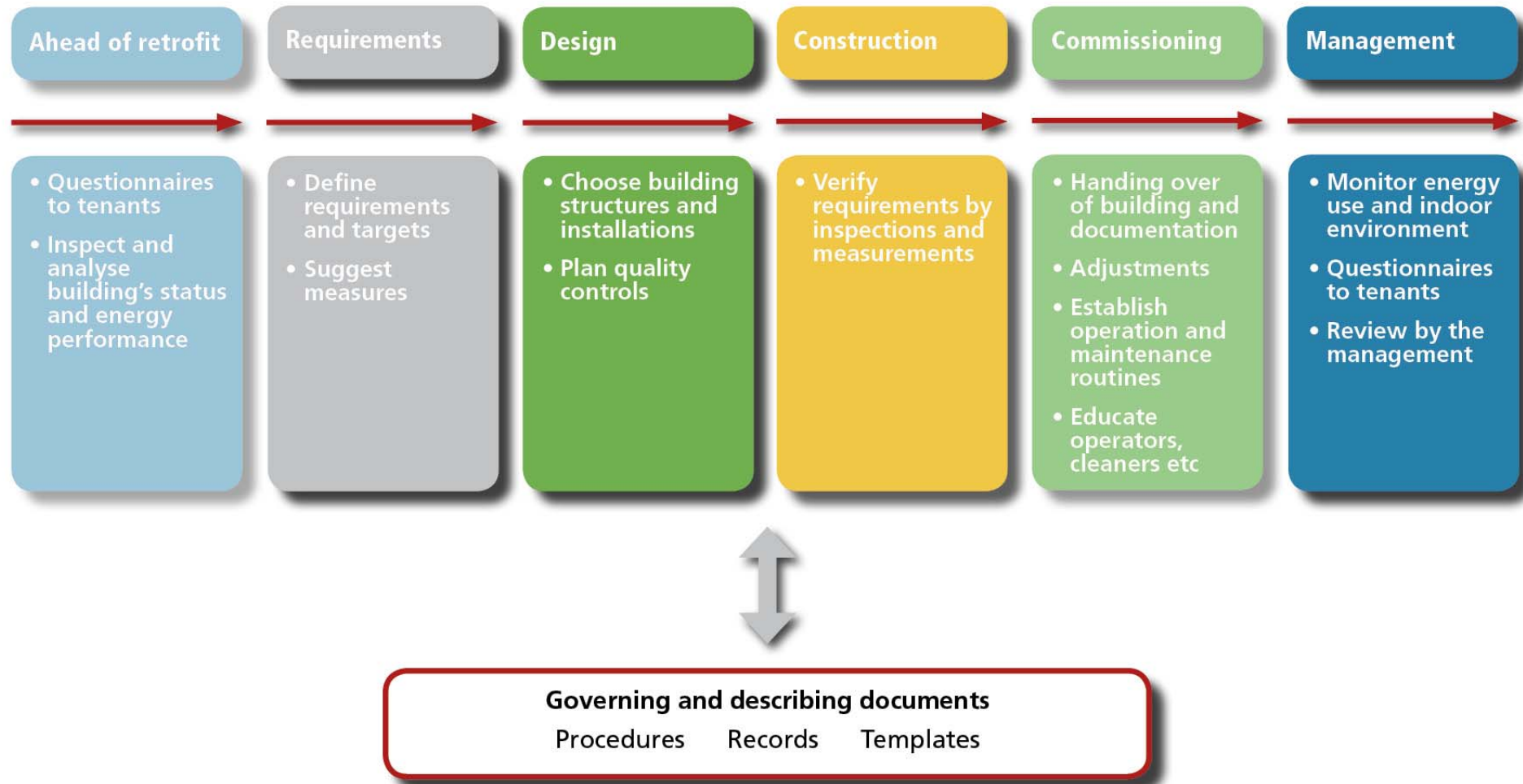
- Integrate requirements in existing management system (such as ISO 9001 or similar).
- If there is no existing system, the SQUARE QA system has all the basic elements of a quality management system.
- New elements must be customised to suit the organisations' activities and routines





Implementation of a QA System...

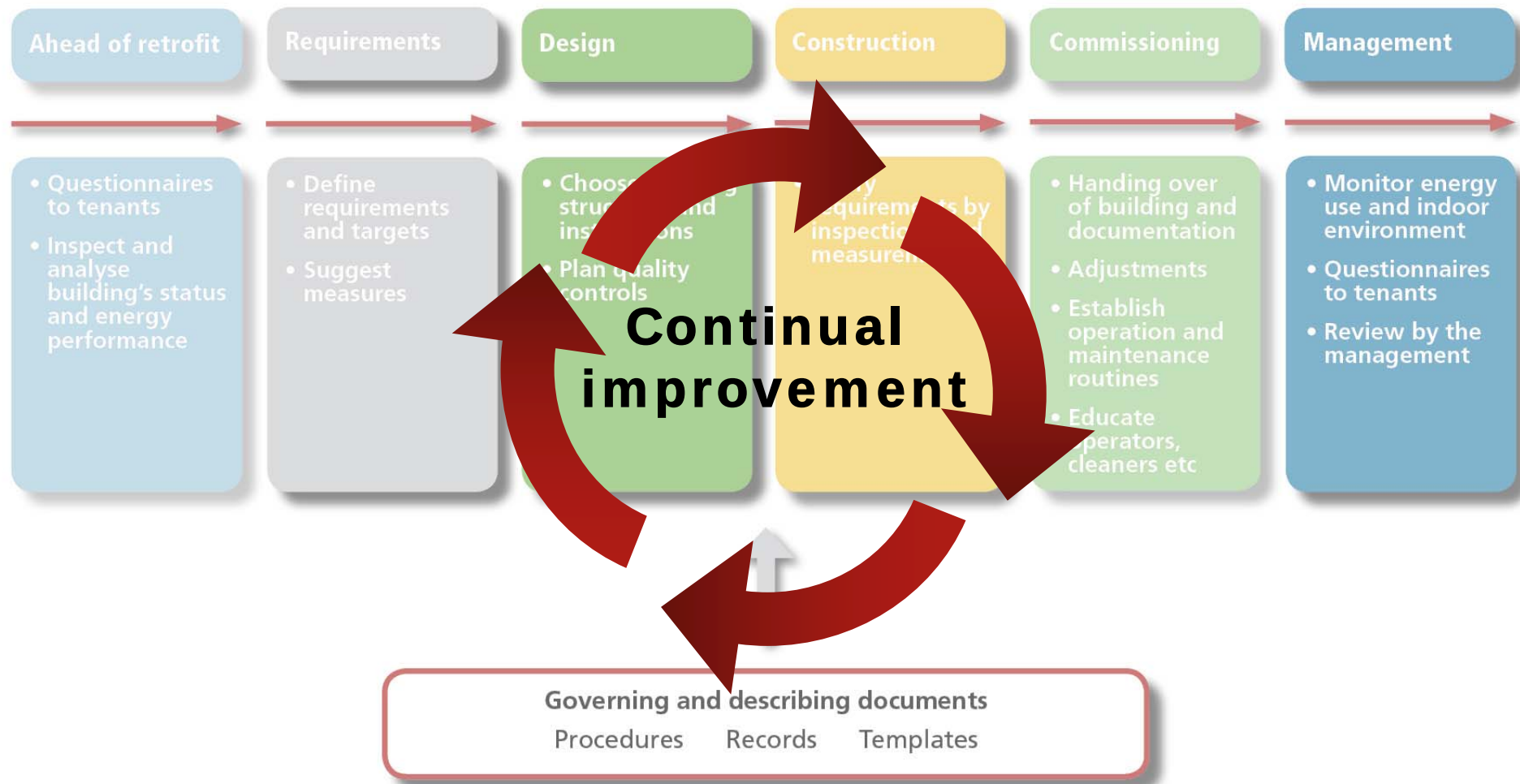
...for Renovation Projects





Implementation of a QA System...

...for Renovation Projects



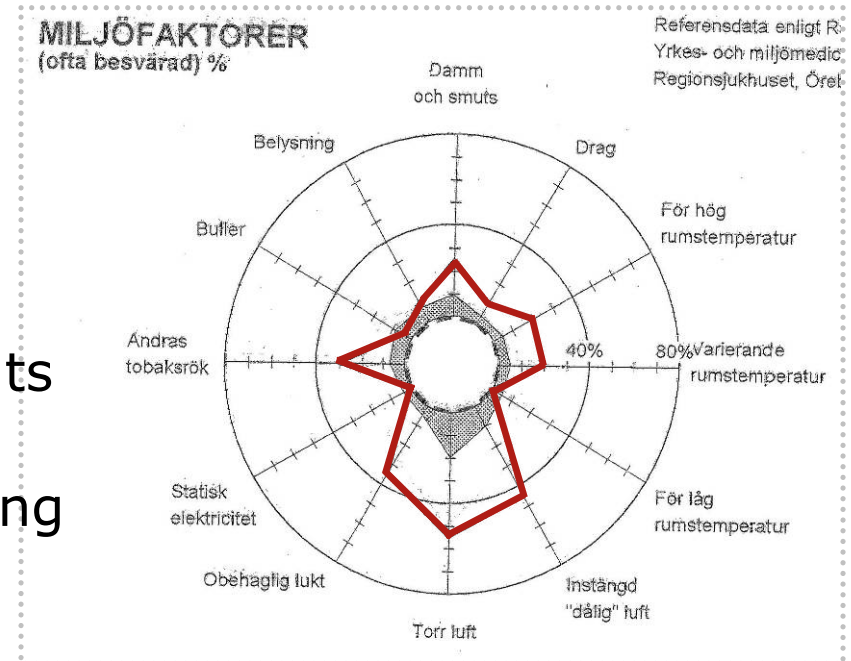


Ahead of Retrofit 1

Thorough Primary Inspection (TPI)

The TPI includes

- Inspection and measurements, checking fulfilment of requirements
- Questionnaire to tenants identifying existing or potential problems
- Inventory of construction status and damage, design concepts, materials





Ahead of Retrofit 2

First Energy analysis (FEA)

The FEA includes

- Analysis of data of current (and past) energy use
- Inventory of design and standard of HVAC systems, lighting, monitoring system etc.
- Inventory of insulation standard, previous energy efficiency measures, adjustment records etc.





Definition of Requirements and Targets

The requirements and targets are based on legal requirements (binding), guidelines and recommendations (voluntary)

Requirements and targets include

- Energy requirements and targets for the indoor environments in the buildings under consideration
- Requirements concerning the indoor environment
- Quality requirements and targets for the construction process, including components
- (Performance requirements for critical components)

Certificación Energética de Edificios Indicador kgCO ₂ /m ²	Edificio Objeto	Edificio Referencia
	9.4 B	20.6 D
Demanda calefacción kWh/m ²	C 25.2	D 42.8
Demanda refrigeración kWh/m ²	B 4.1	C 5.4
Emisiones CO ₂ calefacción kgCO ₂ /m ²	C 5.3	E 13.7
Emisiones CO ₂ refrigeración kgCO ₂ /m ²	C 1.5	D 2.0
Emisiones CO ₂ ACS kgCO ₂ /m ²	A 2.6	D 4.9



Requirements and Targets

- Results from the TPI and FEA (actual status) are compared with requirements and targets
- $\Sigma(\text{Requirements} - \text{Actual status}) = \text{Major retrofit or Limited action?}$
- Conditions favouring choice of major retrofit
 - Adequate knowledge and active policies in the organisation
 - Calculation models using LCC
 - Financing options
 - Access to experienced and dedicated contractors





Requirements and Targets – Measures 1

Measures needed to reach the requirements and targets are developed

Examples of desirable achievements

- Minimized ventilation heat losses (by eliminating air leakages, efficient heat recovery etc.)
- Improved indoor environment (through increase or decrease of temperatures of internal surfaces, ensuring of adequate supply air volume,...)
- Rectification of construction damage (moisture, degradation)
- Minimized thermal bridges (to avoid moisture damage and mould growth)





Requirements and Targets – Measures 2

Measures needed to reach the requirements and targets are developed

Examples of desirable achievements

- Minimized transmission heat losses (through insulation of exterior walls, high-performance windows, etc.)
- Increased share of renewable energy input
- Enabling continuous monitoring of energy performance parameters through proper instrumentation
- Encouraging “energy-wise” behaviour of the occupants e.g. by means of separate temperature control and metering of hot water and electricity per apartment



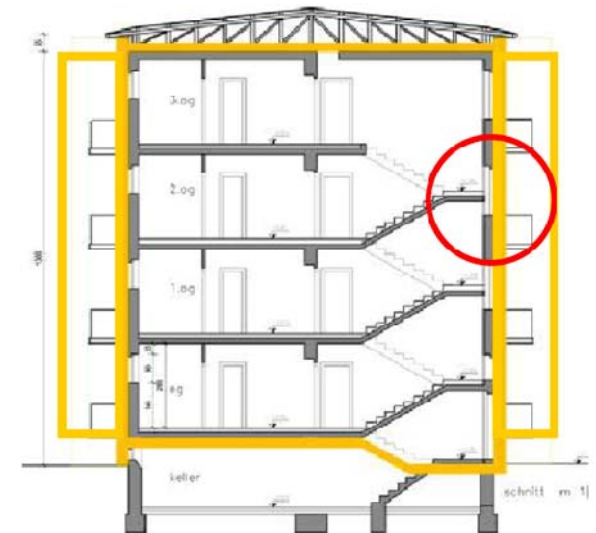


Design Stage 1

Design of retrofit of the building structures and building services systems in accordance with chosen measures

Important actions at the design stage include

- Active participation by the organisation's representative(s) in construction meetings required!
- Communicate the importance of high quality in the construction work to reach targets for indoor environment and energy use
- Present and discuss new energy-efficient concepts and products
- Highlight "extraordinary" requirements





Design Stage 2

Planning of construction quality requirements and controls

Important actions in the design stage include

- Discuss methods for quality checks; e.g. sound or illuminance levels, airtightness, moisture content
- Agree on “who checks what ?” and how to report results
- Request calculation or simulation showing that requirements concerning indoor environment and energy use are fulfilled
- Third-party testing/ control of new/ advanced components required?





Construction Stage

The following actions during the construction stage are an important prerequisite for good indoor environment and energy performance during the management stage

- Inspection and measurements to verify that requirements are fulfilled
- Supervise, collect verification reports and system documentation
- Continue the dialogue, visualise the property management stage, encourage knowledge sharing and feedback on upcoming challenges





Commissioning 1

The QA system aims to bridge the gap between the renovation and the management stage

Important activities include

- Handing over of the building and documentation to the organisation
- Adjustments of the building and the building services systems (expected to take at least a year)
- Documented plans for operation and maintenance, including e.g.
 - Cleaning
 - Inspection/ calibration of meters and sensors
 - Inspection/ adjustment of buildings and technical systems
 - Purchase of energy-demanding equipment





Commissioning 2

- Training of operators, caretakers, cleaners
- Consider outsourcing of e.g.
 - Operation and maintenance
 - Energy delivery
 - Measurement and analysis of energy use





Property Management Stage

During the property management stage the follow ups and inspections of the building and the building services systems continuous in order to ensure good energy performance and indoor environment.

Activities include

- Follow up of energy use
 - Monthly monitoring/ compilation
 - Electricity, heating and cooling separated and further broken down if possible (tap water, space heating...)
 - Comparison with target values (it must be possible to verify all targets through measurements + calculations)
- Regular (e.g. monthly) checks during operation
 - Indoor air temperature
 - Moisture problems/ leakages
 - Hot water temperature
 - Cleaning
 - Function of central heat and electricity meters
- Questionnaire to tenants and continuous feedback





When Setting up a QA System...

- Do not create parallel QA Systems!
If an ISO 9001 system is in place - integrate new indoor environment and energy use aspects in the existing system.
- Every organisation must find its own way to an effective QA system. Customising a general system to the particular procedures, activities and needs of the organisation is thereby a must!
- Use software tools (for QA and energy management) and document templates as far as possible!
- It is better to start out with a modest ambition and increase it later than vice versa. Over-ambition killed many QA systems.



Thank you for
your kind
attention.

