



THE FUTURE  
OF ENERGY EFFICIENCY  
STARTS HERE

***PRINCIPLES, EXPECTED EFFECTS AND  
NATIONAL IMPLEMENTATIONS OF EUROPEAN  
DIRECTIVE 31/2010 AND 27/2012***

***PRINCIPI, EFFETTI E ATTUAZIONE NAZIONALE DELLE  
DIRETTIVE 31/2010 E 27/2012***

**Fiera Milano Rho, 17<sup>th</sup> March 2016**



# THE FUTURE OF ENERGY EFFICIENCY STARTS HERE

REHVA



Federation of  
European Heating,  
Ventilation and  
Air-conditioning  
Associations



**Royal  
HaskoningDHV**  
*Enhancing Society Together*

## nZEB Hospitals



**TVVL**

*Platform voor mens en techniek*

**TU/e**

Technische Universiteit  
Eindhoven  
University of Technology

**Wim Maassen MSc PDEng**  
***Royal HaskoningDHV, TU/e, TVVL***



# Inspiration & Enthusiasm



Wubbo Ockels (1946-2014)







# Hospitals



concept en ontwerp : D/DOCK design development





# Royal HaskoningDHV



## Business Lines:

- Industry & Buildings
- Maritime & Aviation
- Transport & Planning
- Water

**Global consultancy, design, engineering and project management service provider**

7,000 employees, 100 offices, 35 countries





# Royal HaskoningDHV

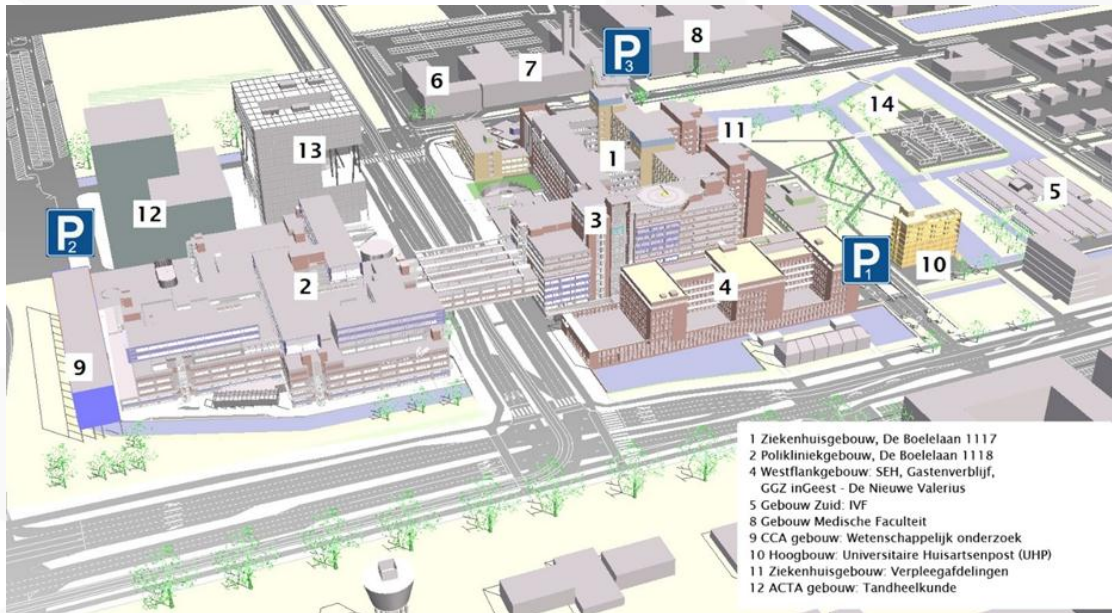


## Rotterdam Erasmus Medical Center Project Management, Building Services





# Royal HaskoningDHV



## Amsterdam VU Medical Center

Multi disciplines, Energy Master Planning, Imaging Center, Diagnostic Center, BREEAM







# Royal HaskoningDHV

## Circular economy

The city of 2050 is a circular city



## Sustainable urban mobility

Accelerating towards a Liveable City



## Liveable city

Planning cities for our children



## Smart city

Only a smart city can survive in 2050



## Water

Water shapes the city of tomorrow



## Governance

Participation and cooperation are the standard



# The future city of 2050



# Roadmap to nearly Zero Energy Buildings

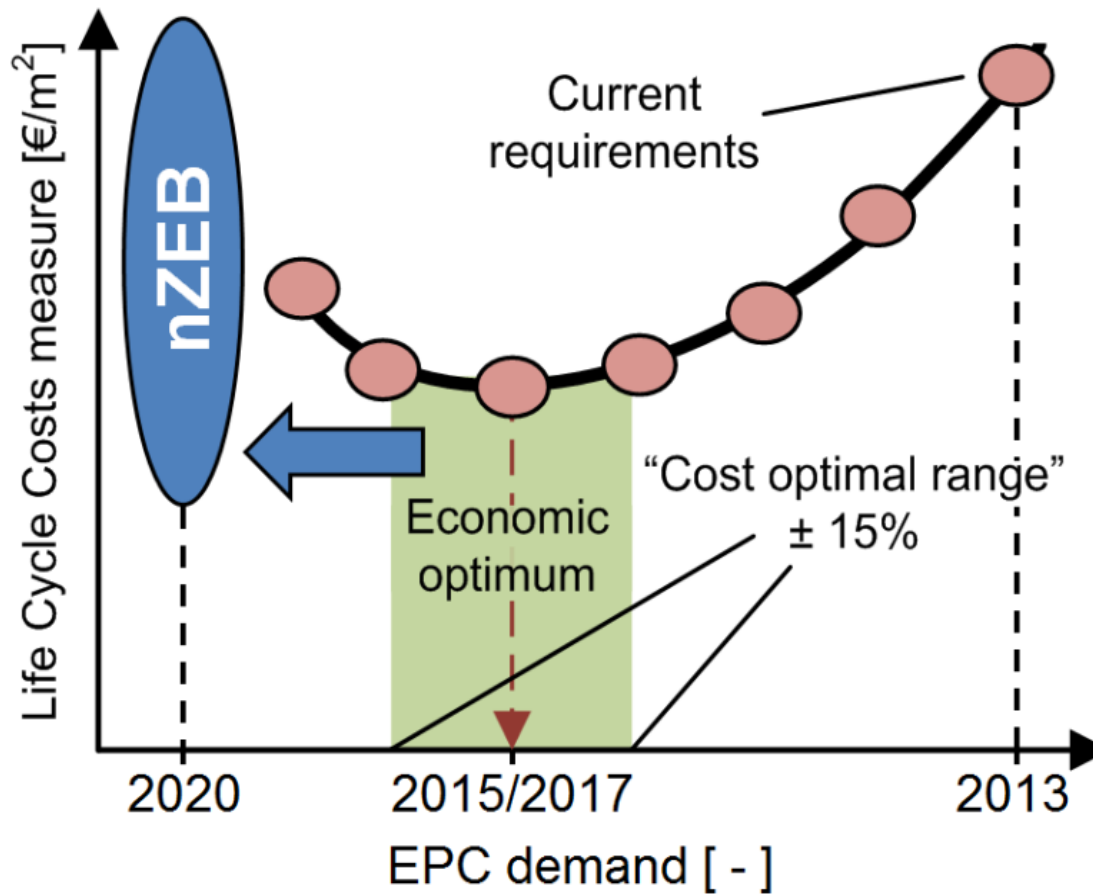


2014: The Netherlands compete in the REHVA Student Competition





# EU nZEB Requirements





# DRAFT - NL nZEB definitions (July 2015)

$\Delta$ EPC  
(2015)

-/- 100%

> -/- 100%

-/- **50%**

Building function	Energy demand [kWh/m <sup>2</sup> .y]	Energy use [kWh/m <sup>2</sup> .y]	Sustainable energy [%]
Dwellings	25	25	50
Offices	50	25	50
Schools	50	80	50
Health Care facilities	65	120	50





# Project – nZEB Hospitals

Royal HaskoningDHV executes project with Eindhoven University of Technology.

Supported by TVVL and REHVA.

- Give information and insight in nZEB developments
- Contribute to the road to nZEB





# Project – nZEB Hospitals

## GOAL:

- Existing Hospitals: energy saving potential and measures
- New Hospitals: optimized solutions and realistic nZEB definitions
- Measures: Closing the Energy Gap





# Project – nZEB Hospitals

How to achieve a feasible nZEB level ?:

- Updating Hospital Design Standards
- Effective building concept
- Passive building design
- Monitoring – Closing Energy Performance GAP
- Energy exchange & storage
- Local generation of sustainable energy
- BIO fuels
- Smart Grids





# Project – nZEB Hospitals

Related research project:

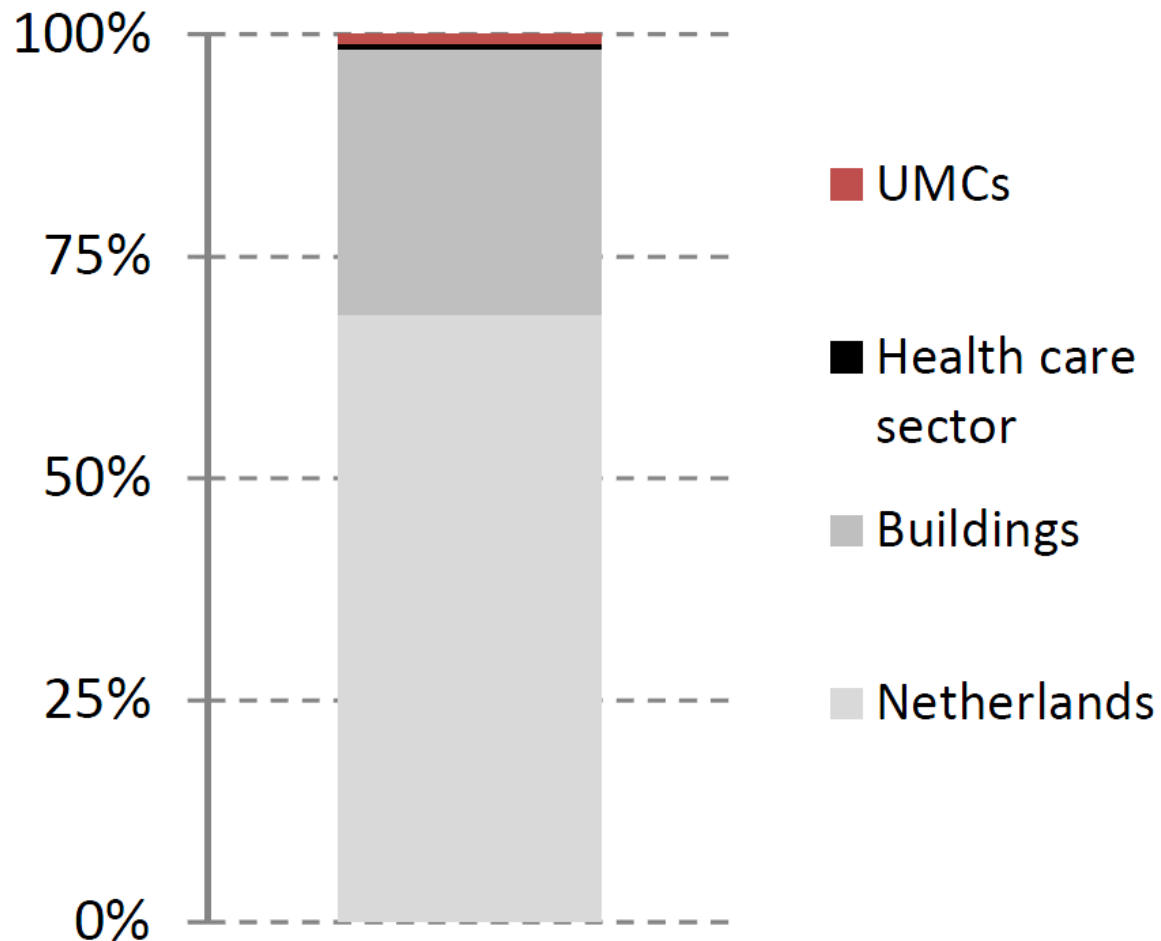
- Reduced ventilation for isolation rooms (EMC)
- **Renovation existing Policlinic (VUmc)**
- **Feasibility NL nZEB Hospital definitions**
  
- Closing the Energy Performance Gap
- Transformation of multi- to one-patient rooms (UMCU)







# Energy consumption of AMCs

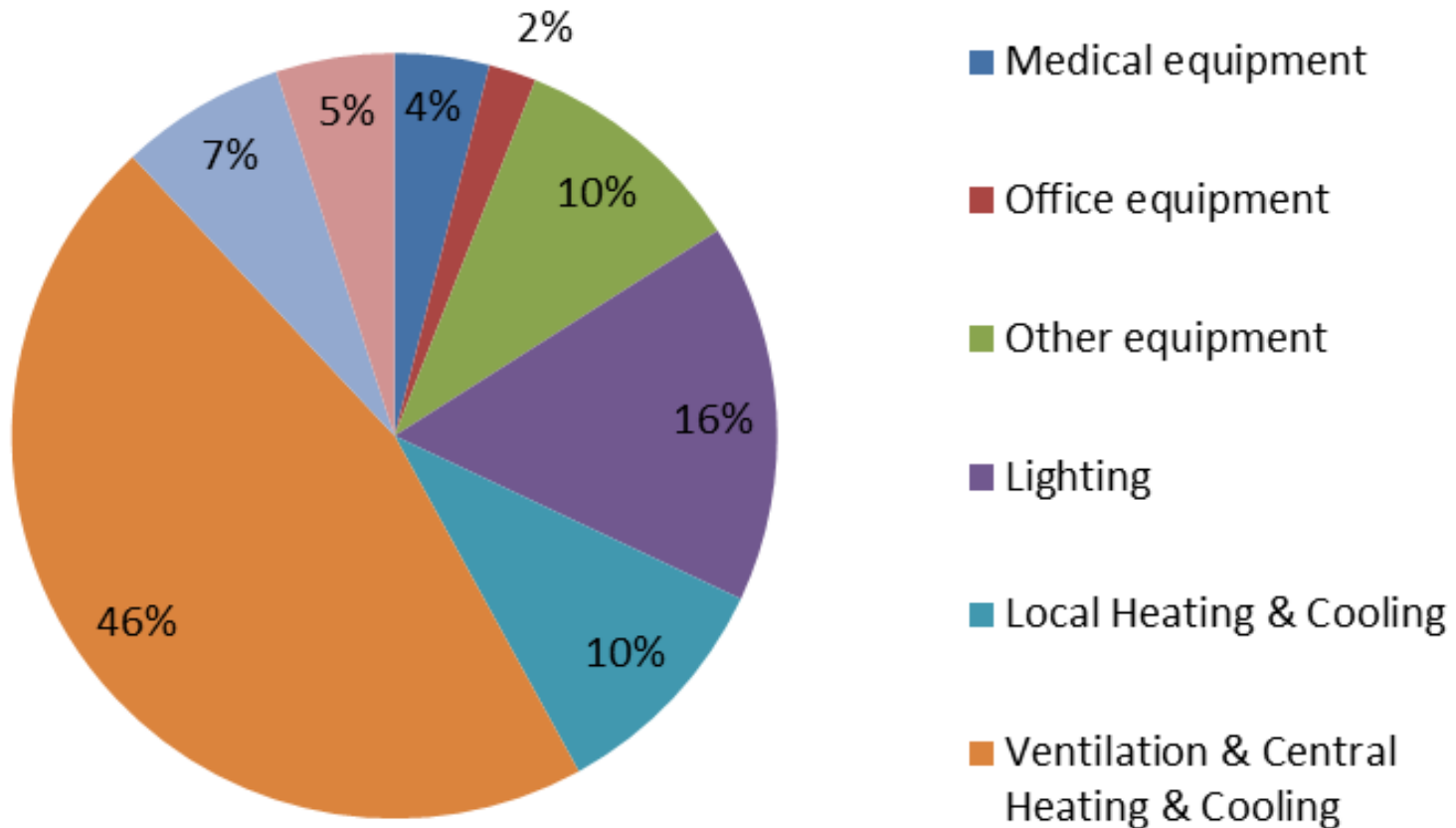


Schoenmakers I., 2014, A systematic approach to obtain energy reduction in the complex HVAC systems of UMCs, MSc thesis TU/e. Eindhoven, Netherlands





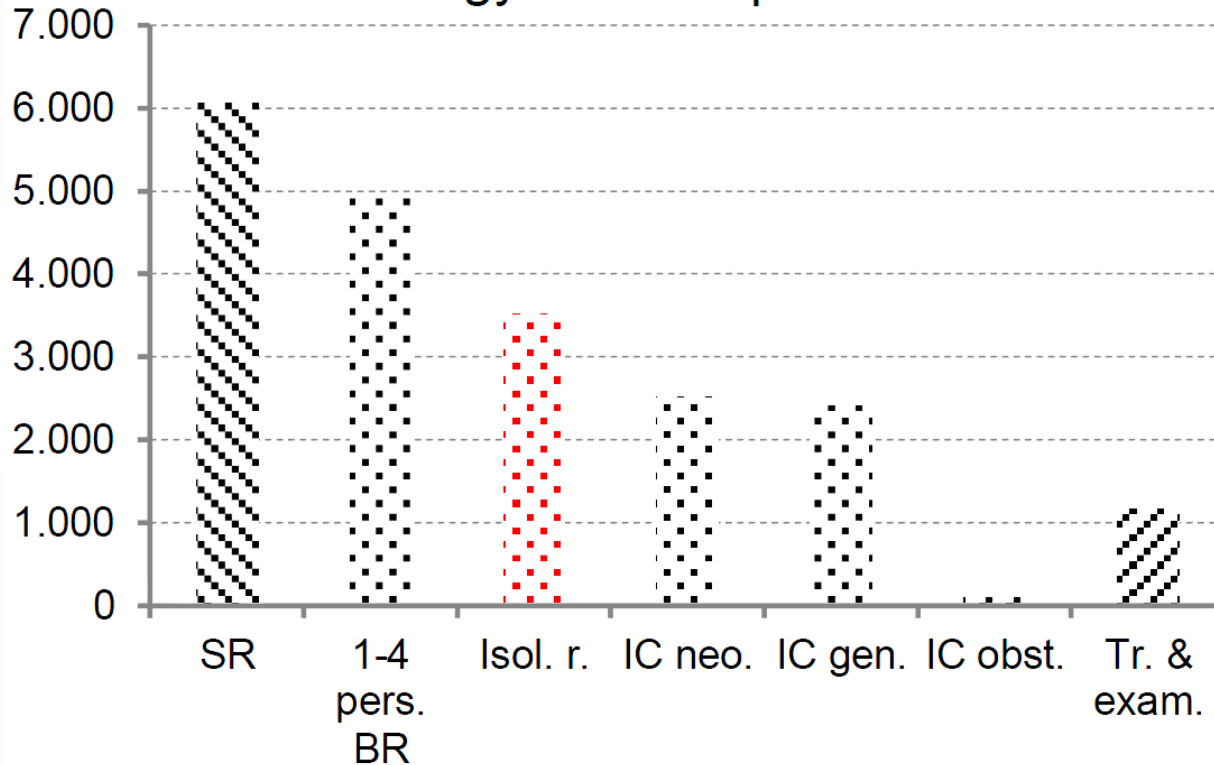
# Energy consumption of AMCs








# Energy consumption of AMCs

Energy demand per function



 Surgery department

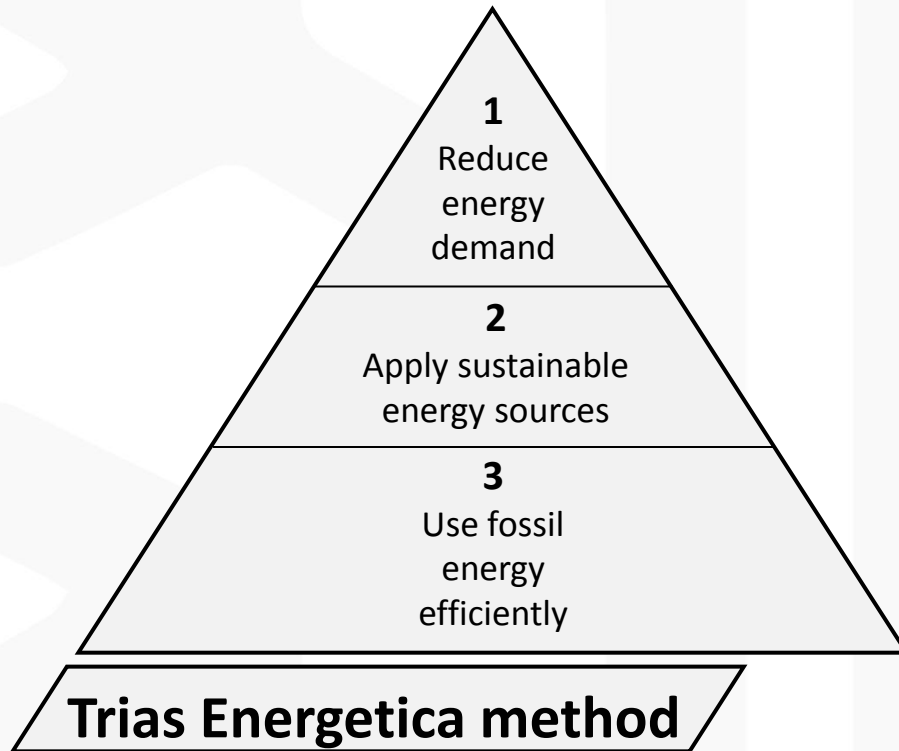
 Bedroom department

 Outpatient department

Schoenmakers I., 2014, A systematic approach to obtain energy reduction in the complex HVAC systems of UMCs, MSc thesis TU/e. Eindhoven, Netherlands

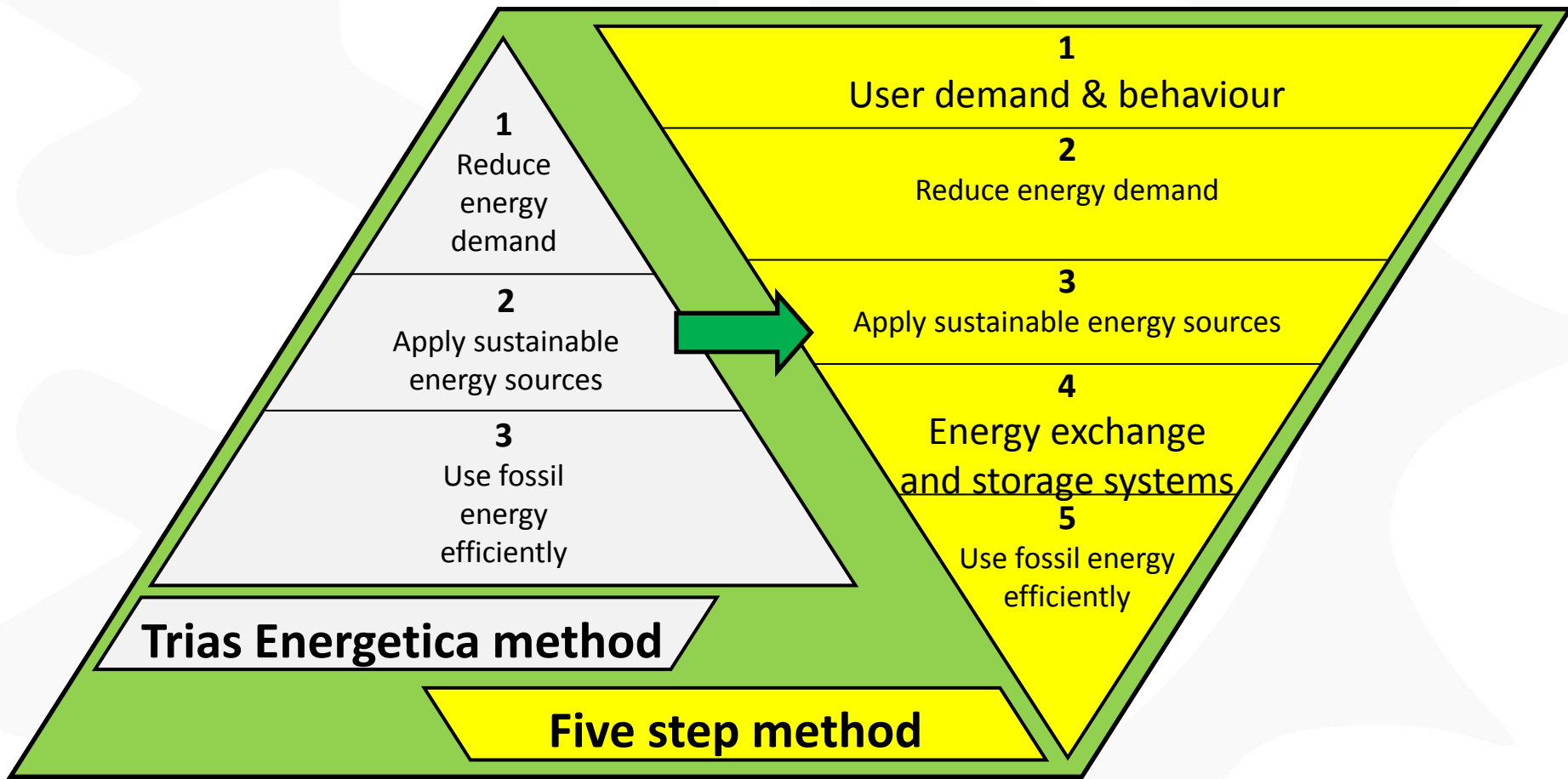


# Method – Trias Energetica



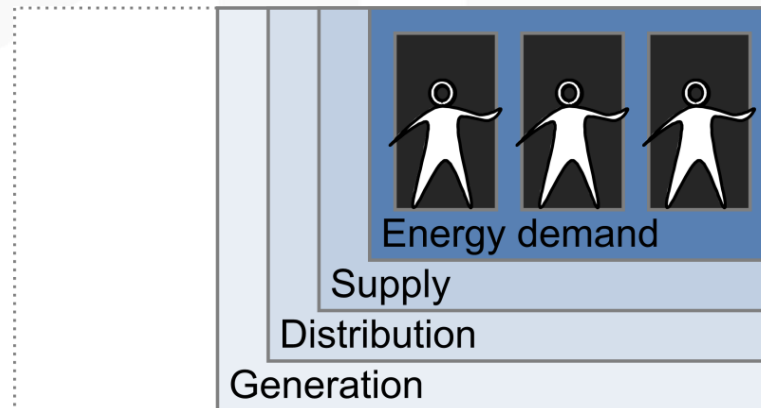
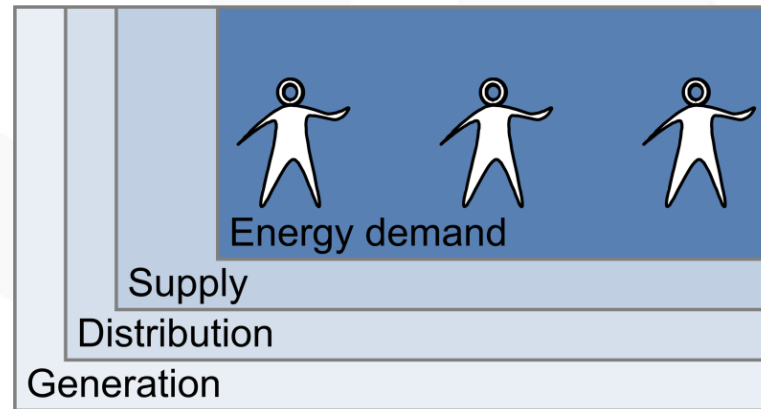


# Method – 5 step approach





# Method – User Central





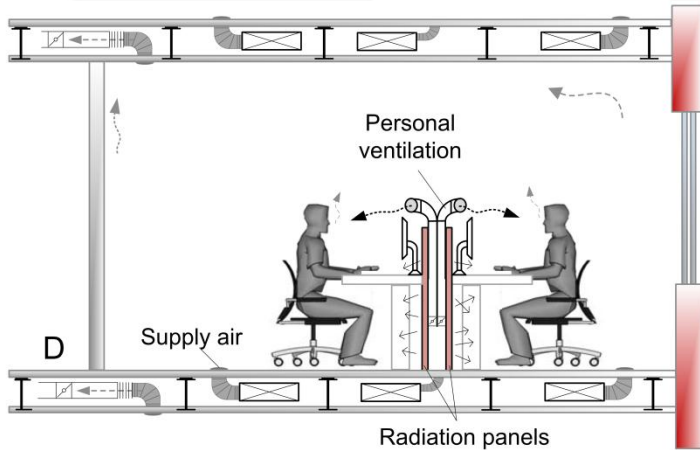
# Method – Healing Environment



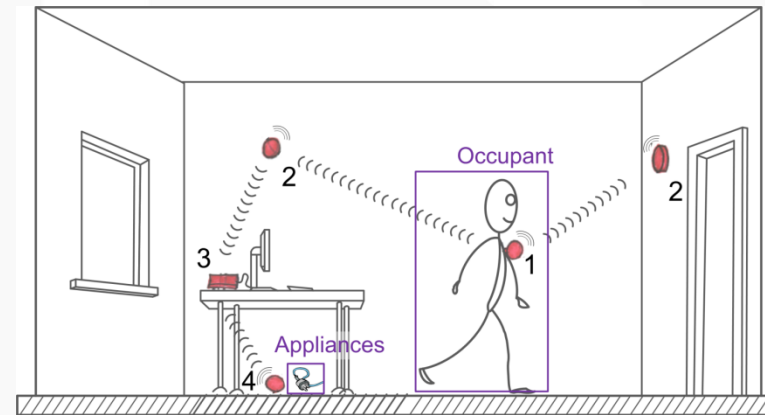


# Method – User demand control

## Workplace Air Conditioning



## HUMAN IN THE LOOP



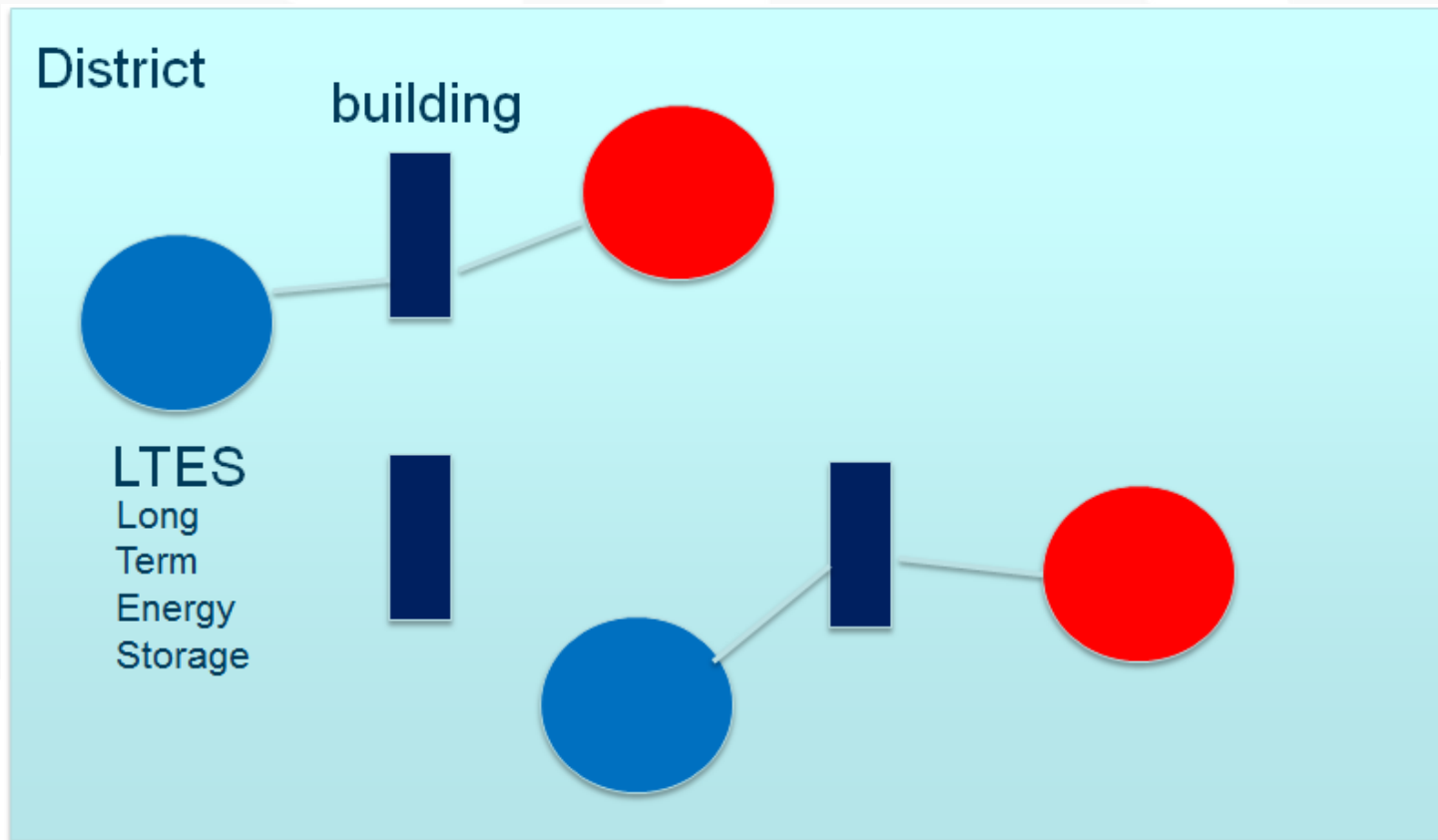
## 2012: The Netherlands wins Rehva Student Competition





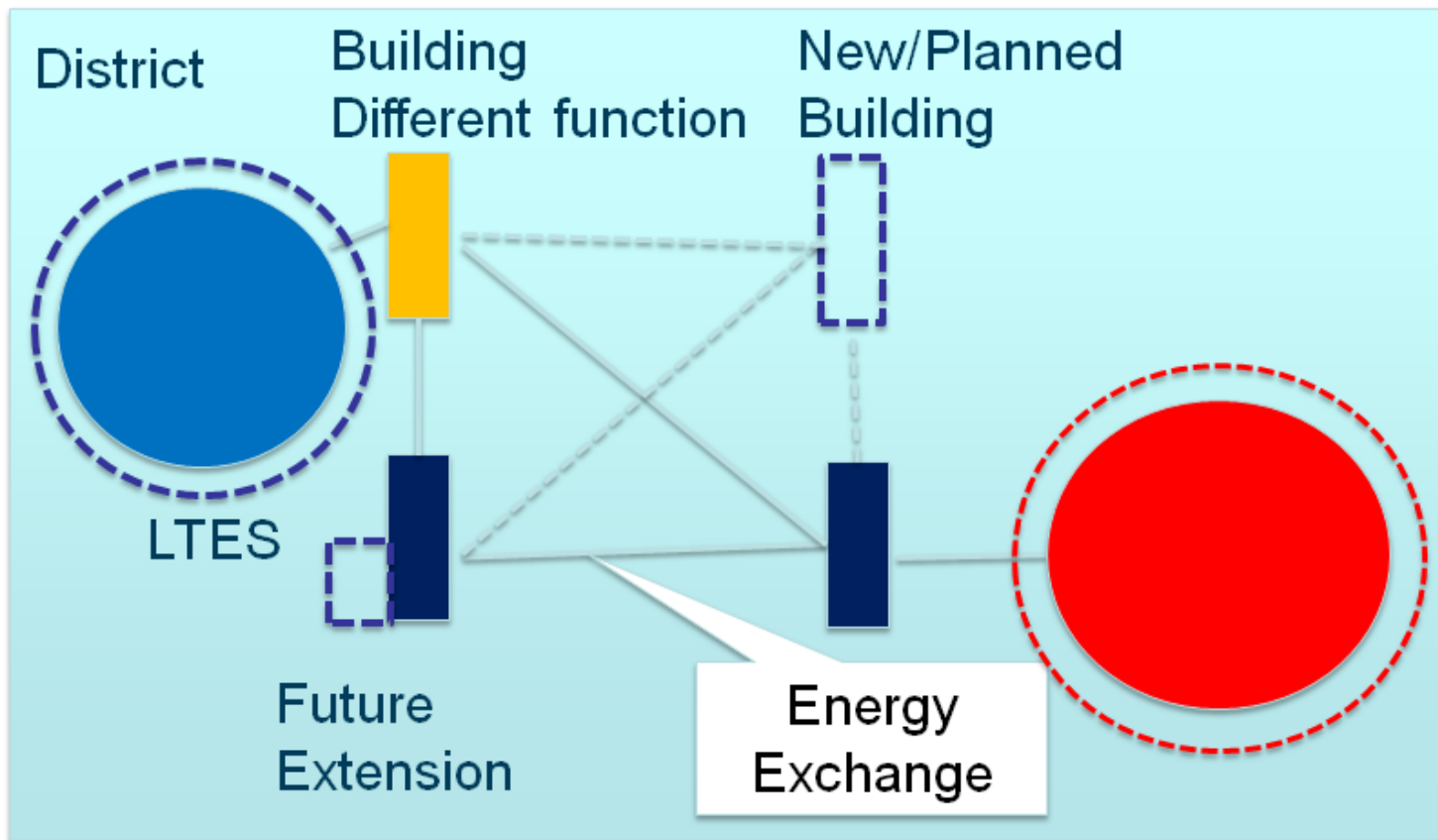


# Method – Energy Exchange & Storage





# Method – Energy Exchange & Storage





# Feasibility NL nZEB Hospital definitions

NL nZEB definitions July 2015 based on global study:

- Some faults: Energy demand +/- 17%; % renewable energy +/- 5%.
- Only 1 building function was considered: clinical. NON-Clinical functions consume more energy.





# Feasibility NL nZEB Hospital definitions

## Measures:

- Insulation
- Infiltration reduction
- Ventilation Reduction
- **CO2 control**
- Heat Recovery
- Hot Tapwater Recovery
- LED lighting
- Heat Pump & Long Term Energy Storage in Soil





# Feasibility NL nZEB Hospital definitions

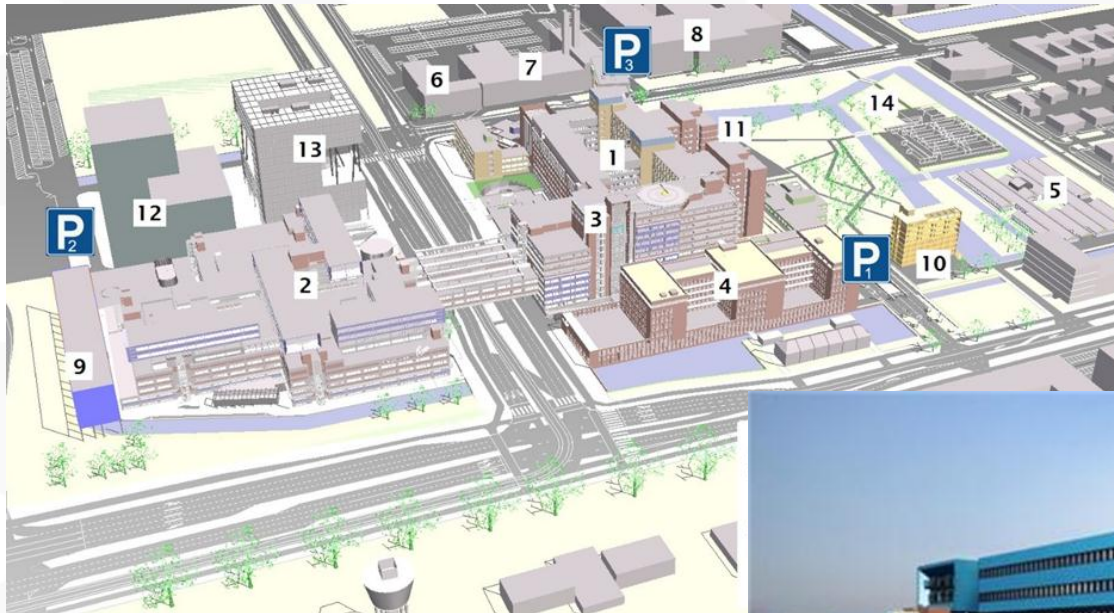
Advice:

- **Only specific functions CO2 control**
- Consider Cogeneration of Heat and Power
- Consider future Hospital design and operation
- Consider more than 1 function in a Hospital
- Update indoor climate requirements/standards (ventilation, temperature en humidity)
- To achieve real energy reduction more aspects and also (medical) appliances should be considered





# Case Study Existing Polyclinic VU Medical Center Amsterdam





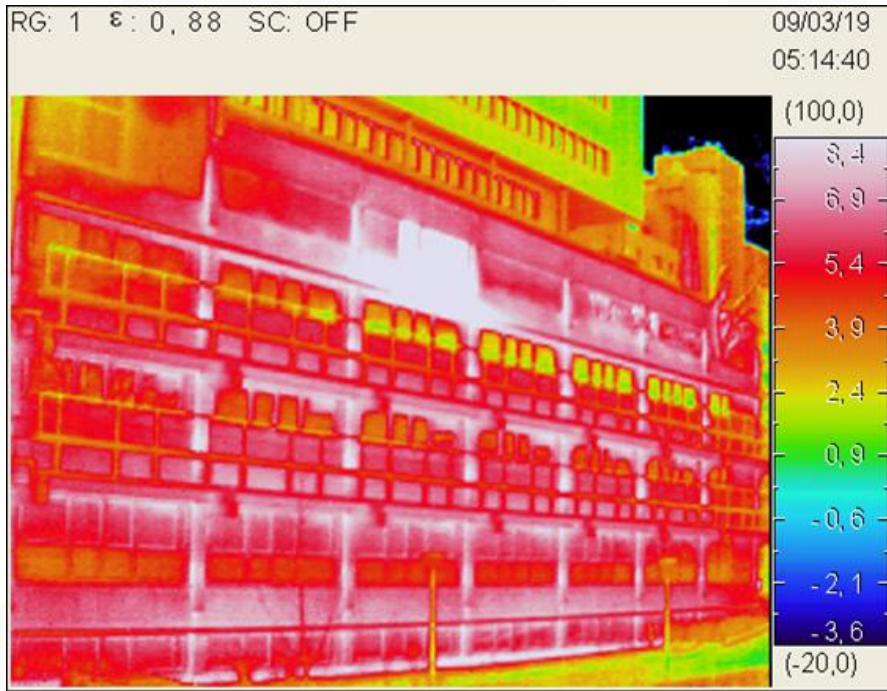
# Case Study Existing Polyclinic VU Medical Center Amsterdam

- Extended life time 10 to 30 years
- No reliable design and monitoring data
- No thorough recommissioning
- Energy costs reduction of € 300,000.– per year realized by professional optimization.





# Case Study Existing Polyclinic VU Medical Center Amsterdam







# Case Study Existing Policlinic VU Medical Center Amsterdam

## Top 5 Measures:

- Upgrade HVAC system (CAV=>VAV)
- Occupancy-base smart controls ventilation, heating and cooling
- Upgrade building envelope
- Upgrade lighting systems
- Occupancy-based smart control lighting and equipment





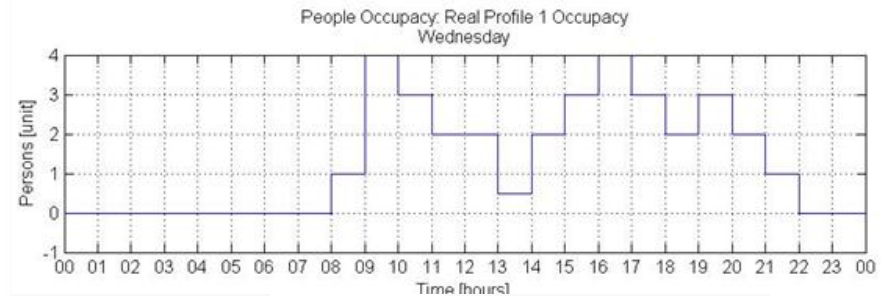
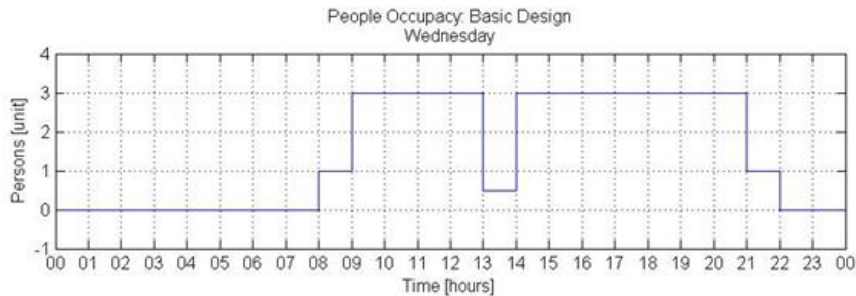
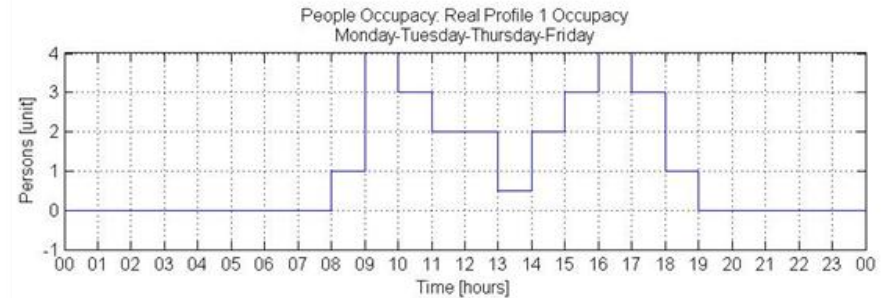
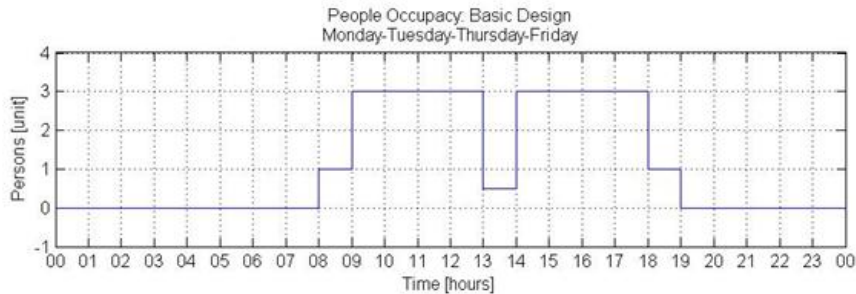
# Case Study Existing Polyclinic VU Medical Center Amsterdam

CALCULATION NUMBER	HVAC		OCCUPATION		ENVELOPE	
	Type	I – CAV	Type	0 – Constant	Type	0 – Current
		II – VAV		1 – Stochastic		1 – Improved
<b>I.0.0</b>		I		0		0
<b>I.1.0</b>		I		1		0
<b>I.0.1</b>		I		0		1
<b>I.1.1</b>		I		1		1
<b>II.0.0</b>		II		0		0
<b>II.1.0</b>		II		1		0
<b>II.0.1</b>		II		0		1
<b>II.1.1</b>		II		1		1



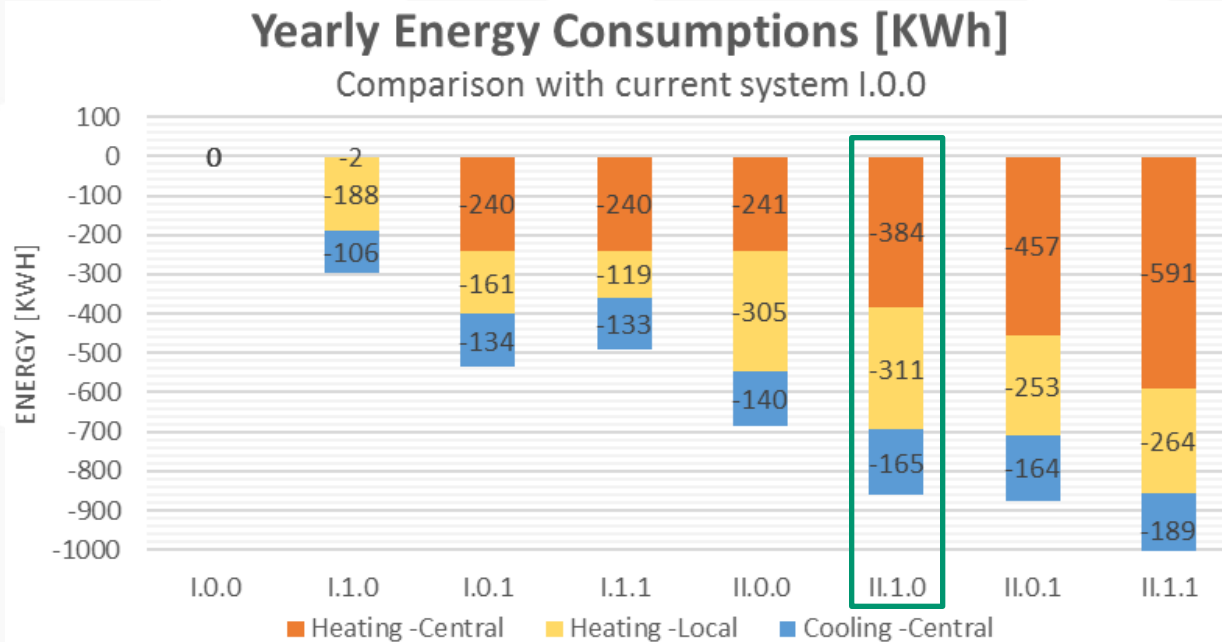


# Case Study Existing Polyclinic VU Medical Center Amsterdam





# Case Study Existing Polyclinic VU Medical Center Amsterdam



CALCULATION NUMBER	HVAC		OCCUPATION		ENVELOPE	
	Type	I – CAV	Type	0 – Constant	Type	0 – Current
		II – VAV		1 – Stochastic		1 – Improved





# Conclusions



- Energy reduction within Hospitals not yet one of the priorities
- NL nZEB definitions need to be reconsidered
- A lot of (SAFE) possibilities to realize energy reduction
- Start with organization, base case performance, monitoring and setting ambitions





# Thank you for your attention !



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