

Building sustainable environments

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Buildings and Built Environment has a central role

- 78% of European citizens are living in cities (54% globally)
- 85% of GDB in Europe (70% globally) is created in cities
- 90% of all innovations are created in cities
- People are spending 90% of their time indoors
- 45% of our national wealth is in buildings (365 mrd.€)
- The maintenance of buildings has a value of 15.5 mrd. €
- New buildings 12.4 mrd. €
- The sector employs 500 000 people
- At the same time over 70% of all CO₂ emissions are originated from cities



$$\text{Eco- efficiency} = \frac{\text{Quality of Life}}{\text{Environmental pressure} * \text{Resource use} * \text{Costs}}$$





We need to create good living and working environments

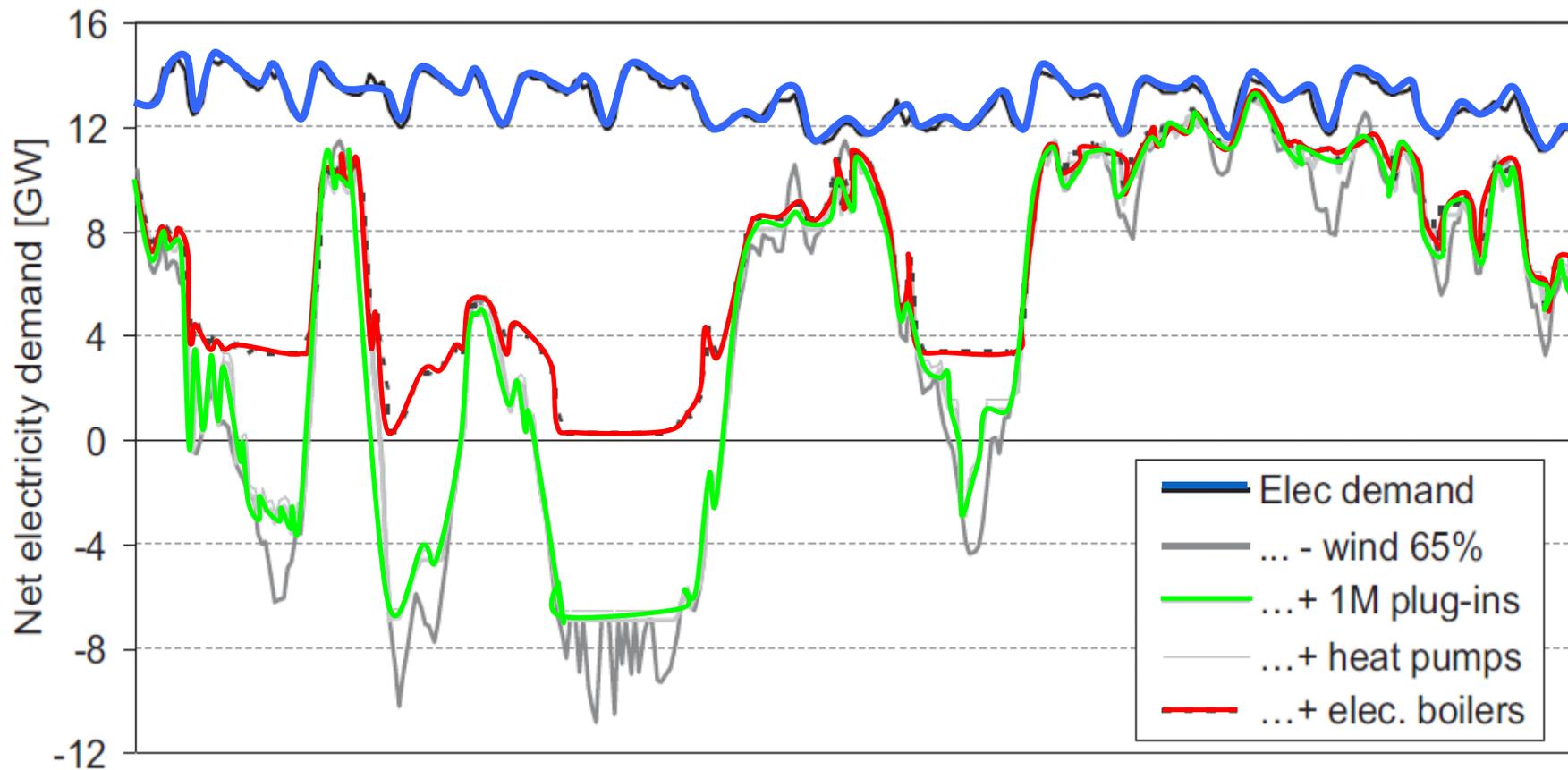
Upgrading and renovating existing stock and infrastructures

- The total costs due to delays in transport, sick leave due to bad indoor air quality etc is estimate to be 3.4 mrd € (VTT 2017) corresponding 1 300 € per household in Finland
- Lost business opportunities 57 mrd €, 39 000 working places (2% of the employment rate)
- According to VTT Finland needs 16 mrd € in next 10 years for renovation but the investment is giving 34 mrd € economical benefits





Our energy system is changing



VTT Kiviluoma J, Meibom P, 2010

Peak power demand, heating

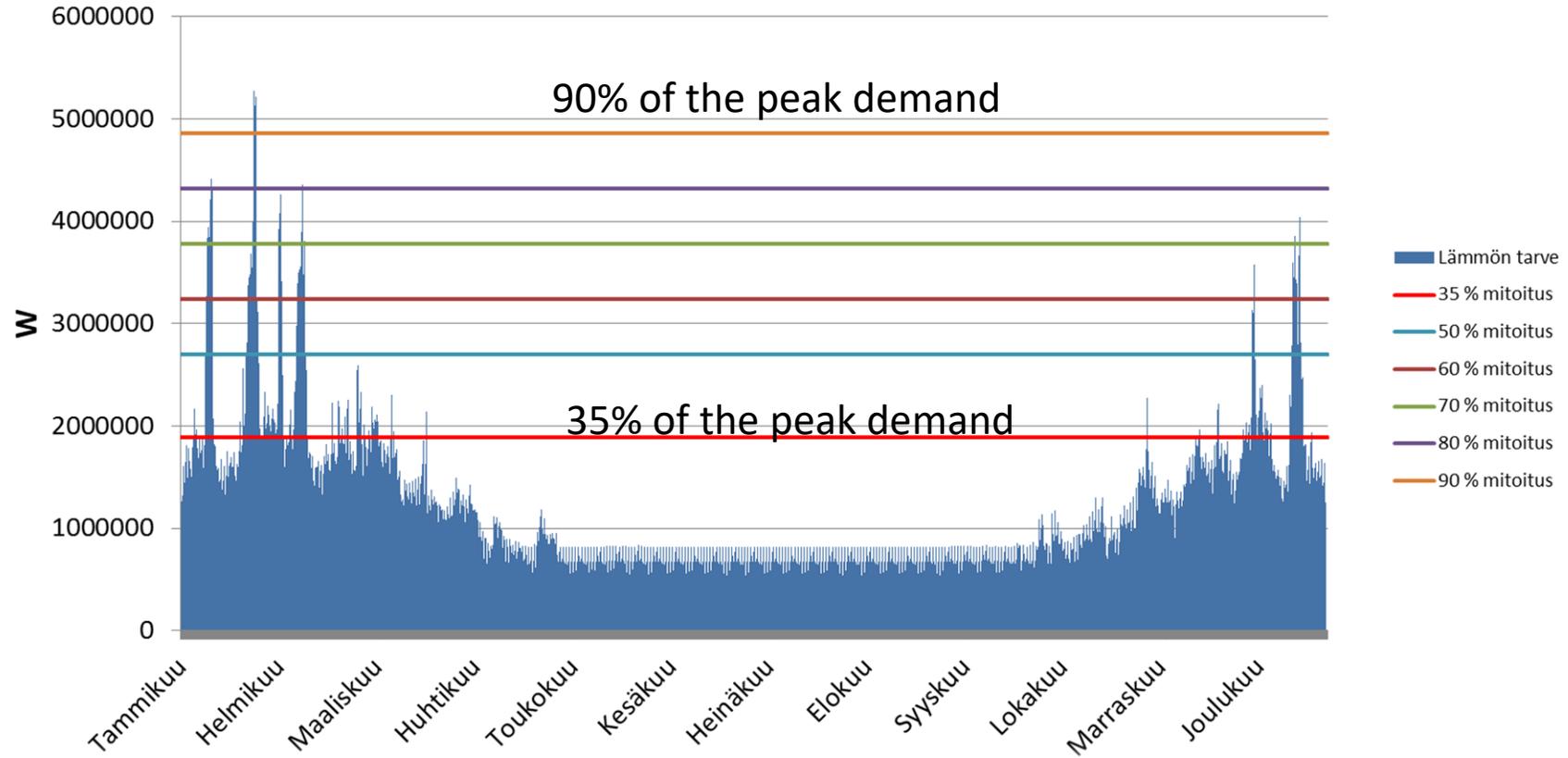


Figure: VTT Co-ZED-project

AI-assisted energy planning

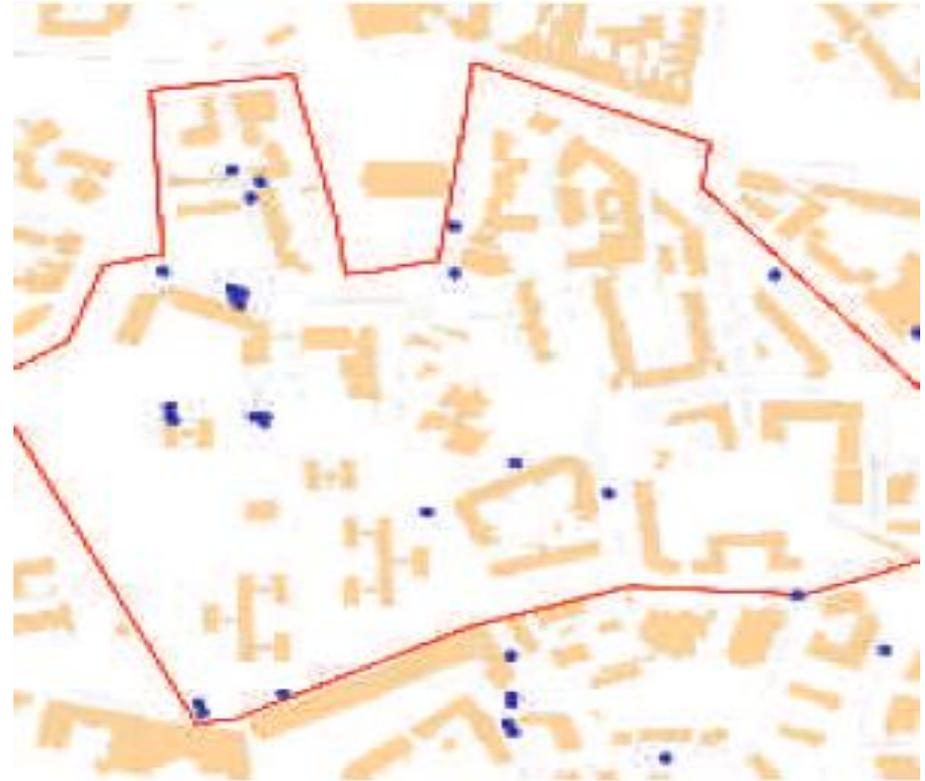
Case example: Östersundom

- Lifetime cost **14–17 %** smaller after optimization
- CO₂ emissions were **29–32 %** smaller
- Planning was supported by a genetic algorithm that went through **2 000** scenarios in 4 hours

AI-assisted Energy Optimization



Urban structure



What kind of city and to whom?

- Existing buildings and infrastructures in cities
- Long life span of buildings
- We are designing city structures for inhabitants who are not even born yet !
- Adaptability of buildings and infrastructures





Adaptive building

Forecasting and learning systems can save 10-30 % energy without compromising indoor environment quality

New algorithms are based on human thermal comfort not air temperature (VTT)





Demand side management in heating

According to several research results the peak demand of buildings can be reduced without customers noticing the reduction in heat quality (e.g. Sipilä ja Kärkkäinen 2000, Stang et al.2002)

Roughly 7-11% of the heating energy can be saved (Wernstedt et al. 2008, Salo 2016)

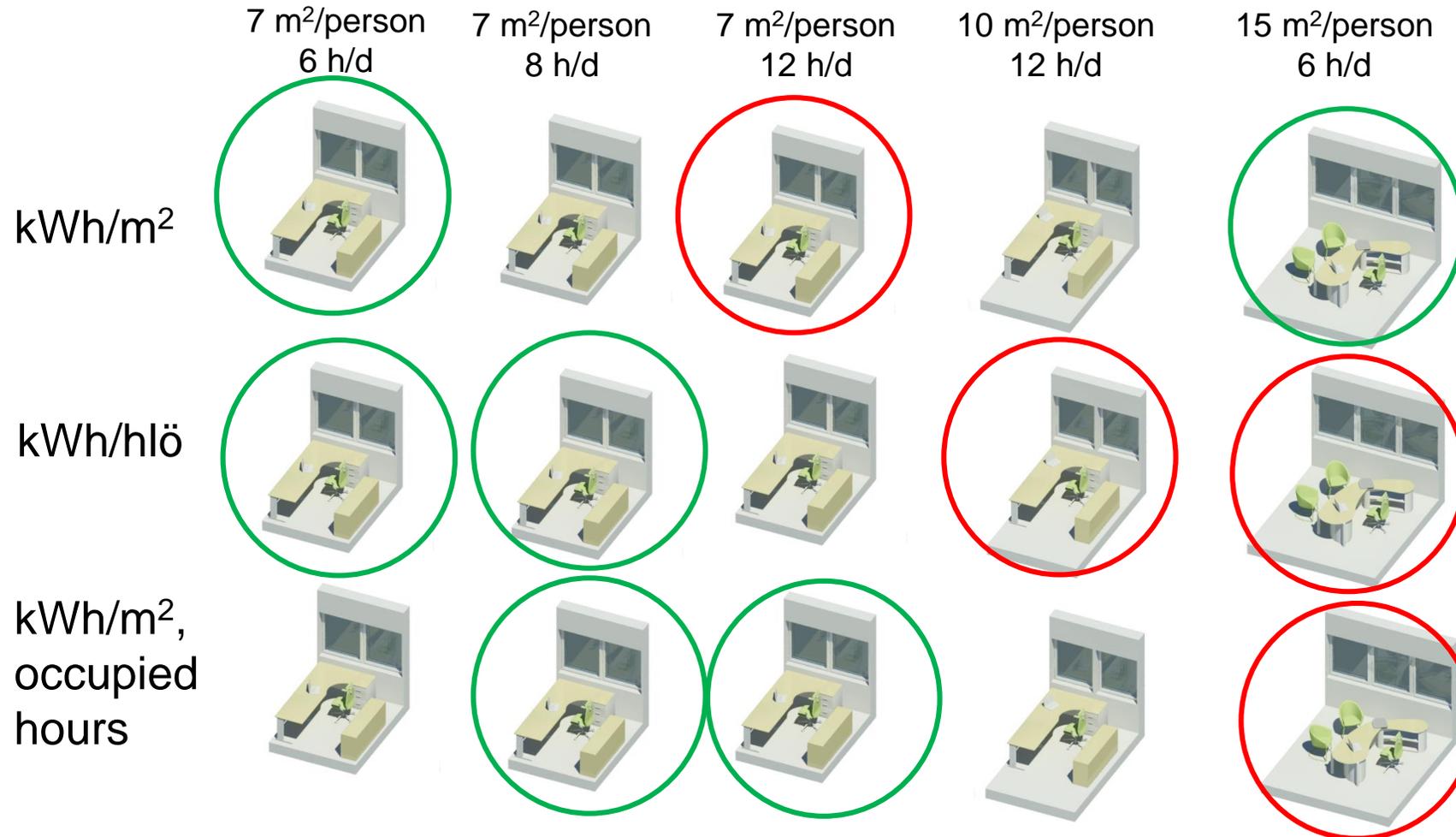
11% of the variable space heating costs can be reduced and variable production costs during the heating season can be reduced by 1.1 €/MWh,(esim. Salo 2016)

more than 40% of the oil boiler start-ups could be avoided during a year (e.g. Salo 2016)

Peak demand can be reduced 10-25% in office and commercial buildings



Example: energy use in office building





Flexible space use and new models for ownership

Multi-use spaces, shared spaces





Why climate resilience is important in cities?

The economic losses caused by weather- and climate-related extremes in the 33 European Environment Agency member countries between 1980–2016 was **over 450 billion euros**.

Main reasons were:

- floods ~40%
- storms 25%
- droughts ~10%
- heat waves ~5%

The insurance coverage is 35 %.

Regarding impacts on human health, heat waves are the deadliest.





Weather and user behavior

When compared to people's regular activity patterns, certain weather conditions affected people's movements and activities noticeably at different times of the day

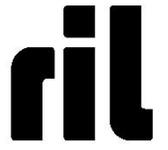
(Horanont et al 2013)



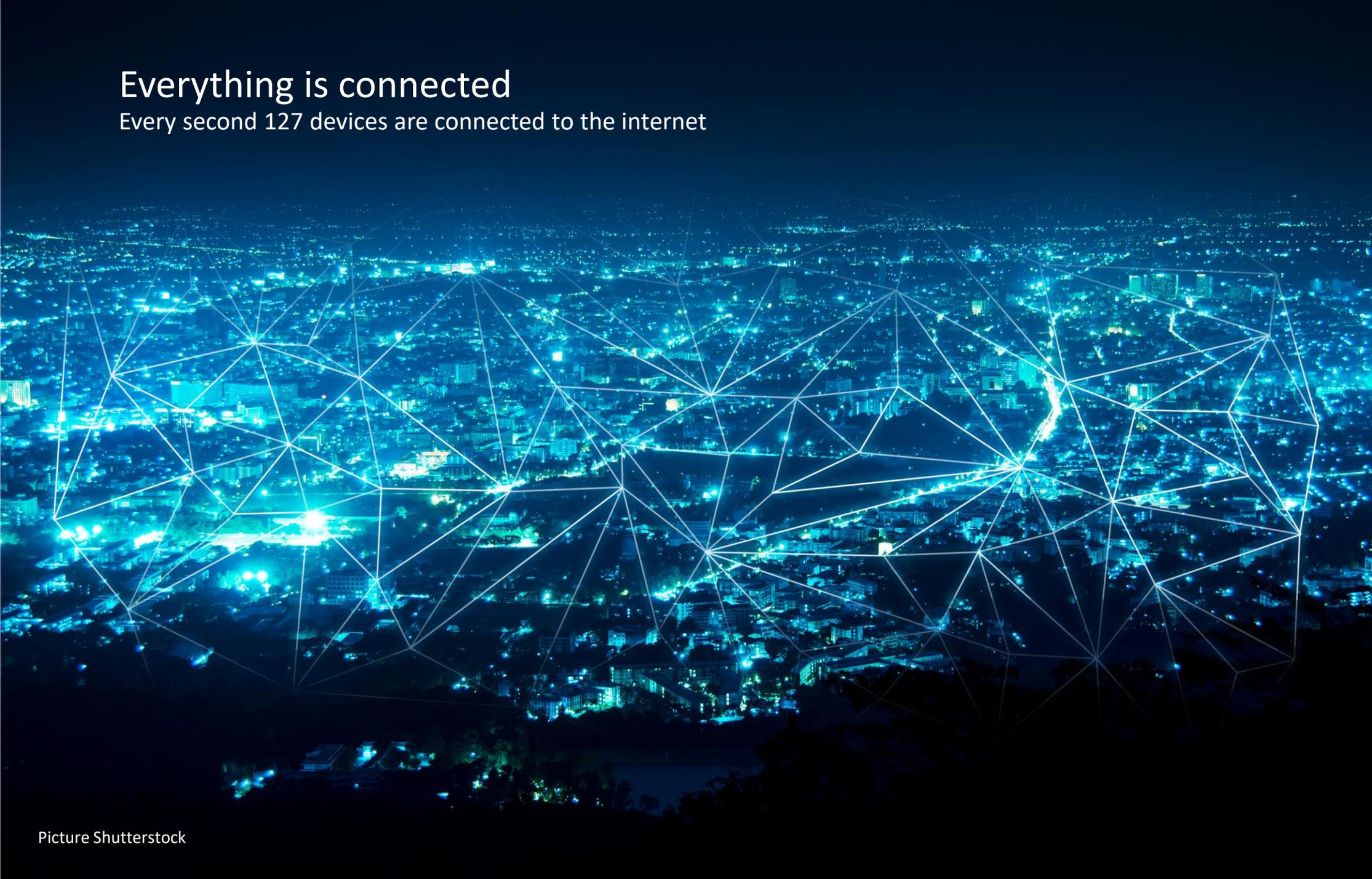
A city has many systems and sub systems which are interlinked and interconnected

- Both system design and operation are in system level, with multi objective optimization
- Since many systems are connected the decision making and leadership processes need to change. In addition the business models are in transition (many stakeholders, new eco-systems)





Everything is connected
Every second 127 devices are connected to the internet





Moving from internet of things to things of meaning

Today's buildings have already tens of thousands data points. M2M reading is needed

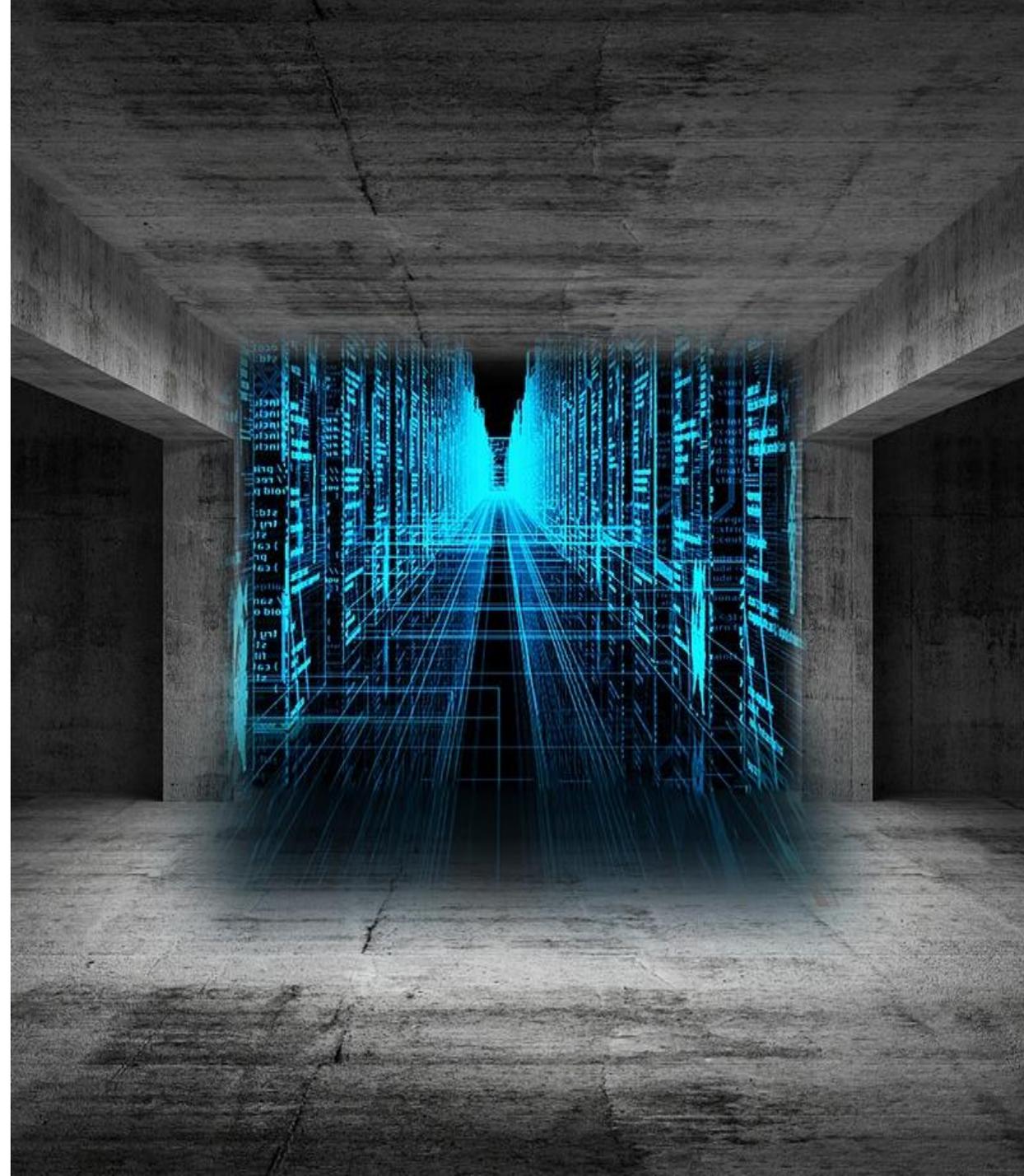
Integration of data from different sources gives better situation awareness and possibility to optimise the whole system





Cyper security

- Only in Europe 315 million people are using internet daily
- Different domains of our infrastructures are connected
- Cyper security is a growing business area, the European market is estimated to be over 100 mrd \$ (European Commission 2017)
- The amount and quality of attacks is increasing, the World Economic Forum estimated that the global costs are 445 mrd \$ yearly (WEF 2016)





Services

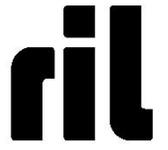
Future services like
Living as a service

Just like a garden, the services are changing their color and form and they are perceived differently by different persons. Need for evolution of services.

Future users of the cities are not yet born.



Picture M Airaksinen



**The future is always overpredicted
but underimagined**



Picture M Airaksinen