







Esbensen









SmartEnCity Network Webinar April 19, 2017

Energy Retrofitting of Buildings

Cost effective energy transition and learnings from European municipalities

David Drysdale Aalborg University

Martin Kikas & Kalle Virkus Tartu Regional **Energy Agency** **Torben Esbensen** DEM-Esbensen

TOWARDS SMART ZERO CO $_{\scriptscriptstyle 2}$ CITIES ACROSS EUROPE VITORIA-GASTEIZ + TARTU + SONDERBORG



SmartEnCity project



- Project funded under the European Union's Horizon
 2020 research and innovation programme
- Under the coordination of Fundación TECNALIA
 Research & Innovation, 35 partners from 6 countries
- To develop strategies that can be replicated throughout Europe in order to reduce energy demand and maximise renewable energy supply
- To develop a **systemic approach for transforming European cities** into sustainable, smart and resourceefficient urban environments in Europe
- SmartEnCity Network is being developed for European cities









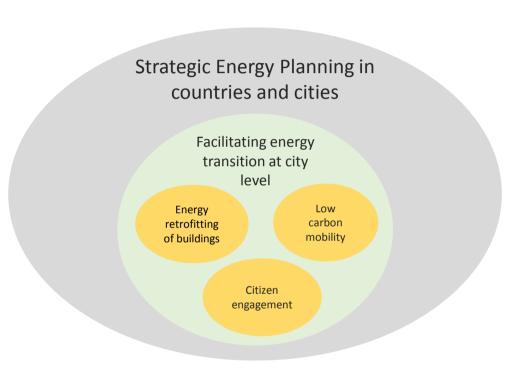
- These webinars are for city planners, policy-makers, private companies, government, researchers etc.
- They are being carried out to share the knowledge of the SmartEnCity partners and attract members to the network
- All webinars available online at www.smartencity.eu







- 1. Strategic Energy Planning in countries and cities
- Facilitating energy transition at city level
- 3. Empower your city transition Citizen Engagement
- 4. Energy retrofitting of buildings
- 5. Low carbon mobility

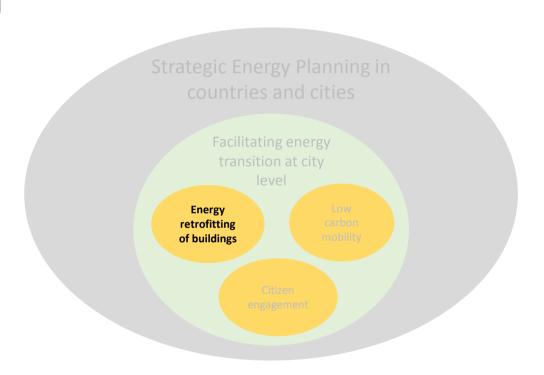








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- 2. Facilitating energy transition at city level
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You can already re-watch webinar 1, 2 and 3:

- #1 Strategic Energy Planning in countries and cities
- #2 Facilitating energy transition at city level
- #3 Empower your city Citizen Engagement learnings from European municipalities

online at

www.smartencity.eu

→ Publications → webinars





Overview of today's webinar



- Introduction to presenters and topic
- Part 1: Role of Energy Retrofitting of Buildings in energy system transition
- Part 2: Tartu experiences Regional approach and practical experiences
 Part 3: Sonderborg experiences Hands on experiences and learnings
- Questions and next webinars





Introduction to presenters and topic





www.aau.dk



Drysdale

- ♣ Doing Ph.d. as part of Sustainable Energy Research Group at Aalborg University
- Working with smart energy systems including the role of energy efficient buildings
- Msc. in Civil Engineering.



www.trea.ee



- Director and energy expert at TREA
- Working with regional approach to implement Energy Retrofitting of Buildings in Tartu (region)
- BSc. in Energy Engineering



Kikas

Kalle Virkus

- Energy expert at TREA
- Working with the concrete actions to implement Energy Retrofitting of Buildings in Tartu (city)
- Msc. In Civil Engineering



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Introduction to presenters and topic





www.dem-esb.dk



Esbensen

- Founder of Esbensen Consulting Engineers specialized in low energy buildings (now consulting engineer in Danish Energy Management & Esbensen).
- ♣ Working with Energy Retrofitting of Buildings for +35 years and involved in Sonderborg actions.
- M.Sc. in Mechanical Engineering





Introduction to presenters and topic



Questions?

If you have questions please write them in the "Question box" and we will try to answer at the end of the webinar

You can also email questions afterwards to sss@planenergi.dk





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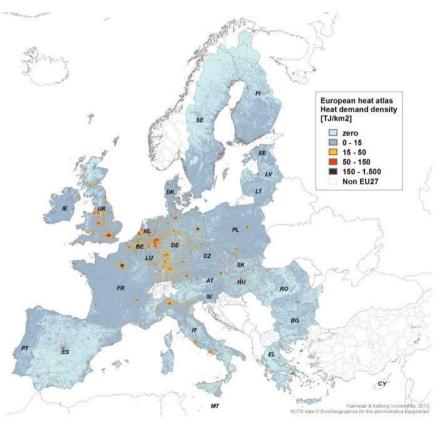




The European heat supply challenge



- Around half of Europe's energy demand is for heating
- Most of this heat is supplied by fossil fuels
- There is a large potential to renovate buildings
- Most of the heat demand in the future will be consumed in buildings that exist today
- New buildings are **not likely** to deliver significant benefits for the low-carbon energy system



http://www.heatroadmap.eu/Peta4.php

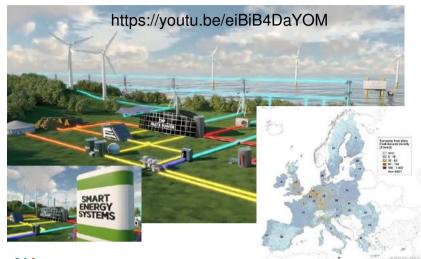




How can we address this challenge?

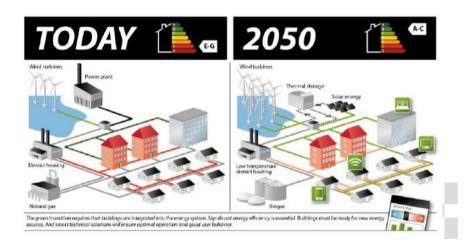


- Two research projects have provided us with some insights on the role of buildings
- Heat Roadmap Europe (2012-2019):
 Low-carbon heating and cooling strategies
 (www.heatroadmap.eu)
 - + For EU a combination of:
 - + 50% District Heating (*Cities*)
 - + 50% Heat Pumps (Rural Areas)
 - + 30-50% Heat savings (*Everywhere*)
- Future Green Buildings in Denmark (2015): Buildings in low-carbon Danish energy system (www.EnergyPLAN.eu/buildings)





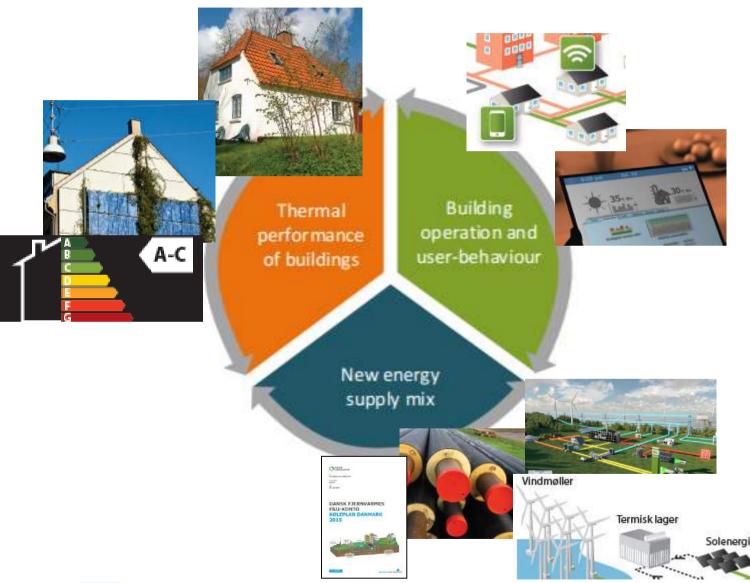
http://www.heatroadmap.eu/Peta4.php





The solution involves three interrelated factors

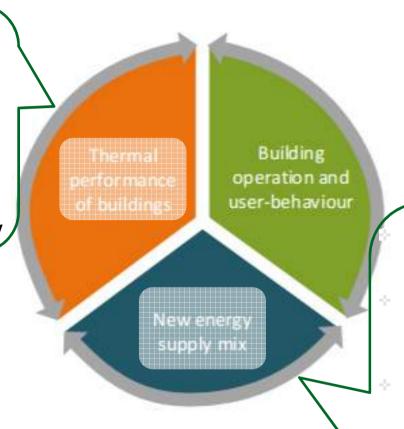




Benefits from the three interrelated factors



- Retrofitting lowers primary energy demand of the system
- Increases heat retention and flattens peak heat demand
- Enables lower temperature heat supply



Retrofitting allows for **smaller heat supply units**

Enables low-temperature heat technologies, e.g. low-temperature district heating and heat pumps

Low-grade heat sources can be integrated in DH, e.g. industrial excess heat

Enables better integration of renewable electricity using **smart technologies**, e.g. heat pumps



Summary



- Energy retrofits are interrelated with: 1) building operation/userbehaviour; and 2) the entire energy supply mix
- The benefits from energy retrofitting are numerous and they are not only related to the building
- We should focus on building retrofits <u>AND</u> the supply of sustainable energy from the wider energy system





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Regional approach and practical experiences in Tartu, Estonia MARTIN KIKAS Tartu Regional Energy Agency, 18.04.2017

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VITORIA-GASTEIZ + TARTU + SONDERBORG







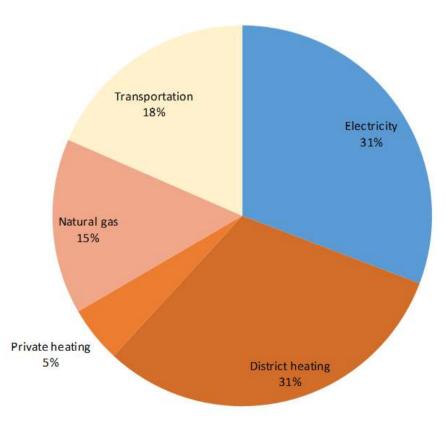
Energy consumption per year in Tartu

Total 1448 GWh

Heat 819 GWh

DH 448 GWh

Local heating 66 GWh



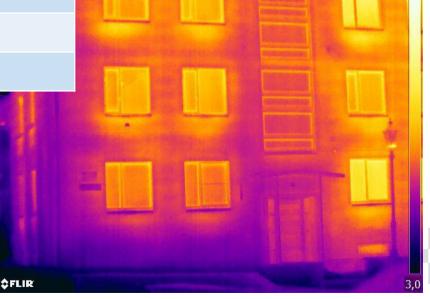




- Energy consumption on buildings in Tartu
- ♦ 66% of households are connected to DH

District Heating (DH)	429 GWh
Housing sector	232 GWh
Public sector	99 GWh
Others	98 GWh

Most of housing sector buildings in DH are multi-family houses (MFH)



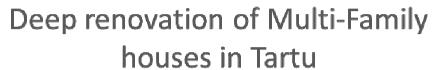


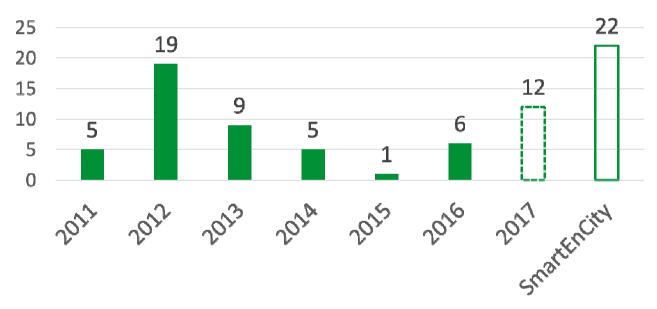


- Most important driver for energy retrofitting today are:
 - ♣ state support from Kredex
 - ♣ awareness of owners and lower of cost for energy
- ♣ State grant by Kredex:
 - ♣ on period 2010-2014 35% of total energy retrofitting costs
 - ♣ on period 2015- ... 40% of total energy retrofitting costs
- ♣ Main targets:
 - ♣ guaranteed inside climate
 - → reduction of heat energy consumption al least 50%, etc.
 - ♣ energy performance target 150 kWh/m² year















- ♣ Energy retrofitting of multi –family houses in Tartu by SmartEnCity
- ★ Targets are:
 - ♣ energy consumption reduction at least 50%
 - ♣ energy performance class "A" 90 kWh/m² year

Today most of buildings have ca 250 kWh/m² year

controlled inside climate in apartments

Today: no guaranteed inside climate

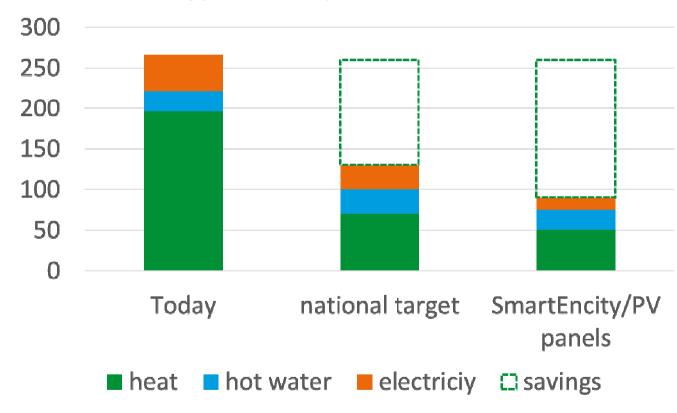
→ Pilot area: 22 multi-family buildings, ca 39 000 m² living area







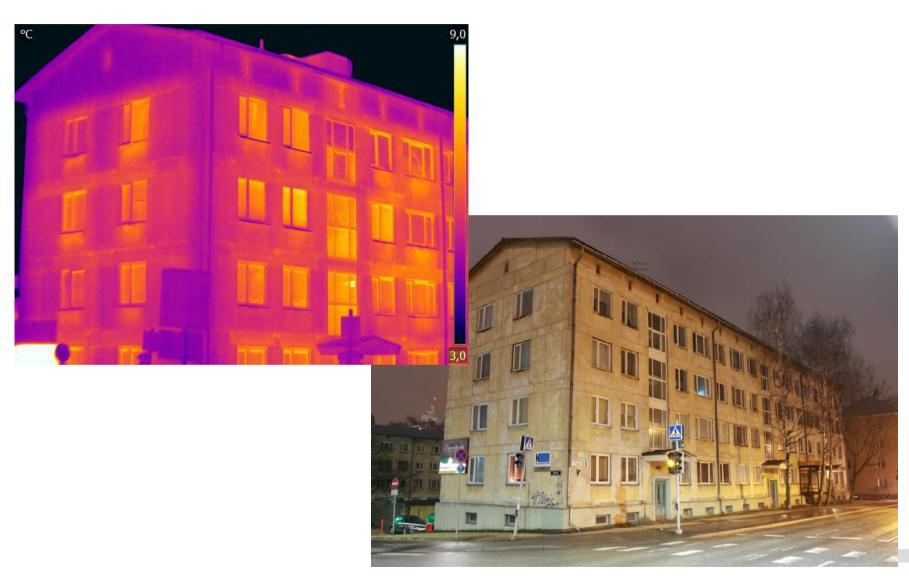
Energy consumption in MFH, Tartu





Retrofitting in Tartu





Contact



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Retrofitting in Tartu - Practical experience

Webinar April, 19th 2017

Kalle Virkus
Tartu Regional Energy Agency





- * Background information on housing in Tartu and Estonia
- Khrushchyovka multi family house (MFH) of the 1960s
- + Challenges and problems, expected and unexpected





Massive residential construction started early 1960s





- + Material changed from brick to concrete in late 60s
- Former SU was not affected by oil crises of 70s
- Erection of the same type of houses continued up to 1991



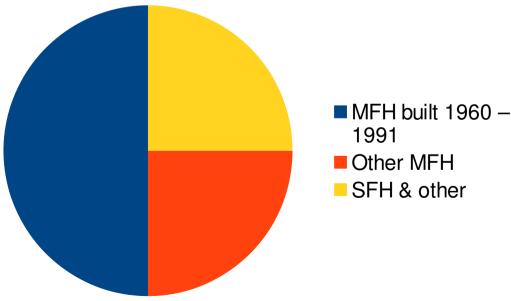






75% of population live in MFHs

- 50% of households live in MFHs built 1960 to 1991
- Energy efficiency is consistent with oil prices of 1960s









- Over 95% of housing is privately owned
 - ~85% of apartments are owner occupied
 - Rental market is undeveloped and mostly "grey"

- KredEx Fund provides renovation subsidies up to 40%
 - Subsidies all well organized and include QC





- Base type of apartment building
 - Low cost;
 - Brick or concrete;
 - 3 to 5 stories.

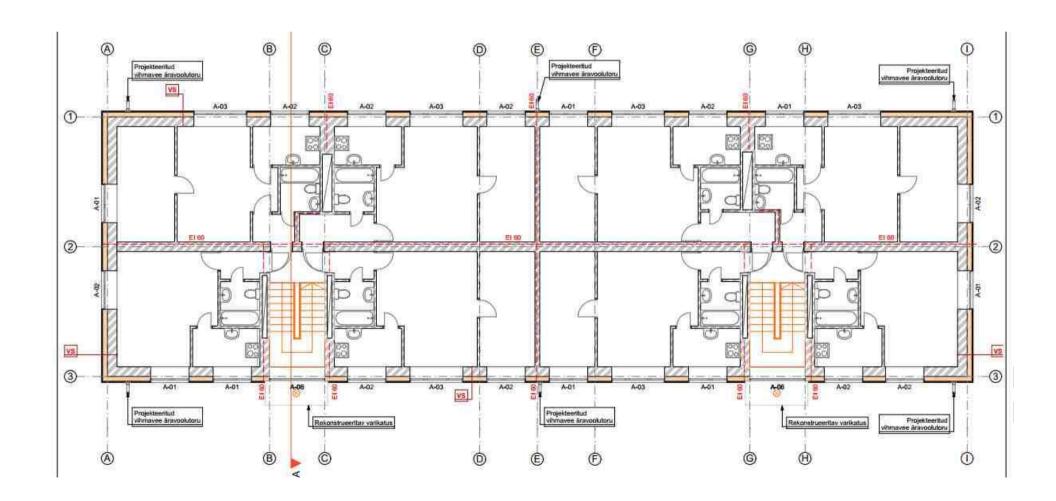


Photo: Andrei Mahhonin, TASS



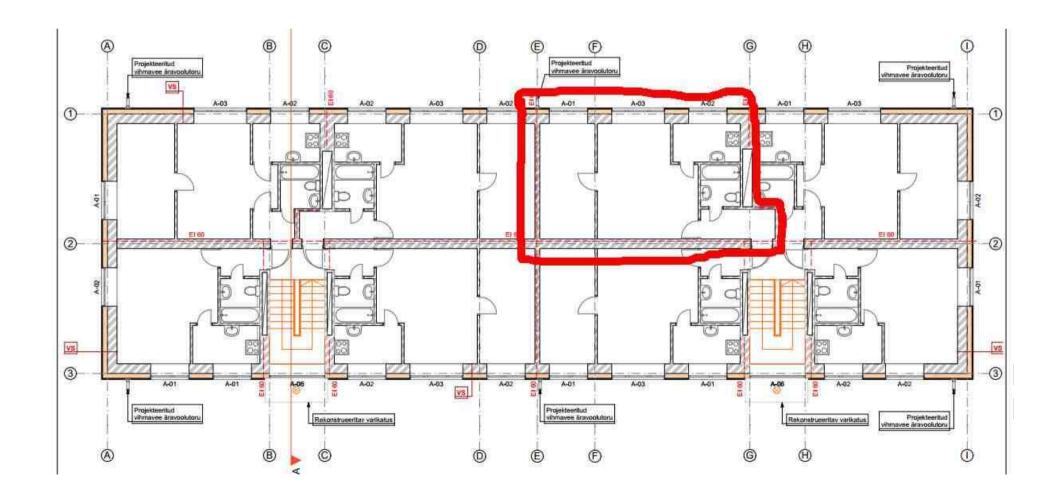


- Typical flat 44m², two rooms;
- Kitchen ~6m²;
- + Little on no storage space.



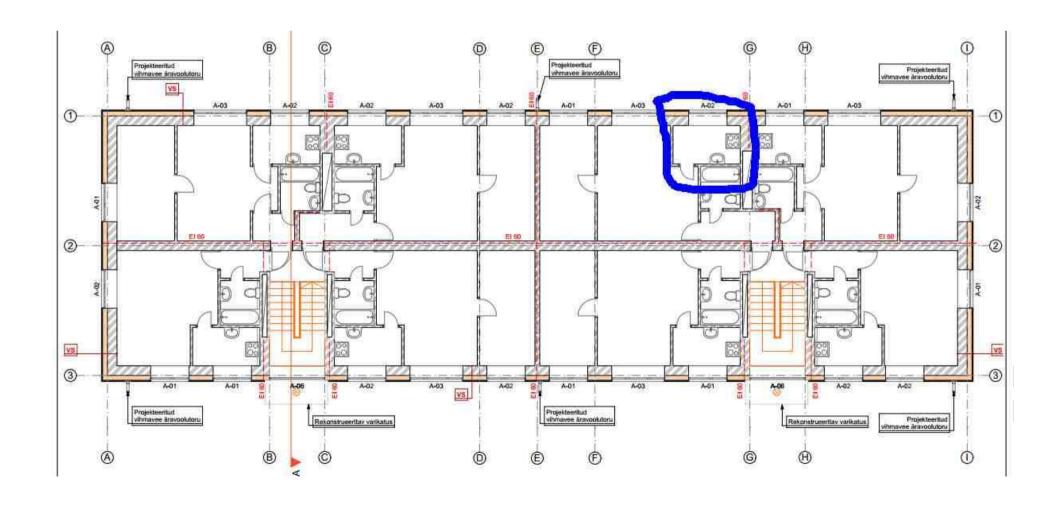


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- Typical flat 44m², two rooms;
- Kitchen ~6m²;
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Khrushchyovka – child of housing policy



- Ventilation free flow; intake through untightness of windows;
- → DHW gas boilers;
- Little or no storage space;





Technical details



Renovated house will have

- Insulated envelope (currently walls U~1,0 W/mK)
 - » Walls 15-20 cm thick insulation
 - » Roof ~40 cm insulation
 - » Windows, doors U=0,7-0,9 W/mK
- Mechanichal ventilation
 - » Heat pump recovery or heat exchanger
 - » On-demand; based on CO₂ levels
 - » Heat recovery >82%
- Windows replaced and repositioned to avoid cold bridges
- Room based heating control
- DHW gas end electric boilers replaced with DH



Challenges - anticipated



Shortage of engineers, designers

- KredEx Fund´s subsidising of renovation has created a workload;
- HVAC engineer has not been a popular academic choise;
- A lot of design offices dare not take on a demanding task;

Awareness of residents / home owners

Near Zero Energy Building as a concept is unknown



Challenges - anticipated



Legislative challenges

- A legal body as a building owner is a Home Owners
 Association. Decision making by committee may take a long time
- Integrating micro generation unit to the building is yet to be solved as every apartment has a different and independent contract with different power companies.





Challenges – not anticipated



- Local strict urban development policies do not allow significant alteration of houses which led to:
 - Loss of interest of more creative architectural design offices;
 - Diminished enthusiasm of residents
- Idea of converting some idle space to common rooms was not accepted
 - Laundry;
 - Bicycle and pram storage room etc...
- Building code is lagging behind nZEB construction
 - Calculation of energy consumption (EPC) is too coarse
 - No provisions to calculate on-demand ventilation
 - etc.



Smart renovation



- Concept of "smart city" is to be filled with details
 - Do houses of smart city have to be smart?
 - ... how smart?
- It is crucial to inform, involve and educate residents and home owners
 - What do they want?
 - What do they get?
 - Do they have a choice?
 - » ...do they?
- PR is impossible to overestimate





Thank You for listening!





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Energy Retrofitting of Buildings

Torben Esbensen Danish Energy Management & Esbensen A/S, 19.04.2017

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VITORIA-GASTEIZ + TARTU + SONDERBORG



Soebo Housing Association. Dept. 11, Sonderborg. DK

Building integrated solar cells on 4 southfacing roofs



SOEBO Housing Association, Dept. 11, Sonderborg, DK





- 4 two- floors apartment buildings with total 88 social housing apartments.
- 160 kW (950 m2) building integrated solar photovoltaic panels.
- New low energy windows and doors.
- New central heating automatic control for district heating.
- LED outdoor lighting
- All measures installed and finished in January 2017





SOEBO Housing Association





- **→** Building integrated solar cells panels
- → 950 m2 (160 kW) produce 160.000 kWh per year.
- → Total installation costs for roof integrated panels: 367.000 Euro + VAT corresponding to 2,30 Euro per kWh produced per year.
- → Total installation costs for panels mounted on top of the existing roof: 271.700 Euro + VAT corresponding to 1,70 Euro per kWh.
- → Building integrated solar panels are 35 % more expensive to install, but maybe also 35 % more nice to look at ??





Sonderborg Housing Association SAB, Dept. 22.



- → 19 three-floors apartment buildings with total 432 social housing apartments.
- **+** Energy retrofitting measures:
- → Building integrated solar photovoltaic panels on roofs towards South, East and West, in total 3.000 m2 solar panels.
- LED outdoor lighting in common areas (corridoors and basement)





Sonderborg Housing Association, SAB, Dept. 22.





- → 460 kW solar cells (3.000 m2 panels) produce 408.000 kWh electricity per year corresponding to 37 % of the total electricity consumption in the 432 apartments.
- → The solar system is designed in such a way, that 80 % of the produced electricity is used hour-by hour directly in the apartments, and 20 % is sold to the public grid.
- → By using the solar electricity directly, the apartments save 0.30 Euro per kWh.
- → The 20 % can be sold to the grid for 0.11 Euro per kWh, which is
 a special support arrangement from the government.



Sonderborg Housing Association, SAB, Dept. 22





- → The tendering included: Delivery and installation of the solar panels, the electrical installations, the roof construction by integrating the panels and the financing scheme for the whole contract.
- → The financing scheme means, that the contractor provides the financing, and only the actual value of the solar produced electricity is used as repayment of the investment.
- → This means, that the residents do not get any savings on their electricity bills the first 10-15 years, but after that they will have a considerable reduction of their bills without having an increase in the rent of the apartments.
- → The solar cells have a lifetime of 25-30 years, and will deliver free electricity to the apartments after the first 10-15 years.





Sonderborg Housing Association, SAB, Dept. 22



- Evaluation of the offers in the tender for solar photovoltaic panels:
- → The financing period (pay-back period) counts 50 % in the evaluation.
- → The technical quality of the solar panels and systems count 30 %
- The architectural integration and the integration system count 20 %.
- **→** The total project will be established before October 2017.



SmartEnergyCity-Sonderborg. B42 Housing Association Dept. 10: Skriverløkken, 87 apartments.

Energy saving measures:

- Insulation of headboards.

- Building integrated solar photovoltaic panels on roof and headboards, in total 190 kW (1.200 m2 solar panels)

- LED outdoor lighting, corridoors etc.
- The project will be established before
 November 2017



B42 Housing Association, Sonderborg, Dept 13, Ringbakken



- → 48 apartments in 4 two-floors apartment buildings.
- **+** Energy retrofitting measures:
- New facades with external insulation and new low-energy windows.
- New ventilation system with heat recovery
- **★ LED lighting outdoor and in corridoors.**
- → Building integrated solar photovoltaic panels in roofs and in facades.
- ♣ In total 97 kW solar panels 780 m2
- → The project will be completed in the autumn of 2018







B42 Housing Association, Dept.21, Morbaerhegnet



- + 122 apartments in several three-floors social housing buildings
- + Energy retrofitting measures.
- **⊹** New ventilation systems with heat recovery.
- **↓ LED lighting outdoor and in corridoors etc.**
- → Building integrated solar photovoltaic panels in roofs, in total
 260 kW with an area of 1.500 m2.

The project is expected completed in the autumn 2018.





Our passion for energy is most directly linked to the 4 UN Sustainable Development Goals:











Contact



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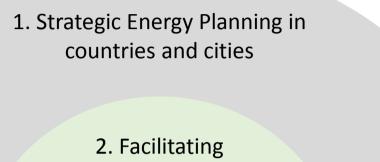
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energy transition at city level

4. Energy retrofitting of buildings

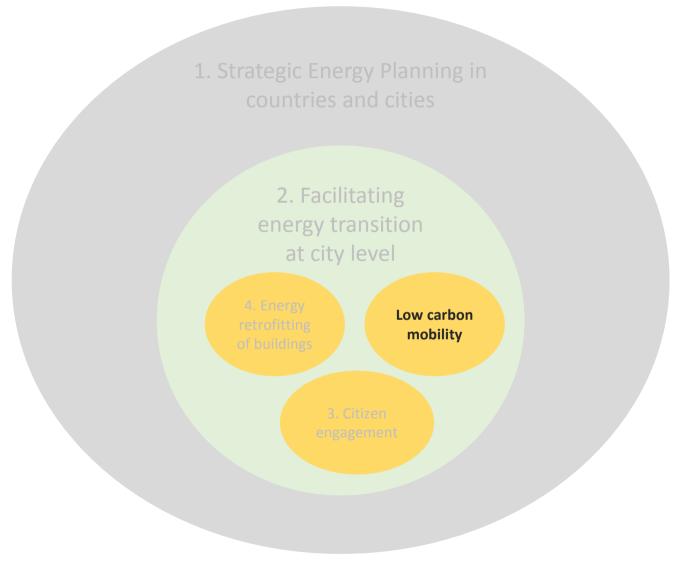
Low carbor mobility

3. Citizen engagement















Thank you for joining & see you!





