Estonian energy policy and EPBD: Deep integrated renovation with KredEx renovation grant programme
• ~65% population living in apartment buildings
• ~95% of apartments are in private ownership
• not insulated, not ventilated …
Grants 15%, 25% and 40%

- 2010-2014: 35% 25% 15%
- 2015-2020: nZEB 40% 25% 15%
  + more strict ventilation and other requirements

TALLINN UNIVERSITY OF TECHNOLOGY
KREDIX
Main steps in the KredEx grant application process

• Housing association decision – simple majority 50% +1 in general assembly meeting
• Qualified technical consultant – steering the preparation
• Energy audit/EPC of the building and investigations (stacks etc.)
• Detailed technical design: full set of building design documents (including calculated EPC for compliance approval)
• Building permit applied/issued
• Credit decision from bank issued
• Grant application to KredEx:
  – Investigation of design documents by third party experts (KredEx)
  – Revision of design documentation if needed (applicant)
  – Funding decision by KredEx if all requirements met
• Tendering with contractors
• Construction (KredEx has special supervision rights)
• Commissioning protocols for ventilation rates and heating system
• Grant payment by KredEx after handing over
• EPC based on measured use after one year operation
Results 2010-2014 (old system)

• Grants - 38 million euros
• Total investments – 135 million euros
• 35% grant most popular (>50% in last years)

• Renovated apartment buildings – 663 (of total of about 20 000 apartment buildings)
• Renovated net area – 1,9 million m²

• Average energy savings per building – 43%
• Total annual energy savings – 60 GWh
Example: Sõpruse pst 202, Tallinn

- 11,375 m² (162 ap. 2012-2013)
- Investment €2,062,000, 181 €/m²
- Grant 35% €721,600, 63 €/m²
- Credit €1,340,000, 20 years
- Measured annual savings 63%, ~500 MWh
Ventilation problems 2010-2014

- No specific ventilation requirements were set however EN15251 indoor climate category II was required.
- Very low ventilation rates except in centralized mechanical supply and extract ventilation systems (Central AHU):

\[ n_{\text{avg.}} = 0.16 \, \text{h}^{-1} \] (Natural ventilation)
\[ n_{\text{avg.}} = 0.18 \, \text{h}^{-1} \] (Room based AHU)
\[ n_{\text{avg.}} = 0.20 \, \text{h}^{-1} \] (Mechanical exhaust)
\[ n_{\text{avg.}} = 0.57 \, \text{h}^{-1} \] (Central AHU)

Hamburg, A; Mikola, A; Kõiv T-A. Analysis of renovated apartment buildings indoor climate and energy consumption and their compliance with the standards and energy audits.
2015-2020 KredEx grants

• **102 M€, grants 15, 25 and 40%** (50% for design, technical consultants, supervision)
• 15% financial support – EPC class E
• 25% financial support – EPC class D (EP ≤180 kWh/(m²·y))
• **40% financial support – EPC class C** (EP ≤150 kWh/(m²·y))
• + additional technical requirements for ventilation and insulation
• More emphasis on preparation, ventilation, energy monitoring:
  – More detailed building design documents (full energy calculation in addition to energy audit + because of third party verification)
  – Investigation of building design documents by third party experts (run by KredEx having contracts with qualified experts)
  – Technical consultants
  – Commissioning protocols for ventilation airflow rates and heating system balancing
  – Agreements for post-maintenance
  – Measured EPC after one full year of operation
Apartment building with gas heating (for district heat slightly more heating is accepted because of primary energy factor of 0.9)

Applies both for renovation with 40% grant as well as for new building

<table>
<thead>
<tr>
<th>Energy need, kWh/m²</th>
<th>Delivered energy, kWh/m²</th>
<th>Primary en. factor, -</th>
<th>Primary energy, kWh/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space heating</td>
<td>22</td>
<td>25.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Vent. heating</td>
<td>14</td>
<td>14.7</td>
<td>1.0</td>
</tr>
<tr>
<td>DHW</td>
<td>30</td>
<td>31.6</td>
<td>1.0</td>
</tr>
<tr>
<td>HVAC aux.</td>
<td>9.5</td>
<td>9.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Lighting</td>
<td>7</td>
<td>7</td>
<td>2.0</td>
</tr>
<tr>
<td>Appliances</td>
<td>22.5</td>
<td>22.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Total</td>
<td>105</td>
<td>111</td>
<td>150</td>
</tr>
</tbody>
</table>

Energy needs of DHW, lighting and appliances are regulated values
Delivered energy of DHW depends on the system (efficiencies etc., in this case no solar collectors or heat pumps are considered)
KredEx Insulation requirements

U-value and thermal bridge requirements

<table>
<thead>
<tr>
<th></th>
<th>25% grant</th>
<th>40% grant</th>
</tr>
</thead>
<tbody>
<tr>
<td>External wall (opaque), W/(m²K)</td>
<td>0.25</td>
<td>0.22</td>
</tr>
<tr>
<td>Windows (tot value), W/(m²K)</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Roof, W/(m²K)</td>
<td>0.15</td>
<td>0.12</td>
</tr>
<tr>
<td>Linear thermal bridge (window-wall) W/mK</td>
<td>-</td>
<td>0.05</td>
</tr>
</tbody>
</table>

In the case of 40% grant, windows are to be replaced and moved to the insulation layer in order to comply with thermal bridge requirement.
KredEx ventilation requirements

25% renovation grant:

• Continuous an average ventilation (for total apartment) 0.5 l/h;
• Supply or intake air flow rates to be at least **10 l/s in bedrooms and living rooms at sound power level no more than 25 dB(A)**;
• Extract air flow rates at least **10 l/s WC, 15 l/s bathroom and 8 l/s kitchen** (10 l/s in bathroom and 6 l/s in kitchen in one room flats);
• **Heat recovery is NOT required** (but depending on the building, EPC class D might be difficult to achieve without HR)

Additional requirements for 40% renovation grant:

• Mechanical supply and exhaust ventilation with heat recovery OR exhaust air heat pump with ventilation radiators required
Sizing of ventilation in typical apartments

Ventilation air flow rates according to requirements:

<table>
<thead>
<tr>
<th>Floor area, m²</th>
<th>Extract airflow rate, l/s</th>
<th>Supply airflow rate, l/s</th>
<th>Air change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WC</td>
<td>Bathr.</td>
<td>Kitchen</td>
</tr>
<tr>
<td>Single room</td>
<td>35</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>1 bedroom</td>
<td>55</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>2 bedrooms</td>
<td>70</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>3 bedrooms</td>
<td>80</td>
<td>10</td>
<td>15</td>
</tr>
</tbody>
</table>

To balance the ventilation, supply airflow rates are to increased in small apartments and extract airflow rates in large apartments:

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<thead>
<tr>
<th>Floor area, m²</th>
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<td>15</td>
</tr>
<tr>
<td>3 bedrooms</td>
<td>80</td>
<td>12</td>
<td>16</td>
</tr>
</tbody>
</table>
Loomulik ventilatsioon:

– Ebapiisav õhuvahetus (peale akende vahetust)
– Puudulik siseõhu kvaliteet
– Kontrollimatu toimivus
– Suur energiakulu
– Puhub peale (värske õhu klappidega)
– Liigniiskus

Some examples of ventilation solutions: Natural ventilation
Room ventilation HR units

- Additional exhaust ventilation needed from toilets, bathrooms and kitchens destroying the heat recovery – room ventilation principle is not suitable for residential ventilation
- Most of equipment too noisy especially in bedrooms
- If small fans, may operate as intake vents because of stack effect – no heat recovery at all
- Defrost protection often not working in a cold climate
Mechanical exhaust, exhaust air heat pump and ventilation radiator

- Heat recovery of: 60-70% (to domestic hot water and return of heating)
- Intake air: ventilation radiators in living rooms and bedrooms
- Extract air: kitchen, WC, bathroom
- Heat pumps: rooftops or in the basement
- Extract ductwork: tightened stacks or new
Mechanical exhaust, exhaust air heat pump and ventilation radiator

- Achievement of EPC class C may need some additional measures (better insulation, PV or heat recovery from waste water)
- Utilization of existing stacks – need to be cleaned and tightened – airflow rate measurements protocols are required
Mechanical supply and extract heat recovery ventilation – rooftop and facade installation – no ductwork in apartments
2015 innovation – economic facade installation of HRV ventilation
Experience with new system

- 85% of the applications for 40% grant, first year was slow start, but then more applications than planned

- **Key figures for 40% grant projects (2016 data):**
  - Average financial support 93 €/m²
  - Average renovation cost (grant included) 246 €/m²
  - Average renovation cost 402 000 €

- Centralized mechanical supply and extract HRV with rooftop AHU and facade ductwork installation one of the most popular ventilation solutions
Ventilation 2015-2017

- Measurement protocols report required ventilation rates in all apartments.
- Measured in operation, average of all apartments 0.57 h\(^{-1}\).
- According to ventilation system:
  - Heat recovery mechanical supply and extract 0.73 h\(^{-1}\).
  - Exhaust air heat pump 0.32 h\(^{-1}\).
  - Mechanical exhaust 0.32 h\(^{-1}\).
- Supply and extract air flows in the rooms in adequate level:
  - Bedrooms and living rooms 9 L/s.
  - Bathrooms and toilets 11 L/s.
  - Average per person 6 L/s, pers.

→ First time in the history renovated apartments have adequate ventilation.
Estonian studies report highly significant economic benefits from renovation:

- quantified **tax return of 32%** of renovation total cost
- job creation of **18 jobs** in a year per **1 M€** renovation cost

Cost structure of renovation projects

- Labor cost of 34% includes all labor cost in design, construction and manufacturing.
- Project management cost of 12% includes all costs in design and construction.
Tax return breakdown

- **32% direct return**
- **VAT return 16.7%**
  - From consultancy 0.4%
  - From construction 16.3%
- **Labor tax return 15.6%**
  - From consultancy 0.5%
  - From construction 11.9%
  - From manufacturing 3.1%
Summary

• Lessons learnt 2010-2014 period – poor ventilation sometimes resulting in moldy apartments the most significant problem

• 2015-2020 grants require HRV ventilation, and moving windows to insulation level in the case of 40% grant as major changes

• Both changes were first seen as „fully impossible“ by stakeholders, but after 6 months economic solutions were found

• Model renovation solutions – KredEx renovation manual is prepared – designers can copy and customize

• Evidence on win-win-win situation:
  – occupants benefit from increased real estate value, monthly payment for the occupant roughly at the same level before and after the renovation
  – government from tax return and job creation
  – environment from energy/emission reduction