Buildings in Estonian ENMAK 2030+ energy strategy – cost optimal energy savings

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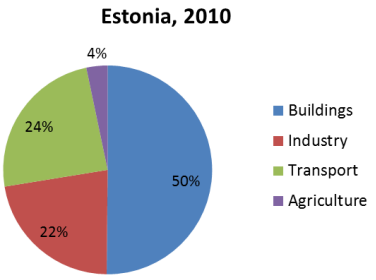
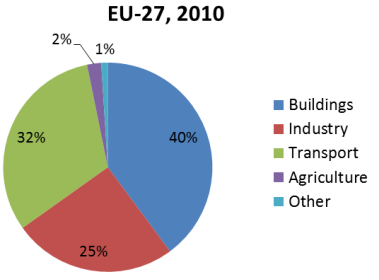
Energy use in buildings

- Final energy use in Estonia 33-34 TWh/a
- The share of buildings 50% (without industrial buildings)
- EU average about 40%

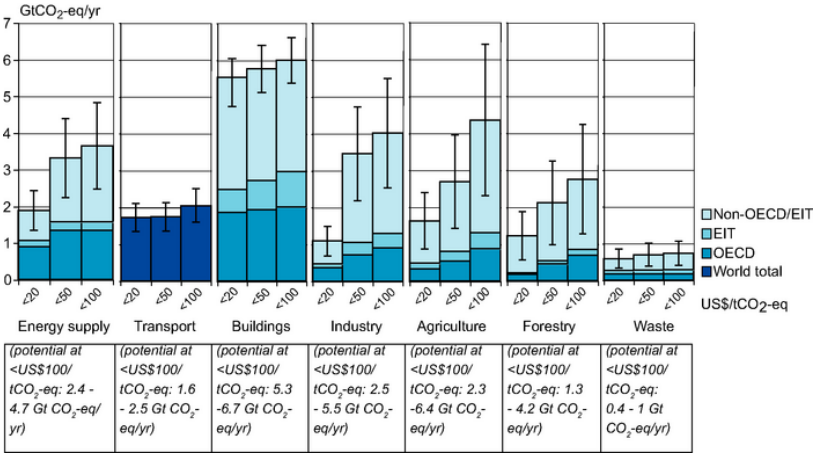




- Energy strategy ENMAK 2030+ under preparation

J. Kurnitski et al. / Energy and Buildings 75 (2014) 51–59

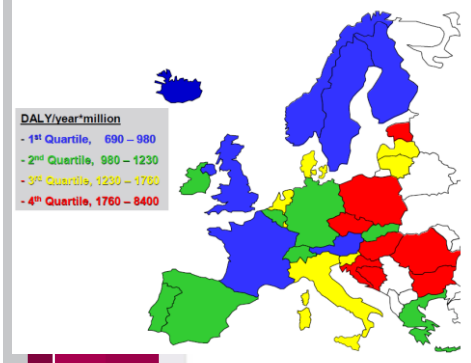
IPCC: Buildings show globally the highest economic carbon reduction potential

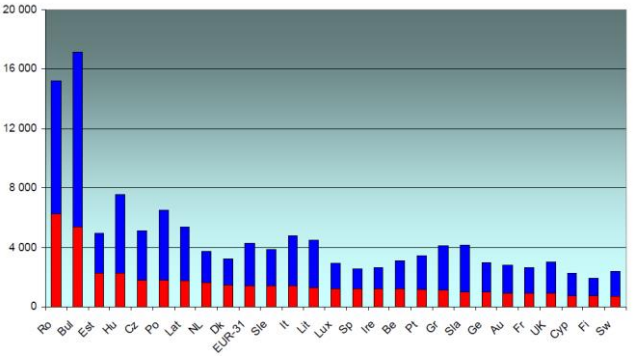


- http://www.ipcc.ch/publications_and_data/ar4/wg3/en/contents.html
- http://www.ipcc.ch/publications_and_data/ar4/wg3/en/spmsspm-c.html
- Energy performance of buildings is globally the highest and cheapest sector for GHG reduction

Integrated renovation: adequate ventilation and indoor climate

- IAQ associated DALYs = 4900 DALY = **186 M€** cost for Estonian goverment in every year
- ⇒ don't save energy on the cost of indoor climate





- DALY/year*million – disability adjusted lifeyear. Blue: outdoor sources, red: indoor sources. *(IAIAQ, 2011)*

2030 energy scenarios – what can be done with building stock?
(ENMAK 2030+)

	Scenario S1	Scenario S2	Scenario S3
Integrated renovation variants	**Min**	**Cost optimal**	**Cost optimal**
Renovation rate of apartment buildings, %/a	0.75	1.5	2.5
Renovation rate of detached houses, %/a	0.5	1.0	2.0
Renovation rate of non-residential buildings, %/a	0.5	0.75	1.0
Building stock loss (demolition), %/a	0.3	0.3	0.3
New construction rate in residential buildings, %/a	1.0	1.0	1.0
New construction rate in non-residential buildings, %/a	1.5	1.5	1.5
Application of nZEB requirements in new buildings, a	2026	2021	2016

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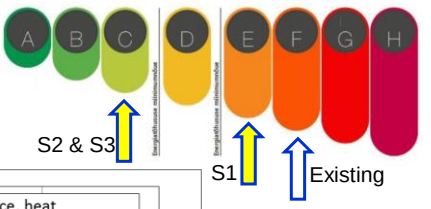
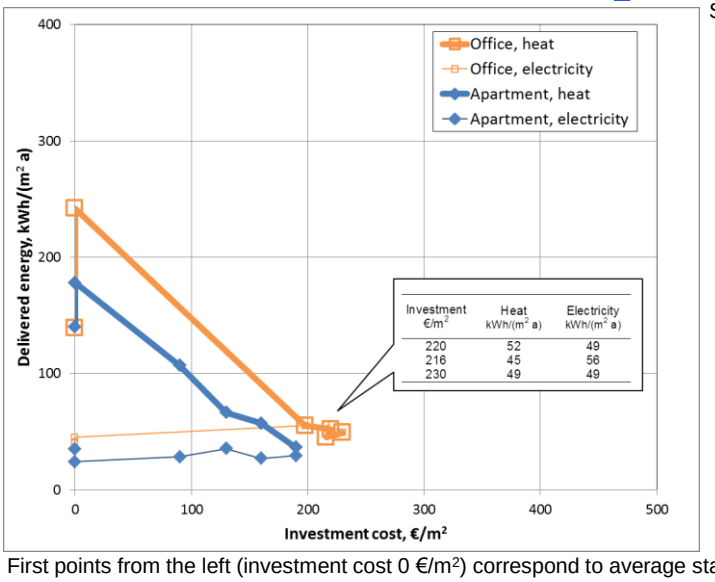
Integrated reno-vation variants





- First points from the left (investment cost 0 €/m²) correspond to average statistical energy use and to existing situation with standard ventilation. Next points correspond to renovation variants from EPC E to C level.

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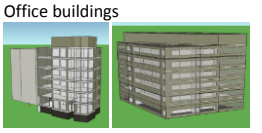
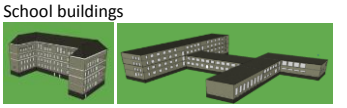
Description of renovation variants

EP-class	DH-New	DH-Old	Apartment buildings
E (260/280)	HRV 80%	HRV 80%, pellet boiler, roof insulation 250 mm	Wall insulation 200 mm, windows U=1.1, mechanical exhaust ventilation
D (210/180)	E + pellet boiler	E + wall insulation 200 mm, windows U=0.7	E + roof insulation 300 mm, basement ceiling 150 mm, two pipe heating system, exhaust air heat pump
C (160/150)	E + GSHP, roof inslulation 250 mm, windows U=0.7	HRV 80%, GSHP, roof insulation 250 mm, wall 300 mm, windows U=0.7	D + HRV 60% (apartment AHU or central AHU)
B (120/120)	C + solar collectors, wall insulation 250 mm, floor insulation 300 mm	C + solar collectors, floor insulation 300 mm (B class not achieved EP=136)	C + windows U=0.6, solar collectors, HRV 80% (apartment AHU)

EP-class, primary energy kWh/m^2 (offices/ schools)	Office buildings	School buildings
		
D (210/200)	HRV 70%, wall insulation 200 mm, roof insulation 250 mm, window U=1.2	-
C (160/160)	HRV 70%, wall insulation 150 mm, roof insulation 200 mm, window U=0.9, demand controlled lighting	HRV 70%, wall insulation 200 mm, roof insulation 250 mm, window U=1.2
C (160/160)	HRV 70%, wall insulation 250 mm, roof insulation 300 mm, window U=0.9	HRV 70%, wall insulation 250 mm, roof insulation 300 mm, window U=0.9, demand controlled lighting
B (130/120)	C + demand controlled lighting (B class not achieved, EP=142)	C + demand controlled ventilation

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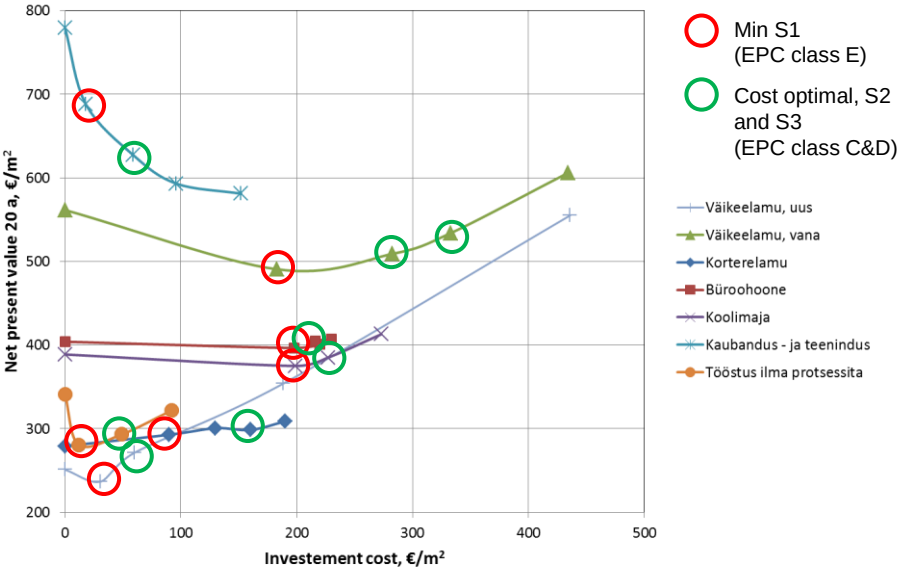
Integrated renovation variants



- Points from left to right: from existing situation to the deepest renovation variant
- Net present value includes renovation cost and discounted energy cost of 20 y

New buildings – nZEB buildings

- Different application time of nZEB in scenarios
- Primary energy requirements for 9 building types (apply from Jan 9, 2013)

	nZEB A kWh/(m² a)	Low energy B kWh/(m² a)	Min.req. new C (cost opt.) kWh/(m² a)	Min.req. maj.ren. D (cost opt.) kWh/(m² a)
Detached houses	50	120	160	210
Apartment buildings	100	120	150	180
Office buildings	100	130	160	210

- nZEB requirement will apply from 2019/2021 (not yet mandatory)
- Primary energy factors:
  - Electricity 2.0
  - Fossil fuels 1.0
  - District heat 0.9
  - Renewable fuels 0.75

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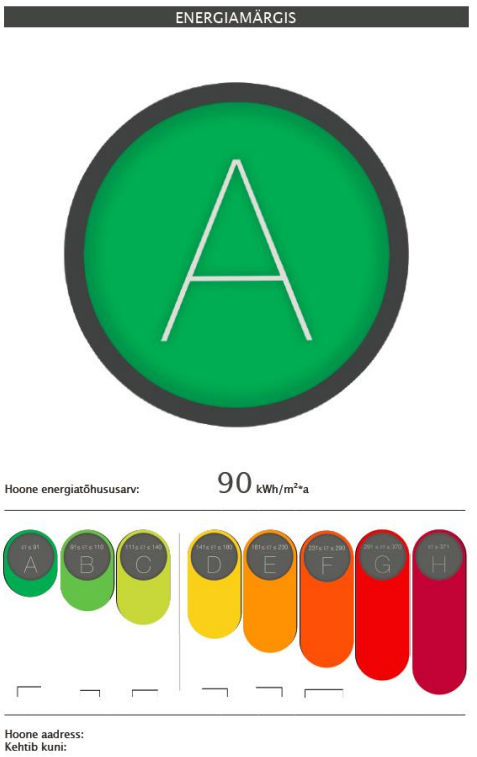
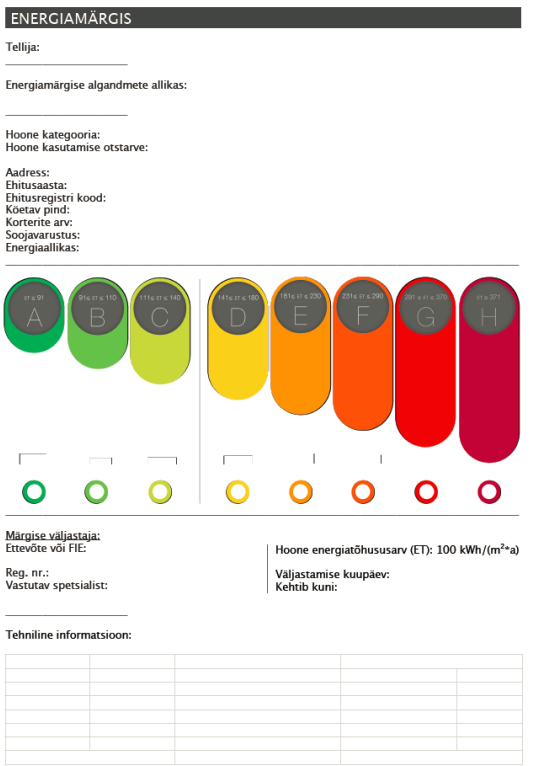
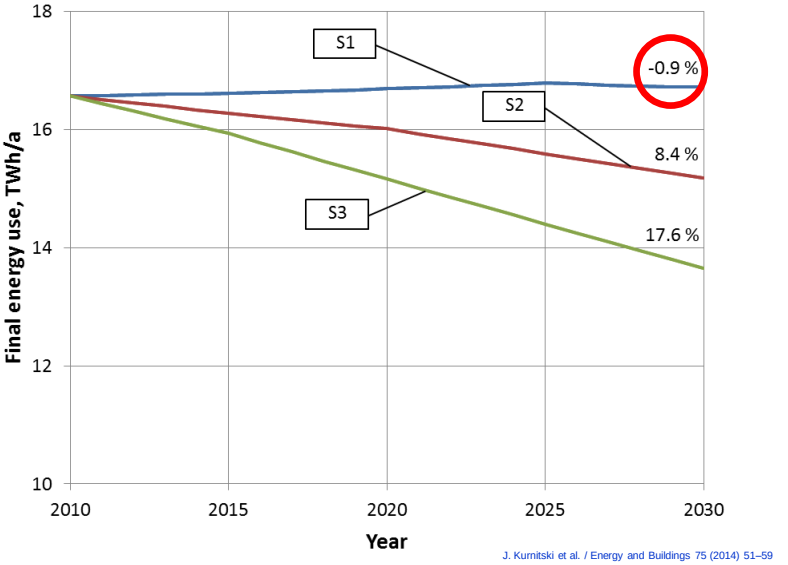




Results: Final energy use



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- Decoupling from energy use increase is not easy because of continuously increasing building stock
- First scenario S1 did not provided energy saving

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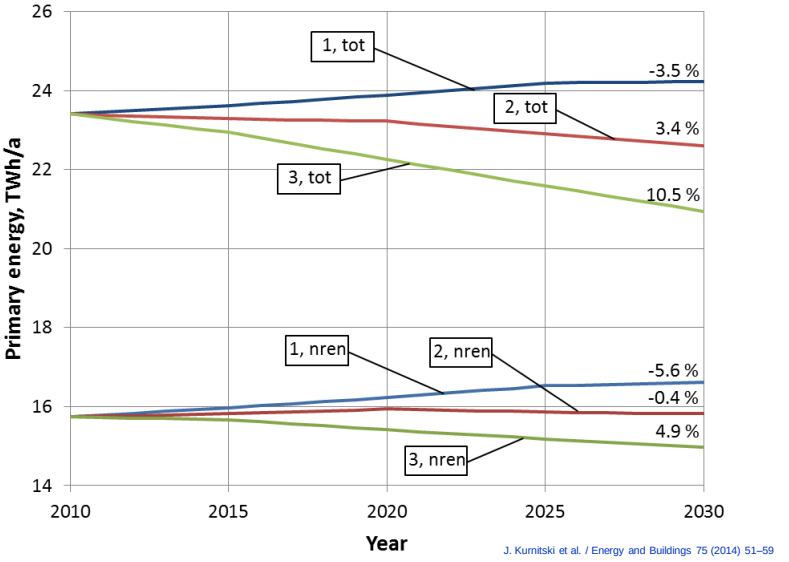
Results: Primary energy use



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- Reduction of non-renewable primary energy is more difficult compared to final energy

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Renovation grants – outcome or income for the government budget?

- In Estonia 520 apartment buildings have been deeply renovated with KredEx renovation grants (direct financial support of 25% or 35%)

- Renovation grants have enabled:

1. to start deep renovation (If not supported by the government, deep renovation would not start because of high investment cost, however economically beneficial in a long run)
2. to set technical requirements as integrated renovation packages, including to install ventilation to improve indoor climate

- Common thinking has been that renovation grants are „lost“ money for the government

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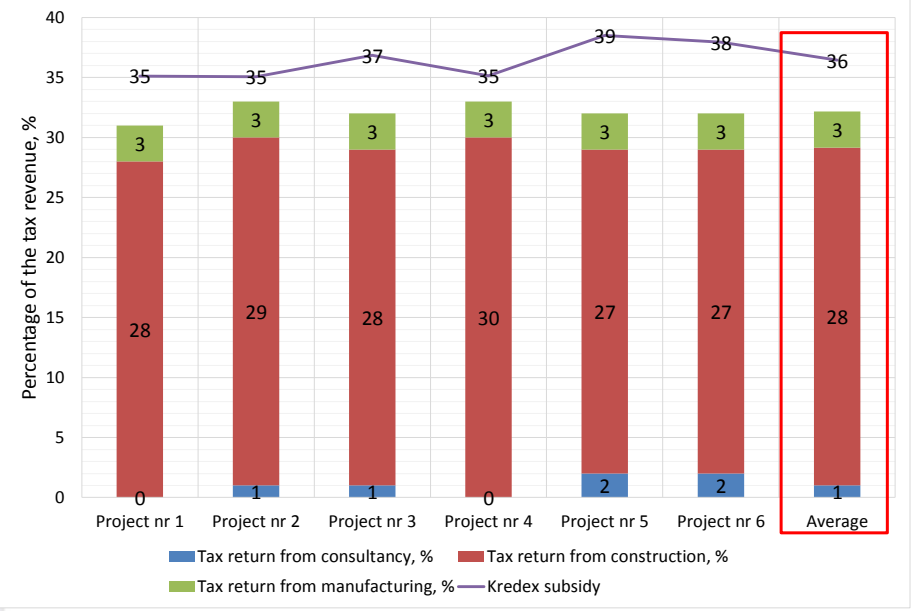
Data from real renovation projects

Kirjeldus	P1	P2	P3	P4	P5	P6
						
Ehitusaasta	1970	1972	1983	1966	1976	1982
Korruselisus	9	10	2-5	5	5	5
Netopindala, m^2	11 374	4 809	10 899	7 461	3 280	2 804
Köetav pind, m^2	10 620	3 986	9 081	6 270	2 677	2 367
Eluruumide pind, m^2	9 630	3 607	7 876	3 977	2 677	2 046
Maht, m^3	43 658	19 084	39 230	15 676	12 484	10 239
Eluruumide arv	162	54	102	119	55	30
Kompaktsus, A/V, m^{-1}	0,23	0,17	0,41	0,40	0,26	0,37
Küte, kWh/m^2 a	179	197	227	169	263	156
Elekter, kWh/m^2 a	36	41	35	27	43	30
Energiatõhusus-arv, kWh/m^2	233	260	275	206	322	201

Job creation per 1M€ investment = 17

Tax return (direct) = 32%



For the same cost – in which building you want to live?

Not renovated

Renovated building

The phenomena of deep integrated renovation:

- Investment cost of renovation of 160 €/m^2 equals to annual repair fund collection during 20 years of 31.2 €/m^2 (19% of renovation investment) for roof etc. small repairs, i.e. the total cost is the same

Pikas et al. 2014

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Cost benefit analyses (direct effects)

- **Incomes for government are higher than expenditures in the case of scenarios S1 and S2 (15% and 25% renovation grants)**
- S3 (35% renovation grants + many other measures) can be justified with job creation and stimulation of economy and export (positive effect on government budget in macro-economic analyses)

	Cost government, M€/a	Cost private s., M€/a	Income government, M€/a	Income private s., M€/a	Jobs created pers-y/y
S1	3.6	48.5	17.5	**-1.4**	880
S2	**40.5**	130.5	**57.5**	61.0	2850
S3	126.2	227.7	111.8	140.4	5620

- All costs without new construction which rate was constant in all scenarios
- Government incomes are tax return from renovation and savings from improved indoor climate
- Private sector incomes: energy savings (per 1 year only) and real estate value increase

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Conclusions

- It is not easy to decouple the building stock (and economy) from energy – calculate scenarios before setting targets
- There are no alternatives for nZEB new buildings and deep, integrated renovation supported/controlled with renovation grants
- Estonian studies report highly significant economic benefits from renovation:
  - quantified tax return of 32% of renovation total cost;
  - and job creation of 18 jobs in a year per 1 M€ renovation cost.
- Quantified economic effects created understanding about the energy economy of buildings

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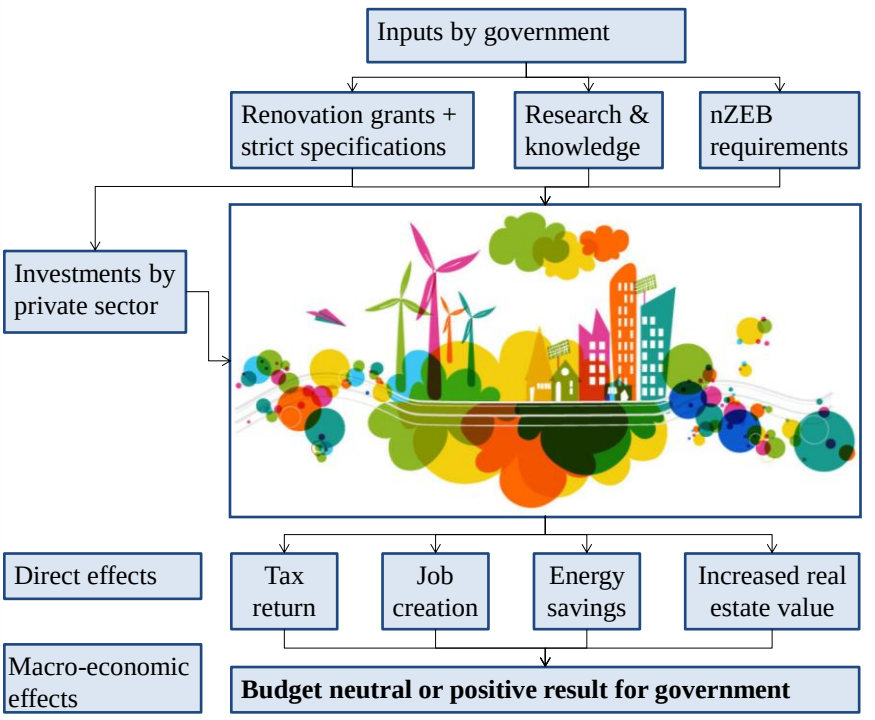
Energy economy of buildings



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