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Environmental Payback of Renovation Strategies in a Northern Climate—the Impact of Nuclear Power and Fossil Fuels in the Electricity Supply

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Table S1. Case Study Building Information.

Basic Information	
Latitude	60,49 N
Longitude	16,4 E
Elevation (m)	153
Number of storeys	3
Total heated are (m2)	2822
Building gross volume (m3)	8387
Number of apartments	36
Type of heating system	Hydronic heating system. District System
Type of ventilation	Mechanical exhaust ventilation
Total U-*Value (W/K m2)	1,47
Heat demand (KWh/m2 year)	152

Table S2. Renovations Scenarios.

Renovation scenario	**Outer walls**	**Unheated Attic**	**Windows**	**Ventilation**	**Heating source**	**Others**
0	120 mm mineral wool insulation	150 mm mineral wool insulation	Double casement	Mechanical	District Heating	
1	120 mm mineral wool insulation	150 mm mineral wool insulation	Double casement	Mechanical	District Heating	Photovoltaic panel system
2	120 mm mineral wool insulation	150 mm mineral wool insulation	Double casement	Mechanical	Geothermal Heat Pump	
3	120 mm mineral wool insulation	150 mm mineral wool insulation	Double casement	Heat Recovery Ventilation	District Heating	

4	120 mm mineral wool insulation	150 mm mineral wool insulation	Double casement	Heat Recovery Ventilation	Geothermal Heat pump	Photovoltaic Panels
5	480 mm mineral wool insulation	300 mm mineral wool insulation	3-glass argon filled low emissivity pane	Mechanical	District Heating	Photovoltaic panes
6	480 mm mineral wool insulation	300 mm mineral wool insulation	3-glass argon filled low emissivity pane	Mechanical	Geothermal Heat pump	
7	480 mm mineral wool insulation	300 mm mineral wool insulation	3-glass argon filled low emissivity pane	Heat recovery ventilation	District Heating	
8	480 mm mineral wool insulation	300 mm mineral wool insulation	3-glass argon filled low emissivity pane	Heat recovery ventilation	Geothermal Heat pump	Photovoltaic panes

Table S3. Greenhouse gas emissions (GHG) emission factors for DH 2016.

GHG Emissions (g CO2eq/kWh)	Borlänge Energi	Göteborg Energi
Total Emissions	66	79
Combustion	62	69
Fuel transport and production	4	10

Table S4. End of life scenarios.

Material group	Material group	Materials included	C3 – C4, waste processing and landfilling	D, recycling benefits
Mineral building materials	Recycling for ground works	Concrete, Cement, Bricks, Porcelain, Plaster, Clay products, Stone, Ceramics, Asphalt	C3: Construction waste preparation for recycling	Recycling benefit from replacing the primary gravel
Metals	Metal preparation and recycling	Aluminum, Steel, Stainless steel, Galvanized steel, Copper coated, Copper uncoated, Brass, Zinc, Lead	C3: Metal waste preparation	Recycling benefits for replacing virgin metal
Bio based materials with heating value	Incineration and energy recovery	Wood, Wood products	C3: Construction waste incineration for energy recovery	Recovered energy (replacing average energy production)

Other materials with heating value	Incineration and energy recovery	Plastics	C3: Construction waste incineration for energy recovery	Recovered energy (replacing average energy production)
Other materials that can be landfilled in construction waste site	Disposal / landfilling of inert material	Coatings, Synthetic materials, Panels and boards, Insulating materials, Glass, Window and façade components	Disposal of inert construction waste	-

Table S5. Electricity production by fuel (%) 2018.

Country	Nuclear	Oil	Waste	Hydro	Solar PV	Wind	Biofuels	Coal	Gas
Sweden	40,4	0,3	2,1	39,8	0,1	9,9	6,3	0,7	0,4
Denmark	0	1,1	5,1	0,1	2,4	41,9	13,3	29	7,1
Norway	0	0	0,3	96,4	0	1,4	0	0,1	1,7
Estonia	0	2,1	1,1	0	0	4,9	7,3	83,8	0
Finland	33,9	0,3	1,4	23,1	0	4,5	16,1	15,3	5,5
Germany	13,1	0,9	2	4	5,9	12,1	7	42,2	12,7