



AALTO UNIVERSITY, DEPARTMENT OF ENERGY TECHNOLOGY

Healthy and Energy-efficient living in Traditional Rural Houses

Technical survey of Finnish houses

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1 General

The technical condition of traditional and historical rural houses is going to improve. Before any improvements and renovation works, the current condition of houses is needed to determine.

The main aim of this research is get an overview about the conditions and main problems of traditional rural houses from the aspect of durability of traditional rural houses in Finland.

2 Methods

2.1 Studied houses

Current project covers a study of 20 wooden houses in Finland. Houses originate from 1760 to 1938. Among the selected houses 75 % of the houses are continuously heated and 25 % are unheated. All the houses are located near the coast line, (see Figure 1).

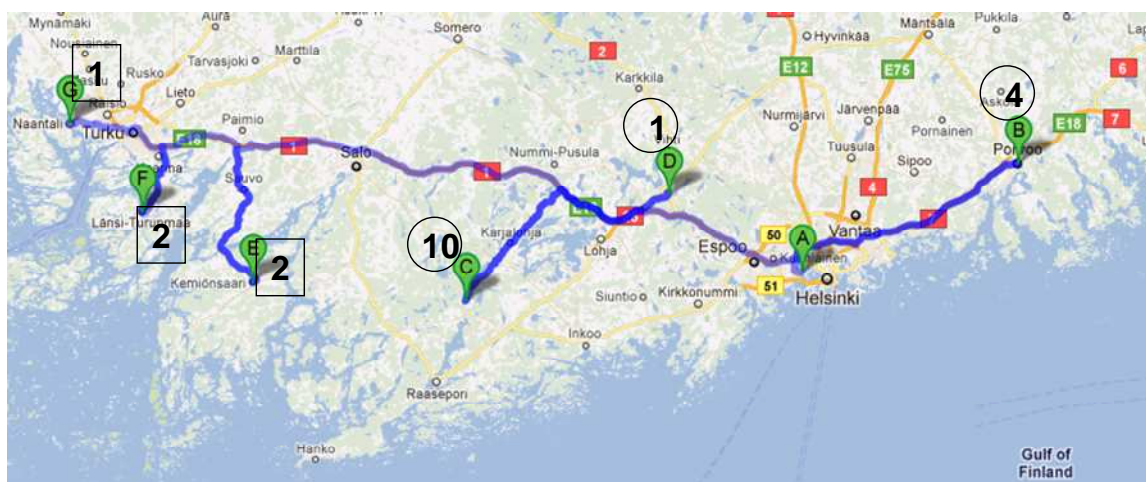


Figure 1. Location of the measurement houses and number of houses and apartments in location, B(Porvoo), C(Fiskars), D (Nummela), E (Kemiö), F(Parainen) and G(Naantali).

Wooden log house is a traditional house in Finland. Houses are usually 1-storey buildings with cold attic.

Stone, brick or concrete is used for bearing structures. Major or minor renovations has been done in all of the houses. Latest renovation was in 2011.

One of the studied houses had two storeys and cellar. Two had one storey and cellar. The other houses were traditional one-storey houses, with attic.

Houses in Porvoo

In Porvoo four houses are investigated in old town area, (see figure 2).



Figure 2. The selected houses in Porvoo

Renovation for two of the selected houses has been done in 1980's and the other two has been renovated in recent years. Attics were renovated in summer 2011.

Houses in Nummela

The old farmhouse in Nummela area has gone through minor renovation in recent years.

Houses in Fiskars

Majority of the houses are located in In Fiskars area. Five of the houses are single family houses. There are two bigger houses that are divided to smaller apartments.



Figure 3. The selected houses (with apartments) in Fiskars area.

The Selected unheated houses

Unheated houses are located in South-West part of Finland near the coast. In Parainen and Kemiö houses belong to museums. In Naantali the house is owned by a private citizen.

2.2 Research methods and basis of evaluation

Questionnaire

Questionnaire was developed for historical buildings to gather information about structures, renovations, ventilation, energy consumption, comfort and living quality.

Survey of 20 Finnish houses is done by researchers of Aalto University.

Surveying of the technical conditions consisted visual observation of main bearing structures, collecting of drawing and documentations of the building and interviewing the owners or inhabitants. Questionnaires were fulfilled. Questionnaire is added as annex A of this report.

Visual observations consisted of evaluation of conditions of load-bearing structures as walls, floors, roof and foundation.

Original building documentation was not available for selected houses. Buildings are measured and registered in the building register much later after the construction time. The design documentation were available if major renovations of the houses has been done in recent years.

Overview of the measurement houses are presented in next chapters.

Not all the information from all the studied houses is available yet.

Air tightness measurements

Air tightness measurements will be done in all houses. Measurements have been scheduled for all houses at summertime and in 3-5 selected house in wintertime.

Air tightness measurement will be done with Minneapolis Blower Door measurement device.

Measurements has been done in a way to avoid gas infiltration to indoor air during under pressure measurement.

Temperature and relative humidity measurements

Follow up measurements for indoor temperature and relative humidity are done in every house in 2 to 7 selected rooms.

Measurements are be done in occupation zone. Lower loggers are located 3-10 cm above floor level and upper loggers from 150-190 cm above floor level.

Location of the loggers was selected so that there are no heat sources or cold bridges or draught sources near loggers.

Thermal camera photographing

Thermal camera photographing will be done in wintertime in selected houses. Thermal camera will be used to locate cold bridges and leakages through envelope.

2.3 Description of structures

Foundation and basement wall basement wall

Foundations of the selected houses are mostly made of granite, concrete or brick. In the latest decades some of the foundations are rebuilt. Width of the foundations varies between 30 and 60 cm.

Walls

Walls of houses are built of wooden logs. Horizontal joints between logs are tightened by tow or moss. During the renovations those traditional materials have been replaced with other materials.

Floors

Majority of floor structures are wooden boards.

Roofs

Roofs are made from different materials. Majority of the houses has a tile roof.

Windows

Windows of the studied houses have mostly with wooden frames. Glasses of windows consisted of 2 layers. Single layer was mostly used in summertime and 2 layers in winter times.

Wet rooms

Originally only a well outside the house was a source for drinking and washing water.

Currently, a domestic water system is installed in the house at 80 % of studied houses. Twenty percent of the houses do not have water system inside the house.

2.4 Main renovations needed due to structural damages

Renovation of structures is not the major problem in the studied houses. Increasing air-tightness and thermal insulation, furbish ventilation, renovating or rebuilding the older power and water installations are possible renovation needs in the studied houses in order to have a better living environment. At the moment the occupants are satisfied with their houses.

1 Annex A. Questionnaire

A1 OBJECTA2 CODE: _____

A3 Address: _____

A4 Contact: _____

A5 Filling date _____ A6 Filling person _____

OCCUPANT'S DATA

A7 Use of the house

- 1 continuous 1
- 2 periodical 1
- 3 seasonal (summer/winter) 1

A8 How long you have lived in this house?

_____ years

A9 Permanently residing adults in house __

A10 Permanently residing children in house__

A11 Number of pets (dog/cat) (indoors) __/__

BASIC DATA OF THE BUILDING

A12 Year of construction _____

A13 Number of floors (above ground level)

- 1 1 1
- 2 1 ½ 1
- 3 2 1
- 4 3 1

A14 Is there the cellar?

- 1 yes 1
- 2 no 1

A15 Type of the main structures:

- 1 log 1
- 2 timber frame..... 1
- 3 uncoursed rubble masonry 1
- 4 brick masonry 1
- 5 something else, what? 1

A16 Roof type

- 1 double pitched roof 1
- 2 hipped roof 1
- 3 mono pitched roof 1
- 4 mansard roof..... 1
- 5 something else, what? 1

sketch of the roof _____

A17 Material of the roof

- 1 stone 1
- 2 steel 1
- 3 wood 1
- 4 reed 1
- 5 asbestos cement..... 1
- 6 something else, what? 1

A18 The main renovations and expansions done (structures, HVAC systems)

Year/work _____

_____/_____
_____/_____
_____/_____
_____/_____

A19 Moisture damages and when happened

- 1 pipe leak (not wikileaks)..... 1
- 2 roof leak 1
- 3 rising soil moisture 1
- 4 leak through walls 1
- 5 wet rooms 1
- 6 something else, what? 1

A20 Using and heating during winter

- 1 continuous use 7
- 2 periodical use..... 7
- 3 not used and heated during winter 7

BUILDING TECHNOLOGY

Structures

B1 Material of foundation

- 1 limestone 7
- 2 granite..... 7
- 3 other stone (what)..... 7
- 4 concrete 7
- 5 something else, what? 7

B2 thickness of foundation wall: _____ (cm)
 B3 depth: of foundation wall: _____ (cm)
 B4 height of the foundation wall _____ (cm)

sketch the section of the foundation/ wall/ floor/ ground connection and write materials

If floor of the cellar exist sketch this also additionally

B5 Hydro insulation of foundation:
what _____

B6 Drainage _____

Floor of the first floor sketch floor section and write layers

sketch the section of the first floor and write materials

B7 Floor of the first floor

- 1 slab on ground 7
- 2 floor with crawl space 7
- 3 concrete 7
- 4 wooden 7

B8 Thermal insulation of the first floor

thickness mm

- 1 mineral wool..... 7
- 2 cellulose 7
- 3 sawdust..... 7
- 4 expanded polystyrenel 7
- 5 something else, what? 7

B9 Sheathing (wind barrier) of the first floor

- 1 wood fibreboard / thickness, mm..... 7 , mm
- 2 paper/membrane..... 7
- 3 something else, what? 7

B10 Floor covering material of the first floor

- 1 wood 7
- 2 stone 7
- 3 linoleum..... 7
- 4 something else, what? 7

External wall: sketch wall section and write layers

sketch the section of the external wall and write materials

B11 Load bearing structure

thickness: _____ (cm)

- 1 limestone
 - 2 granite
 - 3 other stone (what)
 - 4 log
 - 5 timberframe
 - 6 something else, what?
-

B12 Log profile of external wall

- 1 round log
 - 2 plane log
 - 3 something else, what?
-

B13 Seam between logs of external wall

- 1 flax
 - 2 moss
 - 3 something else, what?
-

B14 Cladding (if exists) of external wall

- 1 wooden
 - 2 something else, what?
-

B15 Ventilation air gap of external wall

- 1 yes / thickness, mm, mm
 - 2 not
-

B16 Sheathing (wind barrier) of external wall

- 1 wood fibreboard / thickness, mm....., mm
 - 2 paper/membrane
 - 3 something else, what?
-

B17 Thermal insulation of external wall

- 1 mineral wool
 - 2 cellulosa
 - 3 sawdust
 - 4 something else, what?
-

B18 Air- and vapour barrier of external wall

- 1 bitumen paper
 - 2 vapour permeable building paper
 - 3 plastic
 - 4 paint
 - 5 nothing
 - 6 something else, what?
-

B19 Sealing of air- and vapour barrier of external wall

- 1 taped
 - 2 not taped
-

B20 Plaster of the external walls (external/internal)

- 1 lime-plaster
 - 2 lime/cement-plaster
 - 3 clay-plaster
 - 4 something else, what?
-

Additional information about external walls

Attic floor: sketch floor section and write layers (or attic ceiling/roof section and layers if it is heated)

sketch the section of the attic floor and write materials

B21 Load bearing structure

- 1 wooden beams
 - 2 concrete
 - 3 something else, what?
-

B22 Sheathing (wind barrier) of attic floor

- 1 wood fibreboard / thickness, mm..... , mm
 - 2 paper/membrane
 - 3 something else, what?
-

B23 Thermal insulation of attic floor

- 1 mineral wool.....
 - 2 cellulose
 - 3 sawdust.....
 - 4 something else, what?
-

B24 Air- and vapour barrier of attic floor

- 1 bitumen paper.....
 - 2 vapour permeable building paper
 - 3 plastic.....
 - 4 paint
 - 5 nothing
 - 6 something else, what?
-

B25 Sealing of air- and vapour barrier of attic floor

- 1 taped.....
- 2 not taped.....

B26 Ceiling material

Floor: of the second and third floors

sketch floor section and write layers

sketch the section of the floor and write materials _____

B27 Load bearing structure of floor

- 1 wooden beam
 - 2 concrete
 - 3 something else, what?
-
-

B28 Sheathing (wind barrier) of floor

- 1 wood fibreboard / thickness, mm , mm
 - 2 paper/membrane.....
 - 3 something else, what?
-

B29 Thermal insulation of floor

- 1 mineral wool.....
 - 2 cellulosa
 - 3 sawdust.....
 - 4 something else, what?
-

B30 Floor material

Additional information about inserted ceilings

B31 Windows / age

- 1 old original..... / _____
 - 2 renovated / _____
 - 3 new / _____
-
-

B32 Number of glases

- 1
 - 2
 - 3
 - 4 something else, what?
-

B33 Difference between winter/summer period in windows

B34 Frame of the windows

- 1 wood

- 2 plastic..... 1
- 3 metal (aluminium / steel) 1 / 1
- 4 something else, what? 1

B35 Sealings of windows

B36 Possibility to open the windows

- 1 all windows are openable 1
- 2 one window is openable in all rooms..... 1
- 3 exist bed/livingrooms with closed window? 1
- 4 something else, what? 1

B37 Condensation on windows

- 1 yes, often 1
- 2 yes, sometime..... 1
- 3 never..... 1

B38 Frost on windows

- 1 yes, sometime..... 1
- 3 never..... 1

Additional information about windows

Floor of the wet rooms

sketch wall section and write layers

Wall of the wet rooms

sketch wall section and write layers

Heating systems

C1 Heating type

- 1 direct electricity 1
- 2 electric storage heating..... 1
- 3 oil 1
- 4 wooden boiler..... 1
- 5 wooden stove..... 1
- 6 ground source heat pump..... 1
- 7 air/water heat pump 1
- 8 air/air heat pump..... 1
- 9 something else, what? 1

C2 Temperature regulation of heating system:

C3 Heating energy use during indoor climate measuring period (annual data)

kWh electricity / year
 litre oil / year
 m³ wood / year

C4 Opinion about the heating system?

1 2 3 4 5 6 7

Satisfied Dissatisfied

C5 Number and location of wooden stows

Describe shortly:

C6 Number and average use of fireplaces (use times per week)

- 1 wood stove _____ times/week 1
- 2 open fireplace _____ times/week 1
- 3 baking stove _____ times/week 1
- 4 cooking range _____ times/week 1

5 something else, what?

C7 Are the damper plate opened if fireplace is not used?

Summer / winter

C8 Heat distribution system

Underline the main heat distribution system and mark additionally (by LOG) the system used in room, where the t&RH datalogger is located

- 1 water based system
 - 1.1 radiator
 - 1.2 floor heating
- 2 electricity
 - 2.1 radiator
 - 2.2 floor heating
 - 2.3 ceiling heating
- 3 air heating
- 4 local heating source (oven, stove, etc)
- 5 something else, what?

6 Describe site of heat distribution systems in building if several systems are used or single system does not serve whole building.

Mark, if some problems exist:

- C9 Do you need additional heating
- C10 Radiators do not heat evenly
- C11 Temperature of radiators is too low
- C12 Temperature in rooms is not equal
- C13 Problems with temperature regulation
- C14 Faulty thermostat
- C15 Additional thermal insulation is needed ...
- C16 Draught
- C17 Some other problems:

C18 Mechanical cooling

- 1 no

2 yes, describe

Ventilation

D1 VENTILATION type

- 1 passive stack ventilation (no fans)
- 2 passive stack ventilation + hood
- 3 mechanical exhaust
 - where are fresh air inlets*
 - 3.1 no special inlets
 - 3.2 in windows
 - 3.3 in external walls
 - 3.4 fresh air radiators
- 4 mechanical supply and exhaust ventilation
 - manually regulated
 - 4.4 CO₂ regulated
 - 4.5 relative humidity regulated

Ventilation unit

D2 type and model

fan speed (0 = 0 speed...8 = max speed)

D3 summer

D4 winter

reasons

D5 summer

D6 winter

D7 change of filters (how often)

D8 Possibility to open the windows

- 1 easily
- 2 if necessary
- 3 never

D9 How often do you use window airing during heating period?

- 1 less than once a week
- 2 1-3 times per week
- 3 once a day
- 4 more than 2 times per day

D10 How long do you air at a time during heating period?

- 1 less than 2 minute
- 2 2-10 minute
- 3 10-30 minute

4 >30 minute..... 1

D11 Reason for window airing during winter?

use number of importance 1 (most important), 2, 3....

- 1 Cooking..... 1
- 2 Smoking..... 1
- 3 Cleaning..... 1
- 4 Stuffy air..... 1
- 5 Too hot..... 1
- 6 Airless 1
- 7 something else, what? 1

D12 Keeping open of internal doors?

- 1 generally all opened over day and night..... 1
- 2 generally all closed during night 1
- 2 generally all closed over day 1
- 3 no doors..... 1

D13 *Same position of doors during summer / winter?*

Keeping windows opened during night

D14 *Main bedroom*

- 1 never..... 1
- 2 only during summer 1
- 3 over year..... 1

D15 *Children's bedroom*

- 1 never..... 1
- 2 only during summer 1
- 3 over year..... 1

D16 *Living room*

- 1 never..... 1
- 2 only during summer 1
- 3 over year..... 1

Describe shortly of opening the windows during night

Keeping doors opened during night

D17 *Main bedroom*

- 1 generally opened 1
- 2 generally closed..... 1

3 no doors..... 1

D18 *Children's bedroom*

- 1 generally opened 1
- 2 generally closed..... 1
- 3 no doors..... 1

Additional information about ventilation

DOMESTIC Water system

E1 Type of the domestic water system

- 1 own well, water inside house 1
- 2 own well, water in house with bucket..... 1
- 3 general water system..... 1
- 4 something else, what? 1

E2 Heating of domestic water

- 1 separate electrical boiler..... 1
- 2 main heating system 1
- 3 cooking range 1
- 4 something else, what? 1

E3 Age of water pipes

- 1 older than 20 years 1
- 2 new 1
- 3 something else, what? 1

E4 Materials of water pipes

- 1 plastic..... 1
- 2 steel 1
- 3 zincked steel 1
- 4 something else, what? 1

E5 Water fittings / mark number if many

- 1 sink (kitchen) 1
- 2 sink (bathroom) 1
- 3 shower 1
- 4 lavatory 1

E6 Water consumption during (measuring period)

m³ water / year..... ____

Additional information about water system

F1 sewerage system

- 1 nothing 1
- 2 own septic tank..... 1
- 3 general swerage system..... 1
- 4 something else, what? 1

Additional information about the sewerage system

G1 Electrical network of the building

- 1 old system 1
- 2 new (<10 years) system 1
- 3 something else, what? 1

Additional information about electricity system

USE OF THE HOUSE

appliances

H1 Use of appliances and equipments

- 1 electrical stove _____h/day 1
- 2 tv _____h/day 1
- 3 computer _____h/day 1
- 4 special el.heater _____h/day..... 1
- 5 washing machine _____times/week..... 1
- 6 dishwasher _____times/week..... 1
- 7 something else, what? 1

Describe of the use of appliances in detail (and specify model or power of appliances if possible)

Moisture sources

Normal presence of occupants

- I1 *Winter*
- 1 daily _____ persons
- 2 night _____ persons
- I2 *Summer*
- 1 daily _____ persons
- 2 night _____ persons

I3 Have you air humidifier?

- 1 no 1
- 2 yes, in bedrooms..... 1
- 3 yes, in livingrooms 1

I4 Use of air humidifier

continuously between _____month and _____month 1

only during very cold periods 1

humidifier closed when occupants not present 1

I5 Aquarium?

- 1 yes 1
- 2 no 1

I6 Number of green plants

- 1 no green plants 1
- 2 1-5..... 1

- 3 5-10..... 1
- 4 >10..... 1

I7 Drying of laundry indoors?

- 1 no 1
- 2 yes, sometimes..... 1
- 3 yes, regularly _____times / week 1
- in bathroom..... 1
- elsewhere, where 1

I8 Have you laundry dryer?

- 1 yes..... 1
- 2 no 1

I9 Toilet

- 1 water closet in house..... 1
- 2 composting toilet in house 1
- 3 composting toilet outdoors..... 1
- 4 something else, where?..... 1

I10 Bathroom / shower

- 1 in house..... 1 / 1
- 2 in separating building..... 1 / 1
- 3 none special room 1 / 1
- 4 something else, where?..... 1 / 1

I11 Sauna

- 1 in house..... 1
- 2 in separating building..... 1
- 3 none sauna..... 1

- 4 something else, where? 1

I12 Using times of shower or bath (on average)?

- 1 1 person-times per day 1
- 2 2 person-times per day 1
- 3 3 person-times per day 1
- 4 >3 person-times per day 1
- 5 something else..... 1

I13 Using times of sauna (on average)?

- 1 1 times per week..... 1
- 2 2 times per week..... 1
- 3 more per week 1
- 4 something else..... 1

Additional information about moisture sources

COMFORT AND QUALITY

Indoor climate

Is there any following indoor climate problems

Possible problem	No	Yes, short description
		Every day, 1-3 days per week, 1-3 days per month, Less Morning, Midday, Evening, Always, During autumn, During winter, During spring, During summer, Always
J1 Too warm		
J2 Too cold		
J3 Unstable temperature		
J4 Cold floors		
J5 Too humid		
J6 Too dry		
J7 Draught		
J8 Stuffy (bad) air		
J9 Bas smell		
J10 Inadequate ventilation		
J11 Dust and dirty surfaces		
J12 Noisy ventilation system		
J13 Poor lighting		
J14 Not the same temperature in rooms		
J15 Static electricity		
J16 Vertical temperature gradient		
J17 Noise of heating system		

Where these problems occur?

What is your opinion about the reasons?

- Source of unpleasant smell during **winter/summer**
- J18 Furniture..... /
 - J19 Cooking..... /
 - J20 Smoking..... /
 - J21 Kitchen..... /
 - J22 Toilet..... /
 - J23 Outdoors..... /
 - J24 Mould..... /
 - J25 Something else, what?..... /

Additional information about indoor climate problems **during winter**

Additional information about indoor climate problems **during summer**

Section of the house

Health information

How do you rate you house affect to your health?

1 2 3 4 5 6 7
K1 Contribute Cause

1 2 3 4 5 6 7
K2 Health Health hazards

Have you any following health problems

K3 Astmatic symptoms

K4 Allergic symptoms

K5 Undue tiredness

K6 Frequent headache problems

K7 Frequent problems with dizziness

K8 Difficulty concentrating

K9 Eye irritation.....

K10 Dry throat, allergic cough.....

K11 Skin rash.....

Some other health problems, what?

Some other problems, what?

Mark heated, "half-heated", and no heated rooms. Add height and dimensions of the rooms. Mark HVAC rooms, t&RH measurement points, north direction, windows, doors and heating sources.

Plan of the first floor

Plan of the second floor

STRUCTURAL DAMAGES

Foundation

- 1 7
- 2 7
- 3 7
- 4 7
- 5 7

External wall

- 1 7
- 2 7
- 3 7
- 4 7
- 5 7

Roof

- 1 7
- 2 7
- 3 7
- 4 7
- 5 7

Windows, doors

- 1 7
- 2 7
- 3 7
- 4 7
- 5 7

Floor

- 1 7
- 2 7
- 3 7
- 4 7
- 5 7

Chimney

- 1 7
- 2 7
- 3 7

Internal wall

- 1 7
- 2 7
- 3 7
- 4 7

Shower rooms (and other "wet" rooms)

- 1 7
- 2 7
- 3 7
- 4 7
- 5 7

Attic floor

- 1 7
- 2 7
- 3 7
- 4 7
- 5 7

Crawl space

- 1 7
- 2 7
- 3 7
- 4 7
- 5 7

Other damages

- 1 7
- 2 7
- 3 7
- 4 7
- 5 7

OCCUPANTS OPINION ABOUT RENOVATION SOLUTIONS

Structures, Building envelope

If the hydro insulation between external wall and foundation is missing, do you accept **renovation works to put the hydro insulation** between external wall and foundation?

- 1 **Yes**, I accept. It is necessary to keep walls dry and longer the service life of building 1
- 2 **I accept, but** I don't have financial possibilities and I don't want to take loan..... 1
- 3 **No, I don't want** , because damages belong to old house (I do not to look the house as new) 1
- 4 **No, I don't want** to make any renovation works for this old house (I will use it to the end I'll built new) 1

If the first rows of the log wall are damaged (rotted), do you accept **the change of damaged log?**

- 1 **Yes**, I accept.
It is necessary for the service life of building 1
- 2 **I accept, but** I don't have financial possibilities and I don't want to take loan..... 1
- 3 **No, I don't want**, because damages belong to old house (I do not to look the house as new) 1
- 4 **No, I don't want** to make any renovation works for this old house (I will use it to the end I'll built new) 1

If the ground around the house is high and the distance between external wall and ground is small, do you accept works **to lower the ground level?**

- 1 **Yes**, I accept. It is necessary to keep walls dry and longer the service life of building 1
- 2 **I accept, but** I don't have financial possibilities..... 1
- 3 **No, I don't want** to make any renovation works for this old house (I will use it to the end I'll built new) 1

If the floors of the first floor are damaged (rotted), do you accept **the change of damaged floor?**

- 1 **Yes**, I accept.
It is necessary for the service life of building 1
- 2 **I accept, but** I don't have financial possibilities and I don't want to take loan..... 1
- 3 **No, I don't want**, because damages belong to old house (I do not to look the house as new) 1
- 4 **No, I don't want** to make any renovation works for this old house (I will use it to the end I'll built new) 1

If the roof is not watertight, do you accept the works to **make the roof watertight?**

- 1 **Yes**, I accept to make the new roof..... 1
- 2 **Yes**, I accept only to repair the roof..... 1
- 3 **I accept, but** I don't have financial possibilities and I don't want to take loan..... 1
- 4 **No, I don't want**, because damages belong to old house (I do not to look the house as new) 1
- 5 **No, I don't want** to make any renovation works for this old house (I will use it to the end I'll built new) 1

If the waterproofment of building fabric of "wet rooms" (bathroom, sauna etc) is not properly done and not watertight, do you accept the works to **make the wet rooms watertight?**

- 1 **Yes**, I accept renovation works to keep building fabric dry and longer the service life of building..... 1
- 2 **Yes**, I accept only minor repairing works 1
- 3 **I accept, but** I don't have financial possibilities and I don't want to take loan..... 1
- 4 **No, I don't want**, because damages belong to old house (I do not to look the house as new) 1
- 5 **No, I don't want** to make any renovation works for this old house (I will use it to the end I'll built new) 1

Do you accept the **external thermal insulation (≈5...12cm) of external walls?**

- 1 **Yes**, I accept 1
- 2 **I accept, but** I don't have financial possibilities and I don't want to take loan..... 1
- 3 **I accept, if** the payback period is below 10 years . 1
- 4 **I accept, if** the payback period is below 20 years . 1
- 5 **No, I don't want** to make any renovation works for this old house (I will use it to the end I'll built new) 1

Do you accept the **internal thermal insulation (≤5cm) of external walls?**

- 1 **Yes**, I accept (how many cm.-s if you know)..... 1
- 2 **I accept, but** I don't have financial possibilities and I don't want to take loan..... 1
- 3 **I accept, if** the payback period is below 10 years . 1
- 4 **I accept, if** the payback period is below 20 years . 1
- 5 **No, I don't want** to make any renovation works for this old house (I will use it to the end I'll built new) 1
- 6 **No, I don't accept**, because internal thermal insulation is hygrothermally risky solution..... 1

Do you accept the **additional thermal insulation of attic floor?**

- 1 **Yes**, I accept 1
- 2 **I accept, but** I don't have financial possibilities and I don't want to take loan..... 1
- 3 **I accept, if** the payback period is below 10 years . 1
- 4 **I accept, if** the payback period is below 20 years . 1
- 5 **No, I don't want** to make any renovation works for this old house (I will use it to the end I'll built new) 1

Do you accept the **change or renovate the old (damaged) windows** to raise their energy efficiency?

- 1 **Yes**, I accept to put new windows..... 1
- 2 **Yes**, I accept only to repairing old windows 1
- 3 **I accept, but** I don't have financial possibilities and I don't want to take loan..... 1
- 4 **I accept, if** the payback period is below 10 years . 1
- 5 **I accept, if** the payback period is below 20 years . 1
- 6 **No, I don't want** to make any renovation works for this old house (I will use it to the end I'll built new) 1

What **other renovation solutions** do you prefer to raise their energy efficiency and to longer the service life?

- 1 1
- 2 1
- 3 1
- 4 1
- 5 1

HVAC systems

Do you accept install energy efficient **supply and exhaust ventilation system with heat recovery?**

- 1 **Yes**, I accept.
It makes the house more energy efficient..... 1
- 2 **I accept** only if ductworks will be properly done (I don't want to see vent. ducts in old house) 1
- 3 **I accept, but** I don't have financial possibilities and I don't want to take loan..... 1
- 4 **I accept, if** the payback period is below 10 years . 1
- 5 **I accept, if** the payback period is below 20 years . 1
- 6 **No, I don't want** to make any renovation works for this old house (I will use it to the end I'll built new) 1

Do you accept install **photovoltaic solar system (PV-panels)** to the roof of the house?

- 1 **Yes**, I accept.
It makes the house more energy efficient..... 1
- 2 **I accept, but** I don't have financial possibilities and I don't want to take loan..... 1
- 3 **I accept, if** the payback period is below 10 years . 1
- 4 **I accept, if** the payback period is below 20 years . 1
- 5 **No, I don't want** to change the outlook of the house 1
- 6 **No, I don't want** to make any renovation works for this old house (I will use it to the end I'll built new) 1

Do you accept install **solar collectors for domestic hot water system** to the roof of the house?

- 1 **Yes**, I accept.
It makes the house more energy efficient..... 1
- 2 **I accept, but** I don't have financial possibilities and I don't want to take loan..... 1
- 3 **I accept, if** the payback period is below 10 years . 1
- 4 **I accept, if** the payback period is below 20 years . 1
- 5 **No, I don't want** to change the outlook of the house 1
- 6 **No, I don't want** to make any renovation works for this old house (I will use it to the end I'll built new) 1

Do you accept install **ground source heat pump heating system?**

- 1 **Yes**, I accept.
It makes the house more energy efficient..... 1
- 2 **I accept, but** I don't have financial possibilities and I don't want to take loan..... 1
- 3 **I accept, if** the payback period is below 10 years . 1
- 4 **I accept, if** the payback period is below 20 years . 1
- 5 **No, I don't want** to make any renovation works for this old house (I will use it to the end I'll built new) 1

Do you accept the installation of **air source (air-to-air) heat pump heating system?**

- 1 **Yes**, I accept.
It makes the house more energy efficient..... 1
- 2 **I accept, but** I don't have financial possibilities and I don't want to take loan..... 1
- 3 **I accept, if** the payback period is below 10 years . 1
- 4 **I accept, if** the payback period is below 20 years . 1
- 5 **No, I don't want** to make any renovation works for this old house (I will use it to the end I'll built new) 1

Do you accept the installation of **air source (air-to-water) heat pump heating system**?

- 1 **Yes**, I accept.
It makes the house more energy efficient..... 1
- 2 **I accept, but** I don't have financial possibilities and I don't want to take loan..... 1
- 3 **I accept, if** the payback period is below 10 years . 1
- 4 **I accept, if** the payback period is below 20 years . 1
- 5 **No, I don't want** to make any renovation works for this old house (I will use it to the end I'll built new)..... 1

Do you accept the installation of **radiators**, when using heat pump or central heating system?

- 1 **Yes**, I accept.
It makes the house more energy efficient..... 1
- 2 **I accept, but** I don't have financial possibilities and I don't want to take loan..... 1
- 3 **I accept, if** the payback period is below 10 years . 1
- 4 **I accept, if** the payback period is below 20 years . 1
- 5 **No, I don't want** to make any renovation works for this old house (I will use it to the end I'll built new)..... 1

Do you accept the installation of **underfloor heating system**, when using heat pump or central heating system?

- 1 **Yes**, I accept.
It makes the house more energy efficient..... 1
- 2 **I accept, but** I don't have financial possibilities and I don't want to take loan..... 1
- 3 **I accept, if** the payback period is below 10 years . 1
- 4 **I accept, if** the payback period is below 20 years . 1
- 5 **No, I don't want** to make any renovation works for this old house (I will use it to the end I'll built new)..... 1

Do you accept **the renovation old ovens** to make them more energy efficient?

- 1 **Yes**, I accept.
It makes the house more energy efficient..... 1
- 2 **I accept, but** I don't have financial possibilities and I don't want to take loan..... 1
- 3 **I accept, if** the payback period is below 10 years . 1
- 4 **I accept, if** the payback period is below 20 years . 1
- 5 **No, I don't want** to make any renovation works for this old house (I will use it to the end I'll built new)..... 1
- 6 **No, I don't see technical possibilities** to make old ovens highly energy efficient 1

Do you accept **wind turbines near (≤2km) your house** to make electricity?

- 1 **Yes**, I accept to use "green electricity"..... 1
- 2 **No**, it is too **noisy** / it changes the visual environment 1

