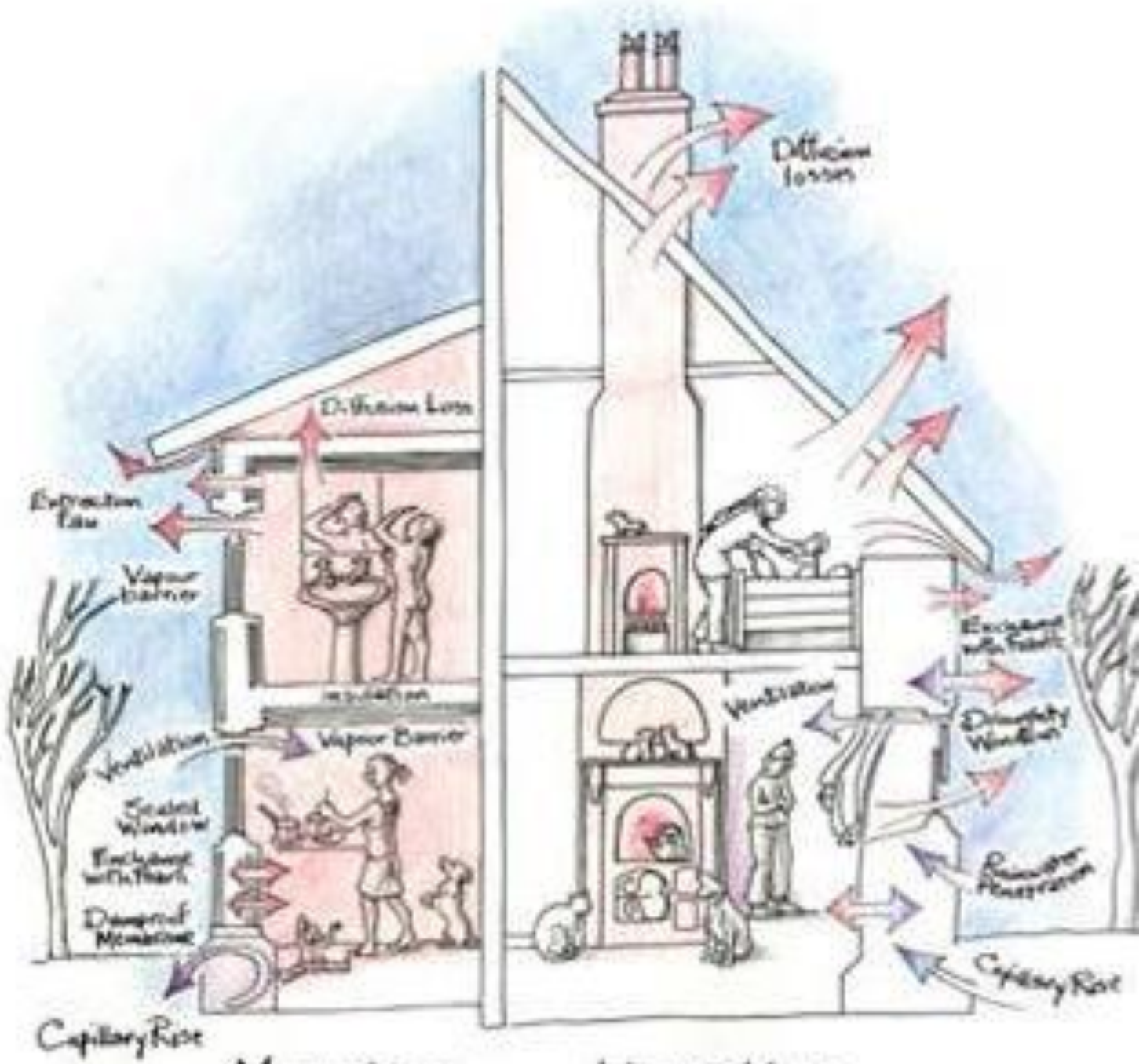
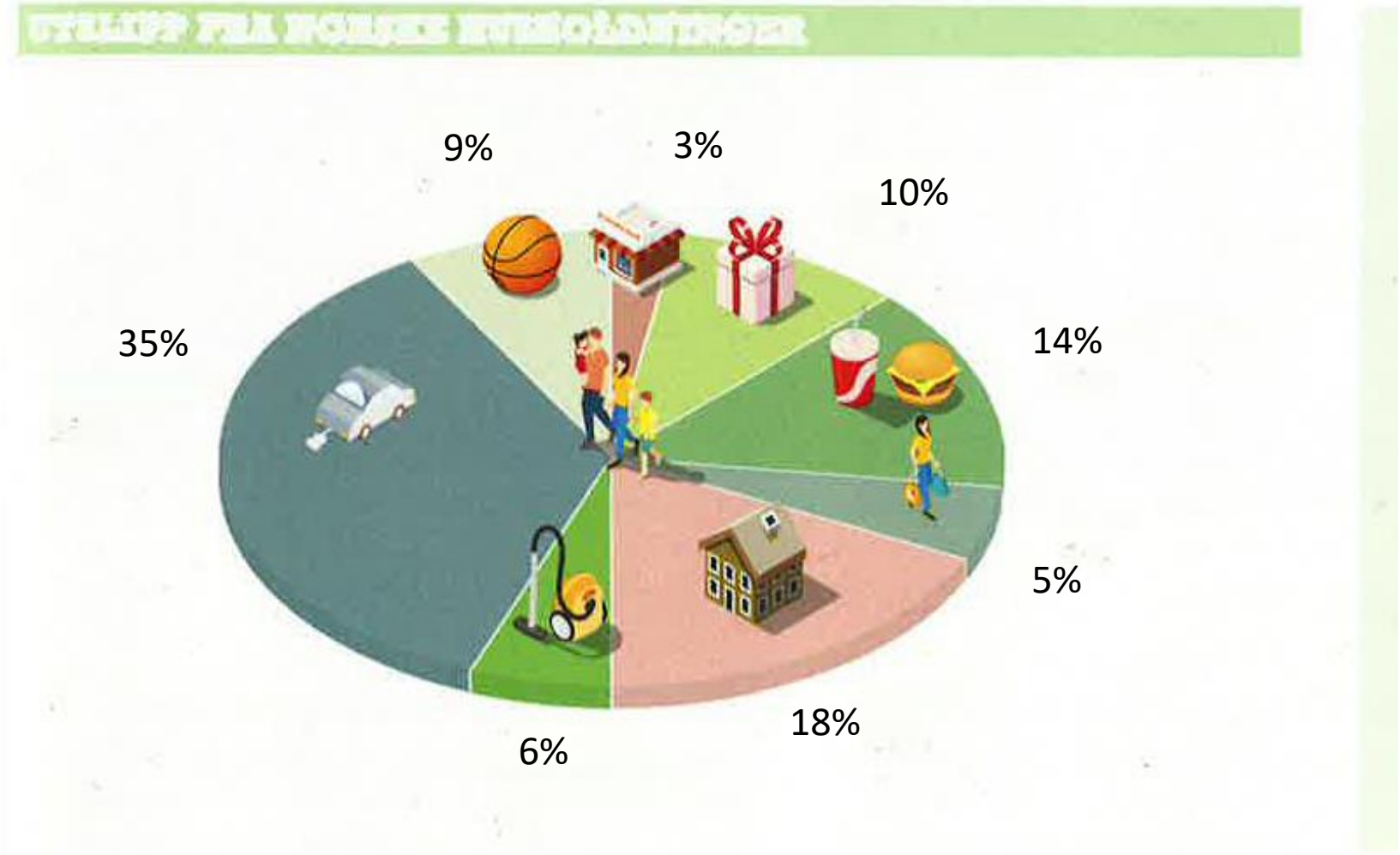

Capillary Rise
Vapor Barrier
Capillary Rise
Modern House
Historic House

Emissions Norwegian households



Hierarchy and levels of obligations

International Agreements.
Kyoto, Paris.

EU level
EU legislation. CEN standards.

National (MS) level
Cultural Heritage Act. Planning and build Act.
Other regulations (fire etc.)

On the Ground. In practice
Solutions, critical insulation, windows, etc.

Policies

The Users

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WHAT IS THE CHALLENGE?

- **Energy use in buildings constitutes a major part of the energy consumption.**
- **EU directives Energy Efficiency 93/76/EEC and Energy Performance in Buildings 2002/91/EC demands energy certification and enforces mandatory energy efficiency measures.**
- **Often the prescriptive measures demanded to reduce energy loss are detrimental to the historic values of buildings.**

Source: Energy efficiency research in historic and protected buildings. A review of existing Norwegian research and results.

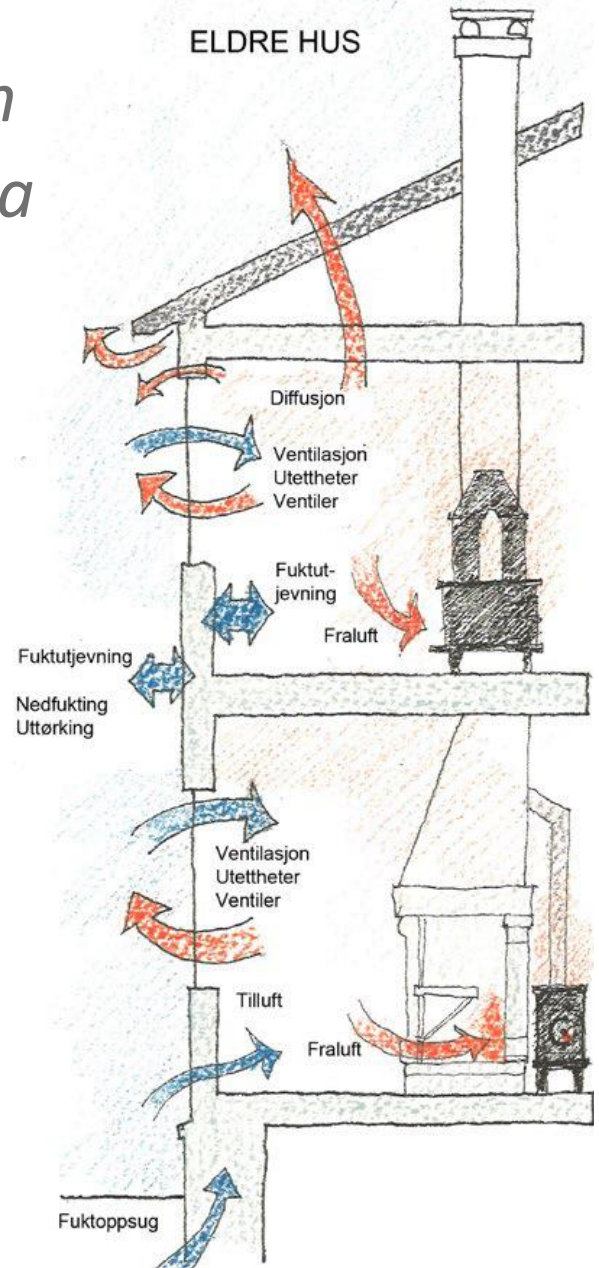

I WANT YOU
TO REPLACE
YOUR WINDOWS
Courtesy AWDI, LLC.


GROENBURGWAL
CENTRUM

Fig 1
Common Norwegian windows

Main principles for moisture and air mouvments in an older house and a modern house.

Riksantikvaren.

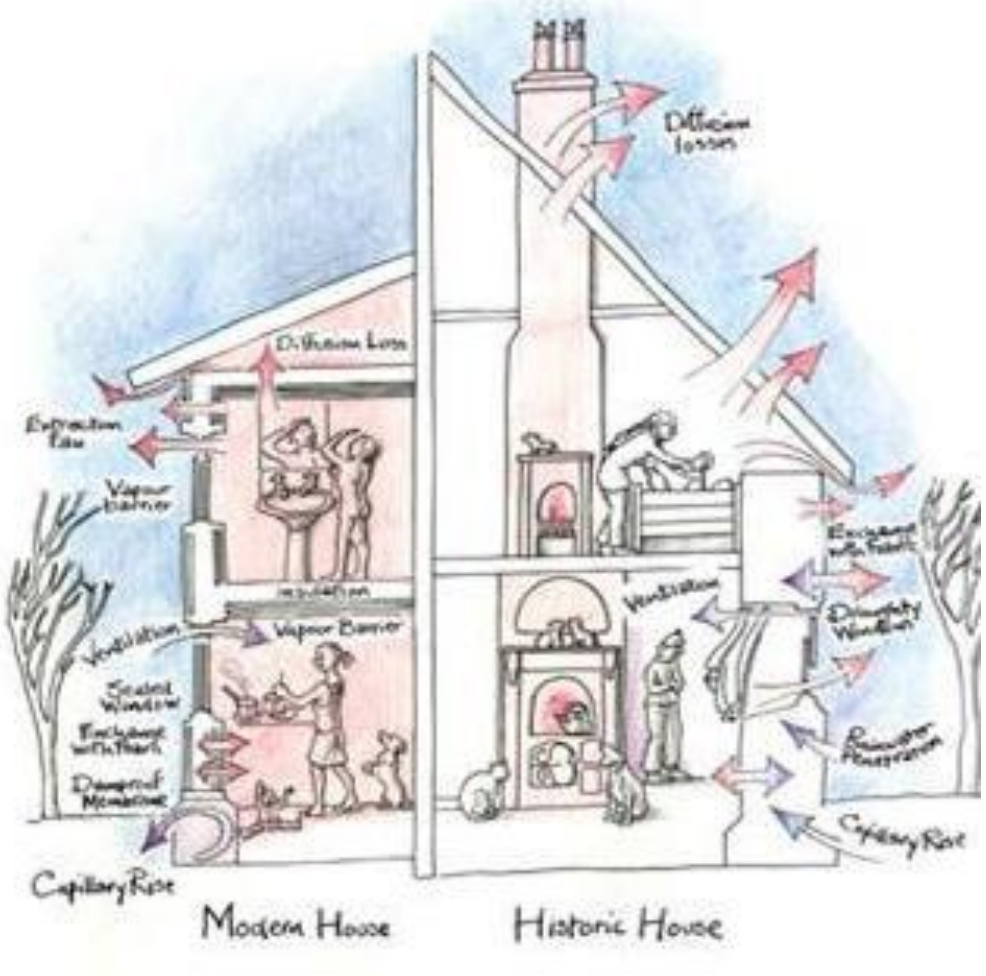


Modern building technology

- Many types of materials
- Air and watertight structures
- Controlled ventilation

Old building technology

- Few materials
- Weaker and more vapor permeable materials
- Simple designed structures that leak air and heat



- Thus, the structure remains dry and the air is ventilated

The Comparative life cycle studies of energy efficiency of a traditional and a modern house.

- **Due to a public ban on traditional log construction in buildings proposed because this construction did not conform to the U-values demanded, a study was commissioned to do a life cycle study of a traditional log house and a modern, insulated wood-frame house to assess the environmental impact from the two different construction systems.**
- **The study "Energy consumption and environmental impact of buildings" (NBI 1995) concluded that the traditional building was not less energy efficient when analysed in a life-cycle perspective which included constituent materials. For this reason the clause in question was removed from the new building regulations.**
- Source: Energy consumption and environmental impact of buildings. Case study of traditional and modern wooden buildings. Sverre Fossdal, Knut Ivar Edvardsen. Project report 177 – 1995, Riksantikvaren, Directorate for Cultural Heritage, Norwegian Building Research Institute. From: Grytli / Nypan

The study of environmental and energy effects of changing old windows

- After some 20 years of government subsidies for changing windows in older houses a research project looked at the actual energy savings achieved. **The study "Windows in existing buildings – maintenance, upgrading or replacement? Windows in existing buildings in a sustainable perspective" (NBI 1996)** showed that changing windows in historic buildings resulted in net energy savings **lower than the theoretical calculations**
- The Norwegian window study came to the following conclusions: **The smallest environmental impact is obtained if the old windows are supplied with an inner frame with single glass,** followed by old windows supplied with an inner frame with double glazing. This is with respect to a number of environmental categories (global warming potential, acidification, photo-oxidant formation, euthrophication, and consumption of fossil fuels) over a period of 90 years.
- The total energy consumption over 90 years, however, is higher for the older window supplied with an inner frame with single or double glazing that with new windows with energy glass. For the chosen building the calculations show app. 15% higher energy consumption in the user phase of the building with old windows (single pane) compared with new windows with energy glass. Source: Grytli / Nypan

Possibility to gain acceptance for **not** meeting the requirements when it:

- will lead to disproportionate costs.

or

- is **not advisable in the interest of preserving historic and aesthetic qualities** (when it comes to energy efficiency).

Political, Legal & Normative

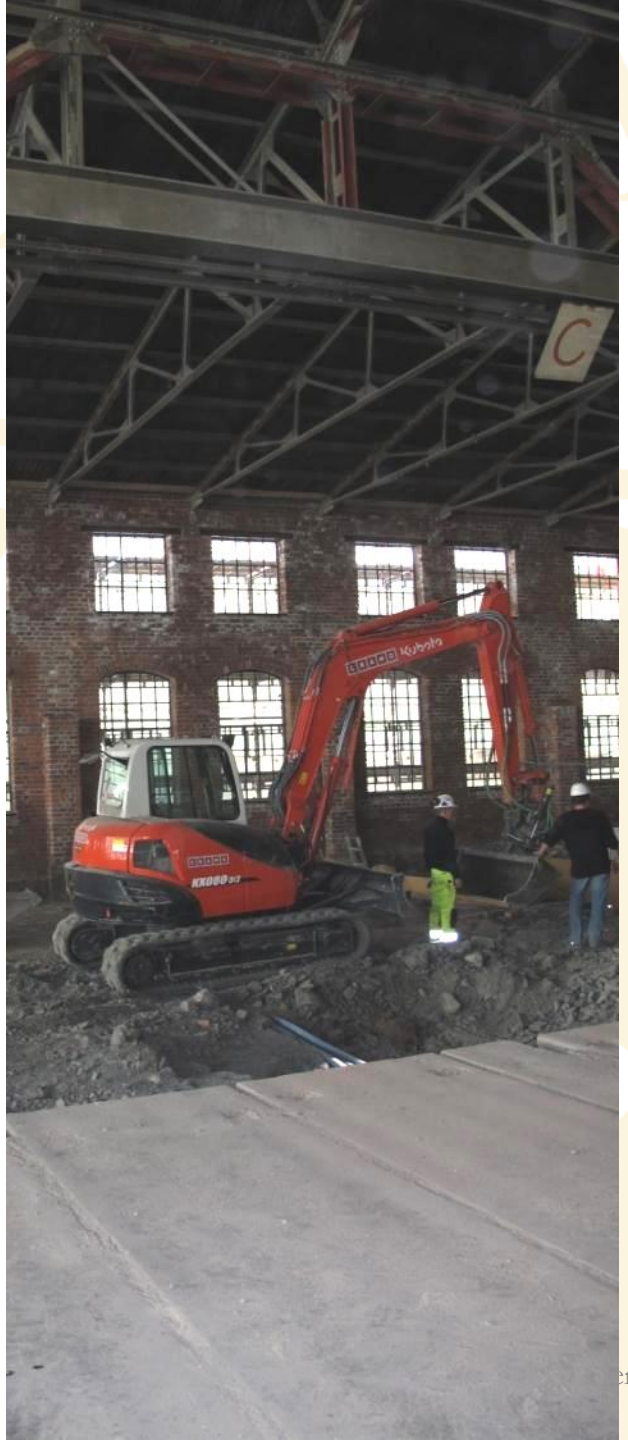
- **Political**
  - Kyoto protocol.
  - Paris agreement.
  - National and EU policies. Focus on reduction of CO2 emissions. Focus on energy.
- **Legal and normative**
  - EU Directives and regulations – possibilities for exemptions
  - Planning and Building Act (national)
  - Standardised proceedures to calculate operative energy use. CEN standard number?
  - TC 346 specific standard (Guidelines). CEN TC 346 EN 16883: Conserva1on of cultural heritage — Guidelines for improving the energy performance of historic buildings. Demands in-situ measurements.
- Normative legal and administrative national proceedures. **Austrian guideline** (Austria 2011) “Energieeffizienz am Baudenkmal”.

Directives of relevance

- Energy Efficiency 93/76/EEC and Directive 2012/27/EU on energy efficiency
- Energy Performance in Buildings 2002/91/EC
- Energy Efficiency 93/76/EEC revised proposal 2008. Derogation possibility
- Purchasing Directive (Directive COM (2003) 503). Derogation possibility
- HARMONISED CONDITIONS FOR THE MARKETING OF THE CONSTRUCTION PRODUCTS, COM(2008) 311 final, 2008/0098 (COD). Derogation possibility

Energy Efficiency 93/76/EEC revised proposal 2008

- Exemption in 4 a.:
- “4.2 Member States may decide not to set or apply the requirements referred to in paragraph 1 to the following categories of buildings:
  - (a) buildings **officially protected** as part of a designated environment or because of their special architectural or historical merit, in so far as compliance with certain minimum energy performance requirements would unacceptably alter their character or appearance;
  - (b) buildings used as places of worship and for religious activities;
  - (c) .....
  - (d) residential buildings which are used or intended to be used for either less than four months of the year or, alternatively, for a limited annual time of use and with an expected energy consumption of less than 25 % of what would be the result of all-year use;”
  - Each member state may decide to apply the exemptions in article 4 or not. Each member may also decide on the interpretation of 4 a.



Planning and Building Act

Measures under this Act shall be designed and constructed in accordance with the requirements that follow directly from the Act

The act is getting stricter!

What is defined as a «measure«?

- New construction
- Extension
- Alteration of the façade
- Change of use
- Substantial alteration, repair and rebuilding

European Committee for Standardization

CEN TC 346 EN 16883: Conservation of cultural heritage — Guidelines for improving the energy performance of historic buildings

- This European Standard provides guidelines for sustainably improving the energy performance of historic buildings, e.g. historically, architecturally or culturally valuable buildings, while respecting their heritage significance.
- The use of this standard is **not limited to buildings with statutory heritage designation**, it applies to historic buildings of all types and ages.
- "This European Standard presents **a normative working procedure** for selecting measures to improve energy performance". … based on an investigation, analysis and documentation of the building including its heritage significance.
- Source http://files.site-fusion.co.uk/ab/de/abde40d9-9cf3-4830-9e5a-b7cd7b860691.pdf And http://oldwww.nordicrenovationcenter.fi/wp-content/uploads/2016/09/EN-16883-Tommi-Lindh.pdf

CEN Others

- EN 15603, Energy performance of buildings - Overall energy use and definition of energy ratings
- EN 16096, Conservation of cultural property - Condition survey and report of built cultural heritage
- EN 16247-2:2014, Energy audits - Part 2: Buildings
- EN ISO 13790, Energy performance of buildings - Calculation of energy use for space heating and cooling (ISO 13790)
- **Austrian guideline** (Austria 2011) “Energieeffizienz am Baudenkmal”. http://www.bda.at/documents/944221227.pdf

Benefits of energy efficiency measures.

- Generates a lot of work. Creates and sustains jobs. Important to remember.
- Leads to maintenance measures.
- Does result in important CO2 reductions, even when cultural values are taken into consideration.
- Follows the principle: Do as little as possible. Do as much as necessary.
- Follow guidelines and use the exemptions and possibilities.
- It is a cost, should be seen as an investment.

Energy efficiency research in historic and protected buildings. A review of existing Norwegian research and results. Grytli, Nypan

Case1: Log building from the **early 1800-ies**. Nedre Bakklandet 33, Trondheim.

Case 2: Half-timbered house **from 1920-ies**. Jonsvannsvegen. 5, Trondheim.

Case 3: Timber frame house from **1950-ies**. Ekely borettslag, Jarlsborgveien 34, Oslo.

Case 4: Tenement house in reinforced concrete from the **1930**-ies. Drammensveien 116b, Oslo.

Case 5: Tenement house in brick and plaster, **end of the 1800**. Nygårdsgaten 70a, Bergen.

Case 6: Building of natural stone with plaster and bricks from **1700.** "Corps de Garde", Klostergaten 1, Bergen.

Energy efficiency research in historic and protected buildings. A review of existing Norwegian research and results.

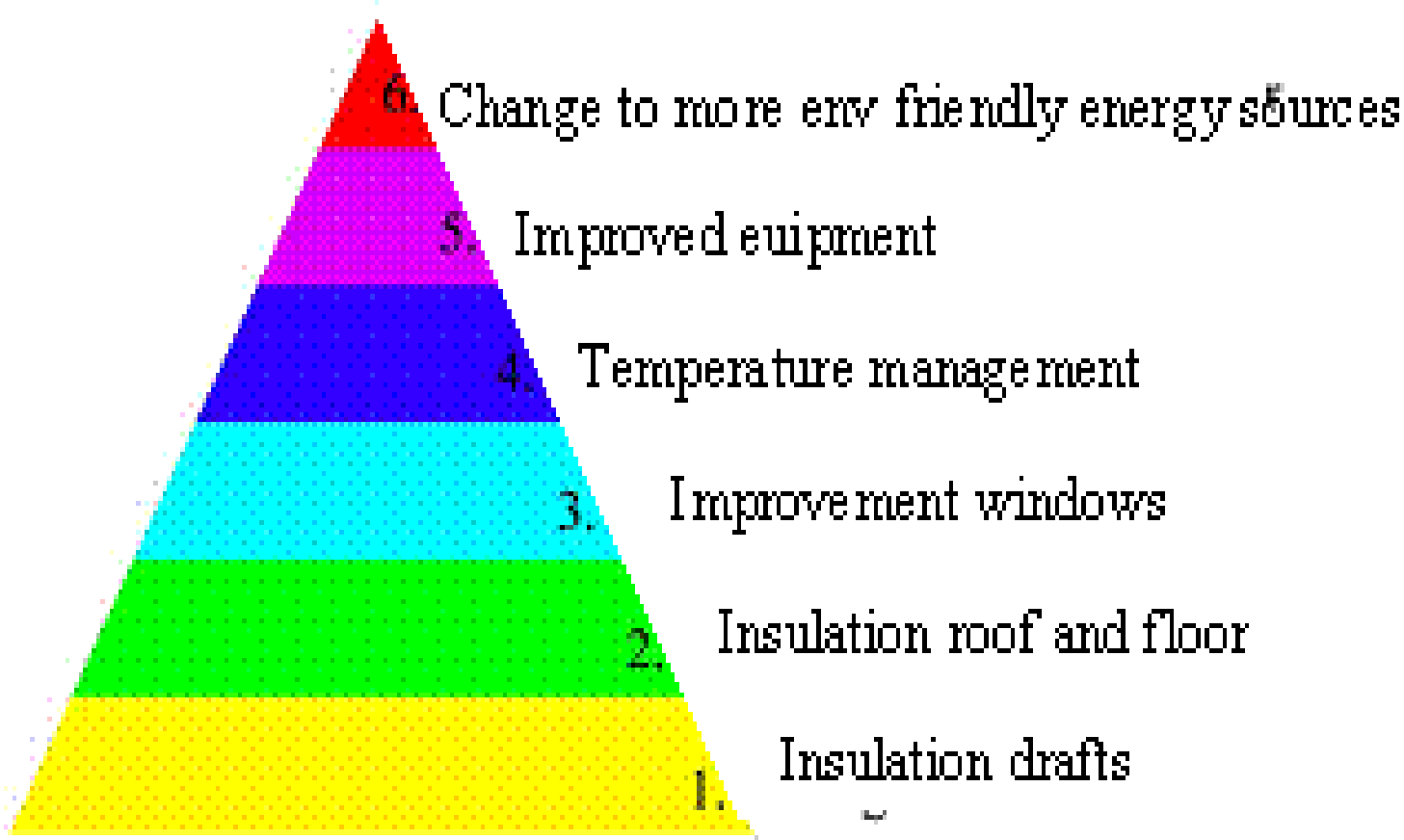


Figure 1: The steps and effects of different measures to increase energy efficiency in historic buildings.

Measures in order of benefit.

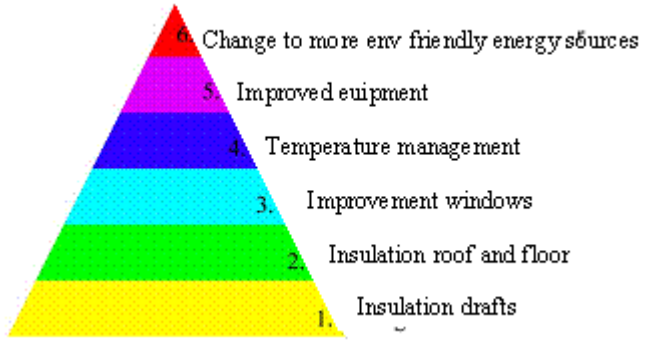
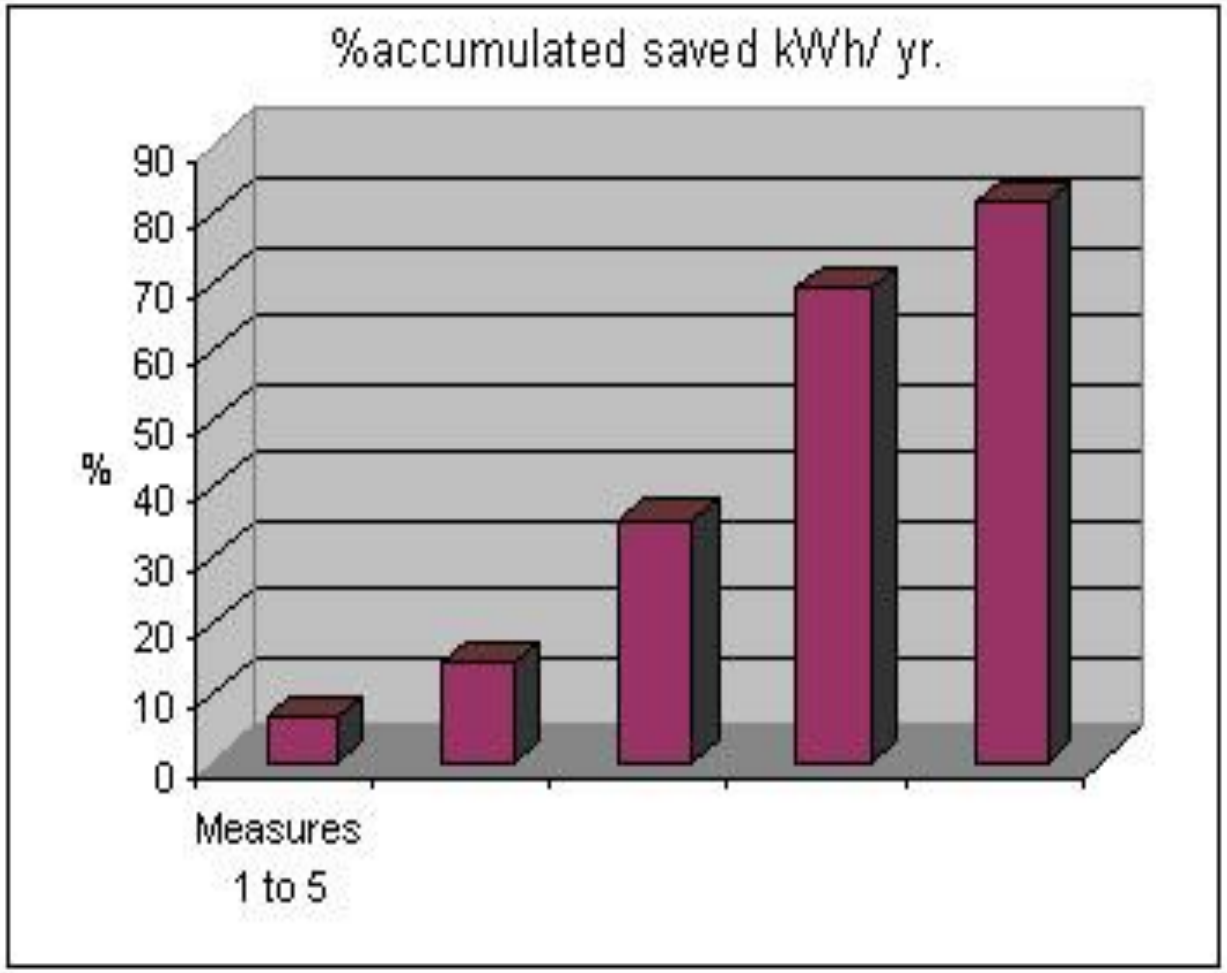


Figure 1: The steps and effects of different measures to increase energy efficiency in historic buildings.

- **Measure 1, Closing and insulating draught from air leakages**
  Energy demand for heating reduced from 68 200 kWh/yr. to 63.900 kWh/yr.
- **Measure 2a, Insulation of the joisting between heated space and cold loft:**
  Energy demand for heating reduced from 63.900 kWh/yr. to 58.800 kWh/yr.
- **Measure 2b: Insulation of floor against a cold basement:**
  Energy demand for heating reduced from 58.800 kWh/yr. to 46.400 kWh/ yr.
- **Measure 3: Installation of 1 layer windows with LowEmissivity coating:**
  Energy demand for heating reduced from 46.400 kWh/ yr. to 30.600 kWh/ yr.
- **Measure 4: Installation of new temperature control system for electric heating**
  Energy demand for heating reduced from 30.600kWh/yr. to 26.800 kWh/yr.
-
- **Measure 5 and 6 entails adding alternative energy sources and technology for covering the remaining energy demand of the house for obtaining the demands given by public regulations.**
- **With only the structural measures implemented (without implementing 5 and 6) the energy demand may be reduced from 68 200 kWh/yr to 26.800 kWh/yr**

Measure	before kWh/ yr.	after kWh/ yr.	% reduction	%accumulated	measure name
1	68 200,00	63 900,00	6,30	6,30	Closing and insulating draught fair leakages
2	63 900,00	58 800,00	7,98	14,29	Insulation joisting between heated space and cold loft:
3	58 800,00	46 400,00	21,09	35,37	Insulation floor against cold basement:
4	46 400,00	30 600,00	34,05	69,43	Installation 1 layer windows LowEnergy coating:
5	30 600,00	26 800,00	12,42	81,84	Installation new temperature control system el-heating

Energy efficiency research in historic and protected buildings. A review of existing Norwegian research and results.



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Case1: Log building from the early 1800-ies. Nedre Bakklandet 33, Trondheim.

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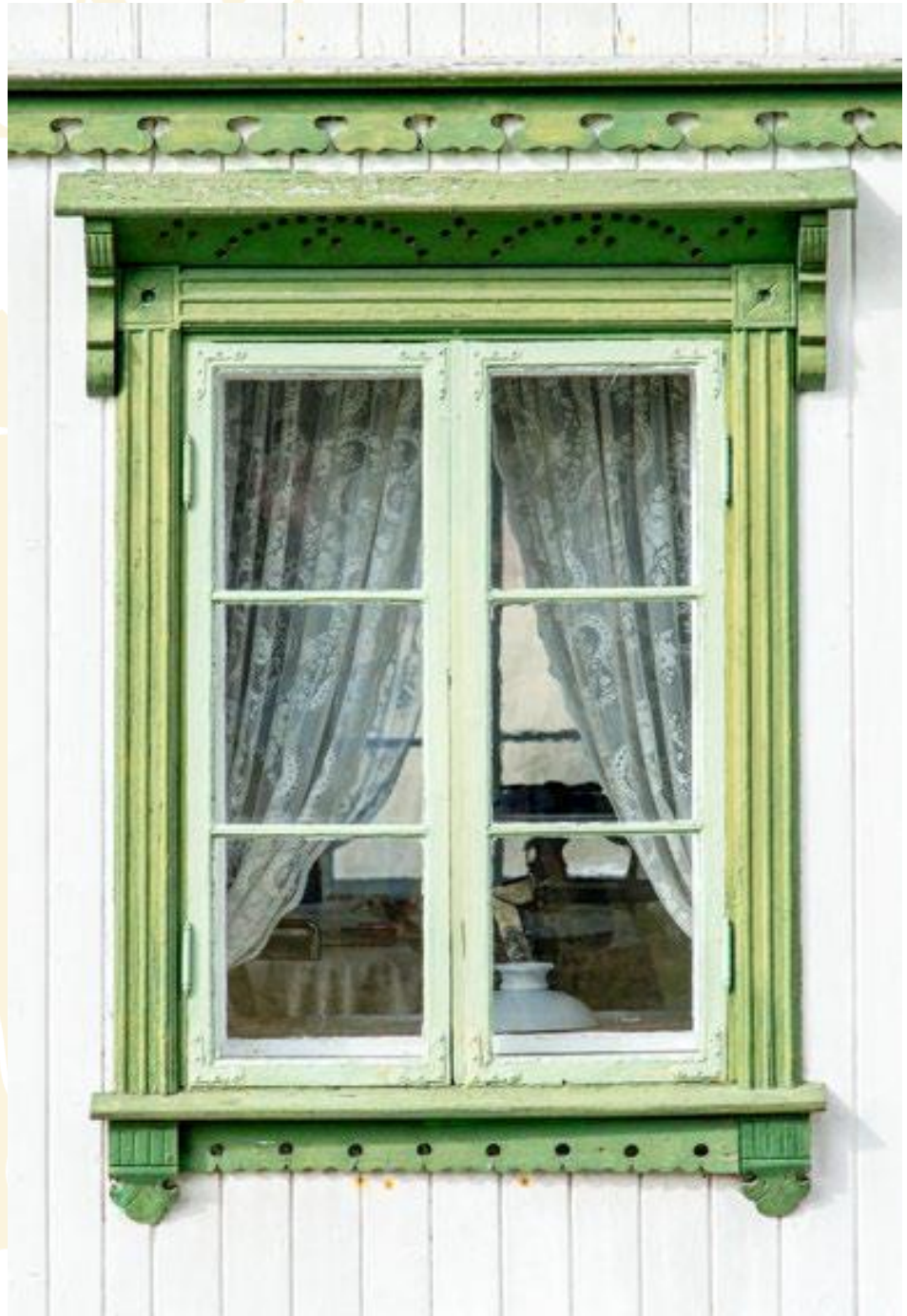


Smart oppgradering: Originalvindu med nytt varevindu koblet til det gamle.

Cellulosis insulation of old floor to cold cellar

- Organic material

Formula: $(C_6H_{10}O_5)_n$
Molar mass: 162,1406 g/mol
Density: 1,5 g/cm³

Which house is the most environmentally friendly? - An old log house or a new low-energy building?

Old log house

- Not energy efficient in operation
- Environment-friendly materials, short transport and lightly processed materials
- Already built
- CO_2 storage
- Long life
- Heating mainly with wood - renewable resource

New low-energy house

- Energy efficient in operation
- The construction demands energy and gives greenhouse gas emissions in production, transportation and waste
- Operation and maintenance will probably give more emissions

The factors we have considered

- Emissions from energy use in the operational phase
- Emissions from production of building materials

A lifespan of 60 years

www.klimagassregnskap.no

The log house

- Panelled timber building from 1812
- Was built long ago. The environmental impact of building the house has been taken long ago, and are not counted.
- Upgraded (insulation of floors, walls and new inner windows). From 510 kwh/year/m² to 252 kwh/year/m²
- The environmental impact of these materials is included in the calculation.

The new house

- An imagined dwelling of similar size, "designed" like a low-energy house with low energy consumption – 80 kwh/year/m2
- Will be built. Emissions from the production of materials needed to build is included in our calculation.

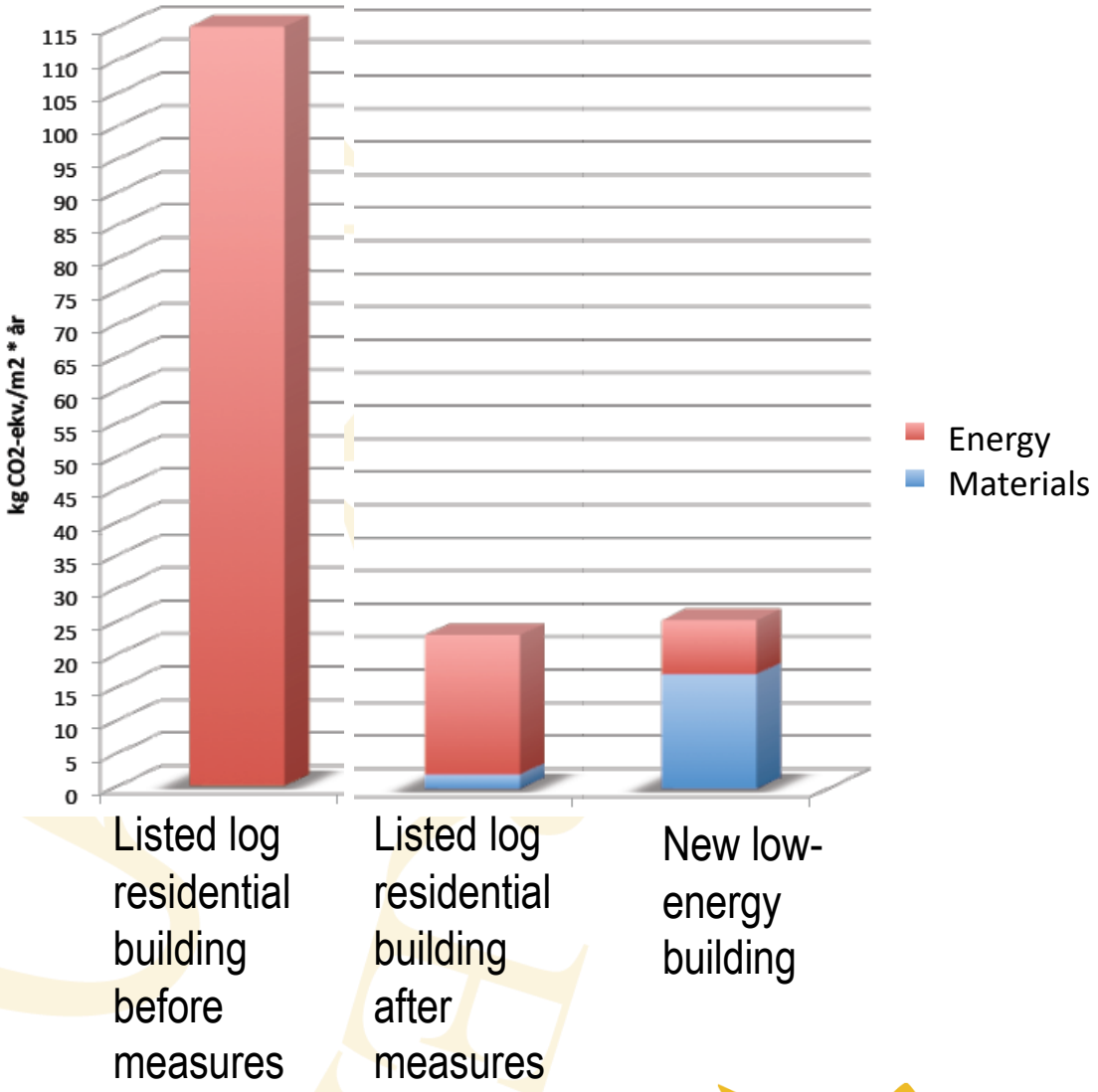
Greenhouse gas emissions/year/m²

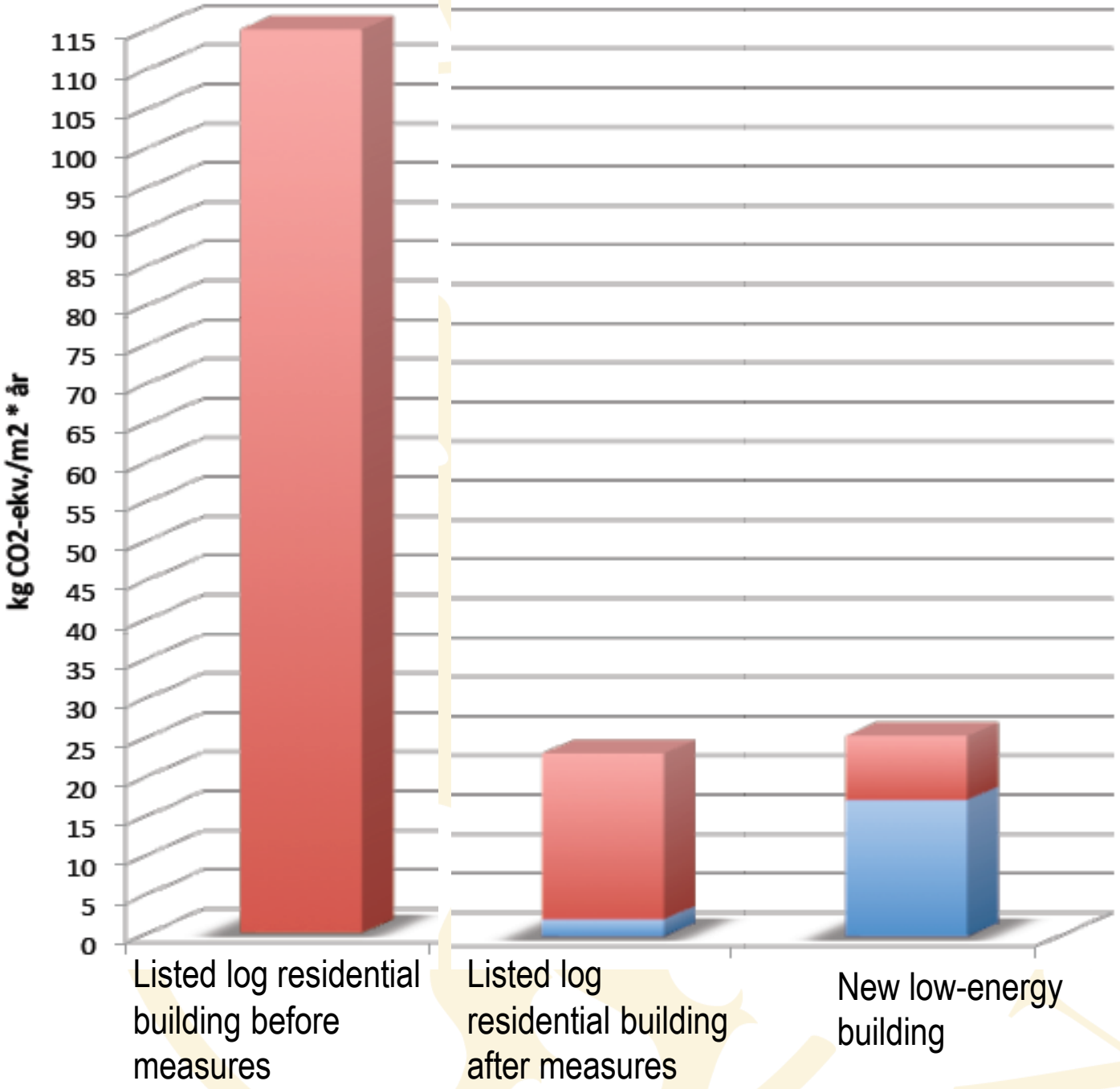
Energy source

- To what extend is electricity polluting? El emissions as the EU reference
- Conversion to more environmentally friendly energy source
  - Pellets, solar heating

El-specific consumption

- Modern appliances similar to the new building





Reduction in log house OE.

Material use for new low-energy house

Life expectancy new build is 60 yrs. **Takes 52 years to become more energy efficient than a historic house**

Most important measures

• After insulation	ETTERISOLERING
• Loft and cellar. Not walls.	LOFT OG KJELLER – IKKE VEGGER
• Windows.	VINDUER
• Insulating leakages.	TETTING
• Temprature controll.	TEMPERATURSTYRING

- **Achives reduction in energy use of up to 70% without the temprature controll technology. With temprature controll we can achieve another 13 %. Or in total ca. 80% reduction in heating needs.**

The Cultural management sectors perspective - also moving towards an ecological view.

It is sustainable to make use of already **existing resources** (houses) rather than using new resources, building new houses, for the same purpose.

The physical principles of older buildings can provide **useful knowledge** in the development of new construction techniques that are more holistic.

Focus on **greenhouse gas emission** and a holistic view of the total **climate emissions** from buildings instead of only focus on energy use during operation face.

What is on the agenda in the EU?

- **New Cultural Heritage Expert Group**. Meets 15-16 October. Mandate: to support the Commission and improve EU Cultural Heritage policies.
- Based on 3 **EU Council Conclusions**. *Integrated and cross sectorial* Cultural heritage policies and more targeted financing.
- **Quality Guidelines**. ICOMOS. New. To match increased funding of CH in major Financial Instruments.
- **Circular Economy**. Contributions from Cultural Heritage and Historic constructions / buildings?
- **ESPON** projects – Regional development knowledge based policies and financing.
- A **new organisational landscape**. DG EAC (new name), CAC, EHHF, EHHF Task Force, EHLF, Reflection Group and now new Cultural Heritage Expert Group.

END

- In the end we cannot compete in operational energy of new constructions. But we can contribute to great reductions in operative energy use (80%) with comparatively only a minor carbon foot-print. It takes **52 years for a new house to out-perform the old.**
- We need to focus more on social benefits from CH. Their socio-economic value. Their value for well-being and the cementing of identities.
- Socio-economic value is high. Austria 40% of tourism spending is due to CH. The GVA contributions are critical to the economy.
- Culture and cultural historic value is the essence. Very difficult to value asses.
- **No body ever protected a building because of its energy efficiency, nor for its socioeconomic contributions either! But for is social and cultural value.**

Sources

Energy efficiency research in historic and protected buildings. A review of existing Norwegian research and results. E. Grytli, Professor, NTNU, Trondhjem, Norway NO-7491 Trondhjem, Norway. T. Nypan, Directorate for Cultural Heritage, Norway, Oslo,

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EHLF. Directive lists at www.htps:// EHHF.eu/EHLF

EUROPEAN COMMISSION DG Research and Innovation http://www.3encult.eu/en/deliverables/Documents/WP2-WP3_D2.2D3.2_20130331_P03-P01_PositionPaperCriteria.pdf

Source http://files.site-fusion.co.uk/ab/de/abde40d9-9cf3-4830-9e5a-b7cd7b860691.pdf
And http://oldwww.nordicrenovationcenter.fi/wp-content/uploads/2016/09/EN-16883-Tommi-Lindh.pdf

CEN EN 16883: Conserva1on of cultural heritage — Guidelines for improving the energy performance of historic buildings