

# Danish national plans for Nearly Zero Energy Buildings

ENERGY SEMINAR IN ESPOO  
5 NOVEMBER 2014

KIRSTEN ENGELUND THOMSEN  
DANISH BUILDING RESEARCH INSTITUTE, SBI  
AALBORG UNIVERSITY COPENHAGEN



DANISH BUILDING RESEARCH INSTITUTE  
AALBORG UNIVERSITY COPENHAGEN

# Agenda

- Political ambitions for new and existing buildings in Denmark
- Definition of and plans for Nearly Zero Energy Buildings (NZEB)
- Integration of renewable energy in NZEB



# Political energy ambitions

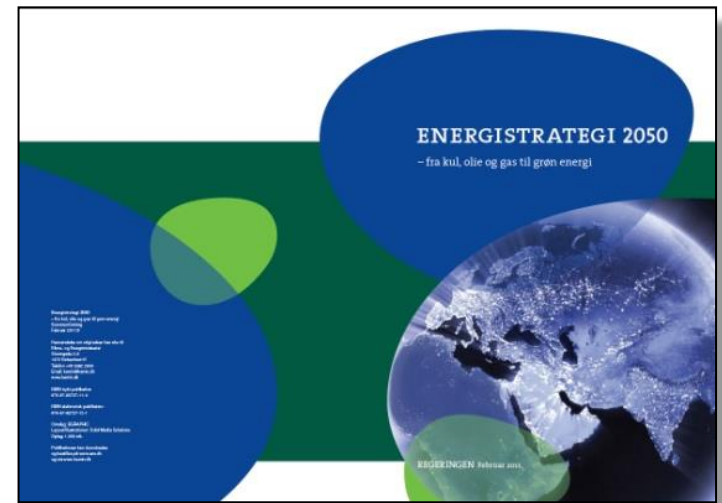
Turning the back to fossil fuels:

2020 – 50% of electricity covered by wind energy

2030 – No more use of coal in power plants

2035 – All electricity and heating covered by renewable energy

2050 – All energy covered by renewable energy (electricity, heating, transports, industry)



# Energy Agreement – March 2012

- Broad coalition in the parliament agrees on a new energy agreement
- Set the directions until 2020
- Concrete initiatives on energy infrastructure, taxation, conditions for energy intensive industries etc.
- AND it spells out the contents of a strategy for energy renovations of the existing building stock



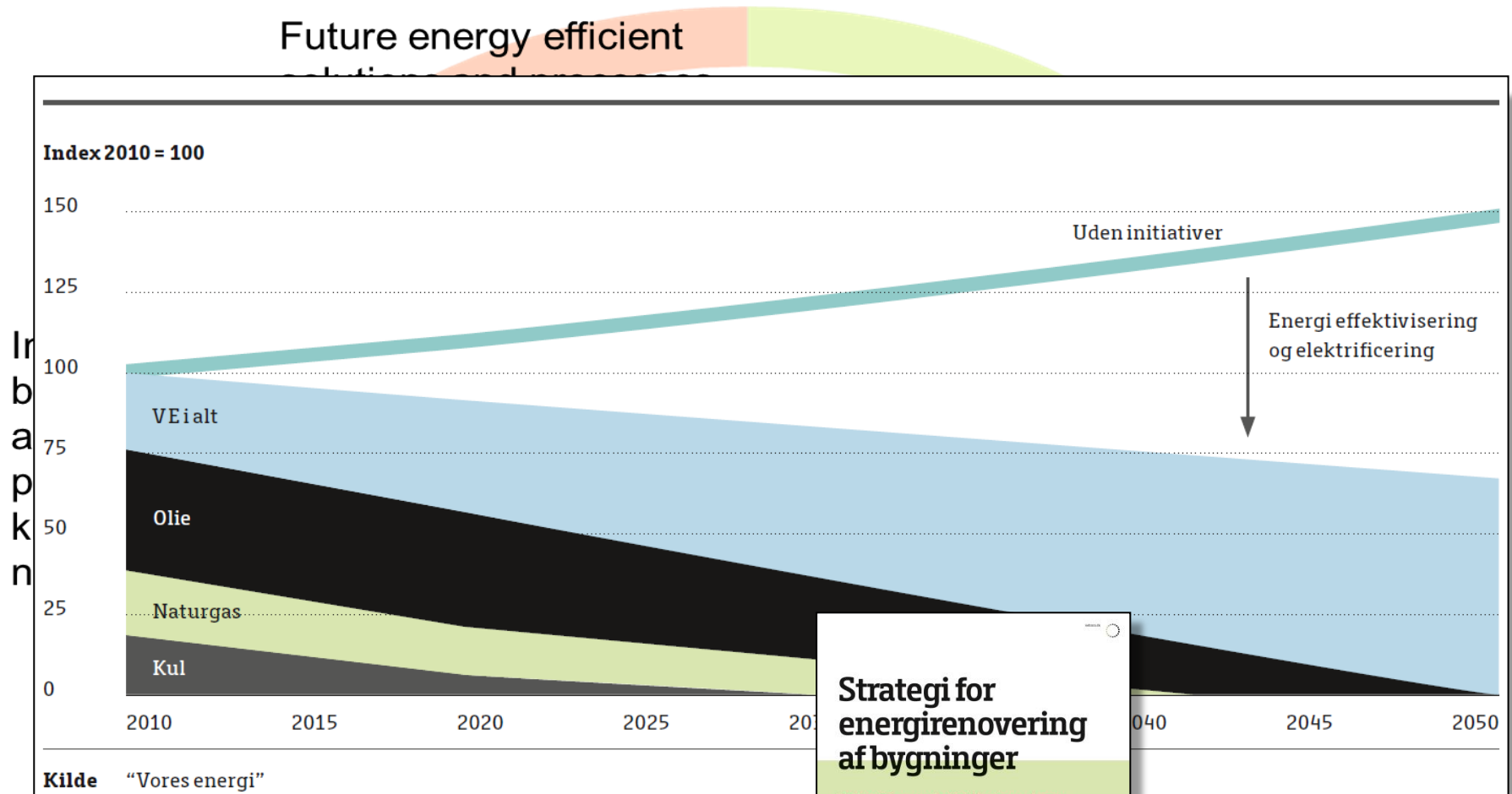
# Energy Agreement – main goals in 2020

62 actions in total

- More than 35% renewable energy in final energy consumption
- Approximately 50% of electricity consumption to be supplied by wind power
- 7.6% reduction in gross energy consumption in relation to 2010
- 34% reduction in greenhouse gas emissions in relation to 1990



# Strategy for energy retrofit of buildings - 2014



## Strategi for energirenovierung af bygninger

Vejen til energieffektive bygninger i fremtidens Danmark



# Some practical consequences

- Political ambitions support and strengthen the already developed measures in the field of Renewable Energy Sources (RES) in buildings
- Voluntary classes included in the Building Code:
  - Low energy class 2015
  - NZEB 2020 class (also called Building class 2020)
- NZEB 2020 class regulates the building envelope, the total calculated energy consumption, indoor climate etc.



# Tightenings of energy performance requirements in Denmark

- In the first version of the Danish Building Regulations 2010 only projections for 2015 were available
- As a result of requests from the building industry and local building service authorities, projections for the 2020 requirements were included in early 2011
- The building industry wanted to be able to:
  - practice to meet the requirements without risking to loose a building permit in case they do not comply with future requirements
  - start to develop components and materials that comply with future requirements, thus decreasing the cost of these improved products when they become mandatory





# Energy frame

Calculated primary energy demand for heating, ventilation, domestic hot water, electricity for building operation, electricity for lighting (non-residential), system efficiency, internal energy transport, and a potential overheating (+26 °C) penalty minus RES contribution.

- Standard conditions for building use
- One climate zone
- One national tool for calculating energy performance in new and existing (certification) buildings
- Two building types, residential and non-residential
- Possible to obtain an extension of the energy frame for special usage of non-residential buildings





# Energy frames<sup>1</sup>

## Residential

**2010**

$52.5 + 1650/A$  kWh/m<sup>2</sup> year

**2015**

$30 + 1000/A$  kWh/m<sup>2</sup> year

**2020**

20 kWh/m<sup>2</sup> year

## Non-residential

**2010**

$71.3 + 1650/A$  kWh/m<sup>2</sup> year

**2015**

$41 + 1000/A$  kWh/m<sup>2</sup> year

**2020**

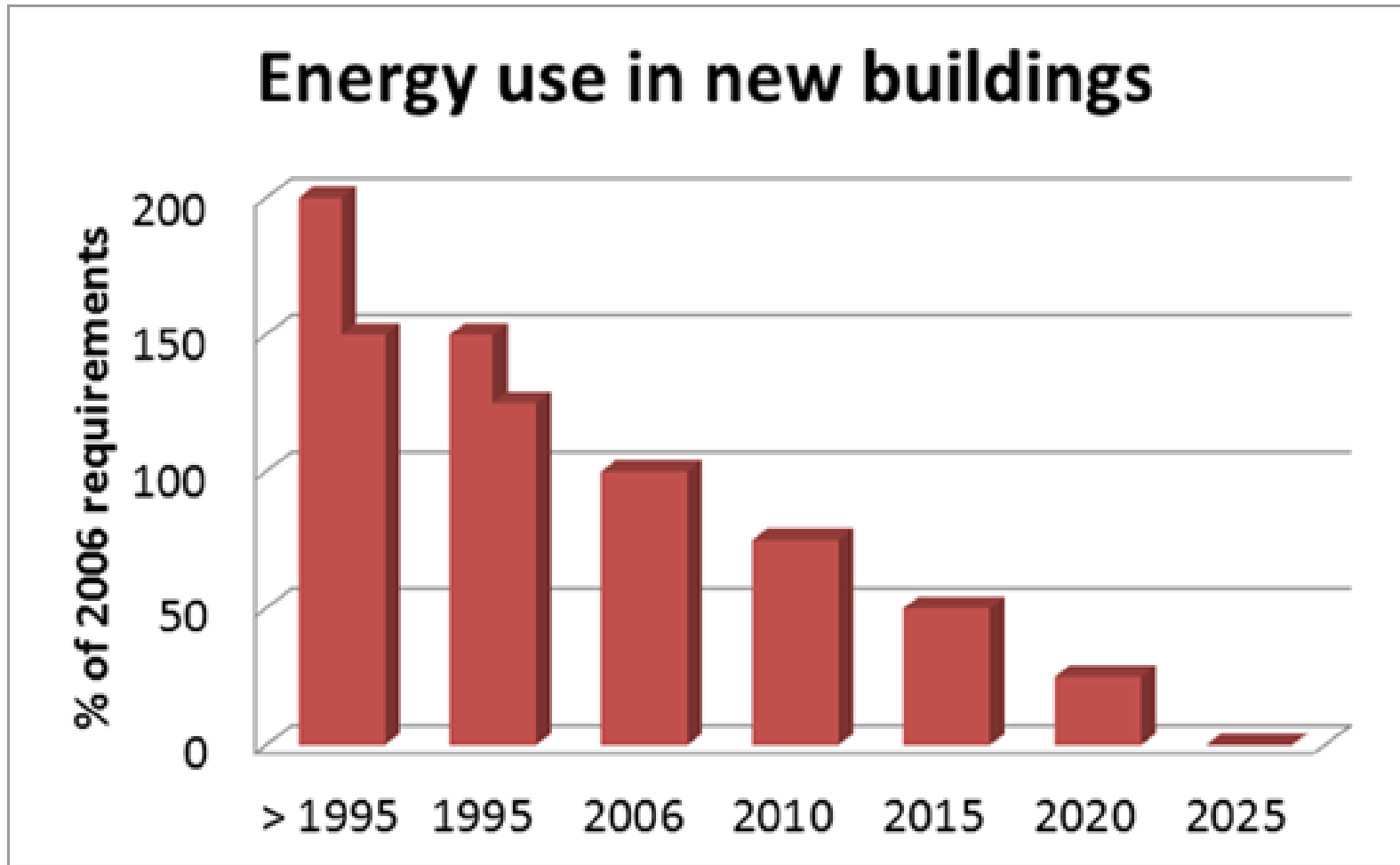
25 kWh/m<sup>2</sup> year

---

1) Primary energy for: heating, ventilation, domestic hot water, electricity for building operation, electricity for lighting (non-residential), system efficiency, internal energy transport, potential overheating penalty - RES



# Requirements for new buildings



# Dimensioning<sup>1</sup> heat loss through opaque parts of the thermal envelope

**2010**

**1 storey**

$$Q \leq 5 \text{ W/m}^2$$

**2015**

$$Q \leq 4 \text{ W/m}^2$$

**2020**

$$Q \leq 3.7 \text{ W/m}^2$$

**2 storeys**

$$Q \leq 6 \text{ W/m}^2$$

$$Q \leq 5 \text{ W/m}^2$$

$$Q \leq 4.7 \text{ W/m}^2$$

**3+ storeys**

$$Q \leq 7 \text{ W/m}^2$$

$$Q \leq 6 \text{ W/m}^2$$

$$Q \leq 5.7 \text{ W/m}^2$$

---

1)  $\Delta T$  (to outdoor) = 32 °C










# Windows - and energy gain reference

	2010	2015	2020
Facade windows	-33	-17	+ 0
Roof windows	-10	+0	+10

$$E_{\text{ref}} = I \cdot g_w - G \cdot U_w = 196,4 \cdot g_w - 90.36 \cdot U_w$$

Energy gain factor in kWh/(m<sup>2</sup>year)

Energitilskud $E_{\text{ref}}$ [kWh/m <sup>2</sup> vindue pr. år]	Klasse	Mærkning
$0 \leq E_{\text{ref}}$	 A	
$-17 \leq E_{\text{ref}} < 0$	 B	
$-33 \leq E_{\text{ref}} < -17$	 C	
$-55 \leq E_{\text{ref}} < -33$ *	 D	
$-60 \leq E_{\text{ref}} < -55$ *	 E	
$E_{\text{ref}} < -60$ *	 F	



# Thermal indoor climate

In buildings complying with Low Energy class 2015 or Building class 2020, thermal indoor climate must be documented via calculations

In dwellings, institutions, offices etc. the thermal indoor climate must not exceed 26°C, except during a limited number of hours compared with the reference year

For dwellings, a temperature of 26°C must not be exceeded for more than 100 hours per year, and a temperature of 27°C must not be exceeded for more than 25 hours per year

*Documentation for the thermal indoor climate can be done according to “DS474 - Norm for specification of the thermal indoor climate” using dynamic simulation tools*

*For dwellings proof can be provided via a simplified calculation implemented in the compliance checking tool Be10 – Buildings energy demand 2010*



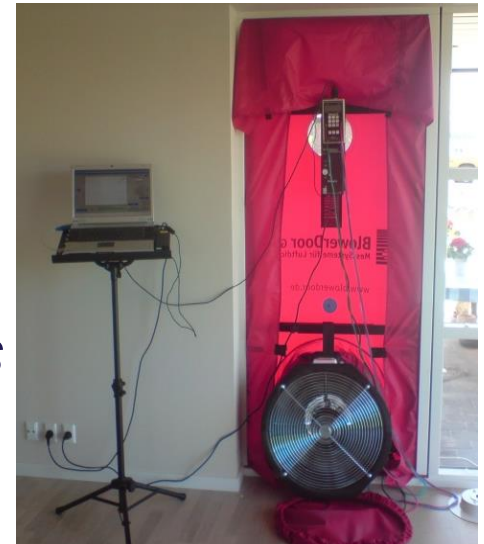
# Airtightness

Air-change must not exceed X.X l/s per m<sup>2</sup> (heated floor area) demonstrated at a pressure difference of 50 Pascal

	2010	2015	2020
Tested air-change:	1.5	1.0	0.5

*The municipality must require a pressure test in more than 5% of all new buildings*

*Fulfilment of 2015 or 2020 regulations require a pressure test*



# Renewable energy

Denmark operates with an energy frame, setting a limit for the allowed primary energy demand per m<sup>2</sup>

- Renewable energy (deducted from the primary energy demand) is locally produced heat (solar thermal) and electricity (PV and wind)
- Bio-fuels are treated in the energy frame as fossil fuels
- Heat pumps are electric heating systems with high efficiency





# Local electricity production

Locally produced electricity can only be deducted in the energy frame up to the amount of electricity used for operating the building, i.e. electricity for pumps, fans, heat pumps, and lighting (non-residential buildings only)

The balancing period for locally produced electricity is monthly, though up to the total monthly consumption of electricity in the building

- The economic balancing period for locally produced electricity is hourly
- The current feed-in tariff for private households is 0.08 €/kWh while the price for buying electricity from the grid is approx. 0.30 €/kWh



# RES must be produced "nearby"

In this context "nearby" means within the same municipality as where the building is located

For buildings close to a municipality border "nearby" can also be in the neighbour municipality, as long as the RES installation is located in the immediate vicinity of the building



# Joint RES installations

For groups of buildings that comply with Building class 2020, it is allowed to establish a joint RES installation at the time of construction and include it in the energy frame

It is a prerequisite that the building owner contributes economically to the installation and that it is established “nearby” the group of buildings

Joint solar thermal systems can though only be deducted in the energy frame outside district heating areas



# RES in NZEBs Energy Performance

There are no specific target for the share of locally produced RES in Danish NZEB

In buildings with a large consumption of DHW, i.e. +2000 liters/day, a solar heating system is required (valid for both current and NZEB requirements)

In 2020, it is expected that the Danish energy mix will contain a minimum of 51% RES – and all buildings will thus by default (on average) have a +50% RES share

- Primary energy factors (PEF) will change accordingly

Local RES production will add to the total RES share in the building



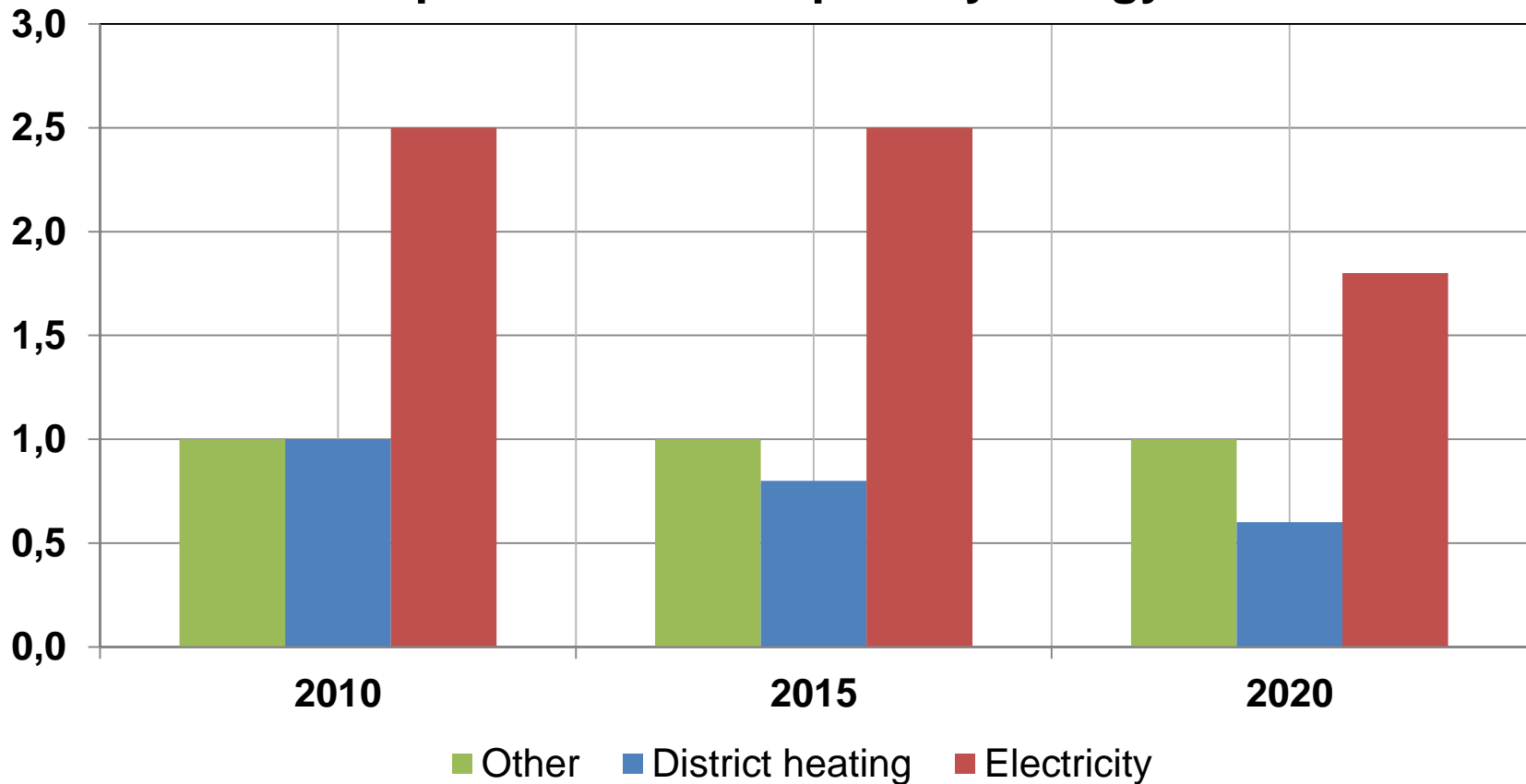
# Integration of renewable energy in NZEB 2020 class

- Primary energy factors will be lowered over time as RES will make up a larger proportion of the energy mix
  - Electricity: 2.5 → 1.8
  - District heating: 1.0 → 0.6
  - Gas, oil, biomass: remains 1.0
  - Renewable energy: remains 0.0
- Energy from RES installations can be subtracted when calculating the overall energy consumption, but only limited – e.g. only electricity for building operation in dwellings



# Primary energy factors in Denmark

Development in Danish primary energy factors





# When are the PEF's in use?

A new building - constructed today - that comply with the 2015 or 2020 energy performance requirements use the PEF valid for the relevant EP level (2010, 2015 or 2020)

The ratio between district heating and electricity (heat pumps) are almost the same in 2015 and 2020

Future increase in COP will favour heat pumps for district heating



# Future steps

- The planned tightening of EP requirements in the Danish Building Regulations 2010 are currently being analysed for compliance with the EPBD requirement about cost optimality
- Low energy class 2015 will most likely become minimum EP requirements next year
- Investigations on voluntary energy classes for existing buildings are currently being carried out
- Investigations on future (beyond 2020) energy classes are currently being carried out





# Thank you for your attention

