

# Radon prevention in new buildings, a successful achievement of the Norwegian NRAP

HERCA PRE-workshop on National Radon  
Action Plans

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and Nuclear Safety Authority

# 1997 Technical regulations

- No specific technical requirements on radon, but “radon should be taken into consideration to avoid health hazard”
- In the guidance material it was stated that radon concentrations in living rooms and bedrooms should not exceed 200 Bq/m<sup>3</sup>

**Norwegian Building Authority:**

Technical  
regulations 1997

**Norwegian Radiation and  
Nuclear Safety Authority:**

Survey:  
Radon 2008



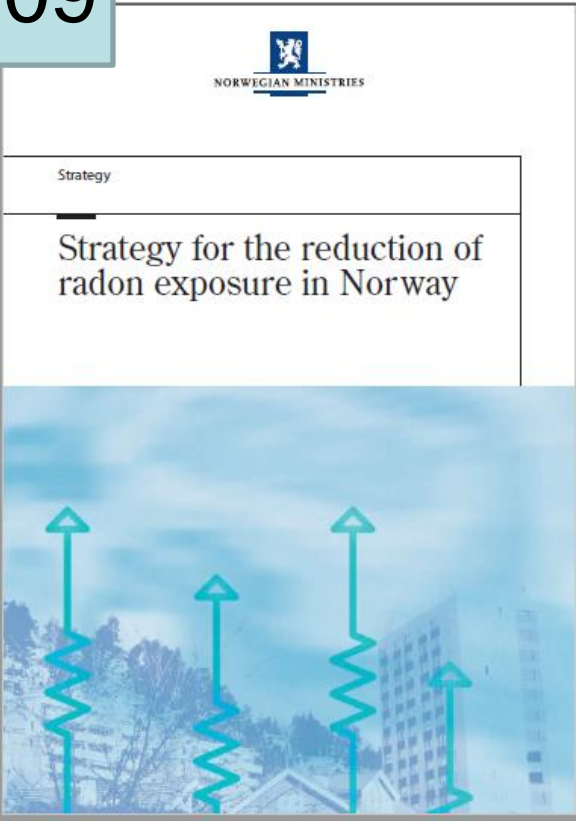
## Norwegian Building Authority:

Technical regulations 1997

## Norwegian Radiation and Nuclear Safety Authority:

Survey:  
Radon 2008

2009



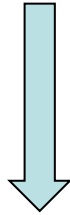
## 2.2 RADON AND THE CONSTRUCTION OF NEW BUILDINGS

**Target:**  
*New buildings that are being constructed in Norway must have indoor radon concentrations that are as low as reasonably achievable and always less than 200 Bq/m<sup>3</sup>.*

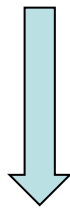


**Norwegian Building Authority:**

Technical regulations 1997



Technical regulations 2010



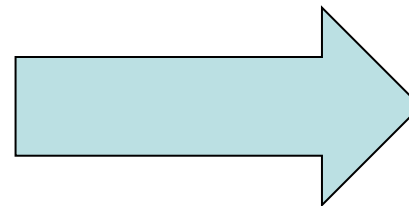
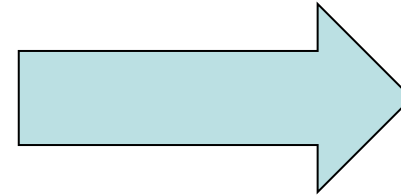
Revised technical regulations 2017  
(minor changes/wording)

**Norwegian Radiation and Nuclear Safety Authority:**

Survey:  
Radon 2008



Survey:  
Radon 2016



# 2010/2017 Technical regulations

- Buildings shall be designed and constructed with radon-preventive measures to limit the inflow of radon from the ground. Radon concentrations in indoor air shall not exceed 200 Bq/m<sup>3</sup>
- The following shall, as a minimum, be complied with:
  - Buildings designed for constant occupancy shall have a radon barrier towards the ground
  - Buildings designed for constant occupancy shall be designed with suitable measures in the building land that can be activated when the concentration of radon in the indoor air exceeds 100 Bq/m<sup>3</sup>

Radon membrane

Fan  
To be activated if necessary

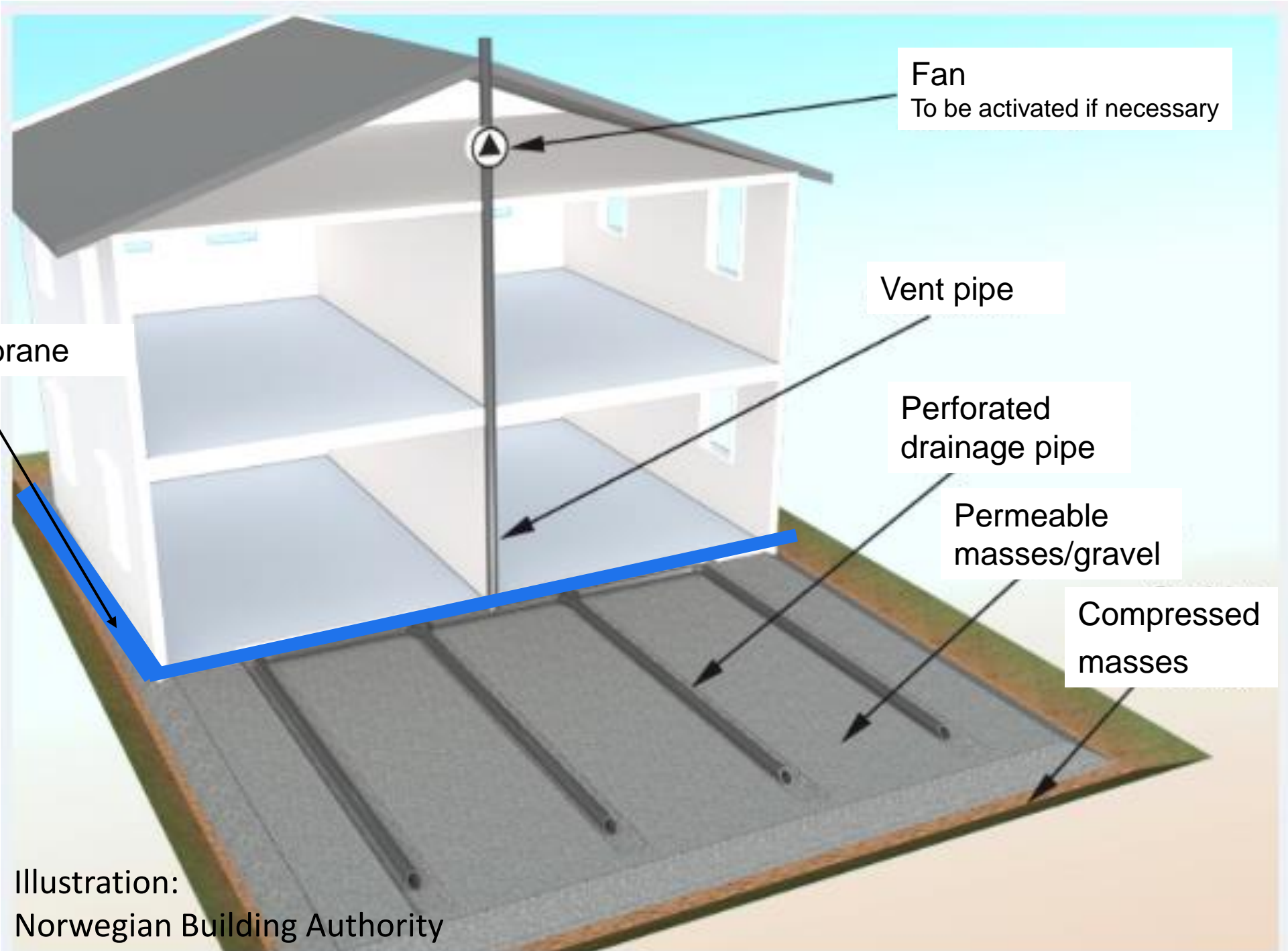
Vent pipe

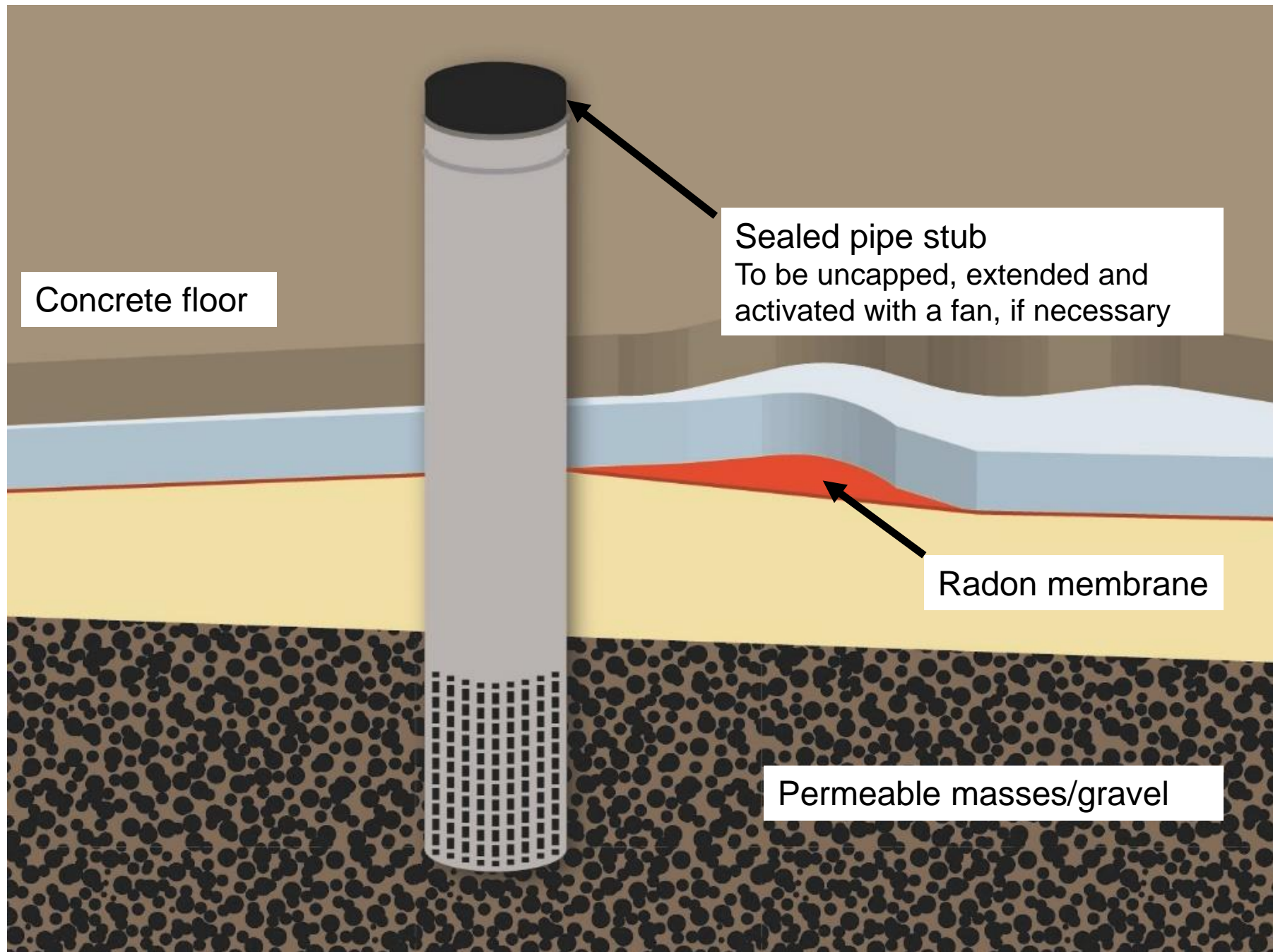
Perforated  
drainage pipe

Permeable  
masses/gravel

Compressed  
masses

Illustration:  
Norwegian Building Authority







# Results

## Detached houses



	<b>N</b>	<b>AM (Bq/m<sup>3</sup>)</b>	<b>GM (Bq/m<sup>3</sup>)</b>	<b>&gt; 100 Bq/m<sup>3</sup></b>	<b>&gt; 200 Bq/m<sup>3</sup></b>
Radon 2008	92	76	38	23,9 % (22)	7,6 % (7)
Radon 2016	486	40	28	6,4 % (31)	2,5 % (12)

Statistical significant reduction. Independent t-test used on log transformed results,  $p=0,002$  ,95%CL

# Results

## Terrace houses



	<b>N</b>	<b>AM (Bq/m<sup>3</sup>)</b>	<b>GM (Bq/m<sup>3</sup>)</b>	<b>&gt; 100 Bq/m<sup>3</sup></b>	<b>&gt; 200 Bq/m<sup>3</sup></b>
Radon 2008	41	44	24	12,2 % (5)	4,9 % (2)
Radon 2016	221	29	23	3,2 % (7)	0 % (0)

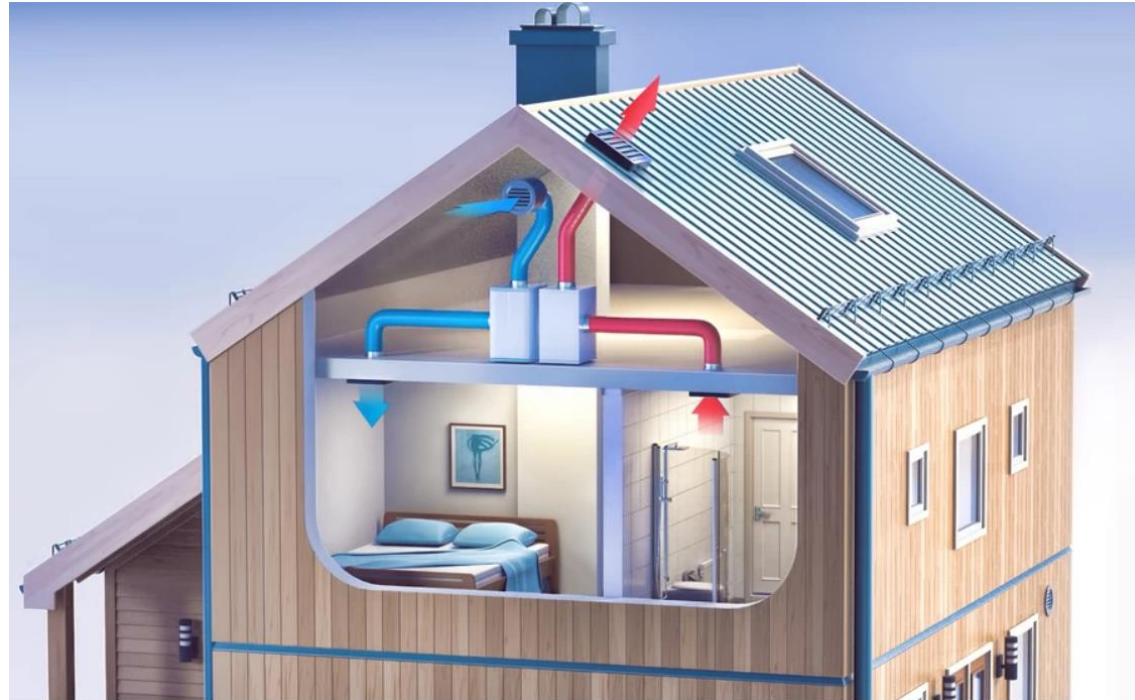
Not statistical significant reduction. Independent t-test used on log-transformed results,  $p=0,760$  ,95%CL

# Block of flats



- Not possible to draw any conclusions due to insufficient number of measurements
- Should be investigated in more detail later

# New requirements with regard to ventilation in Technical Building Regulations 2010



Radon 2008: 45 % balanced ventilation

Radon 2016: 95 % balanced ventilation

	Type of ventilation	N (%)	AM (Bq/m <sup>3</sup> )	GM (Bq/m <sup>3</sup> )	> 100 Bq/m <sup>3</sup>	> 200 Bq/m <sup>3</sup>
Radon 2008	Natural	14 (15,7%)	68	44	21,4% (3)	7,1% (1)
	Mechanical exhaust	25 (28,1%)	96	43	24,0% (6)	12,0% (3)
	Balanced	50 (56,2%)	66	33	24% (12)	6,0 (3)
Radon 2016	Natural	10 (2,1%)	41	31	10,0% (1)	0% (0)
	Mechanical Exhaust	21 (4,4%)	84	47	28,6% (6)	14,3% (3)
	Balanced	446 (93,5%)	38	28	5,4% (24)	2,0% (9)

# Radon 2016

Question:

Have radon preventive measures been implemented?

## All dwellings

	N	%
Yes	380	48
No	25	3
Don't know	246	31
Not answered	145	18
Total	796	100

Too many homeowners do not know!

Same findings in UK (ref. Public Health England, Home Owner Knowledge of Radon in Areas where Full Radon Protection is Expected)

# Radon 2016

Question:

Have radon measurements been carried out?

## All dwellings

	N	%
Yes	28	4
No	634	80
Don't know	117	15
Not answered	17	2
Total	796	

# Norway's experience

- Specific radon preventive measures in national building codes works!
- Not only removing the highest radon concentrations -> ALARA!

Have to work on:

- All homeowners should measure radon concentration in their new home
- All homeowners should have knowledge about radon preventive measure in their new home
- Get more information about radon and preventive measures in block of flats and public buildings

Finne, I.E., Kolstad, T., Larsson, M., Olsen, B., Prendergast, J., Rudjord, A.L.

*Significant reduction in indoor radon in newly built houses*

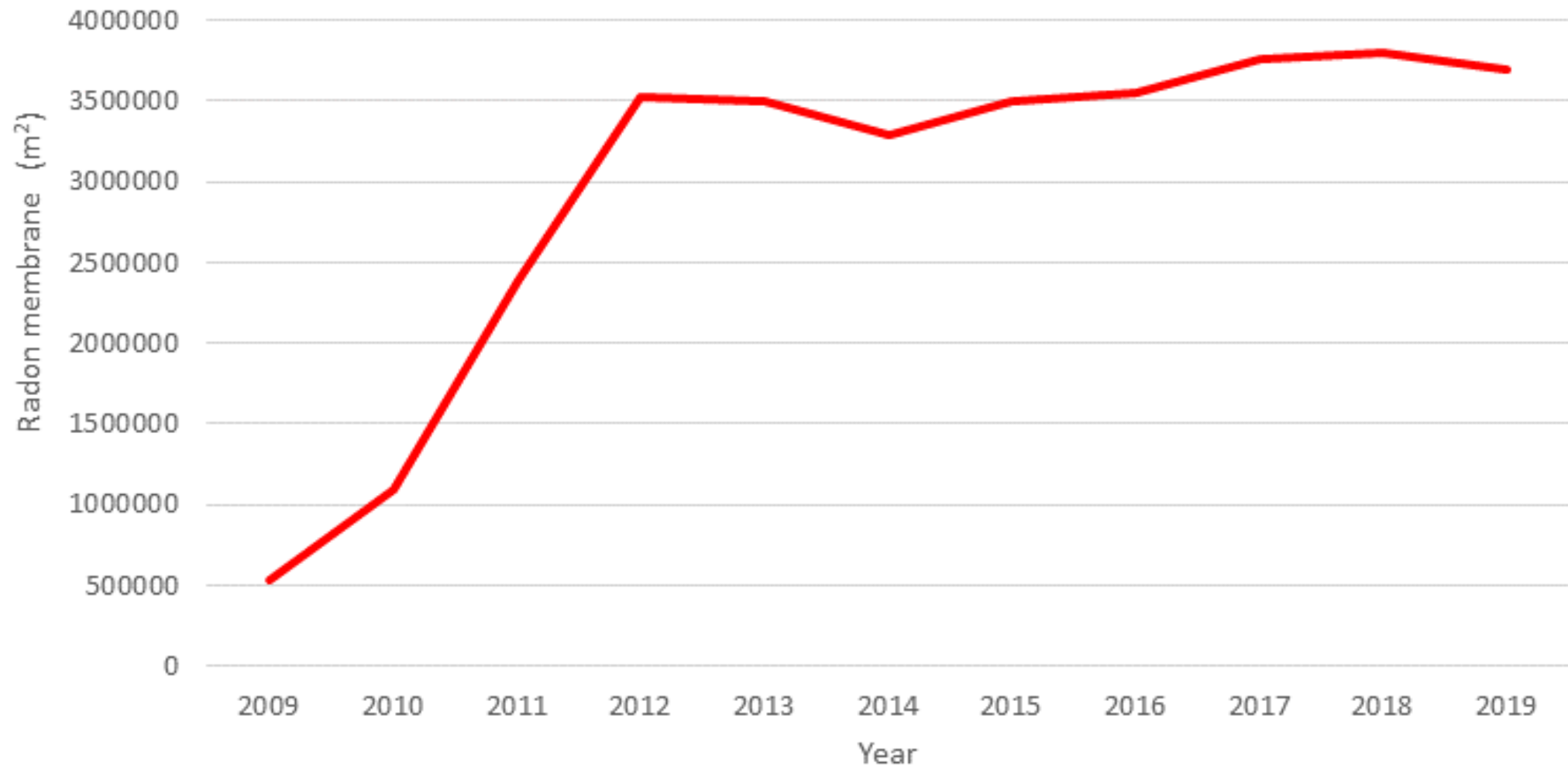
Journal of Environmental Radioactivity (2018), <https://doi.org/10.1016/j.jenvrad.2018.01.013>



# NRAP performance indicators

- Radon concentrations in new homes before and after the implementation of new regulations
- Radon membrane sale before and after the implementation of new regulations

## Radon membrane sale in Norway





2008:  
76 Bq/m<sup>3</sup>

**ALARA**  
in practice

2016:  
40 Bq/m<sup>3</sup>

Thank you  
for your  
attention!