The Norwegian electricity model for buildings LCA: characteristics and effects

Professor Rolf André Bohne
Leader Centre for Green Shift in the Built Environment
Department of Civil and Environmental Engineering
Norwegian University of Science and Technology

green 2050
Omstilling til karbonnøytralt bygget miljø

Overview

- The Norwegian electricity production
  - Physically delivered electricity
  - Electricity Certificates
  - Electricity disclosure
- ZEB
- NS3720

CO_2 physically delivered electricety

Nærmere om beregningen | 2022

Klimadeklarasjon for fysisk levert strøm for 2022 viser at strømmen som ble brukt i Norge i hovedsak kom fra fornybare energikilder. Vannkraft, vindkraft og annen fornybar stod for til sammen 95 prosent av strømforbruket. Beregnet CO2-faktor for bruk av strøm i Norge i 2022 er 19 g CO2e/kWh.

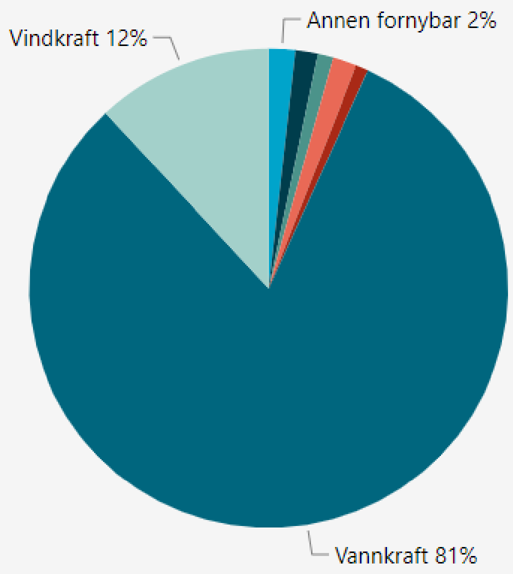
Det vil si at det gjennomsnittlige klimaavtrykket av å bruke strøm i Norge var 19 gram CO2-ekvivalenter for hver kilowattime i 2022.

Beregnet CO2-faktor for strømforbruk:

19

gram CO2e/kWh

Klimadeklarasjon for fysisk levert strøm 2022



Annen fornybar · Annen fossil · Gass · Kjernekraft · Kull · Vannkraft · Vindkraft

- 2020 - 8 g CO2 kWh
- 2021 – 11g CO2 kWh

https://www.nve.no/nytt-fra-nve/nyheter-energi/lavt-klimagassutslipp-knyttet-til-norsk-stroemforbruk-i-2021/

NTNU

green 2050

NORD POOL

MARKET DATA | TRADING | SERVICES | MEDIA | ABOUT US | MARKET UPDATES | LOG IN

EUROPE'S LEADING POWER MARKET

Nord Pool runs the leading power market in Europe, offering both day-ahead and intraday markets to its customers.

- QUICK LINKS
- FAVOURITES
- NORD POOL DAY-AHEAD
- NORD POOL INTRADAY
- NORD POOL UK
- REGULATING POWER
- POWER SYSTEM DATA
- MAPS
- DATA DOWNLOADS

Day-ahead overview

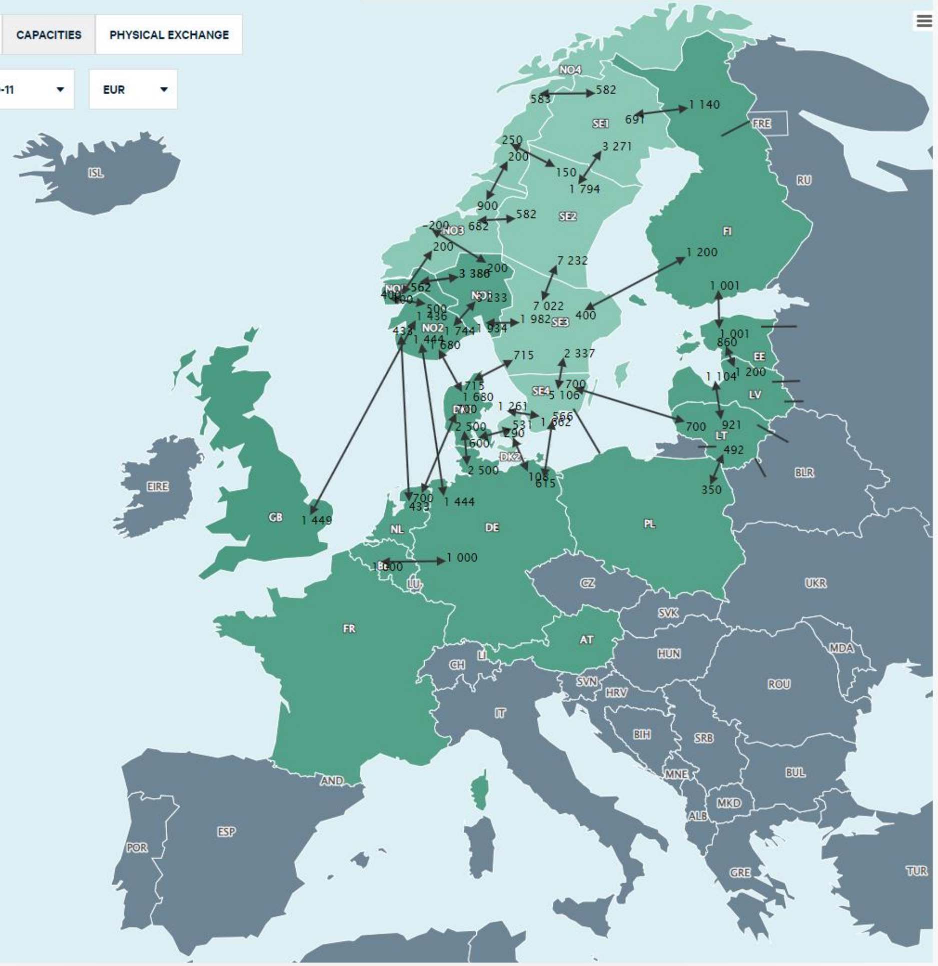
Nordic/Baltic/CWE | UK

PRICES | DAY-AHEAD FLOWS | CAPACITIES | PHYSICAL EXCHANGE

09 NOVEMBER 2023 | 10-11 | EUR

System price:

85.02



NORD POOL

MARKET DATA | TRADING | SERVICES | THE POWER MARKET
Day-ahead | Join our markets | Premium Data Services | Day-ahead market

Electricity Certificates (GO)

- Since January 1st in 2012, Norway and Sweden have established a joint market for electricity certificates.
- The common goal is to increase renewable electricity production by 28.4 TWh by 2020. In this way, Norway and Sweden both contribute to the targets in the EU Renewable Energy Directive.
- Electricity producers that invest in renewable power generation can receive certificates for the electricity generated for the next 15 years. One certificate is allocated for every new megawatt hour (MWh) produced renewable electricity. The electricity certificates are sold in a market where prices are determined by supply and demand. In this way, the electricity producers receive an extra income in addition to the electricity price.

NTNU green 2050

Electricity disclosure

Click to see the calculation

Year: 2022

Electricity disclosure statements for power suppliers

The *electricity disclosure* NVE publish is for power suppliers to use in their statement when they do not buy Guarantees of origin (GOs).

The electricity disclosure is an annual calculation of the origin of the electricity based on European trade of GOs, and does not refer to the actual delivery of electricity to end users in Norway.

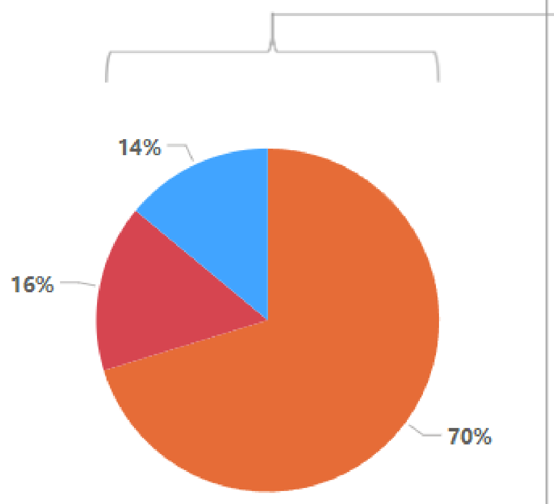
The calculation is based on all electricity sold in Norway the previous year. The electricity corresponding to the GOs that are sold is subtracted. The subtracted electricity is then of unknown origin and is replaced with a European Attribute Mix, which is an estimate of the electricity sold without GOs in Europe.

Calculated emissions in the electricity disclosure:

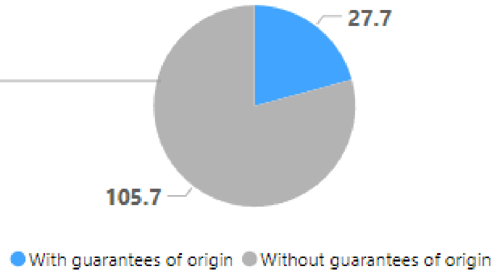
- CO_2-emission: 502 g/KWh*
- Radioactive waste: 0.59 mg RW/KWh*

*Based on electricity that can not be documented by GOs. The calculated emissions do not relate to the actual emissions of electricity generation in Norway.

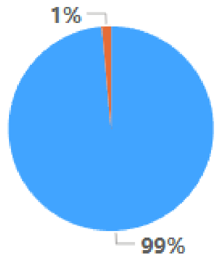
Disclosure for electricity purchases without guarantees of origin 2022 (105.7 TWh)



Electricity purchases in Norway with and without guarantees of origin 2022 (133.4 TWh)



Electricity generation in Norway 2022 (146 TWh)

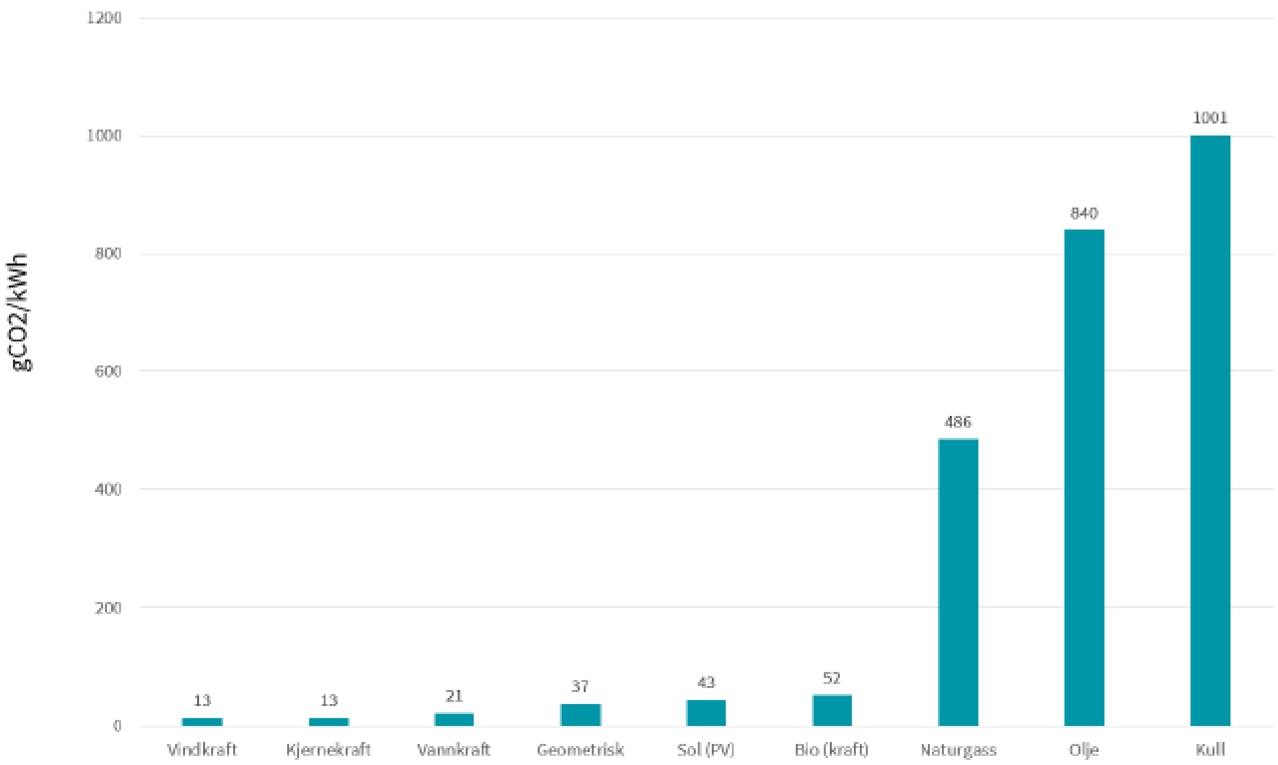


Renewable power   Nuclear power   Fossil thermal power

Power suppliers not buying Guarantees of Origin (GOs) must refer to the electricity disclosure published by NVE in their statements.

Norwegian Water Resources and Energy Directorate (NVE), https://www.nve.no/english/

CO2 faktors for kWh production



TEK 17

Kapittel 14 Energi

§ 14-2. Krav til energieffektivitet

(1) Det totale netto energibehovet for bygningen skal ikke overstige energirammene i tabellen i bokstav a samtidig som kravene i § 14-3 oppfylles.

a)

Tabell: Energirammer

Bygningskategori	*Totalt netto energibehov [kWh/m² oppvarmet BRA per år]*
Småhus, samt fritidsbolig over 150 m² oppvarmet BRA	100 + 1600/m² oppvarmet BRA
Boligblokk	95
Barnehage	135
Kontorbygning	115
Skolebygning	110
Universitet/høyskole	125
Sykehus	225 (265)
Sykehjem	195 (230)
Hotellbygning	170
Idrettsbygning	145
Forretningsbygning	180
Kulturbygning	130
Lett industri/verksteder	140 (160)

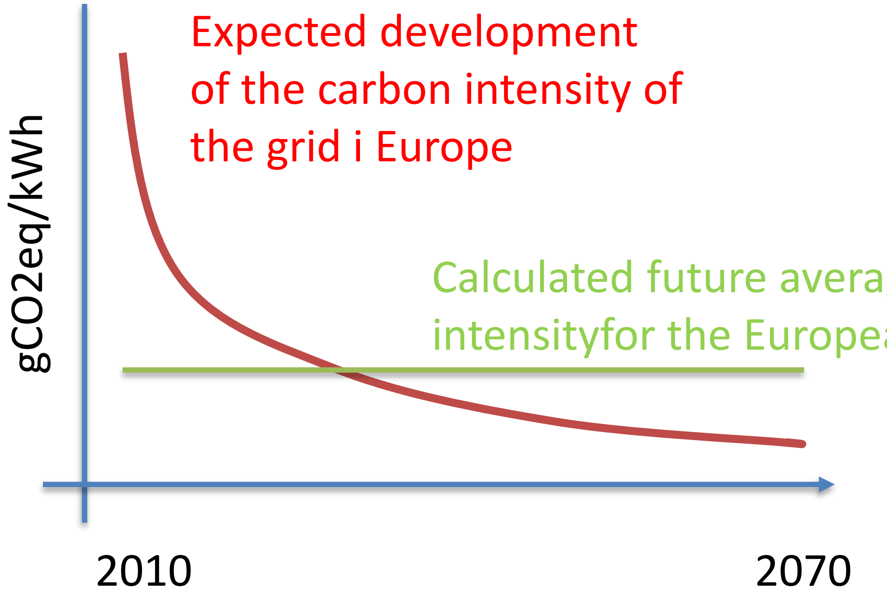
b) Kravene gitt i parentes gjelder for arealer der varmegjenvinning av ventilasjonsluft medfører risiko for spredning av forurensning eller smitte.

Tabell: Energitiltak

	Energitiltak	**Småhus**	**Boligblokk**
1.	U-verdi yttervegg [W/(m² K)]	≤ 0,18	≤ 0,18
2.	U-verdi tak [W/(m² K)]	≤ 0,13	≤ 0,13
3.	U-verdi gulv [W/(m² K)]	≤ 0,10	≤ 0,10
4.	U-verdi vinduer og dører [W/(m² K)]	≤ 0,80	≤ 0,80
5.	Andel vindus- og dørareal av oppvarmet BRA	≤ 25 %	≤ 25 %
6.	Årsgjennomsnittlig temperaturvirkningsgrad for varmegjenvinner i ventilasjonsanlegg (%)	≥ 80 %	≥ 80 %
7.	Spesifikk vifteeffekt i ventilasjonsanlegg (SFP) [kW/(m³ /s)]	≤ 1,5	≤ 1,5
8.	Luftlekkasjetall per time ved 50 Pa trykkforskjell	≤ 0,6	≤ 0,6
9.	Normalisert kuldebroverdi, der m² angis som oppvarmet BRA [W/(m² K)]	≤ 0,05	≤ 0,07

ZEB – and the need for a future average CO2-factor

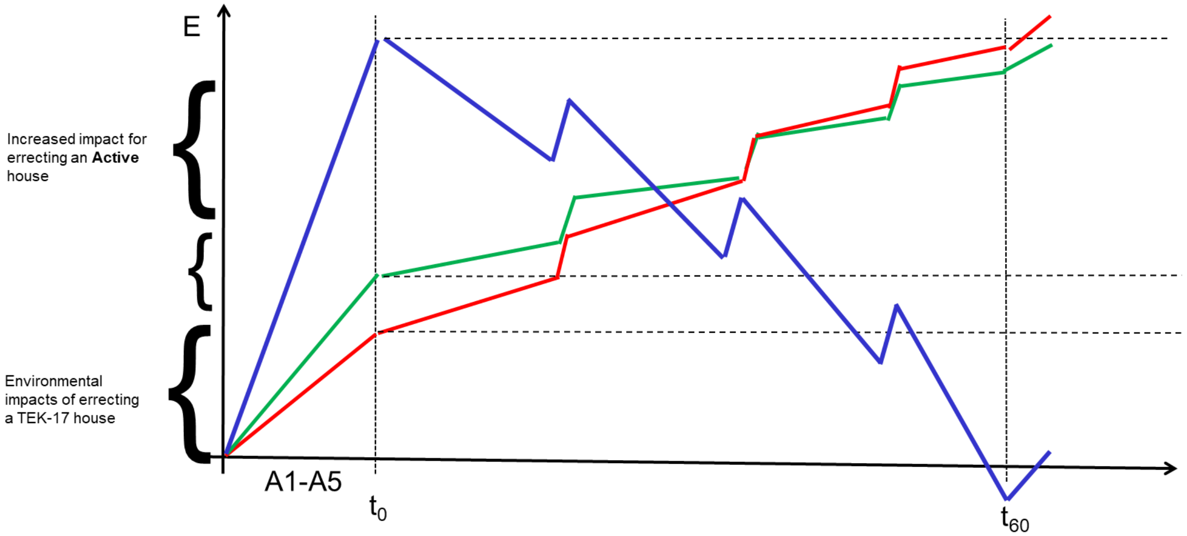
With the development of Zero-Emission-Buildings, the need for an average «future CO2-factor» emerged, in order to calculate «0»

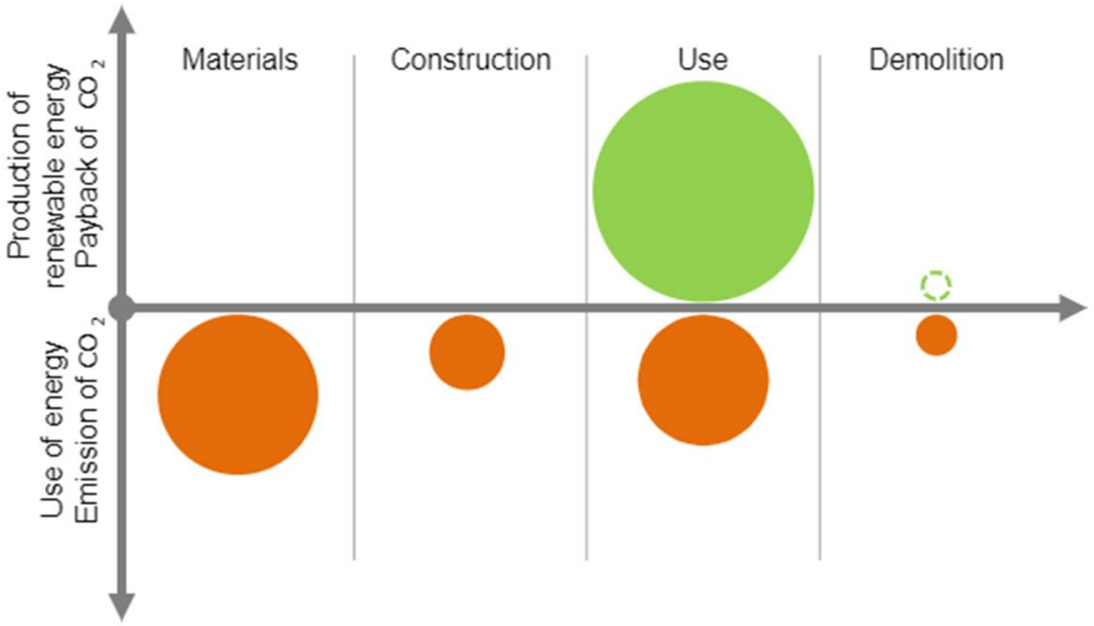


The research project ZEB, **first** developed such a factor, described at the calculated average for the European grid for the period 2010 to 2050, and extrapolated towrads 2070.
Later NS3720 for the period 2015-2075

ZEB => 132 gCO2eq/kWh
NS3720 => 136 gCO2eq/kWh

ZeroEmissionBuildings (ZEB)





$$\Delta E =$$
$$EE_c + EE_m + EE_{plet} + EE_e + \sum_{N=1}^{N=60} \Delta E_{O,N}$$
$$\left(kg\ CO_2\text{-ekv.}/m^2\right)$$

As defined and used by the research centers:

- ***The Research Centre on Zero Emission Buildings, ZEB*** (2009-2017)**,** and http://www.zeb.no/index.php/en/
- ***Zero Emission Neighbourhoods (ZEN) in Smart Cities*** (2018 - 2024) https://fmezen.com/about-us/

NS3720 -

- Two choices:
  - Scenario 1 NO
  - Scenario 2 EU28+NO

Tabell A.1 – GHG-faktorer (CO_2-ekvivalenter) for ulike produksjonsteknologier samt faktorer for de to ulike scenariene for produksjonsmiksen i elektrisitetsforsyningen til EU28, Island og Norge

Produksjons-teknologi	CO_2-faktor (g/kWh)	Kilde
Vannkraft	2–20	Turconi, R., Boldrin, A. and Astrup, T. (2013), Life cycle assessment (LCA) of electricity generation technologies: Overview, comparability and limitations, *Renewable and Sustainable Energy Reviews*, 28 (2013) 555–565.
Vindkraft	3–41	
Kullkraft	660–1300	
Naturgass	380–1000	
PV – solenergi	13–190	
Biotermisk	8,5–130	
Kjernekraft	3–35	EPD® Electricity from Vattenfall Nordic Nuclear Power Plants https://www.environdec.com/Detail/?Epd=11982
Varmekraft fra naturgass med CCS	~100	Modahl, I.S., Askham, C., Lyng, K.-A. and Brekke, A.: Weighting of environmental trade-offs in CCS - An LCA case study of electricity from a fossil gas power plant with post-combustion CO_2 capture, transport and storage, Int, J, Life Cycle Assessment, Springer-Verlag, 27, March 2012, Volume 17, Issue 7 (2012), side 932–943 (http://www.springerlink.com/openurl.asp?genre=article&id=doi:10.1007/s11367-012-0421-z)
Varmekraft i Norge	450	SSB og http://www.uni-obuda.hu/users/grollerg/LCA/hazidolgozathoz/lca-electricity%20generation%20technologies.pdf
Varmekraft i EU	800	Eurostat og http://www.uni-obuda.hu/users/grollerg/LCA/hazidolgozathoz/lca-electricity%20generation%20technologies.pdf
Scenario 1 – NO,	18*	Beregnet på bakgrunn av norsk produksjon i dag og antatt innslag av vann-, vind- og varmekraft som andel av total energiproduksjon i 2050. Basert på middelverdier i Turconi et al. (2013) og tabell C.2.
Scenario 2 – EU28+NO	136*	Beregnet på bakgrunn av Eurostat og EUs Roadmap2050 og http://www.uni-obuda.hu/users/grollerg/LCA/hazidolgozathoz/lca-electricity%20generation%20technologies.pdf

* Gjennomsnitt for perioden 2015 til 2075.

Norsk Standard

NS 3720:2018

Publisert: 2018-09-01

Språk: Norsk

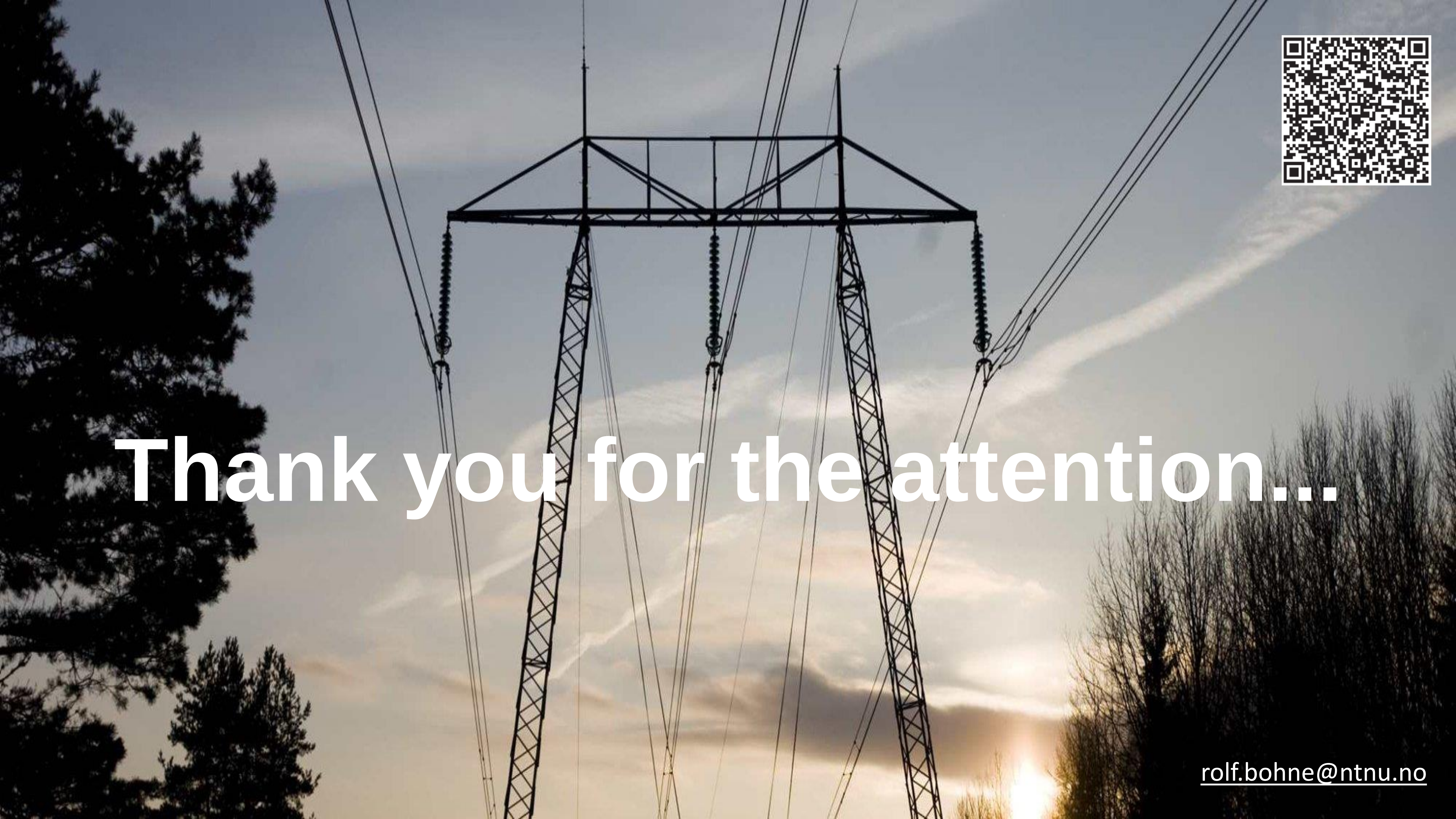
Metode for klimagassberegninger for bygninger

Method for greenhouse gas calculations for buildings

Under revision!

Standard Norge

Referansenummer:
NS 3720:2018 (no)



Thank you for the attention...

rolf.bohne@ntnu.no