Norwegian
Meteorological
Institute

Perspectives of airborne nitrogen input reduction by 2030 (results from the ENIRED-II project)

Michael Gauss, Agnes Nyiri, Heiko Klein

EMEP MSC-W
Norwegian Meteorological Institute, Oslo, Norway

HELCOM

HELCOM ACTION workshop 4.2, Gothenburg, 12 March 2020

The EMEP MSC-W model

- A state-of-the-art chemistry transport model
- Long tradition as scientific tool to underpin policy decisions under the UN LRTAP Convention
- Participating in numerous national and international research projects and operational services
- Regularly evaluated against measurements

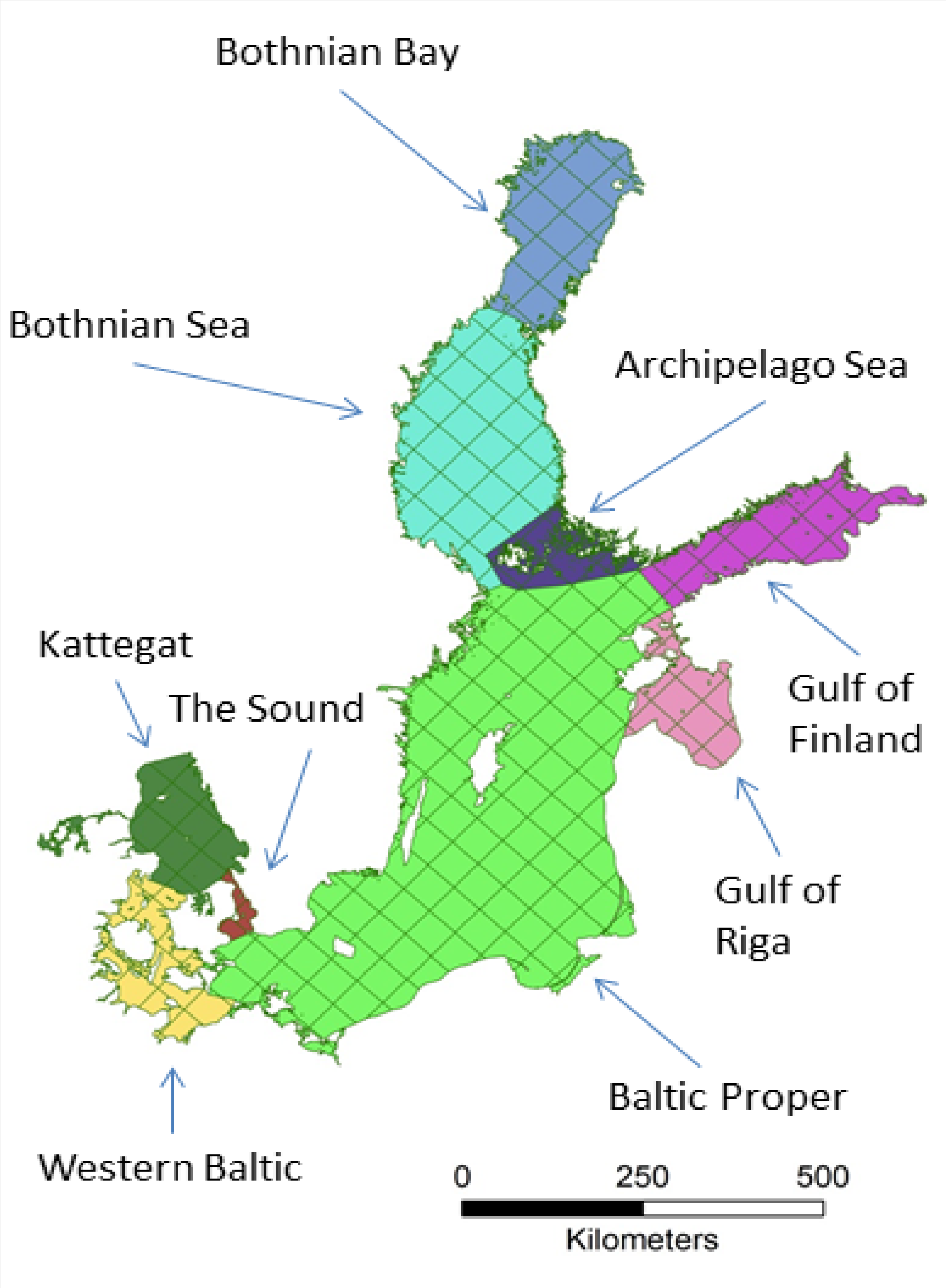
- EMEP MSC-W has decades of experience in air quality and deposition modelling, and in source-receptor calculations like this

Scientific/Policy questions

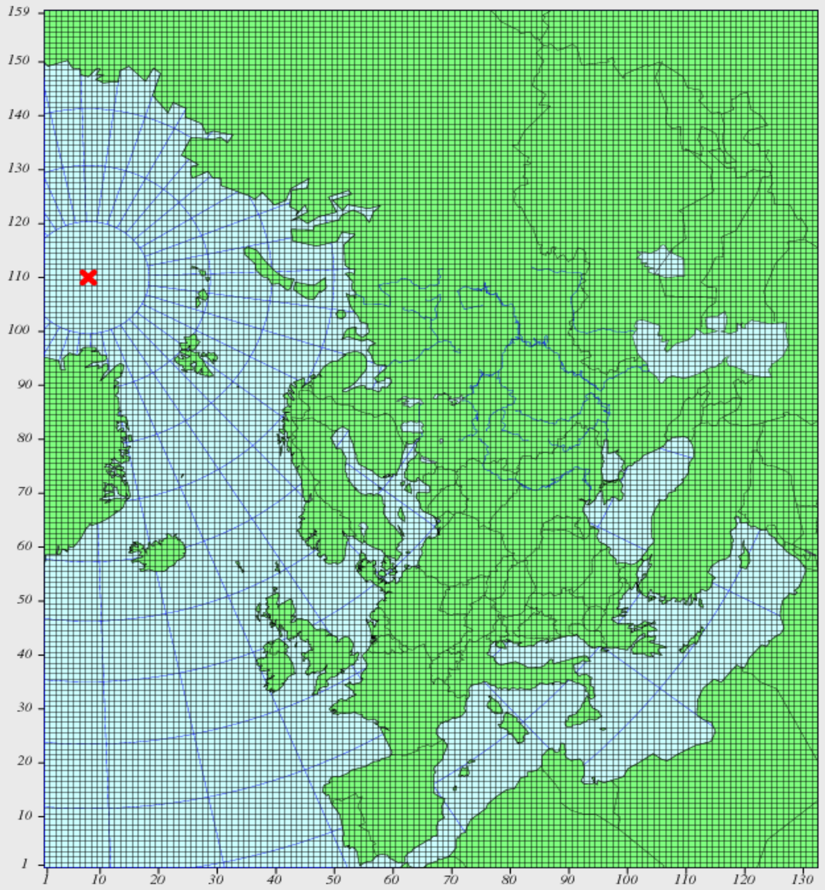
- How large a reduction in N-deposition on the Baltic Sea can be achieved through the implementation of the Gothenburg Protocol/ NEC Directive?
- Reference year: 2005 // Target year: 2030
- *And: By how much can each country's contribution be reduced?*
- Emitters: The nine HELCOM countries, North Sea and Baltic Sea shipping, Rest of EU, Rest of World.
- Receptors: The Baltic Sea and its nine sub-basins.

The 9 sub-basins of the Baltic Sea

Abbreviation	Sub-basin
ARC	Archipelago Sea
BAP	Baltic Proper
BOB	Bothnian Bay
BOS	Bothnian Sea
GUF	Gulf of Finland
GUR	Gulf of Riga
KAT	Kattegat
SOU	The Sound
WEB	Western Baltic



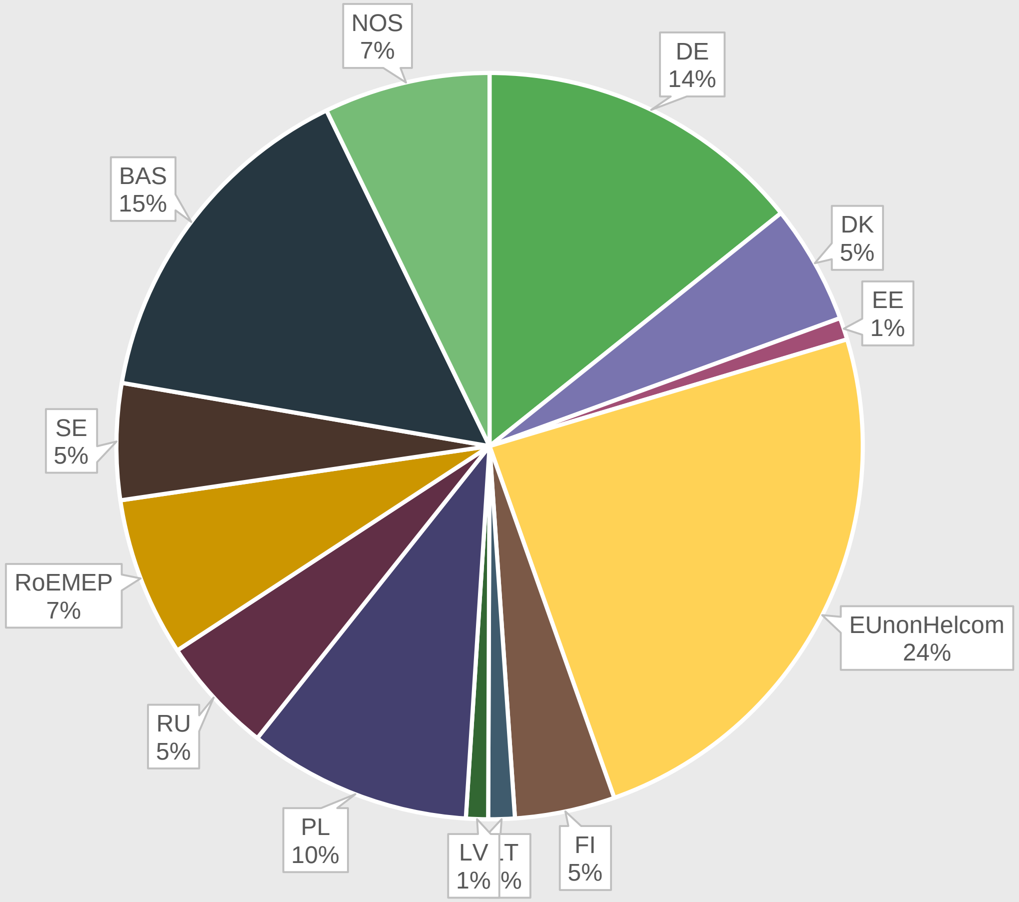
Model setup



- 50 x 50 km^2 polar-stereographic grid
- Meteorological data:
  - ECMWF data from five carefully selected years out of the 2000-2017 period (2002, 2005, 2007, 2009, and 2013)
- Emission data:
  - 2005 : latest data provided by CEIP, based on officially reported emissions (as of 2019)
  - 2030 : best available (gridded) data set, provided by IIASA
  - We have made sure that the NEC Directive is followed exactly in the calculation
  - Emissions from international shipping: Data from the Finnish Meteorological Institute

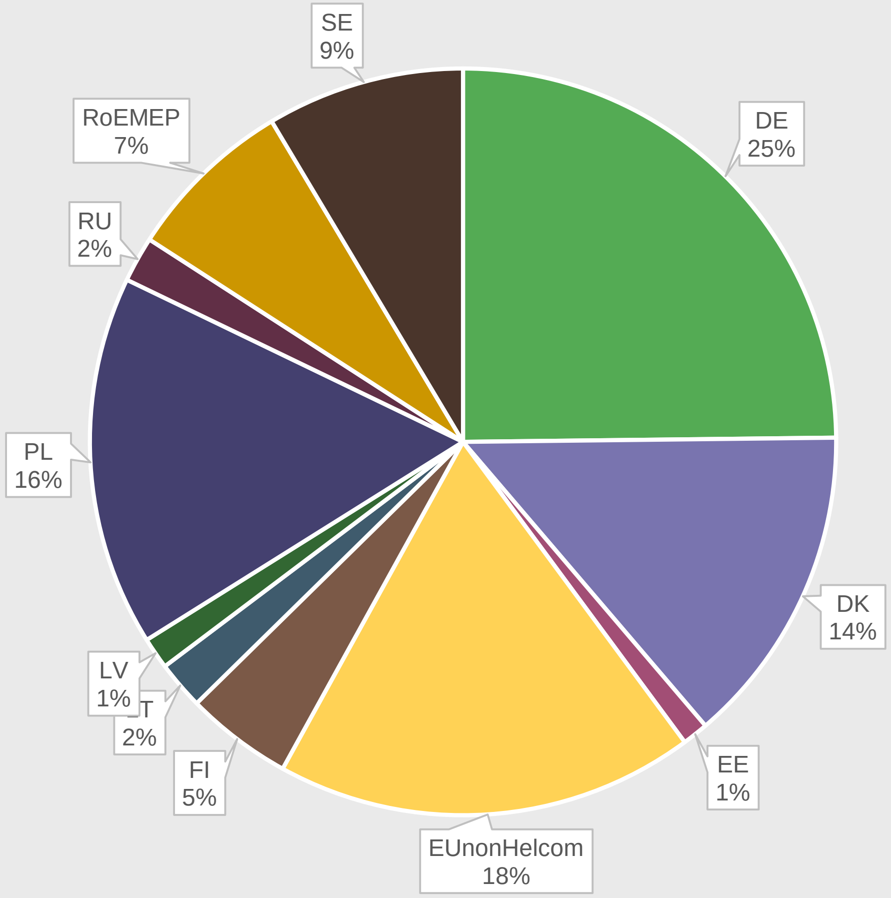
Percentage contributions to deposition in the Baltic Sea '2005'

Oxidized nitrogen



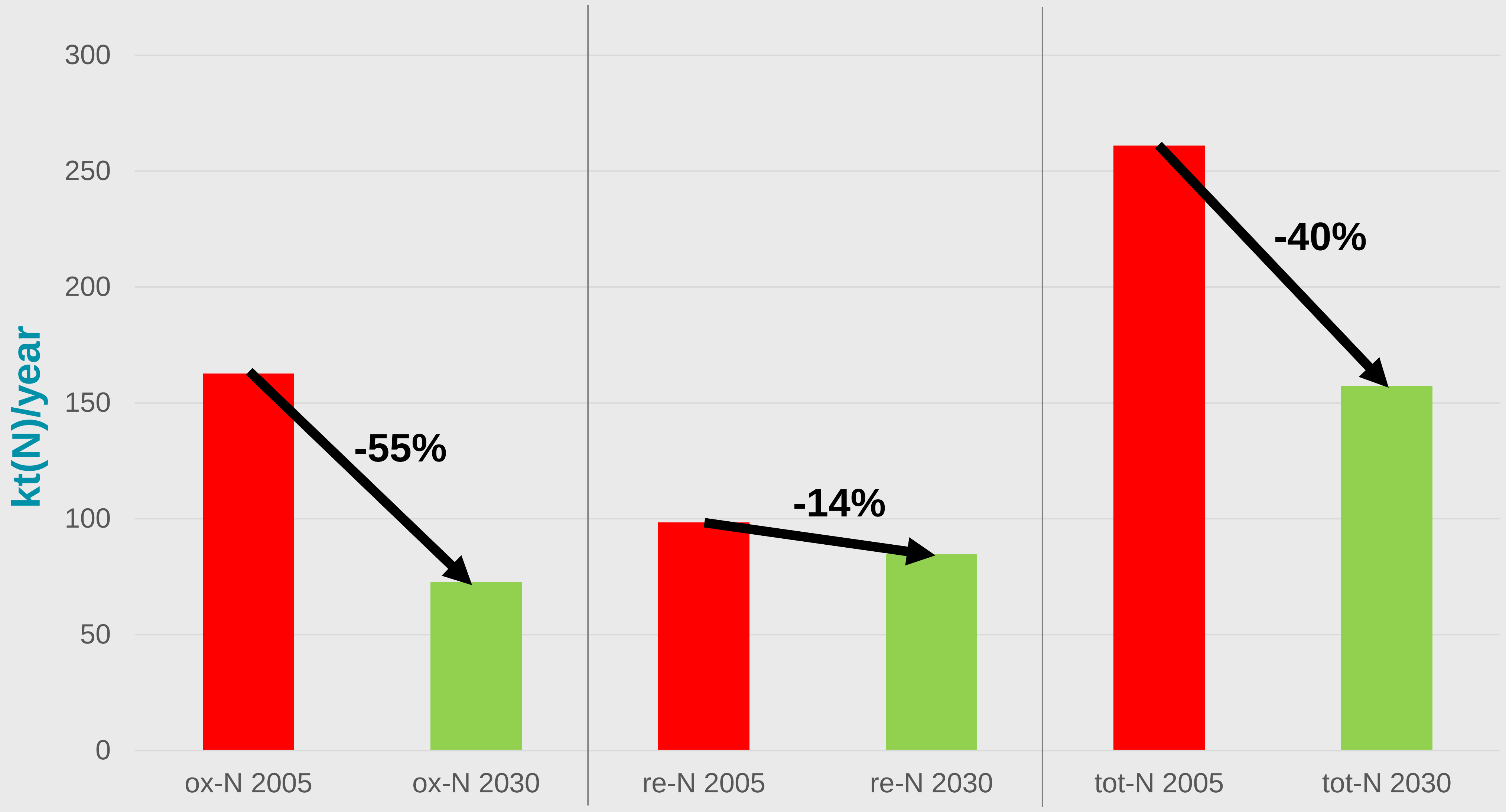
Total: 163 kt(N)/year

Reduced nitrogen

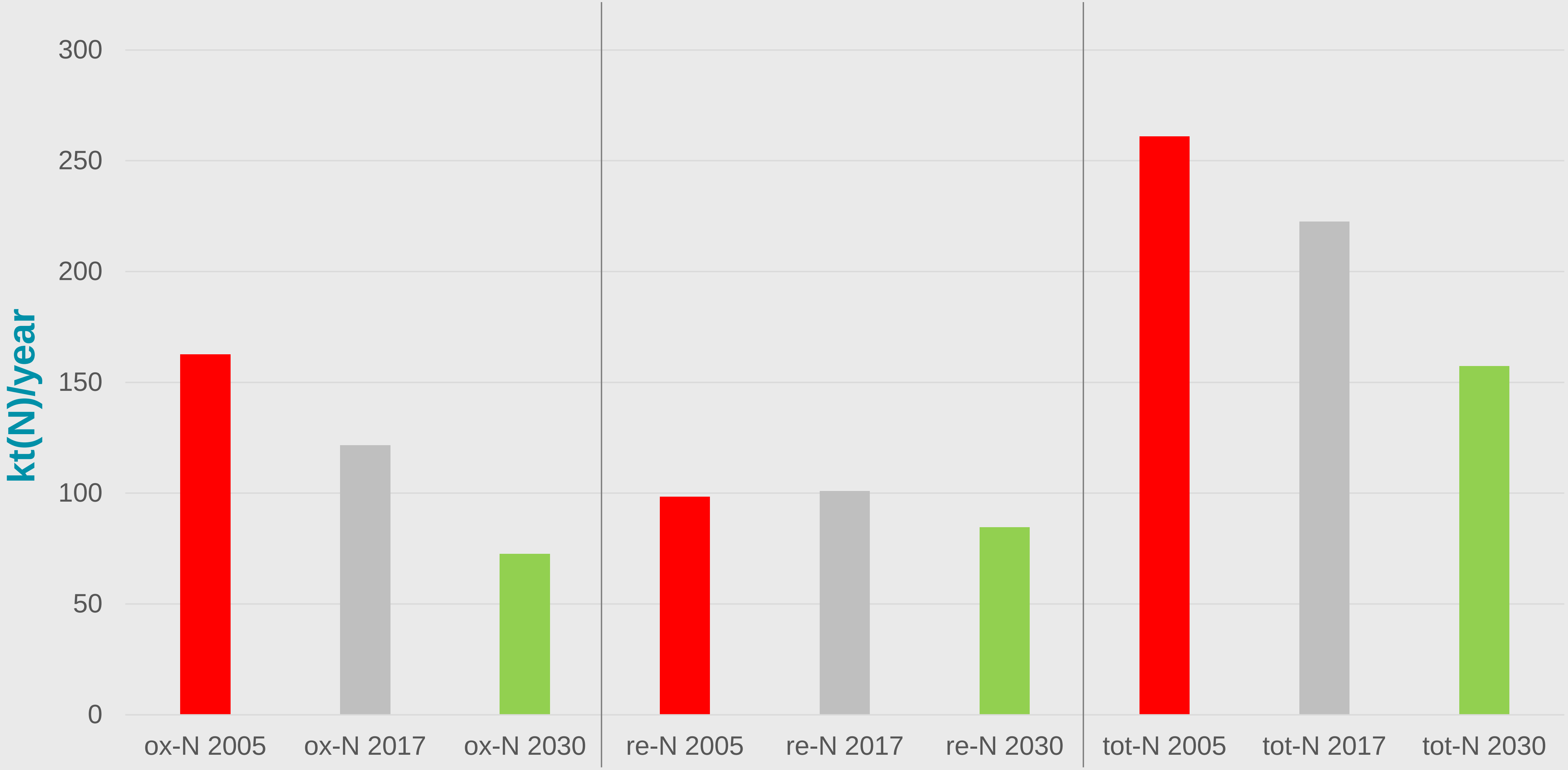


Total: 98 kt(N)/year

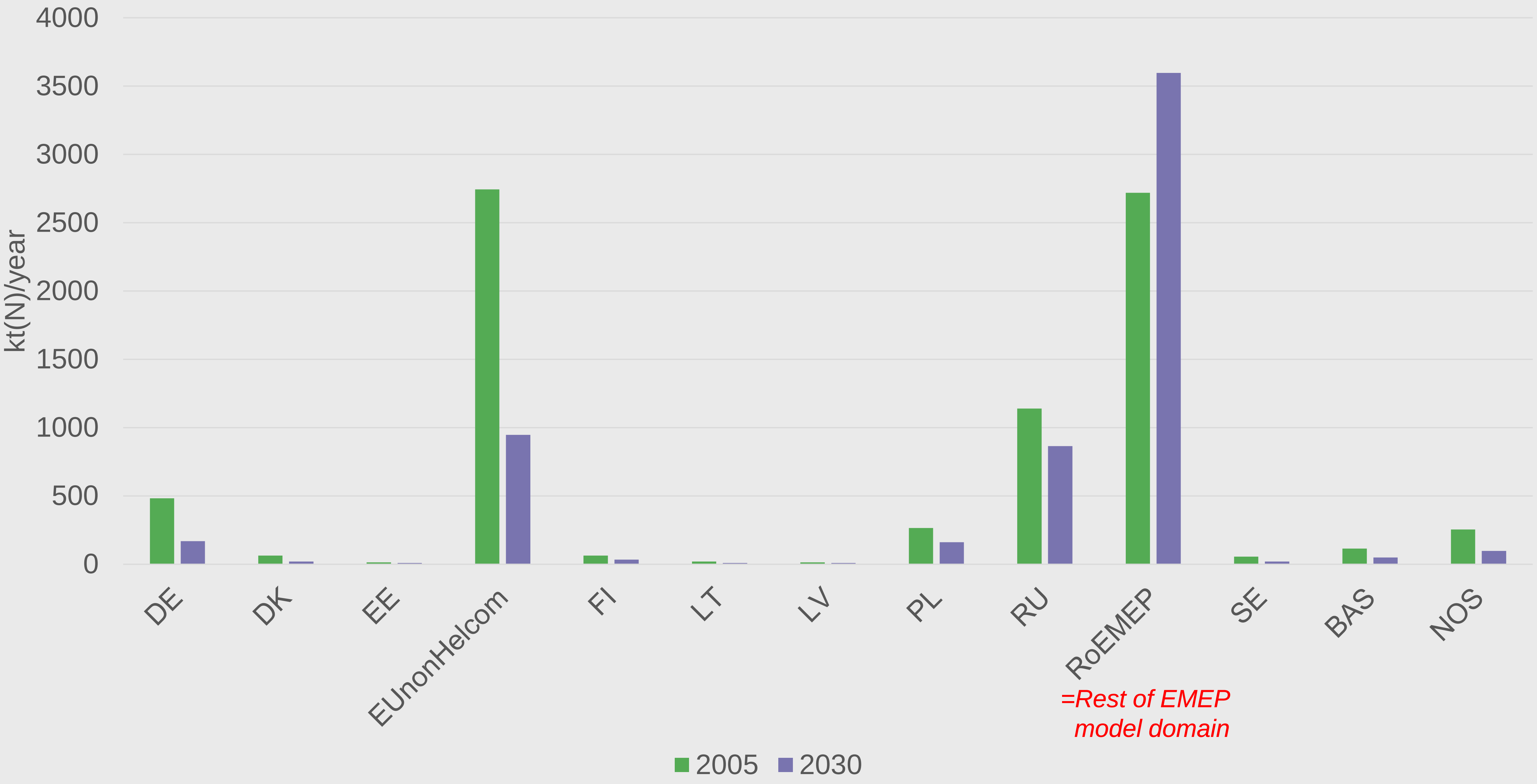
Change in N deposition to the Baltic Sea from 2005 to 2030

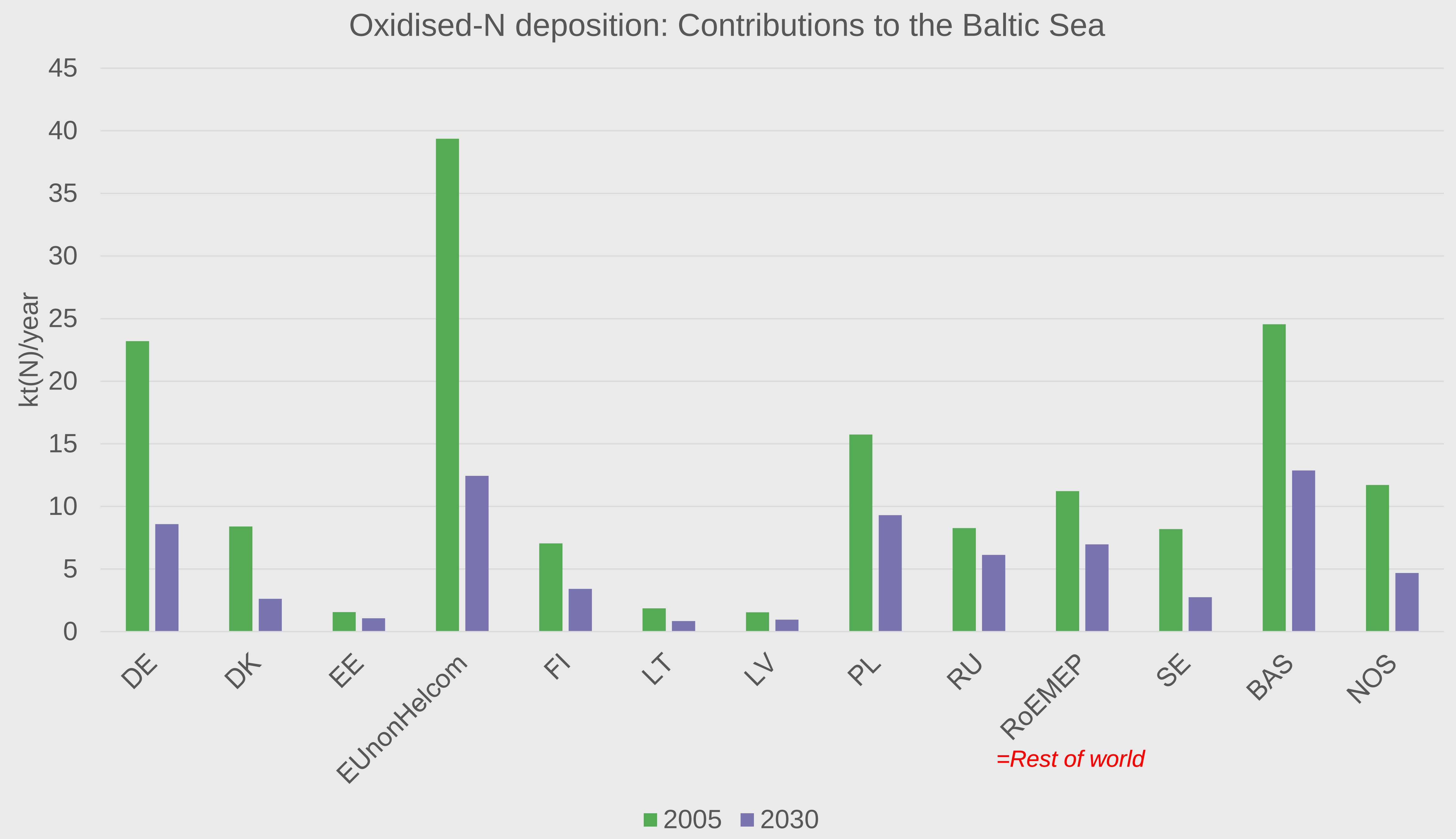


How have we been doing so far?

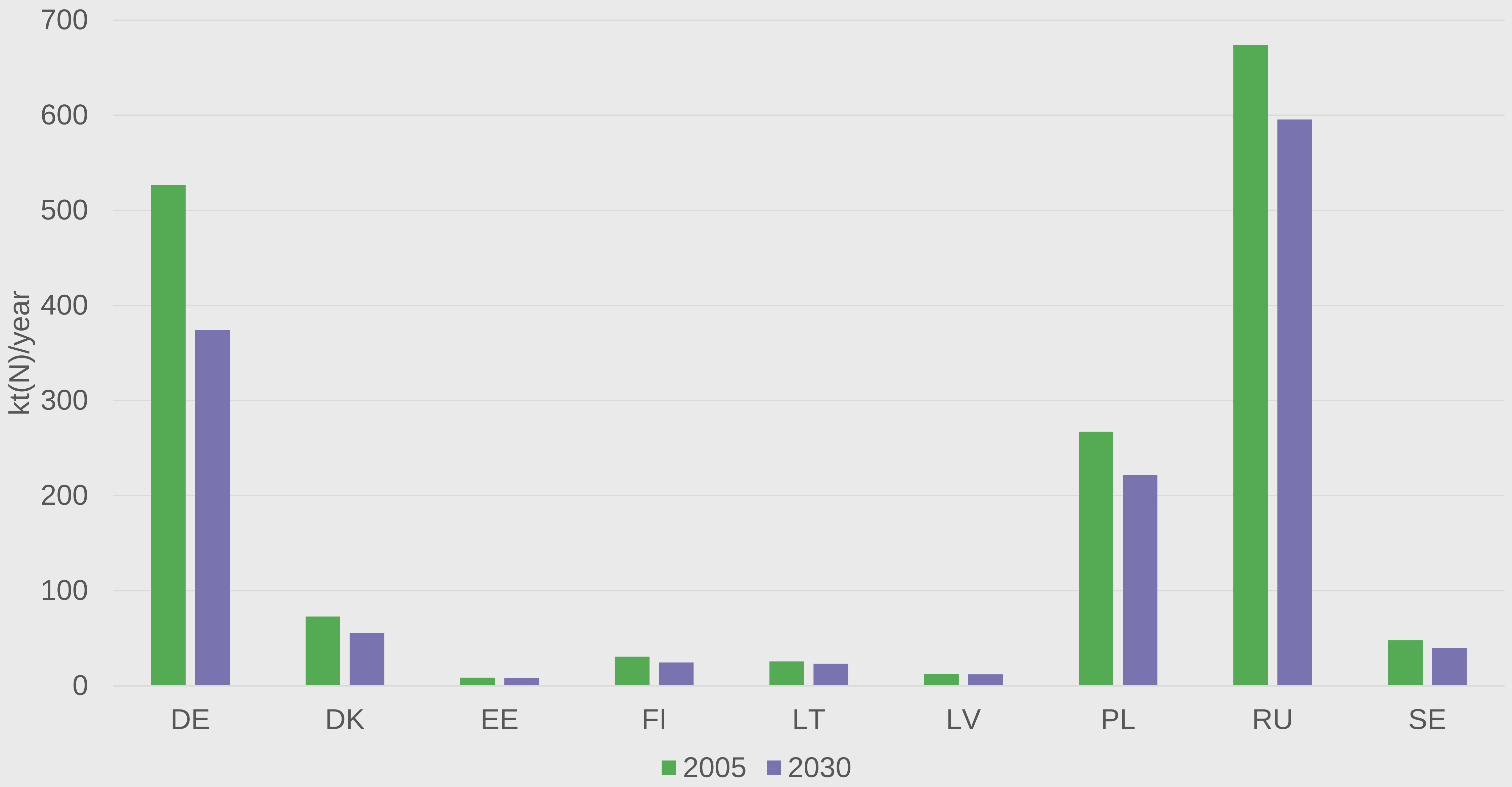


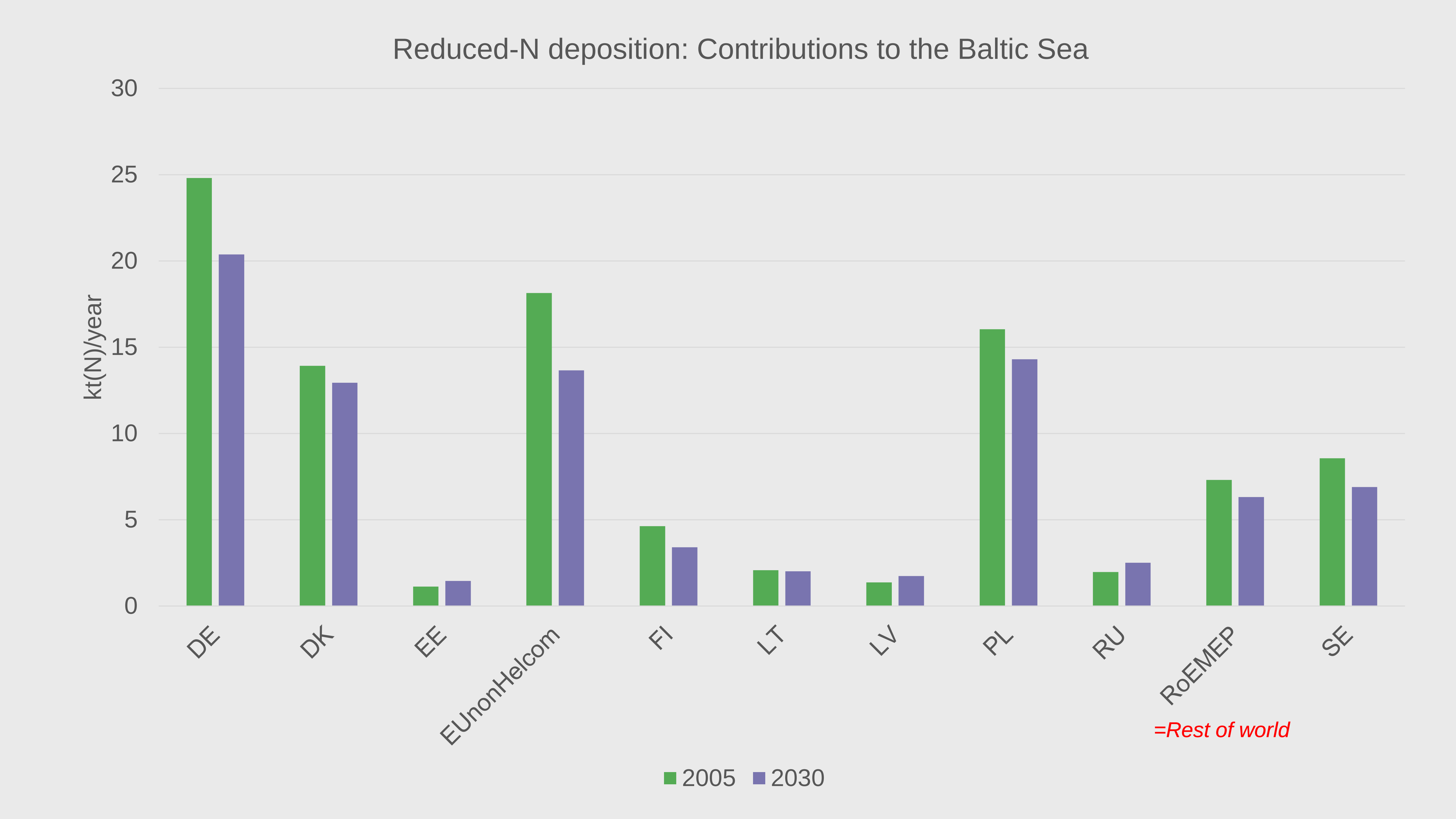
Oxidised-N emissions




Oxidised-N deposition: Contributions to the Baltic Sea
kt(N)/year
45
40
35
30
25
20
15
10
5
0
DE
DK
EE
EUnonHelcom
FI
LT
LV
PL
RU
RoEMEP
SE
BAS
NOS
=Rest of world
2005
2030

Reduced-N emissions




Reduced-N deposition: Contributions to the Baltic Sea
kt(N)/year
0
5
10
15
20
25
30
DE
DK
EE
EUnonHelcom
FI
LT
LV
PL
RU
RoEMEP
SE
=Rest of world
2005
2030

Changes in deposition for each sub-basin

	Oxidized nitrogen			Reduced nitrogen			Total nitrogen		
	2005 kt(N)/yr	2030 kt(N)/yr	Change %	2005 kt(N)/yr	2030 kt(N)/yr	Change %	2005 kt(N)/yr	2030 kt(N)/yr	Change %
BOB	6.3	2,8	-55,8	2.9	1,9	-32,8	9.2	4,7	-48,7
BOS	14.3	6,4	-55,4	6.1	5,1	-17,0	20.4	11,4	-43,9
GUF	12.2	6,3	-48,6	5.7	4,7	-17,3	17.9	11,0	-38,6
GUR	7.6	3,6	-52,9	3.9	3,4	-13,2	11.4	6,9	-39,5
BAP	90.9	40,4	-55,5	53.7	47,3	-11,9	144.6	87,7	-39,3
SOU	1.7	0,7	-59,0	1.3	1,1	-11,5	2.9	1,8	-38,5
KAT	13.0	5,4	-58,3	10.1	8,0	-20,1	23.0	13,4	-41,6
ARC	5.3	2,5	-53,7	2.6	2,2	-14,3	7.9	4,7	-40,9
WEB	11.5	4,7	-58,8	12.2	10,9	-10,8	23.7	15,6	-34,0
sum	**162.7**	**72,7**	**-55,3**	**98.4**	**84,7**	**-13,9**	**261.1**	**157,4**	**-39,7**

Deposition of oxidized, reduced and total nitrogen in the nine sub-basins of the Baltic Sea in 2005 and 2030 (ktonnes(N)/year), as calculated by the average over the five selected meteorological years, along with percentage changes from 2005 to 2030.

Changes in contributions to tot-N deposition

	DE	DK	EE	FI	LT	LV	PL	RU	SE	BAS	NOS
BOB	-56	-54	-18	-49	-34	-19	-36	-24	-62	-51	-65
BOS	-53	-53	-16	-40	-34	-19	-36	-21	-40	-51	-62
GUF	-53	-53	-5	-47	-34	-19	-34	-17	-46	-47	-63
GUR	-51	-51	5	-44	-34	0	-34	-19	-49	-54	-62
BAP	-40	-34	-6	-39	-24	-5	-23	-11	-41	-48	-61
SOU	-41	-20	-20	-46	-28	-19	-29	-18	-31	-38	-58
KAT	-43	-28	-16	-43	-27	-15	-27	-17	-42	-41	-51
ARC	-52	-53	-13	-24	-35	-21	-36	-21	-38	-48	-61
WEB	-26	-15	-21	-47	-27	-19	-26	-21	-44	-49	-56
Sum	-40	-30	-6	-42	-27	-8	-26	-16	-42	-48	-60
emis	-46	-44	-18	-38	-27	-18	-28	-20	-43	-57	-62

Percentage changes from 2005 to 2030 in the contributions from HELCOM countries (and Baltic Sea and North Sea shipping) to total nitrogen deposition in each of the nine sub-basins. Emitters are listed in the top row, receptors are listed in the vertical. ‘Sum’ gives the percentage change for the sum of contributions from one emitter to all the nine sub-basins. The last row (‘emis’) shows the percentage change in *total nitrogen* emissions for each emitter.

Conclusions

- Large reductions can be achieved in oxidized nitrogen deposition to the Baltic Sea, thanks to emission reductions in all HELCOM countries (incl. the Russian Federation), as well as other EU countries and reductions in emissions from international shipping
    - All contributions from individual countries/regions (and shipping) to the Baltic Sea and its sub-basins decrease
- Deposition of reduced nitrogen will be reduced by a smaller amount, but still substantially
    - Contributions from individual countries to the Baltic Sea and its sub-basins decrease in most cases
- Note that part of the percentage reductions between 2005 and 2030 has already occurred