

Integrating Externalities in Optimisation of Future Energy Systems

Kenneth Karlsson and the CEEH community

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Centre of Energy, Environment and Health

The objective of CEEH is to establish an interdisciplinary based system to support optimal future planning of energy production and usage with respect to costs related to the natural environment and human health

Focus is on Denmark and the Nordic Countries

Centre Partners

Niels Bohr Institute (NBI) - University of Copenhagen (UoC)

Danish Meteorological Institute (DMI)

National Environment Research Institute (NERI) - University of Aarhus (AU)

National Institute of Public Health (NIPH) - University of Southern Denmark (SDU)

Risø National Laboratory - Technical University of Denmark (DTU)

Centre for Applied Health Services Research and Technology Assessment (CAST)
- University of Southern Denmark (SDU)

Institute for Public Health - University of Aarhus (AU)



International Collaboration Partners

Dong Energy (Denmark)
University of Queensland (Australia)
Freie Universität Berlin (Germany)
Finnish Meteorological Institute
International Institute for Applied Systems Analysis (Laxenburg, Austria)
CEREA (Marne la Vallée, France)
Los Alamos Laboratory (New Mexico, USA)
University of Cologne (Germany)
Energy Research Centre of the Netherlands
University of Leicester (UK)
VITO (Boeretang, Belgium)
ENEA (Rome, Italy)
ICMMG (Novosibirsk, Russia)
Vienna University of Technology (Austria)
RIVM (Bilthoven, Netherlands)
Institute of North Ecology problems (Russia)
University Medical Centre, ERASMUS MC, (Netherlands)



Organisation

Steering Board

Eigil Kaas, UoC
Allan Gross, DMI
Alexander Baklanov, DMI
Kenneth Karlsson, Risø
Jesper Christensen, NERI
Jørgen Brandt, NERI
Jakob Bønløkke, AU
Torben Sigsgaard, AU
Henrik Brønnum-Hansen, NIPH
Knud Juel, NIPH
Jan Sørensen, SDU
Per Ponsaing, DONG

External Partners

Companies, Research institutions etc.

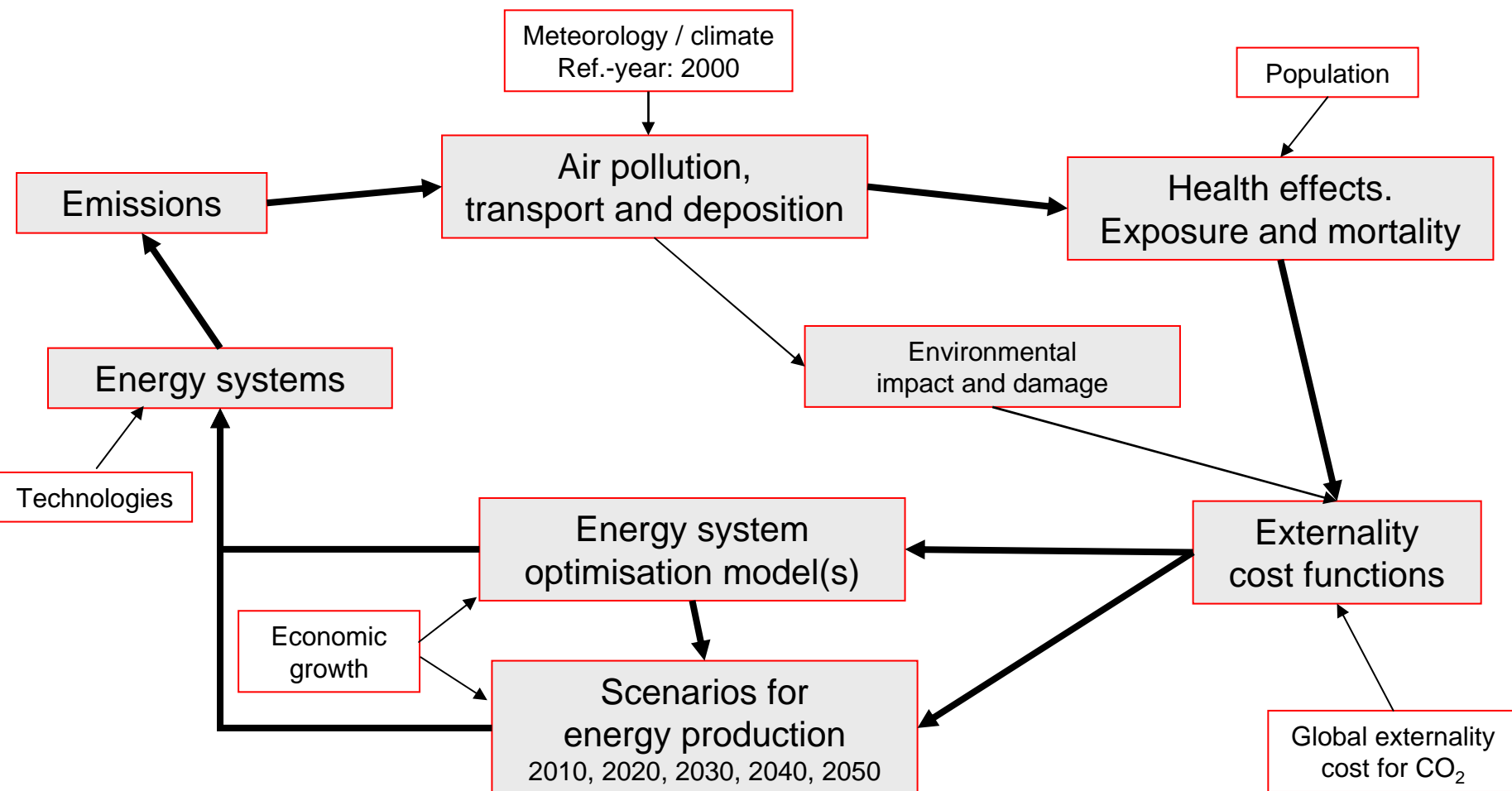
Management

Eigil Kaas, Director
Torben Sigsgaard, Vice-director
Alexander Baklanov, Vice-director
Marie-Louise Siggaard-Andersen, Manager

Work packages

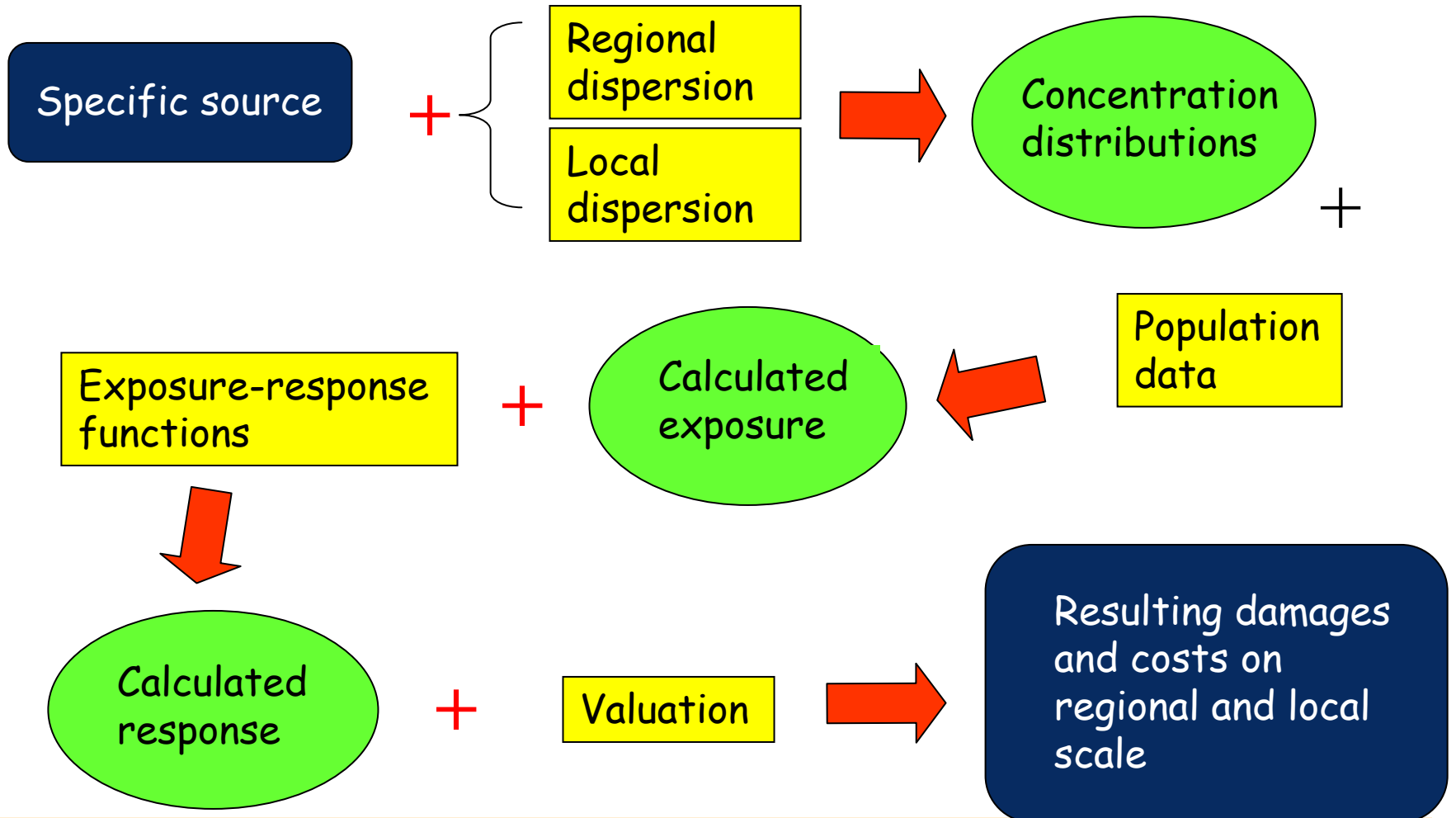
WP1 WP2 WP3 WP4 WP5 WP6 WP7

Centre for Energy, Environment and Health



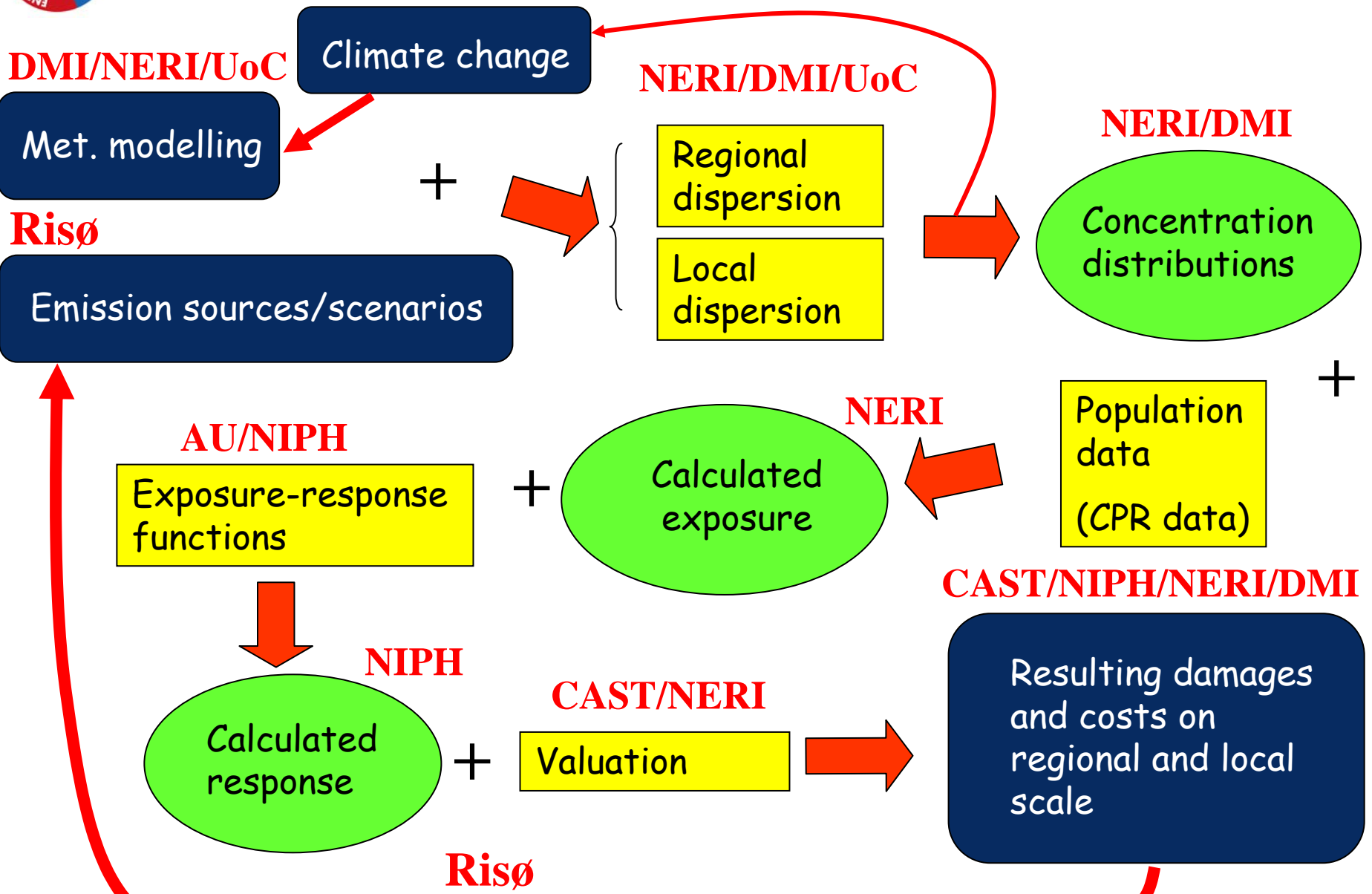
Chain of Impacts

Assessments of air pollution related damages on human health - and the subsequent costs - based on ExterneE - Externalities of Energy

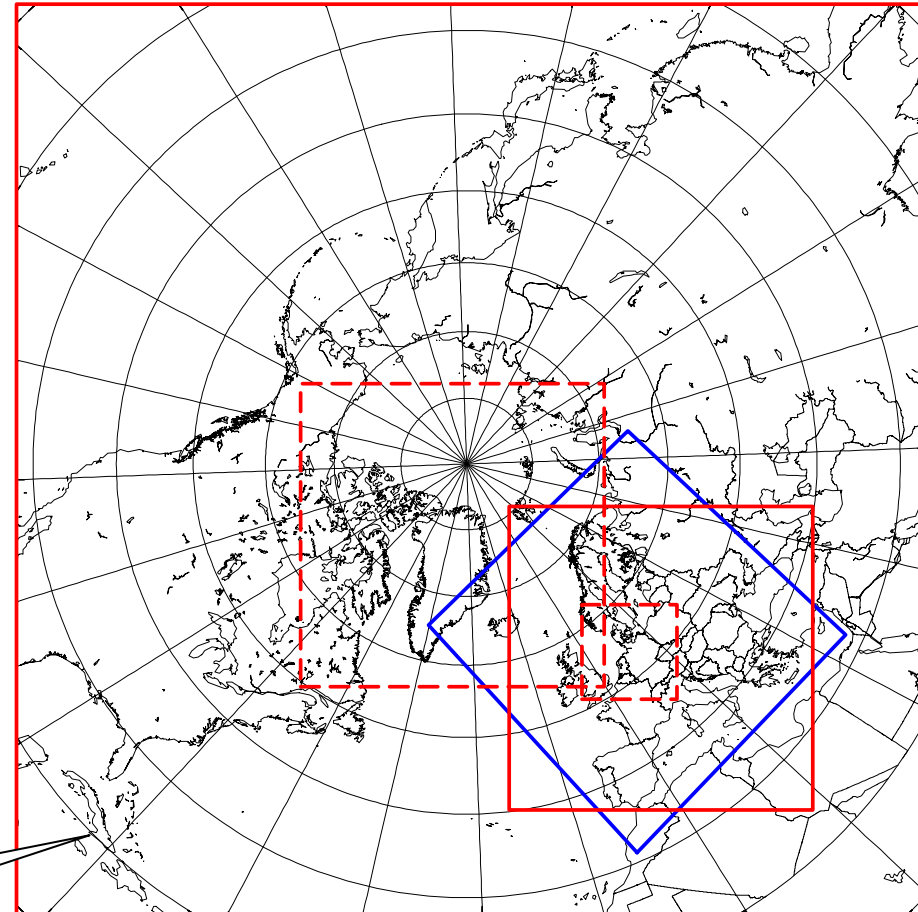
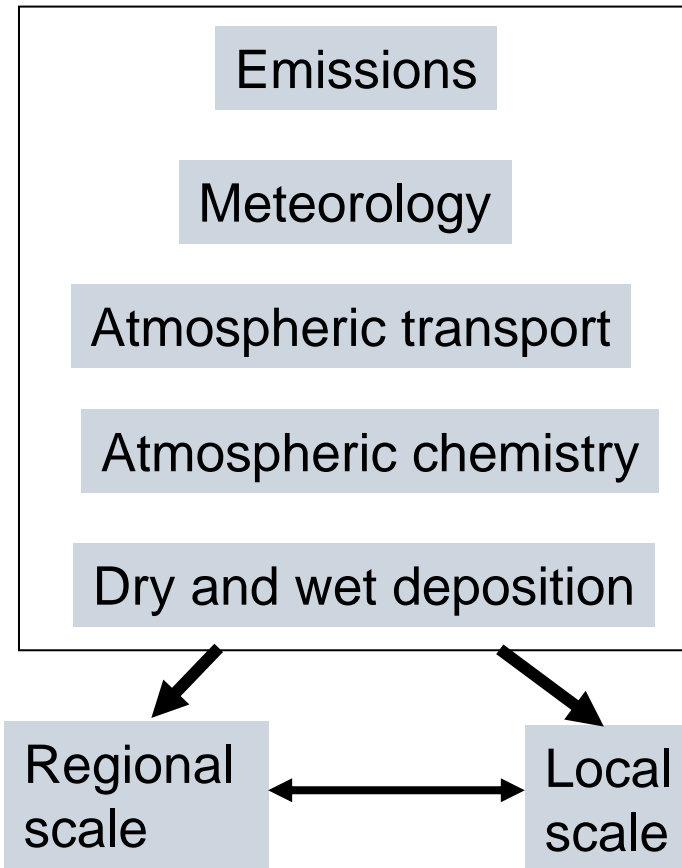




The CEEH Chain Impacts



DEHM System - NERI

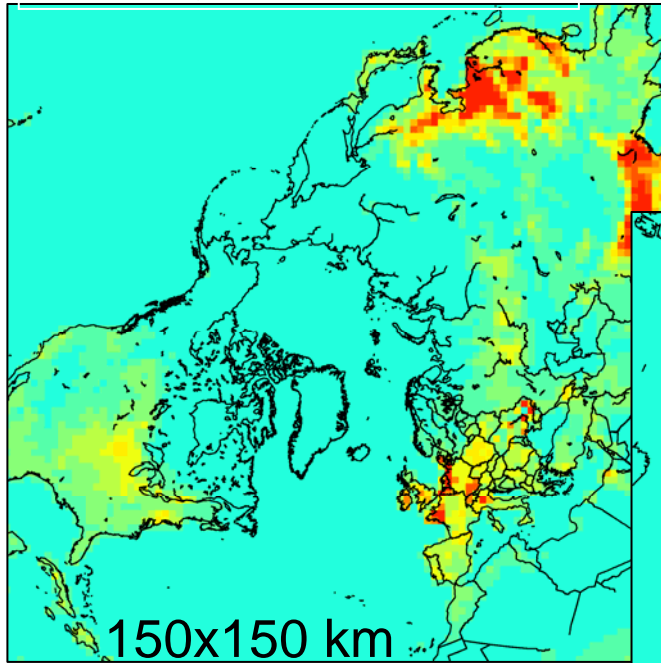


Polar stereographic projection with
a 32° rotation of the plane

MM5 DEHM model domains
Eta DEHM model domain

Domains in the DEHM System

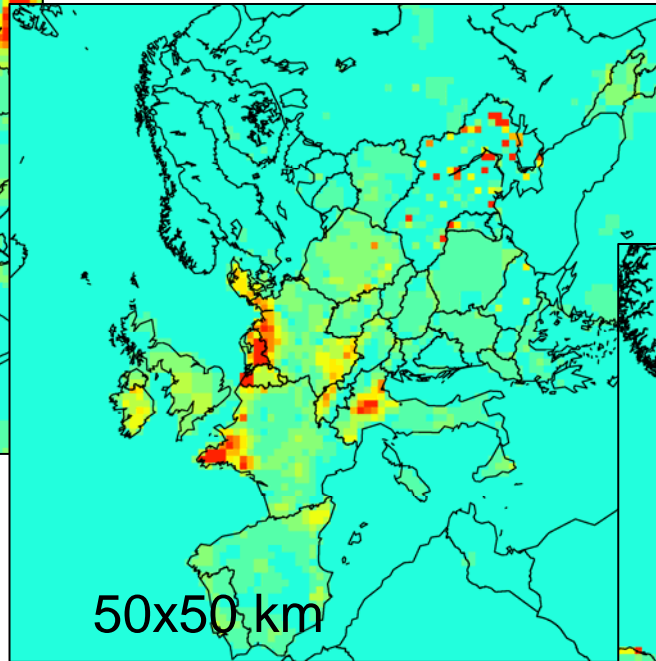
Hemispheric domain



150x150 km

First nest

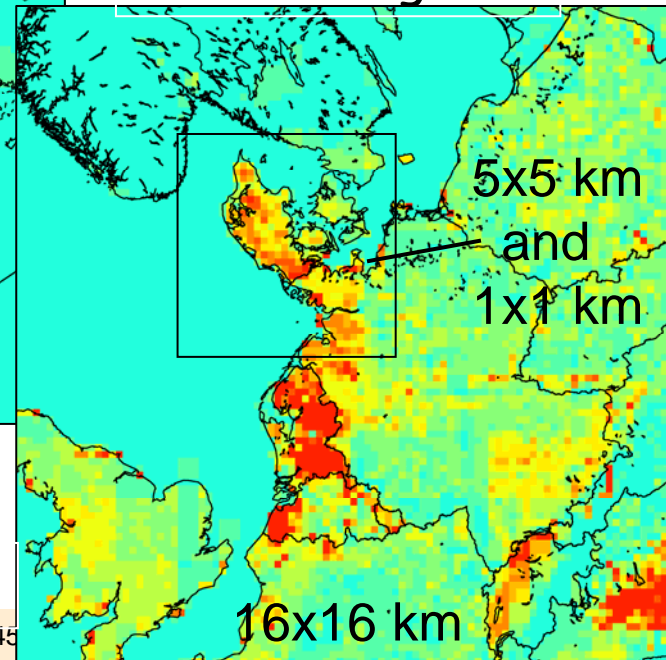
Europe domain



50x50 km

Second nest

Denmark and surroundings



5x5 km
and
1x1 km

16x16 km

Air Pollution Modeling At DMI

Aerosol Module

1. PSC aerosols
2. Tropospheric aerosols

Approaches:

Normal distribution,
Bin approach

Physics:

1. Condensation
2. Coagulation
3. Evaporation
4. Emission
5. Nucleation
6. Deposition

Chemical Solvers

1. Gas Phase
2. Aqueous phase
3. Chemical equil.
4. Climate Modeling

Approaches:

RACM, CBIV,
ISORROPIA

UTLS Trans. Models

Eulerian trans-
port 0..15
lat-lon grid,
3-D regional
scale

Lagrangian
transport, 3-D
regional scale

ECMWF

Met. Models

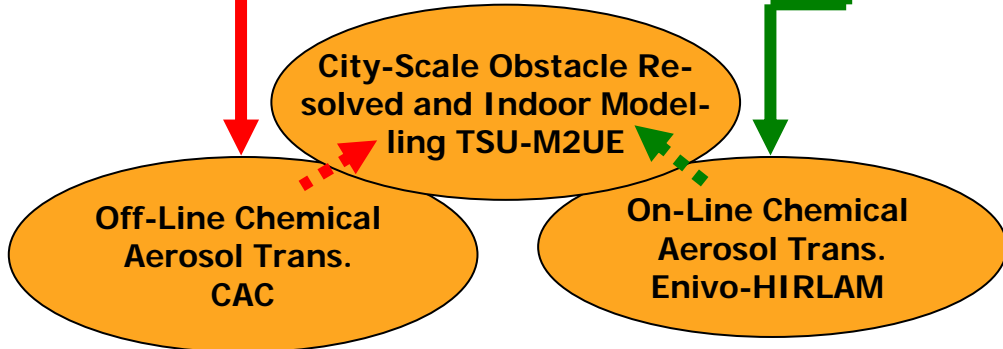
DMI-HIRLAM

Eulerian trans-
port 0.2-0.05
lat-lon, 25-40
vert. layer,
3-D regional
scale

Stochastic
Lagrangian
transport,
3-D regional
scale

Tropo. Trans. Models

Emergency Pre-
parednes & Risk Assess-
ment. DERMA



Regional (European) to city
scale air pollution: smog
and ozone.

Regional (European) scale
air pollution: smog and
ozone, pollen.

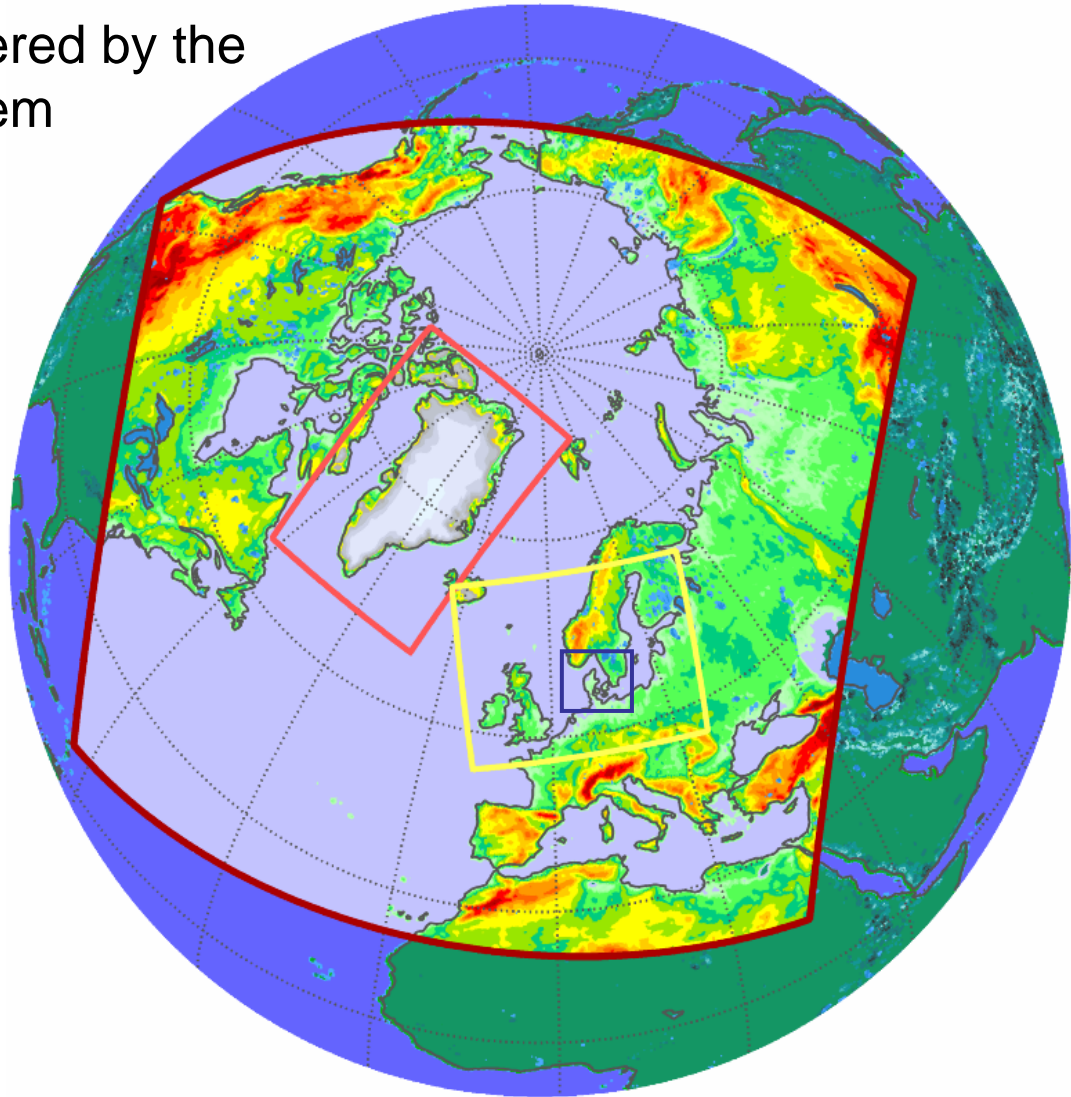
Nuclear, veterinary and
chemical.

Enviro – HIRLAM air pollution modelling at DMI

Operational areas covered by the
Enviro – HIRLAM system
today

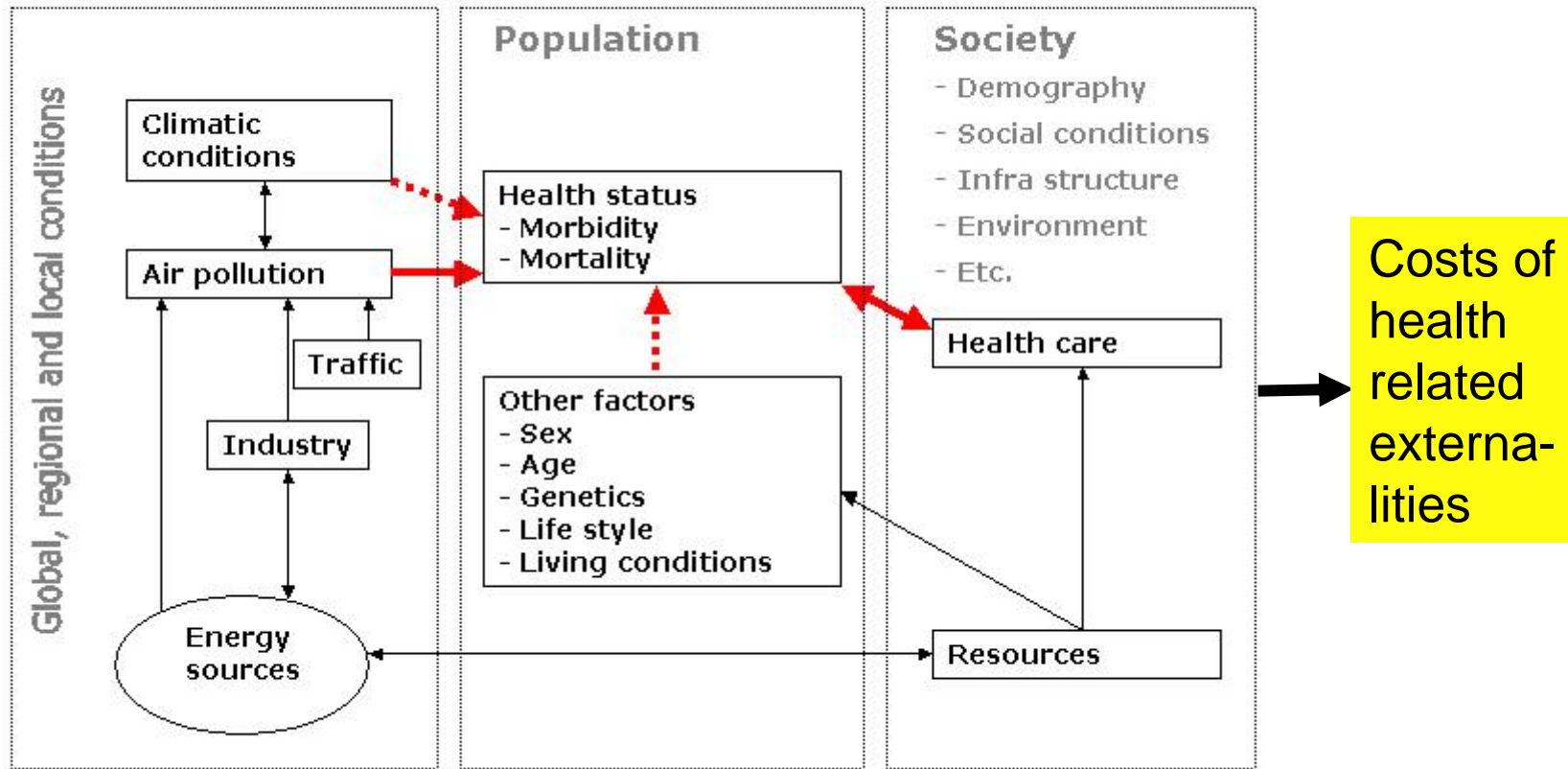
50x50km horizontal
down 1.4x1.4km for
Denmark.

Vertical it goes into
the stratosphere



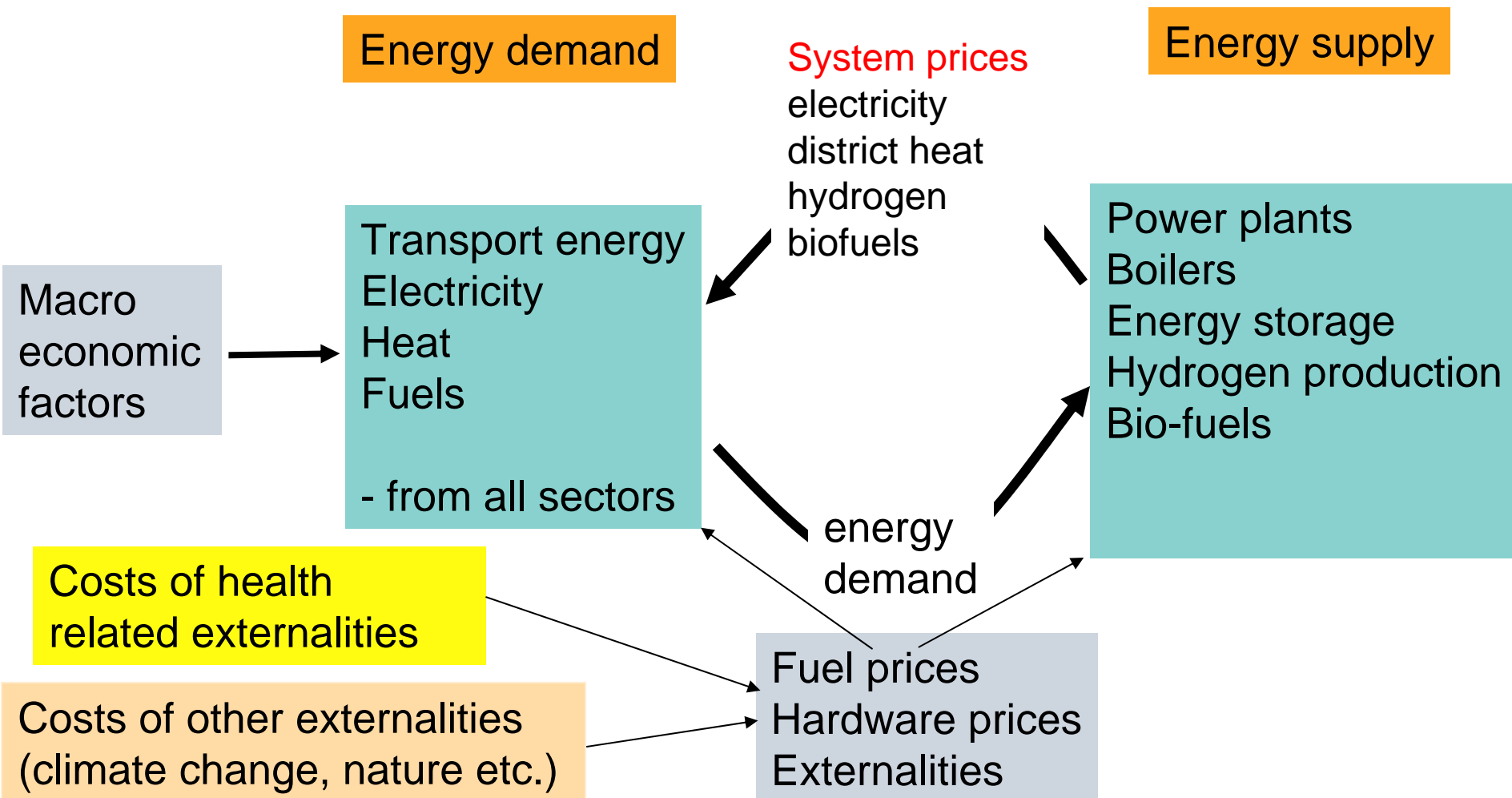
Quantification of Health Effects – Dose Response Functions

Analytical frame



Energy System Modelling – 2005 to 2050

System optimization by minimising total system costs

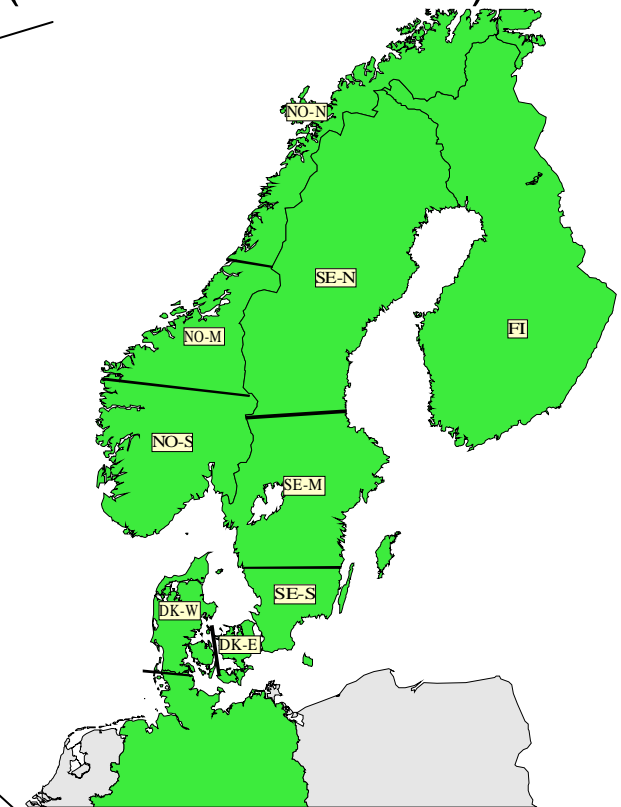


Modelling Global and Regional Energy Systems

Global scenarios
MARKAL/TIMES/TIAM ??

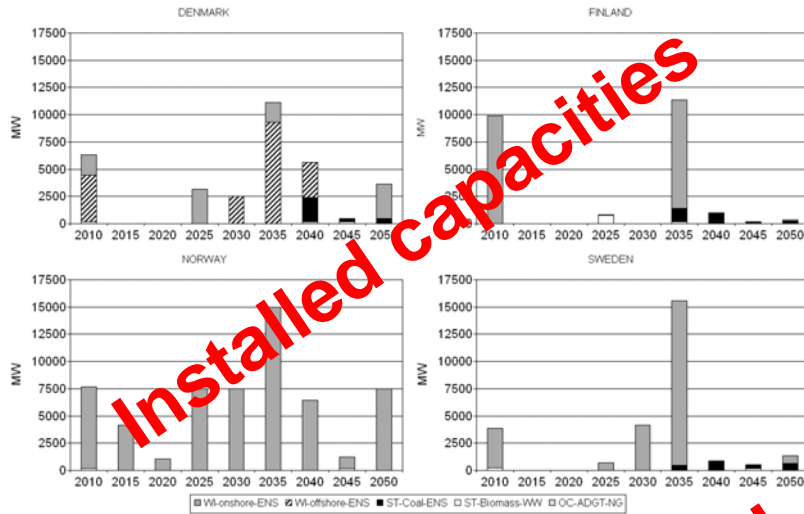
Balmorel

(www.balmorel.com)

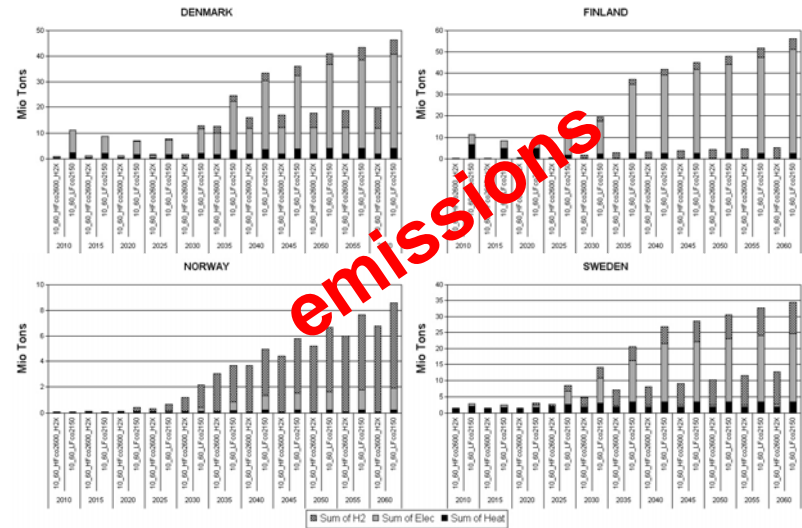


Results from Energy System Modelling

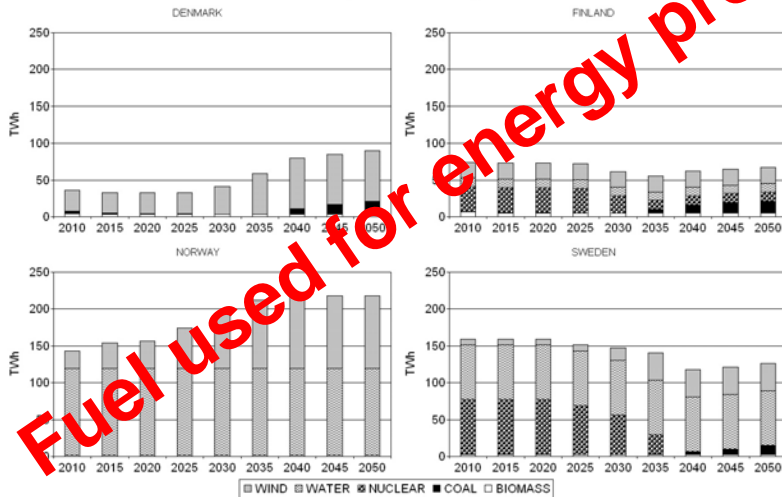
Cummulated Investments in Electricity Generation Technologies



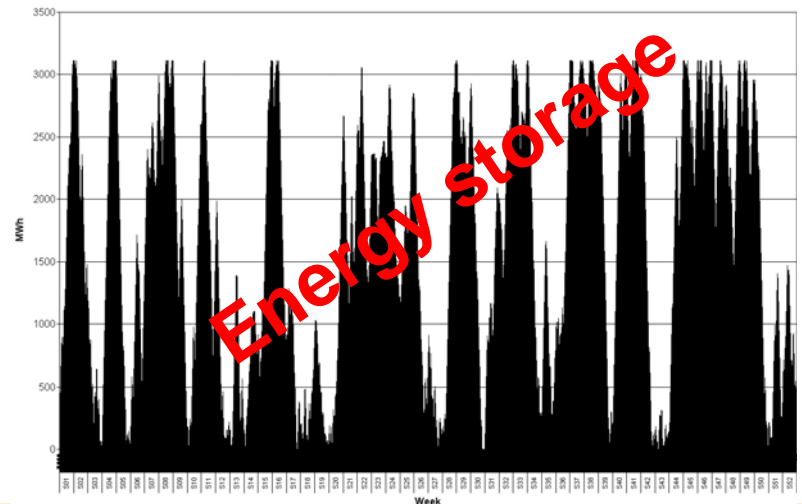
Yearly CO2-emissions



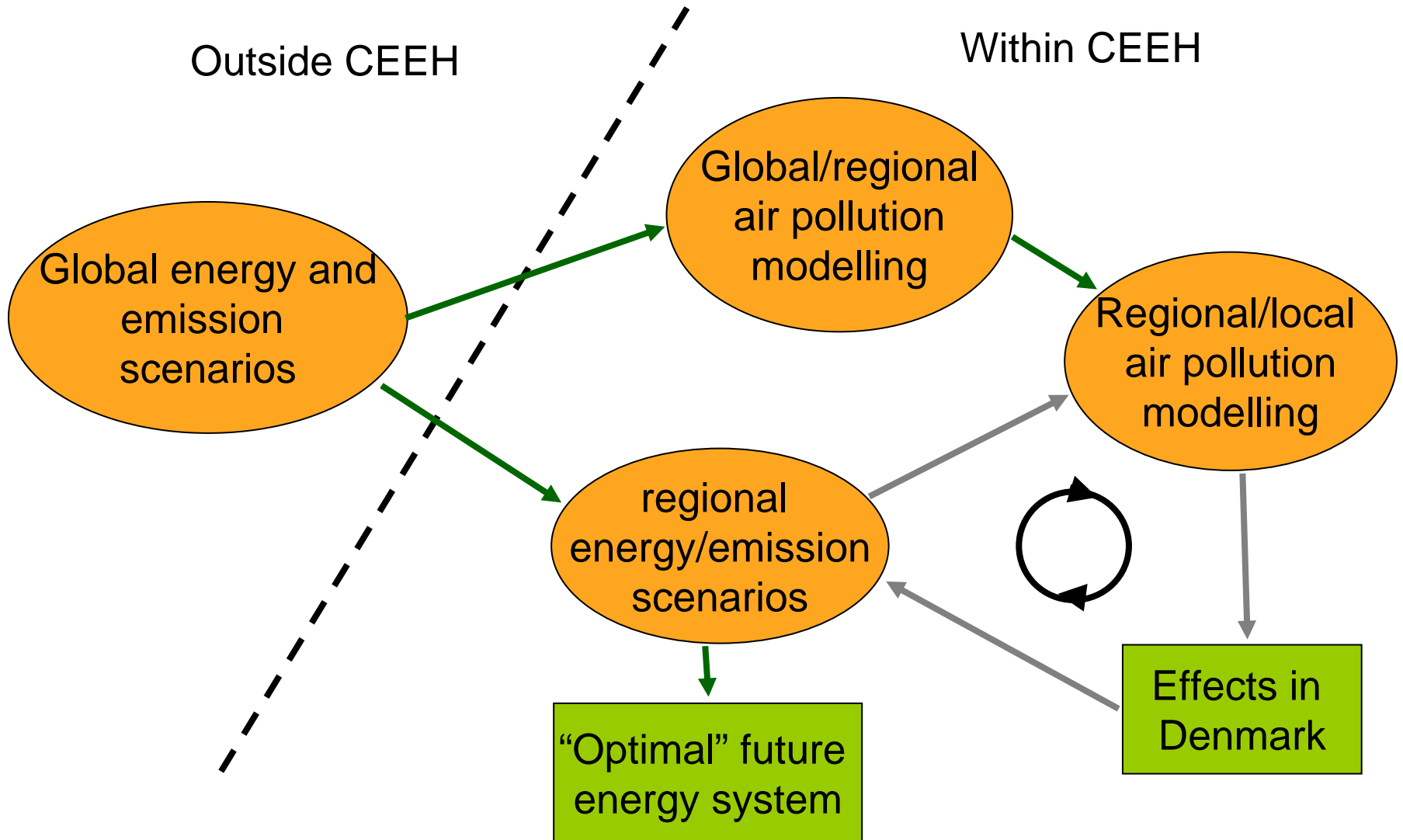
Electricity Generation by Fuel



Hydrogen storage content in Denmark west (DK_W) in year 2020



Seeking Collaboration Partners



Thank you for your attention



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