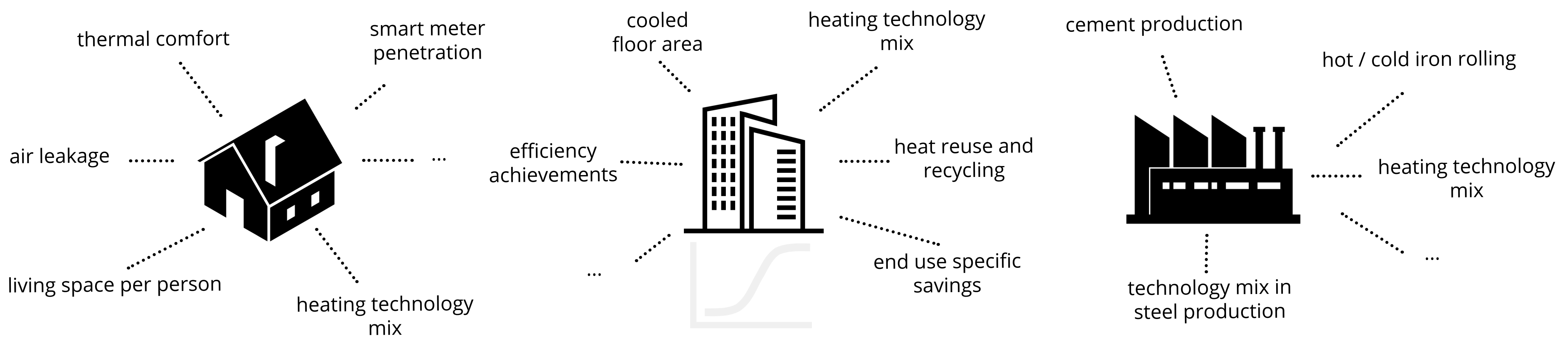# Simulating future energy demand considering societal and technological change
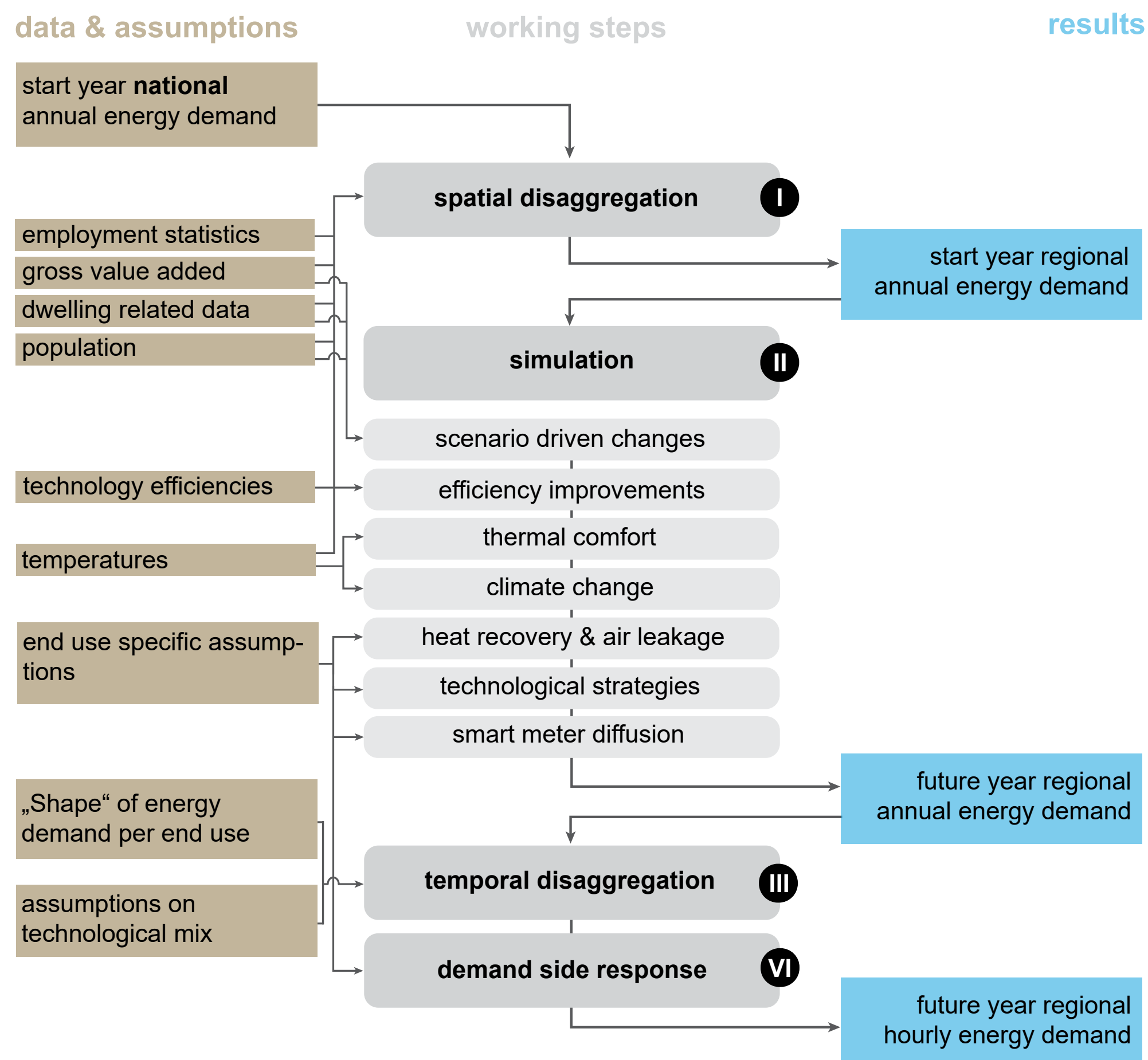
Eggimann Sven and Eyre Nick, University of Oxford.

I Model parameters which can be changed to simulate future energy demand

thermal comfort
smart meter penetration
cooled floor area
heating technology mix
cement production
hot / cold iron rolling

air leakage
efficiency achievements
heat reuse and recycling
heating technology mix

...

living space per person
heating technology mix
end use specific savings
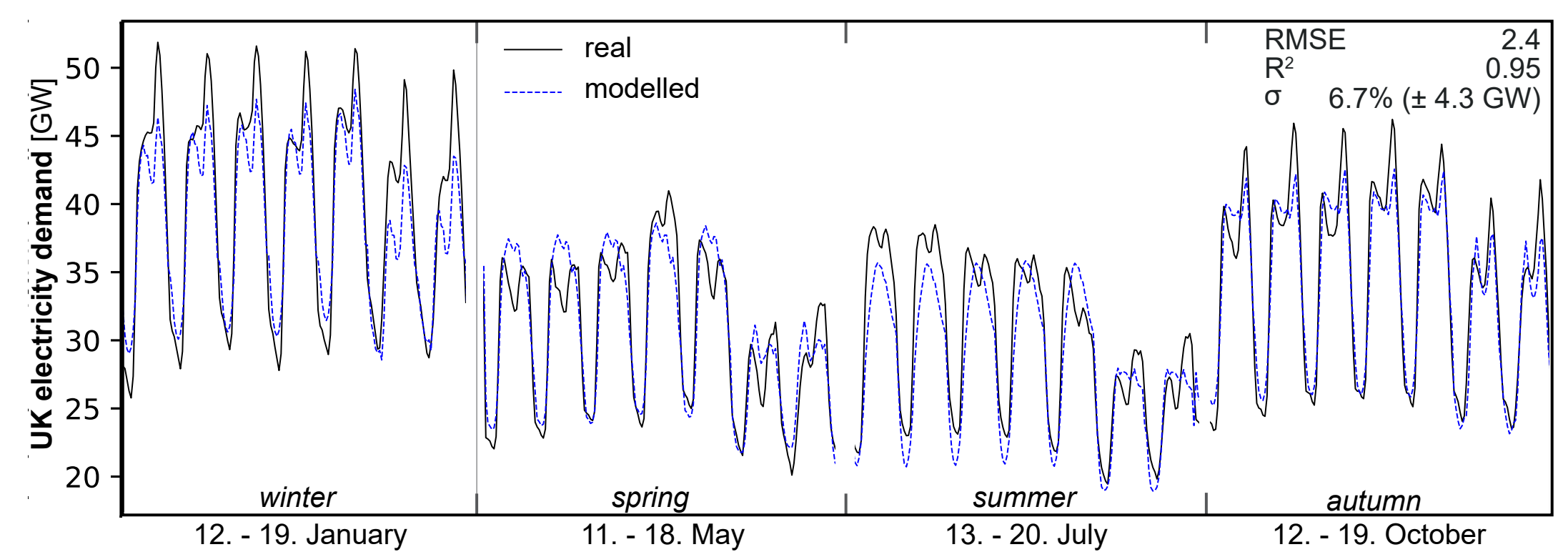technology mix in steel production

...

II Step by step model walk through

Energy demands of a starting year are decomposed into different end uses and sectors. Demand is disaggregated to approximately 400 regions. Different energy demand shapes per end use are assigned to derive hourly energy demand data.

data & assumptions | working steps | results

start year **national** annual energy demand

spatial disaggregation ❶

employment statistics
gross value added
dwelling related data
population

start year regional annual energy demand

simulation ❷

scenario driven changes
efficiency improvements
thermal comfort
climate change
heat recovery & air leakage
technological strategies
smart meter diffusion

technology efficiencies

temperatures

end use specific assumptions

future year regional annual energy demand

„Shape" of energy demand per end use

assumptions on technological mix

temporal disaggregation ❸

demand side response ❻

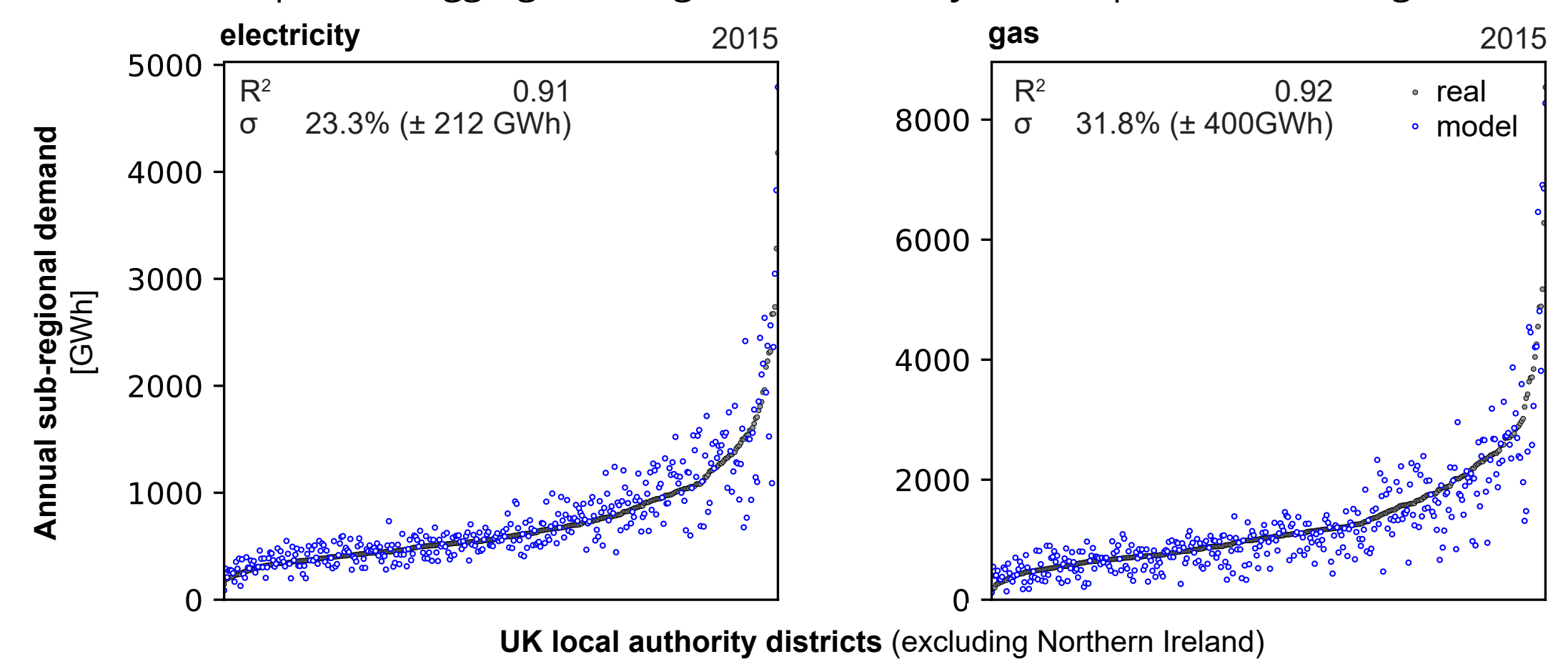future year regional hourly energy demand

III Validation

Our results are successfully validated and calibrated with actual energy demand data for the start year 2015. We find a close fit between actual national electricity consumption and modelled demand for different seasons.
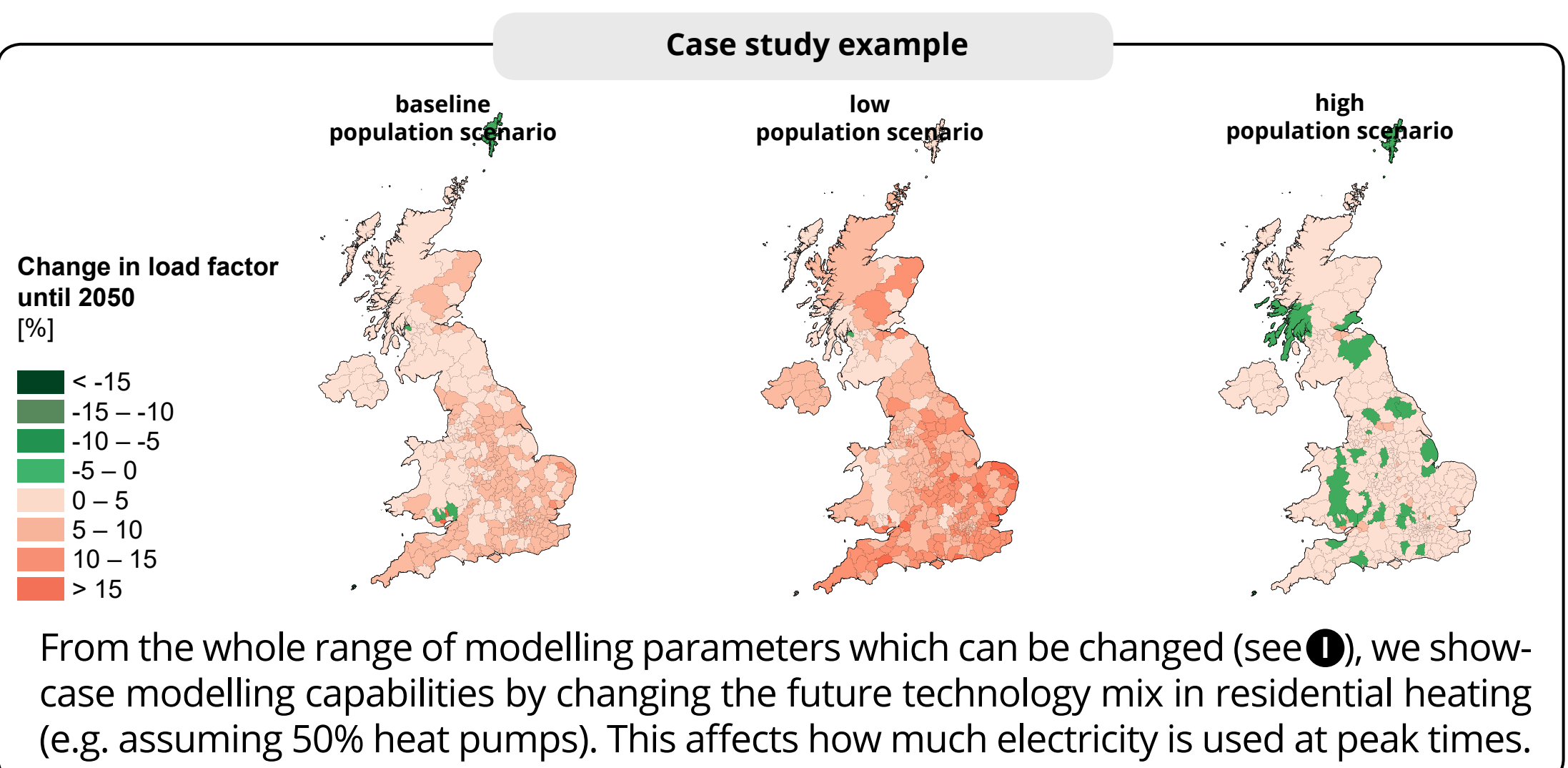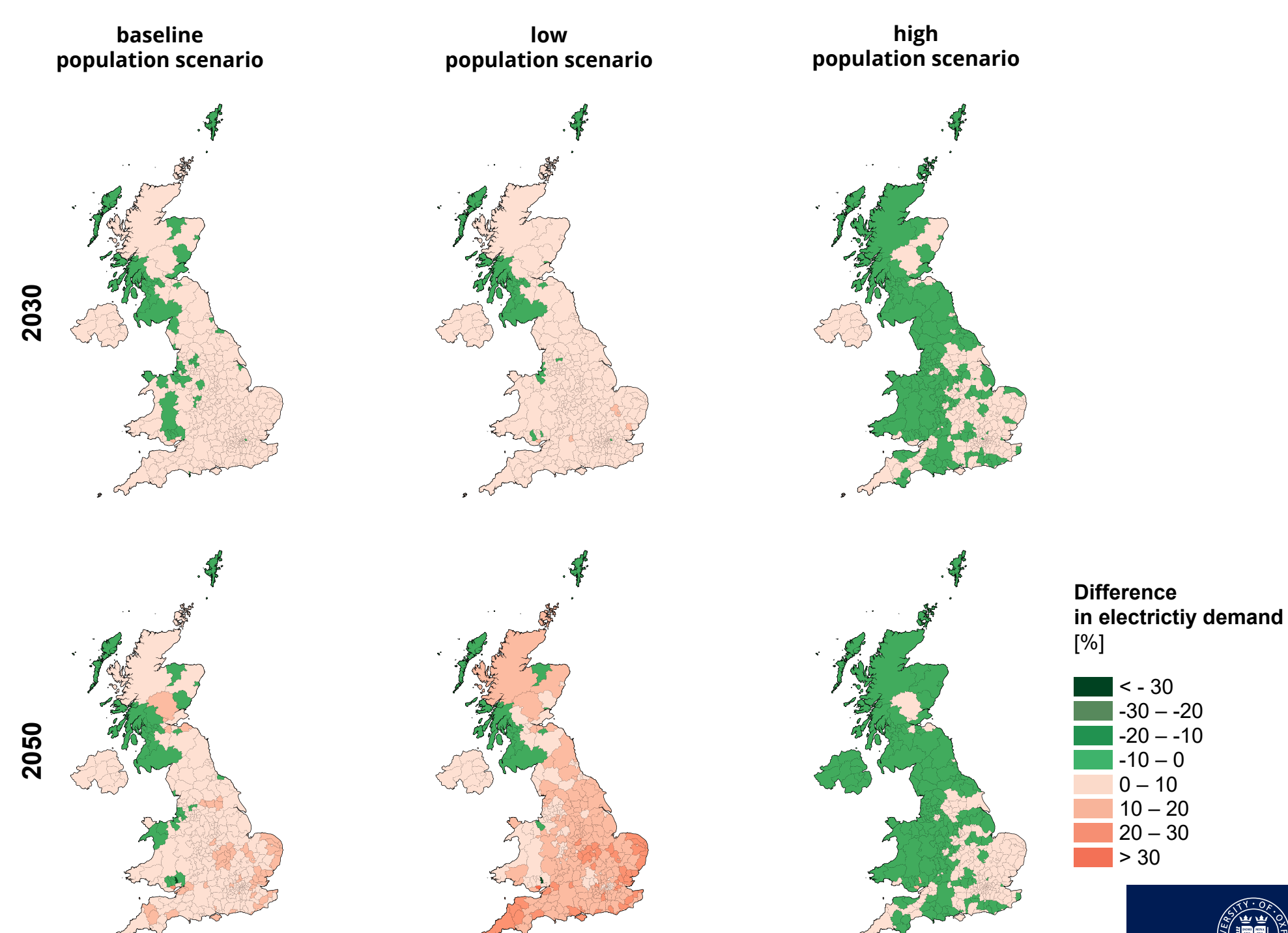

	RMSE	2.4
	R^2	0.95
	σ	6.7% (± 4.3 GW)

— real
- - - modelled

winter 12. - 19. January
spring 11. - 18. May
summer 13. - 20. July
autumn 12. - 19. October

Validation of spatial disaggregation of gas and electricity consumption for ~400 regions.

electricity 2015
R^2 0.91
σ 23.3% (± 212 GWh)

gas 2015
R^2 0.92
σ 31.8% (± 400GWh)
• real
• model

UK local authority districts (excluding Northern Ireland)

IV Demonstration of modelling capabilities

Results of simulated future change in electricity demand for three different example population scenarios for the year 2030 and 2050. Other scenarios related to Gross Value Added or climate could be included. Also, multiple fuel types such as hydrogen or biomass are modelled.

baseline population scenario
low population scenario
high population scenario

2030

2050

Difference in electricity demand [%]
< - 30
-30 – -20
-20 – -10
-10 – 0
0 – 10
10 – 20
20 – 30
> 30

Case study example

baseline population scenario
low population scenario
high population scenario

Change in load factor until 2050 [%]
< -15
-15 – -10
-10 – -5
-5 – 0
0 – 5
5 – 10
10 – 15
> 15

From the whole range of modelling parameters which can be changed (see ❶), we showcase modelling capabilities by changing the future technology mix in residential heating (e.g. assuming 50% heat pumps). This affects how much electricity is used at peak times.

• High spatio-temporal analysis provides crucial inputs for the energy supply model. It allows to model peak demands, demand management and storage or successful integration of renewables.

• The effect on energy demand of innovative technologies and policies and their diffusion across space and time can be modelled for different infrastructure futures.

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