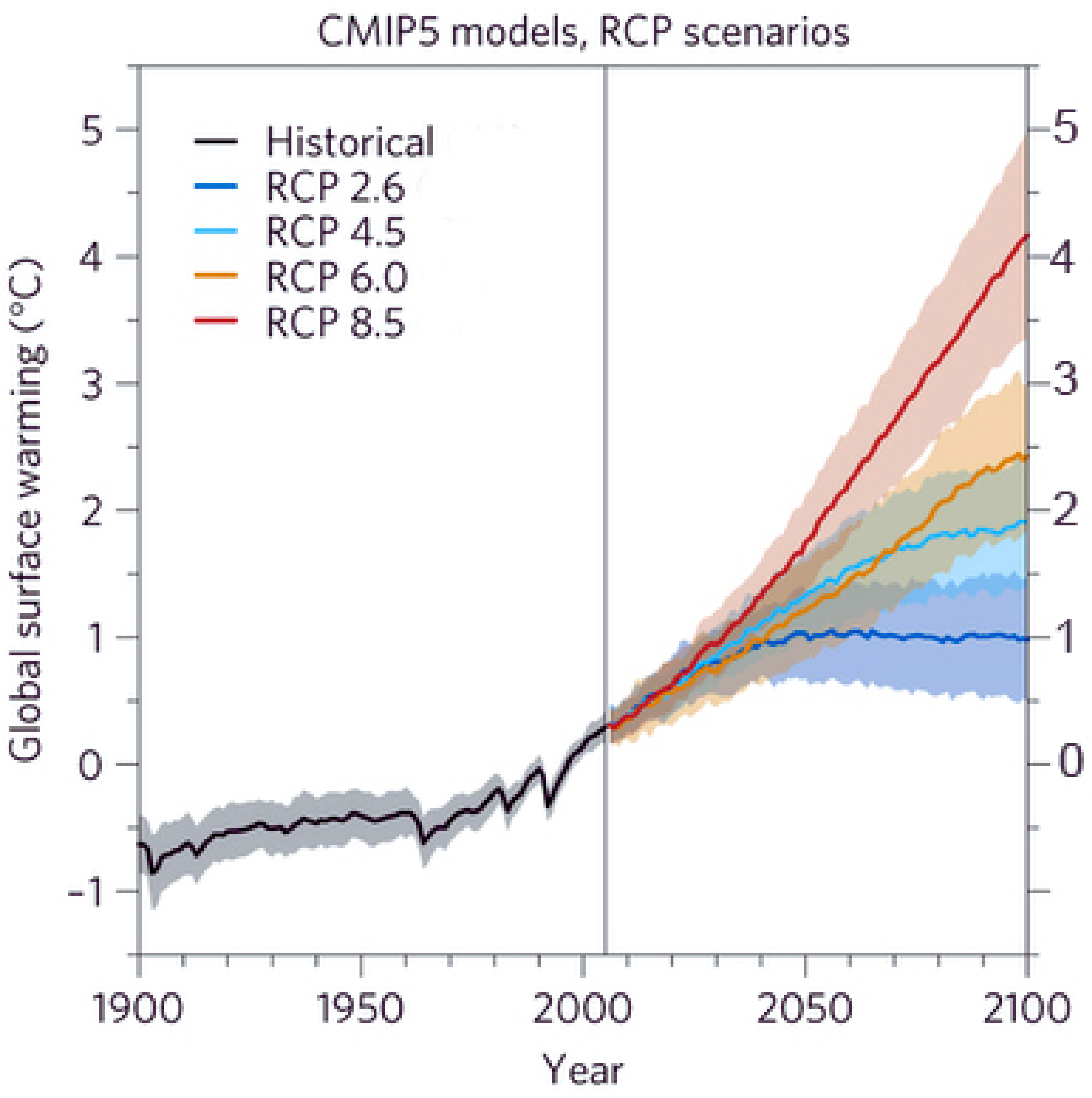
ADAPTATION OF THE ITALIAN ELECTRICITY SYSTEM TO REDUCED WATER AVAILABILITY

AN OSEMOSYS APPLICATION BY WATERGAMS

Luca Lazzari
Camilla Citterio
Matteo Ghesini
Lorenzo Ferrara

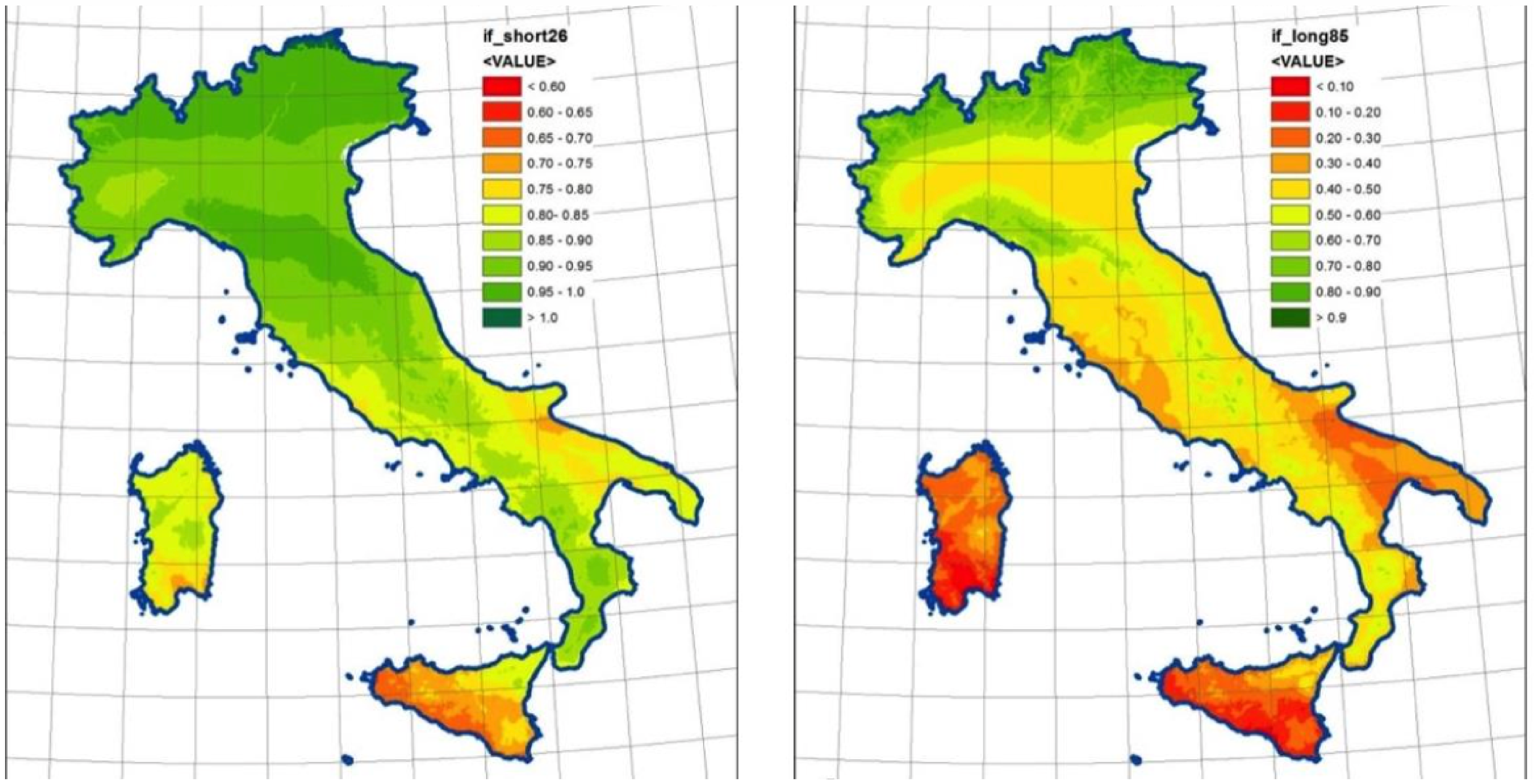
Climate projections



Internal flow projections comparing 1996-2015 avarage with:

2020-2039 under RCP2.6

2080-2099 under RCP8.5



ISPRA (2022)

Aim of the study

Assess the optimal mix for electricity production in Italy taking into account water availability

Time range: **2015-2050**

Model: **OSeMOSYS**

Data Collection

OSeMBE
Open Source Energy Model Base For The European Union

Terna
Driving Energy

PNIEC 2030

Istat

Articles & Pubblications

Upgrades

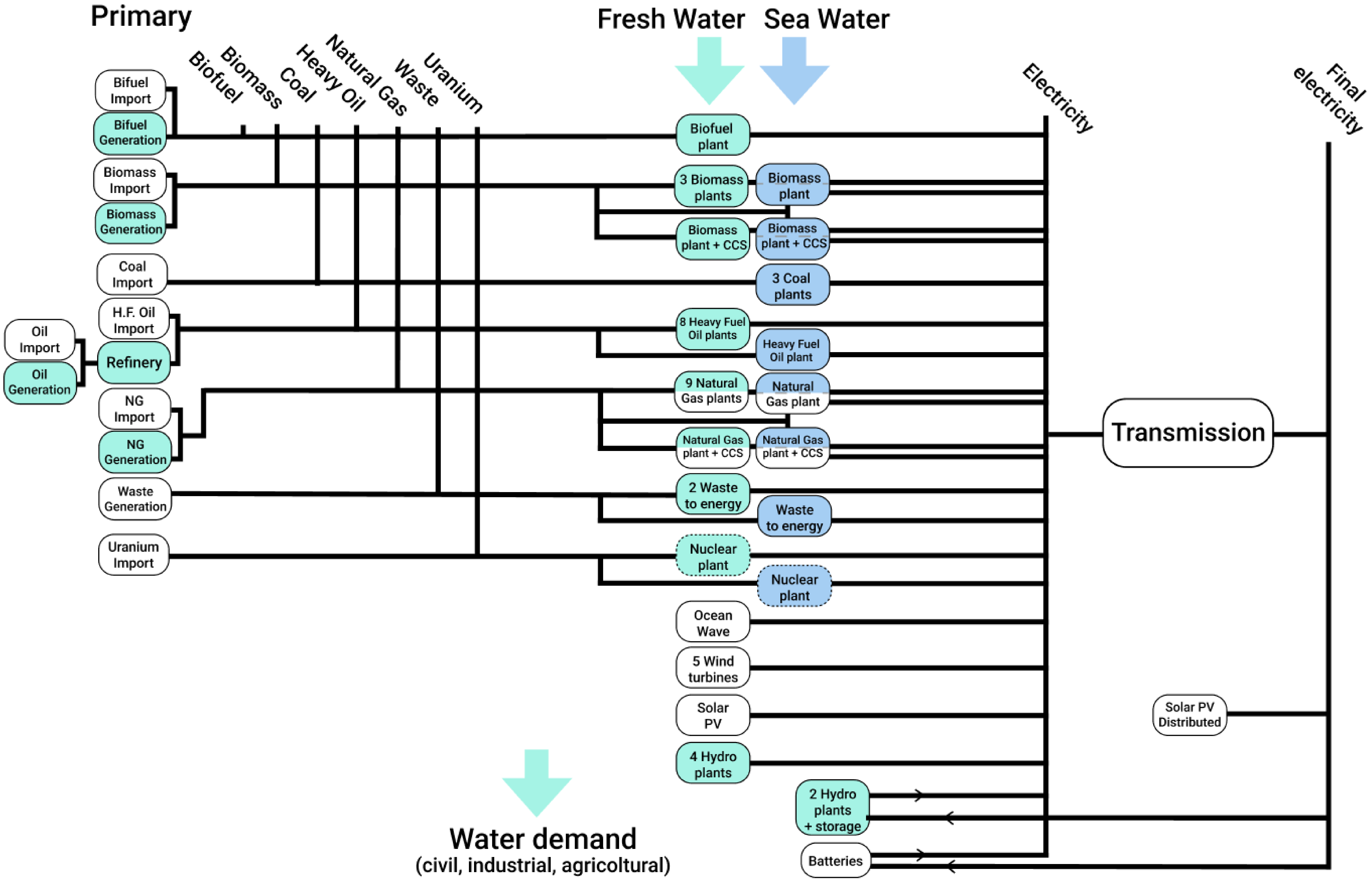
Adaptation of OSeMOSYS for Italian Electricity System, including OSeMBE data

Implementation of **FitFor55** and **PNIEC** policies

Sea water plants
Battery storage

Fresh water consumption and limitations

Reference Energy System



Water availability

$$C(y_0) = k$$

$$C(y) = C(y-1) + P(y) - Eva(y,T) - Use(y)$$

$$Eva(y,T) = \begin{cases} \dfrac{\mathrm{P(y)}}{\sqrt{0.9 + \mathrm{P(y)}^2/\mathrm{L(T)}^2}} & \mathrm{P(y)}^2/\mathrm{L(T)}^2 \geq 0.1 \\ \mathrm{P(y)} & \mathrm{P(y)}^2/\mathrm{L(T)}^2 < 0.1 \end{cases}$$

Water availability

Temperature projections [°C]

YEAR	RCP 2.6	RCP 4.5	RCP 8.5
2020-2039	13.9	13.9	13.9
2040-2060	13.9	14.3	14.8

$$C(y_0) = k$$

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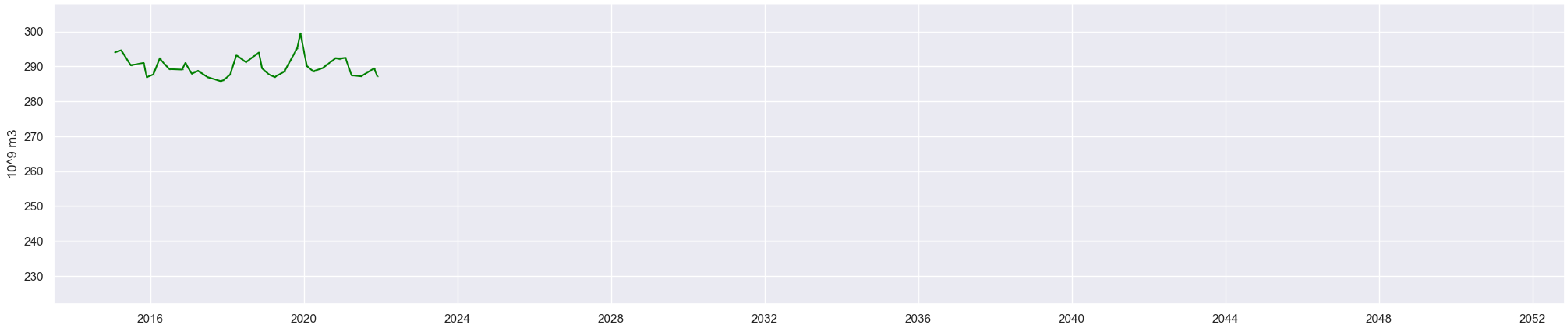
$$Eva(y,T) = \begin{cases} \dfrac{\mathrm{P(y)}}{\sqrt{0.9 + \mathrm{P(y)}^2/\mathrm{L(T)}^2}} & \mathrm{P(y)}^2/\mathrm{L(T)}^2 \geq 0.1 \\ \mathrm{P(y)} & \mathrm{P(y)}^2/\mathrm{L(T)}^2 < 0.1 \end{cases}$$

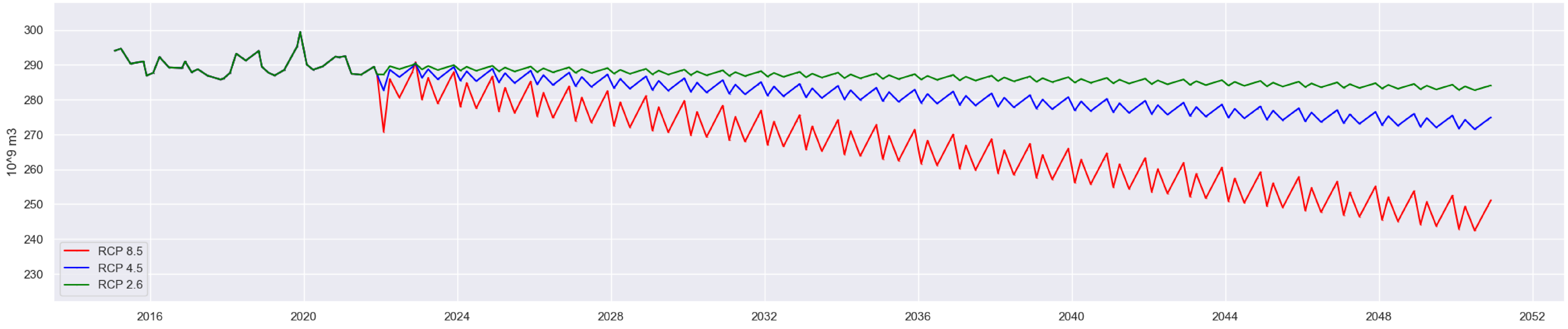
Precipitation Projection

Data Collection



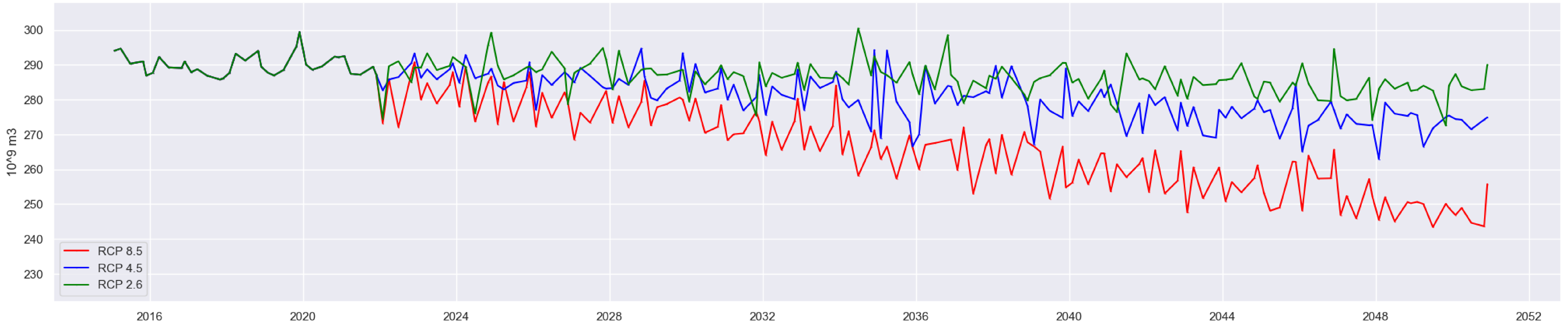
Precipitation Projection

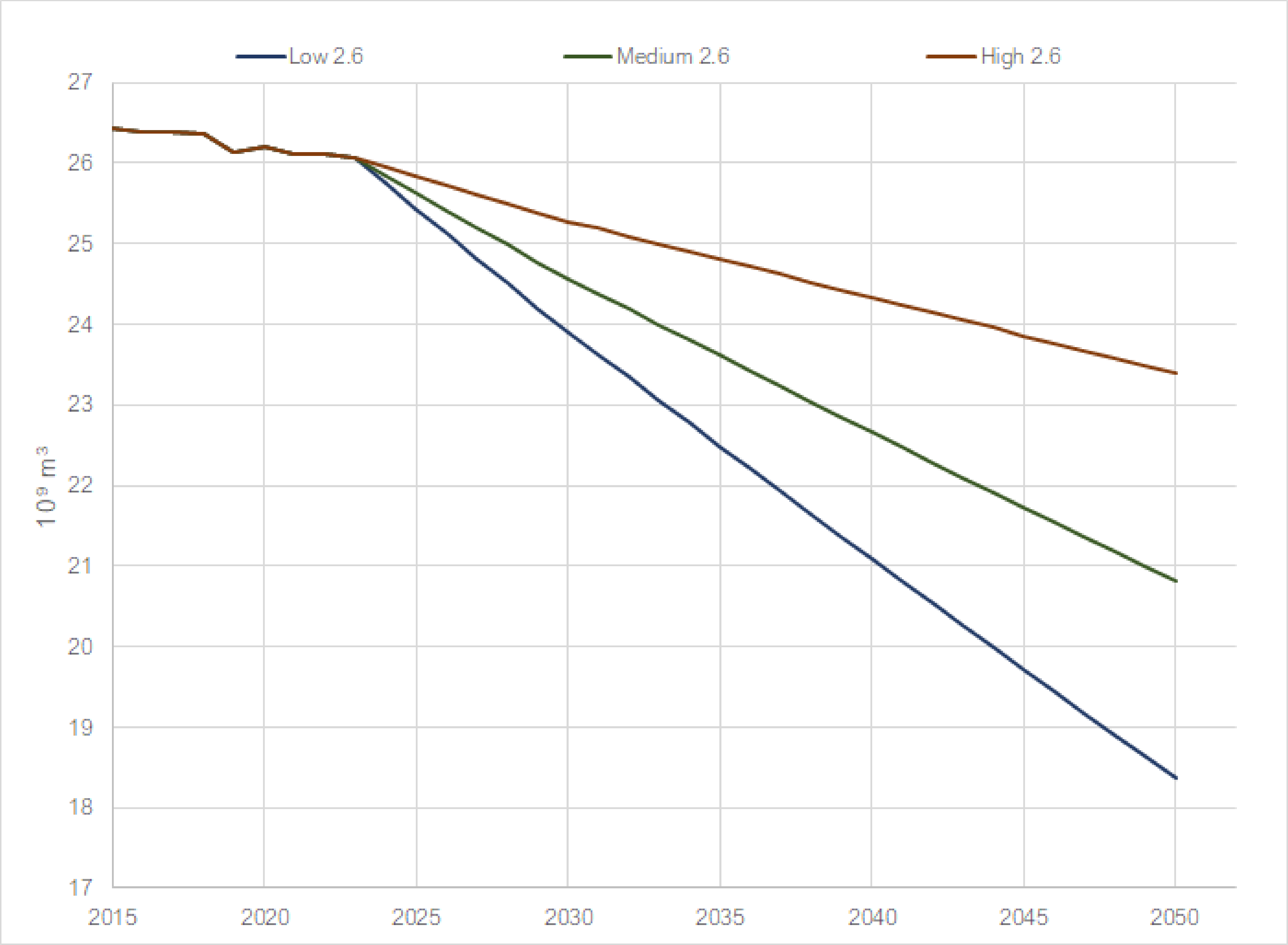
SARIMA



Precipitation Projection

Noise





Water demand

Residential use:

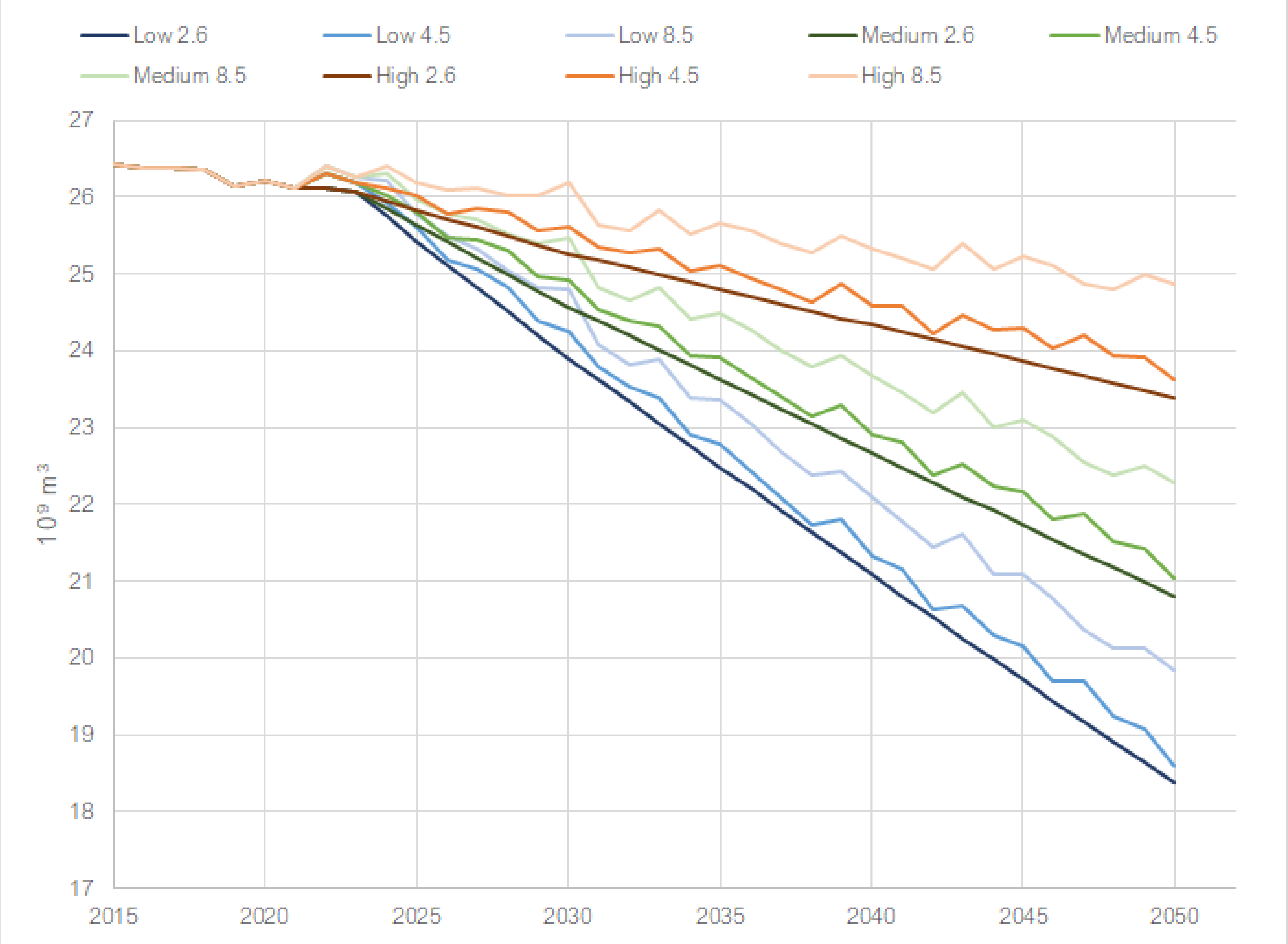
- Low - European average
- Medium - in between
- High - Water Distribution Improvement

Industrial use:

Constant = 5.5 10^9 m^3

Agricolture:

Related to water from rain



Water demand

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Scenarios

- **Base**
  Coal phase-out and european policy about CO2 emissions, no water limitations and no nuclear possibility

- **Nuclear**
  In the hypothetical case that Italy could adopt nuclear power plants from 2036 for electricity

- **Water availability**
  Three possible cases of water shortage in the year span 2021-2050, according to RCP2.6, RCP4.5, RCP8.5

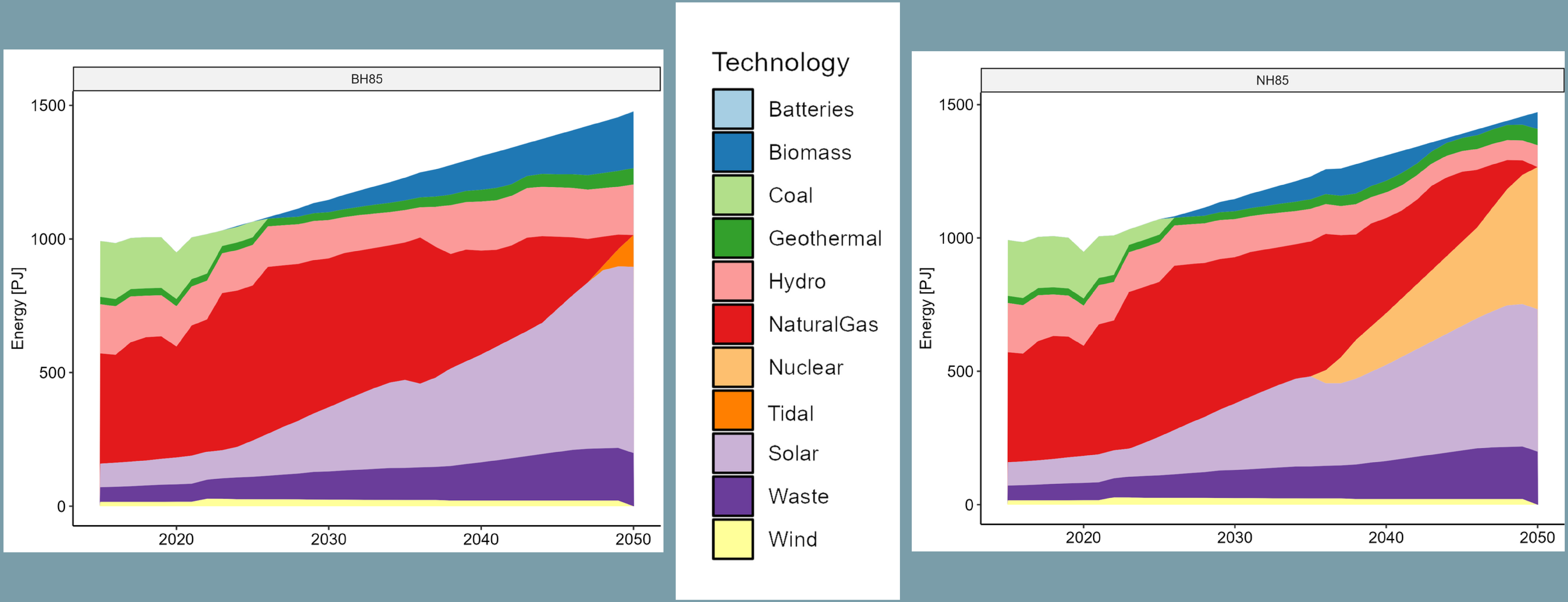
- **Water use**
  Three possible behaviours of people in Italy about water consumption and infrastructure

RESULTS

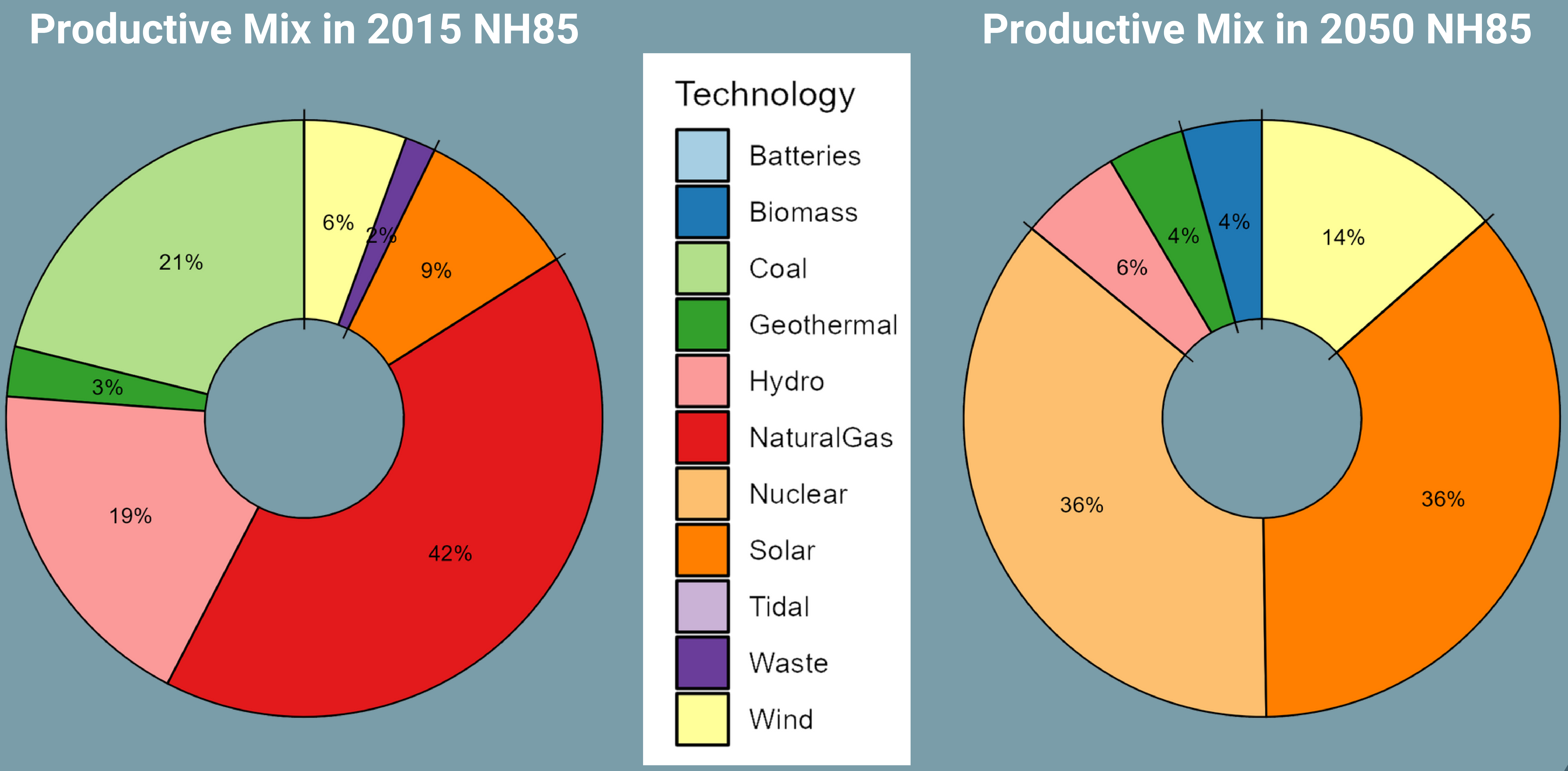
All models are wrong, but some are useful.

G. E. P. Box and N. R. Draper (1987)

Electricity production



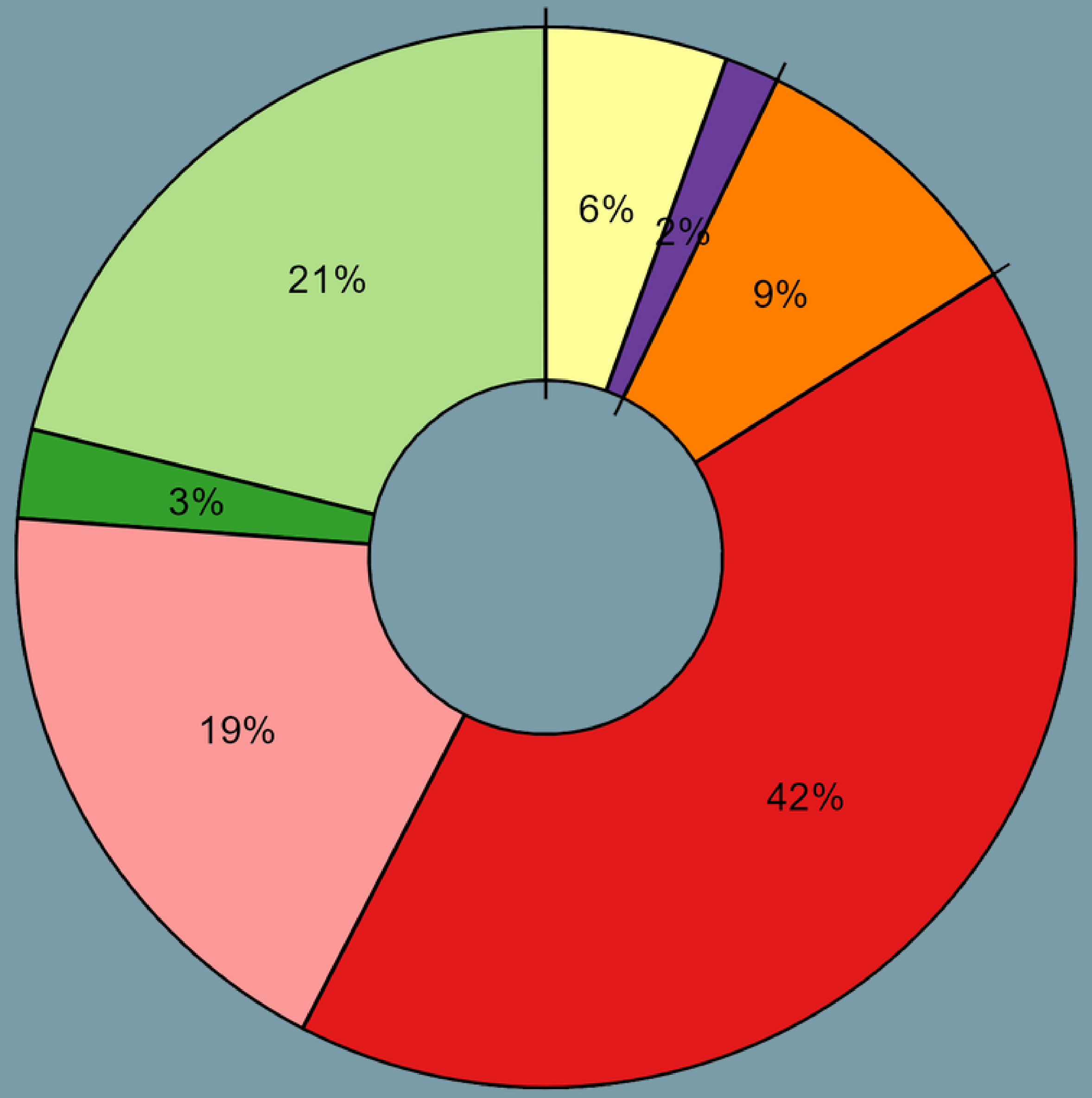
Nuclear energy solution



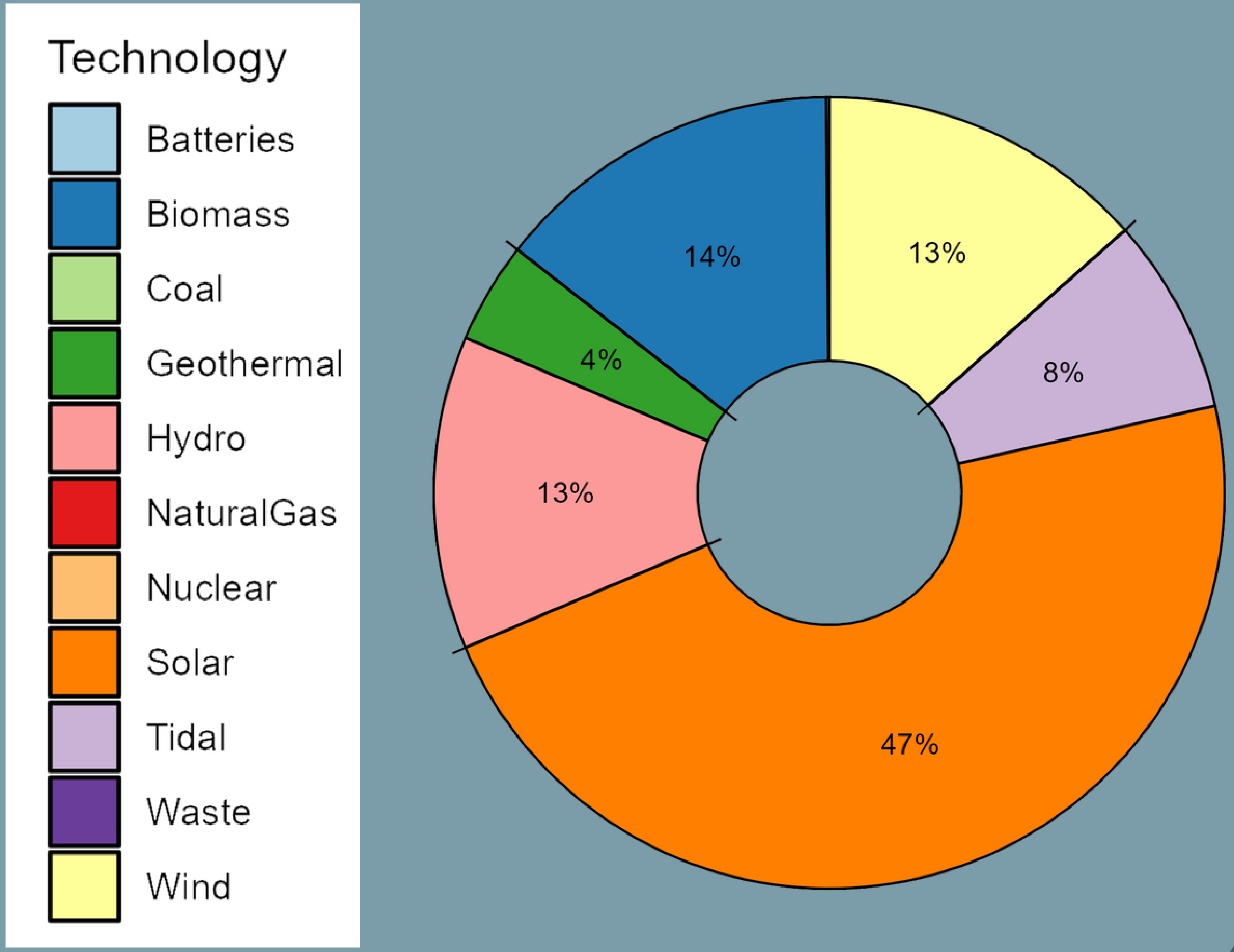
NH85 - Nuclear, High water demand, RCP8.5

Business As Usual solution

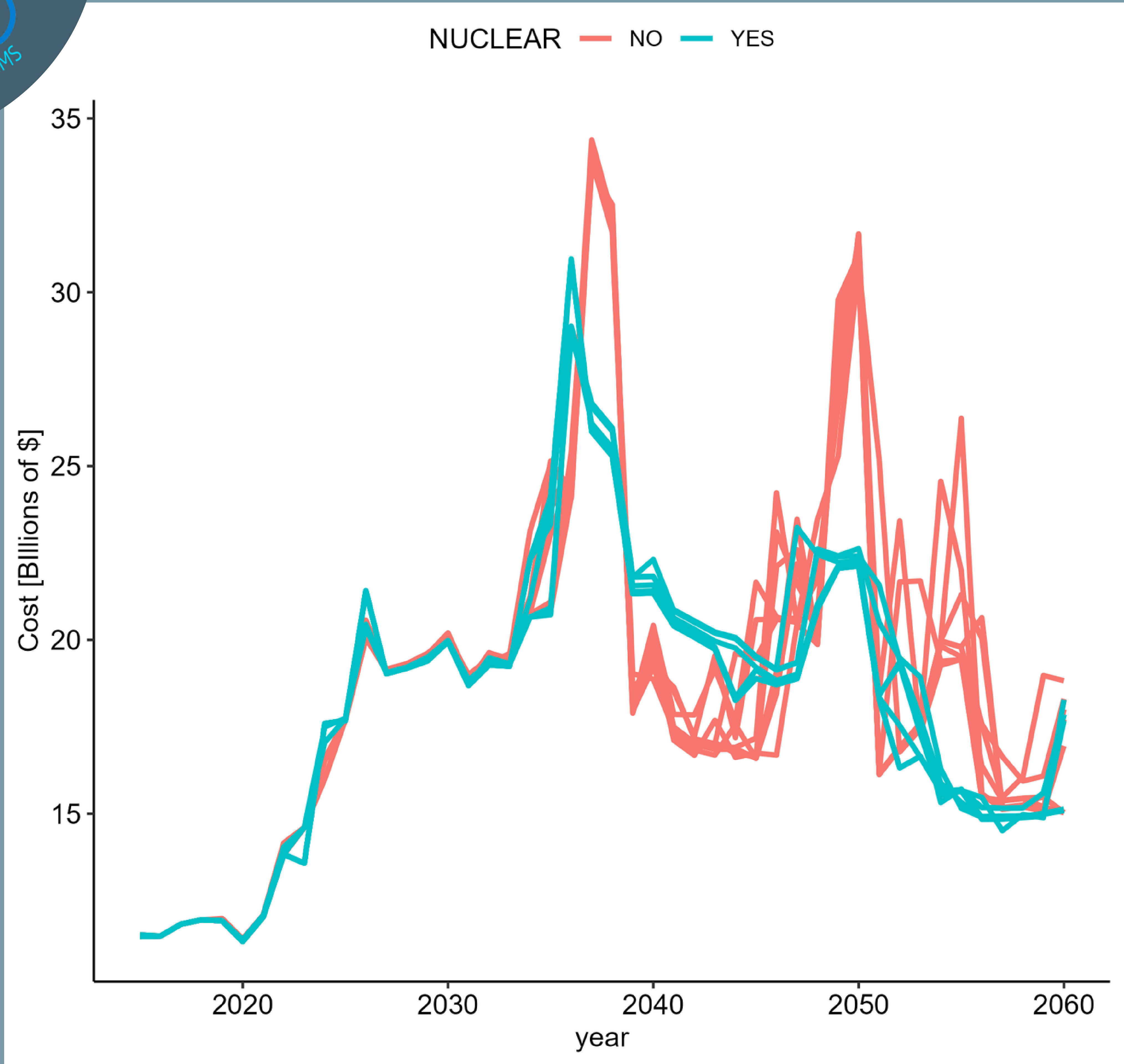
Productive Mix in 2015 BH85



Productive Mix in 2050 BH85



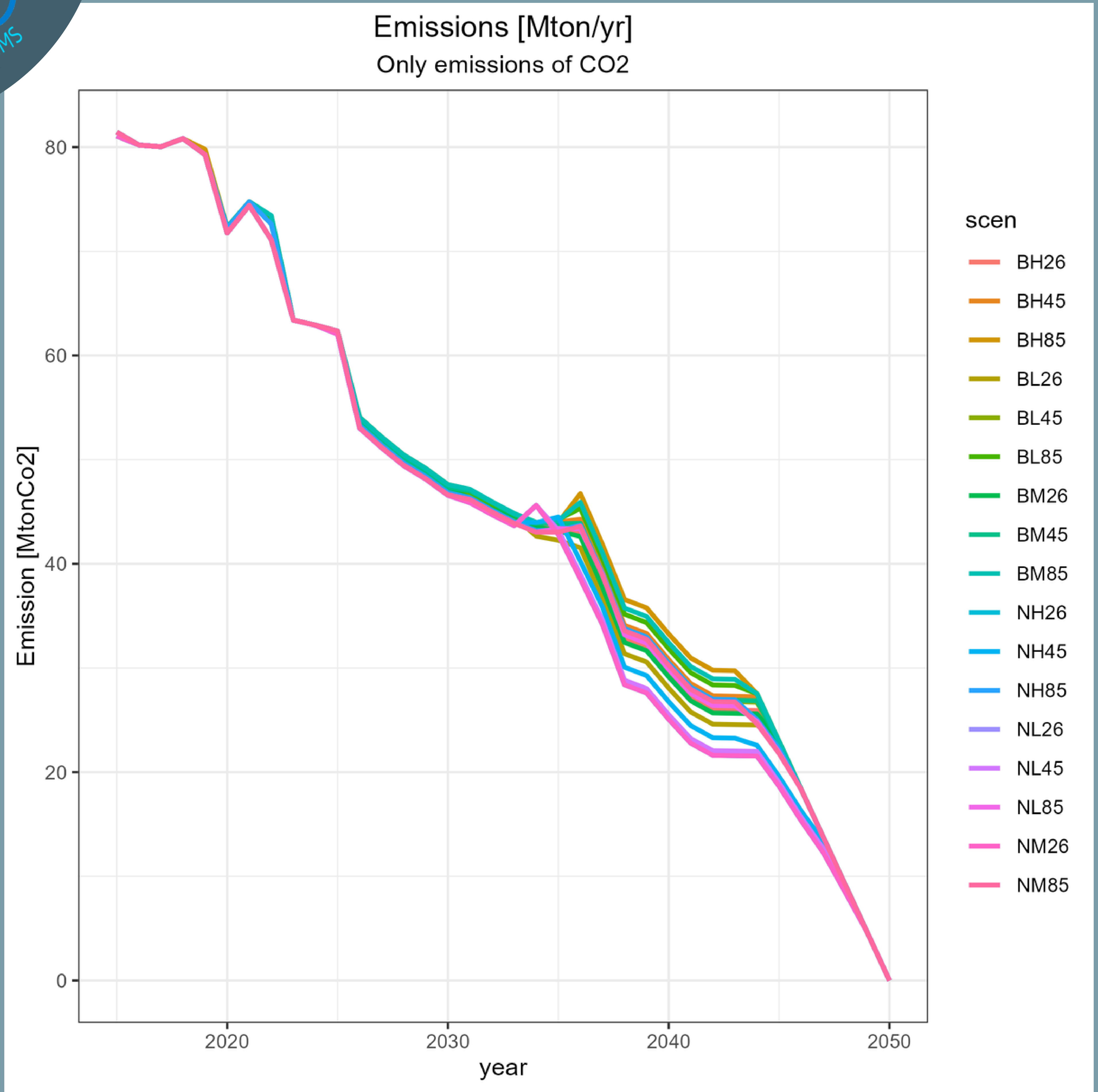
BH85 - No nuclear, High water demand, RCP8.5



Costs

Nuclear scenarios are usually more cost effective with respect to non nuclear ones

Those scenarios are more expensive mainly beacuse of the development in unconventional technologies, and more investment in alredy existing ones.

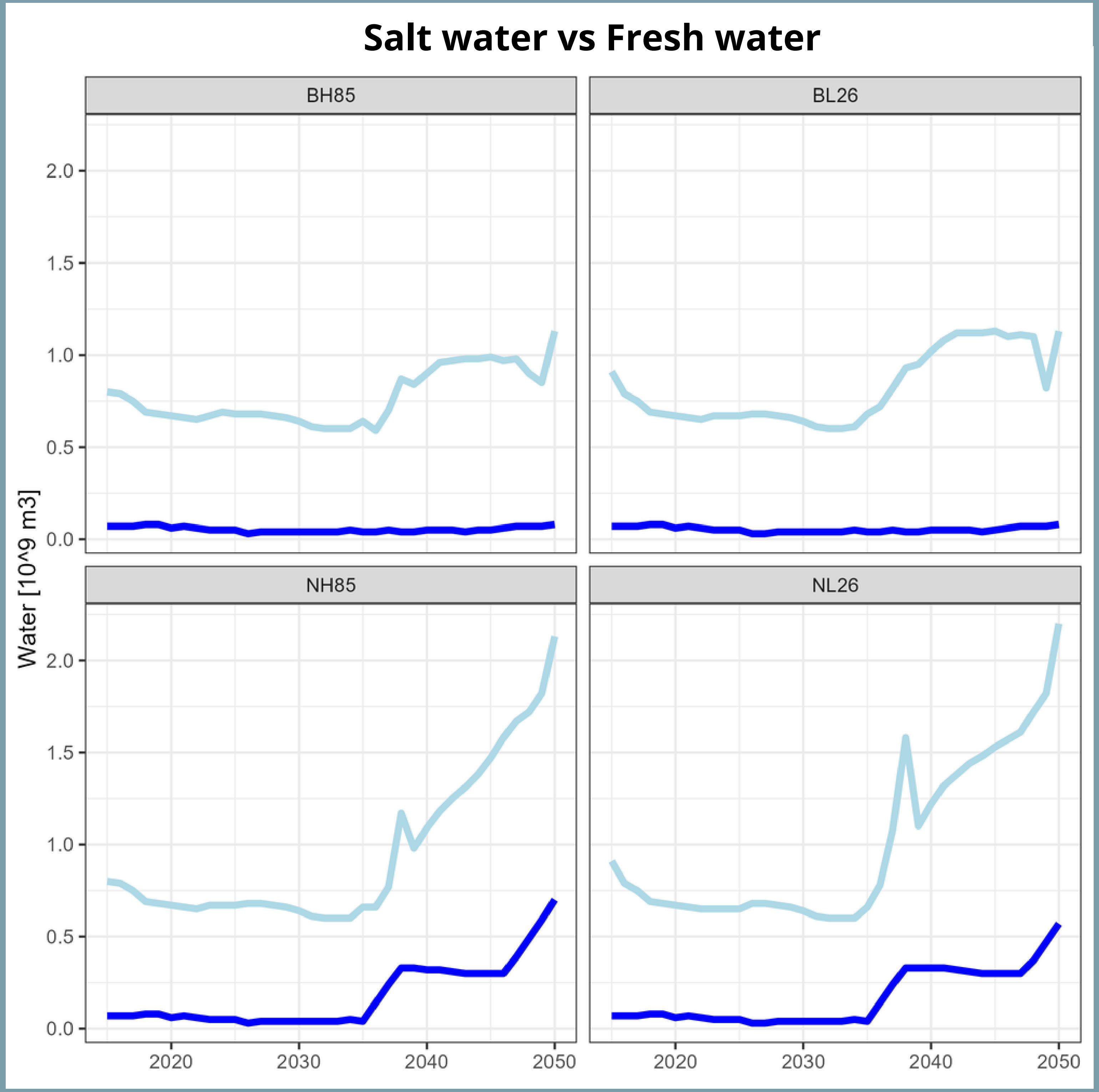


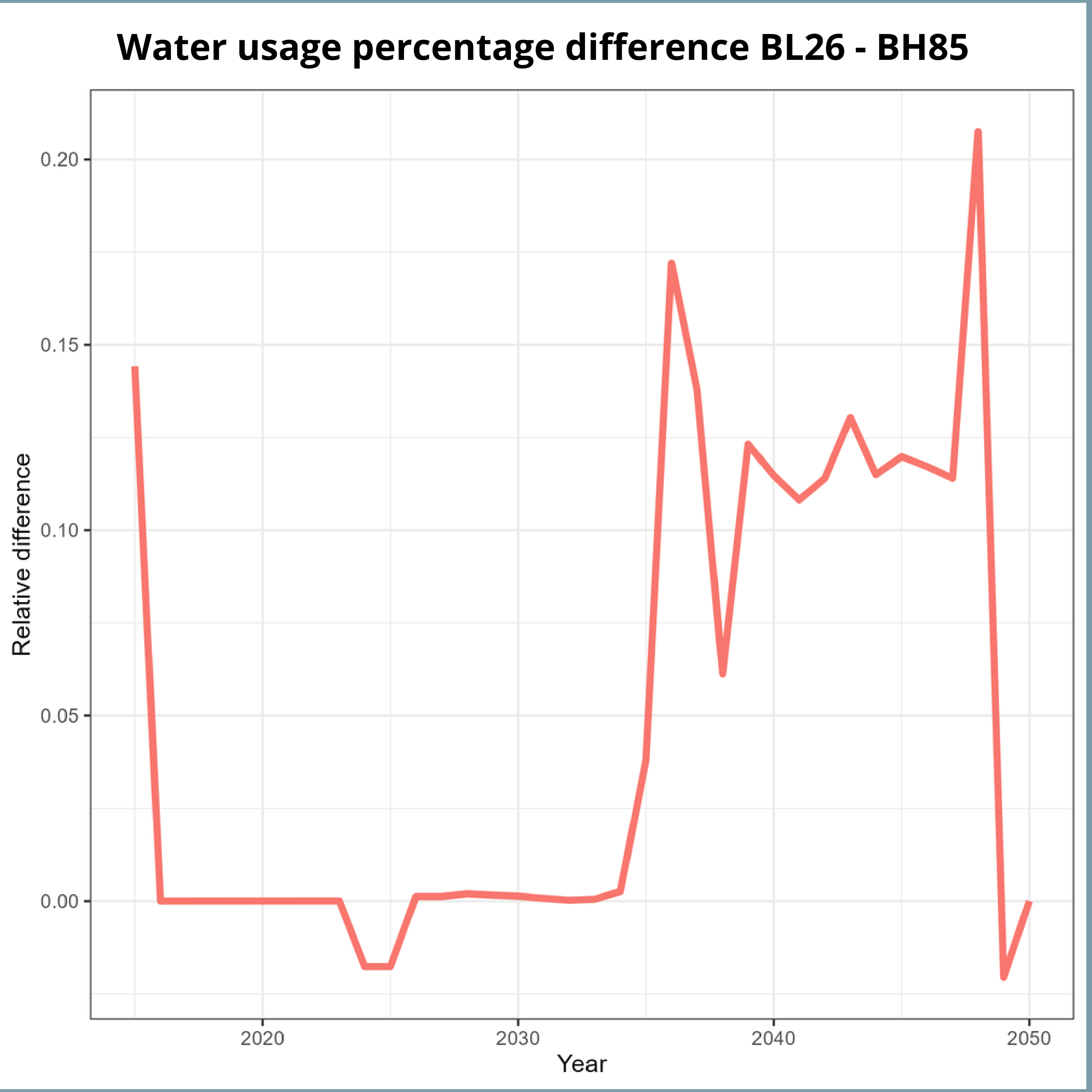
Emissions

Main constrains:

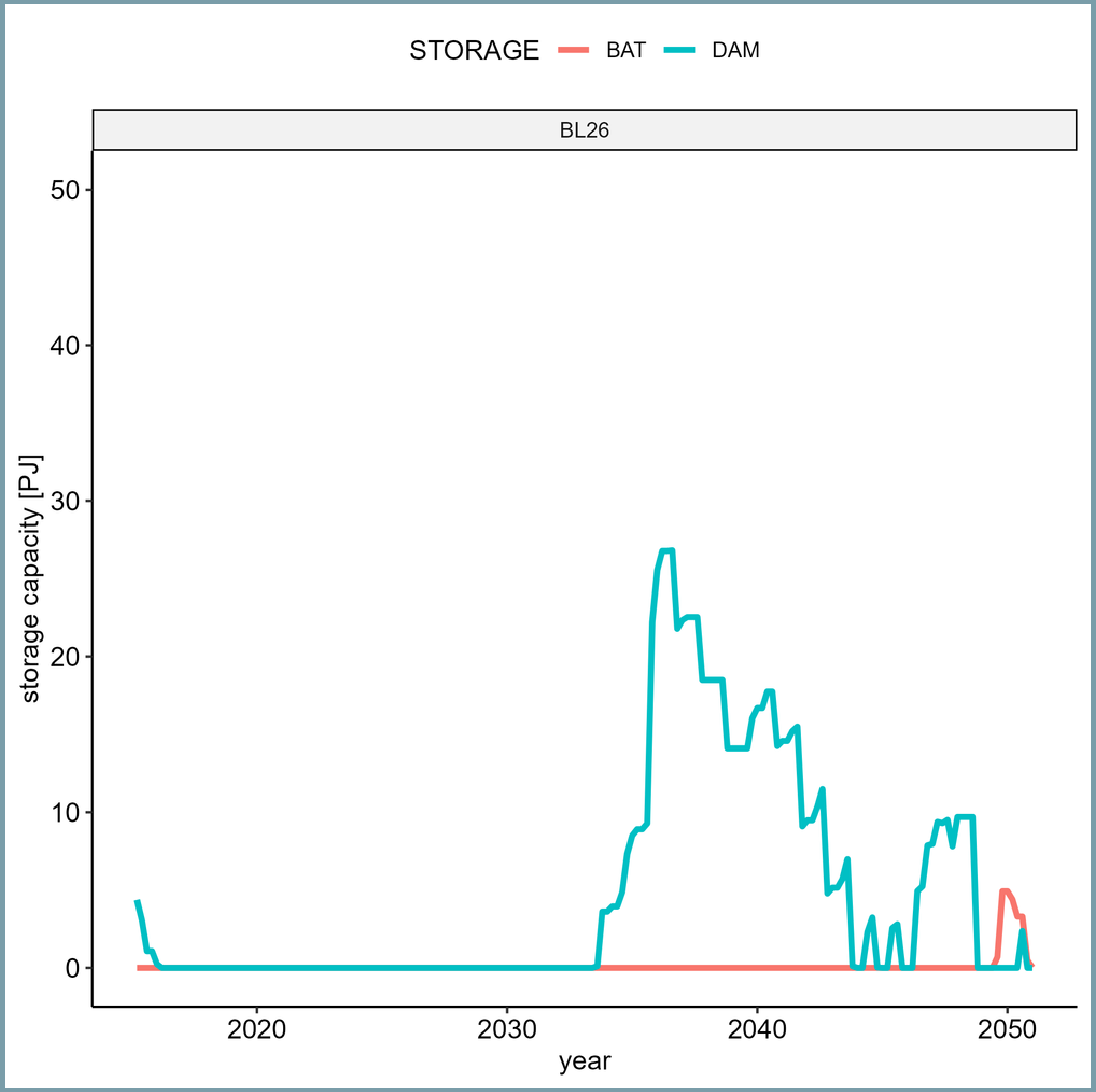
- Reduction of 43% by 2030 compared to 2005 levels
- Net zero by 2050

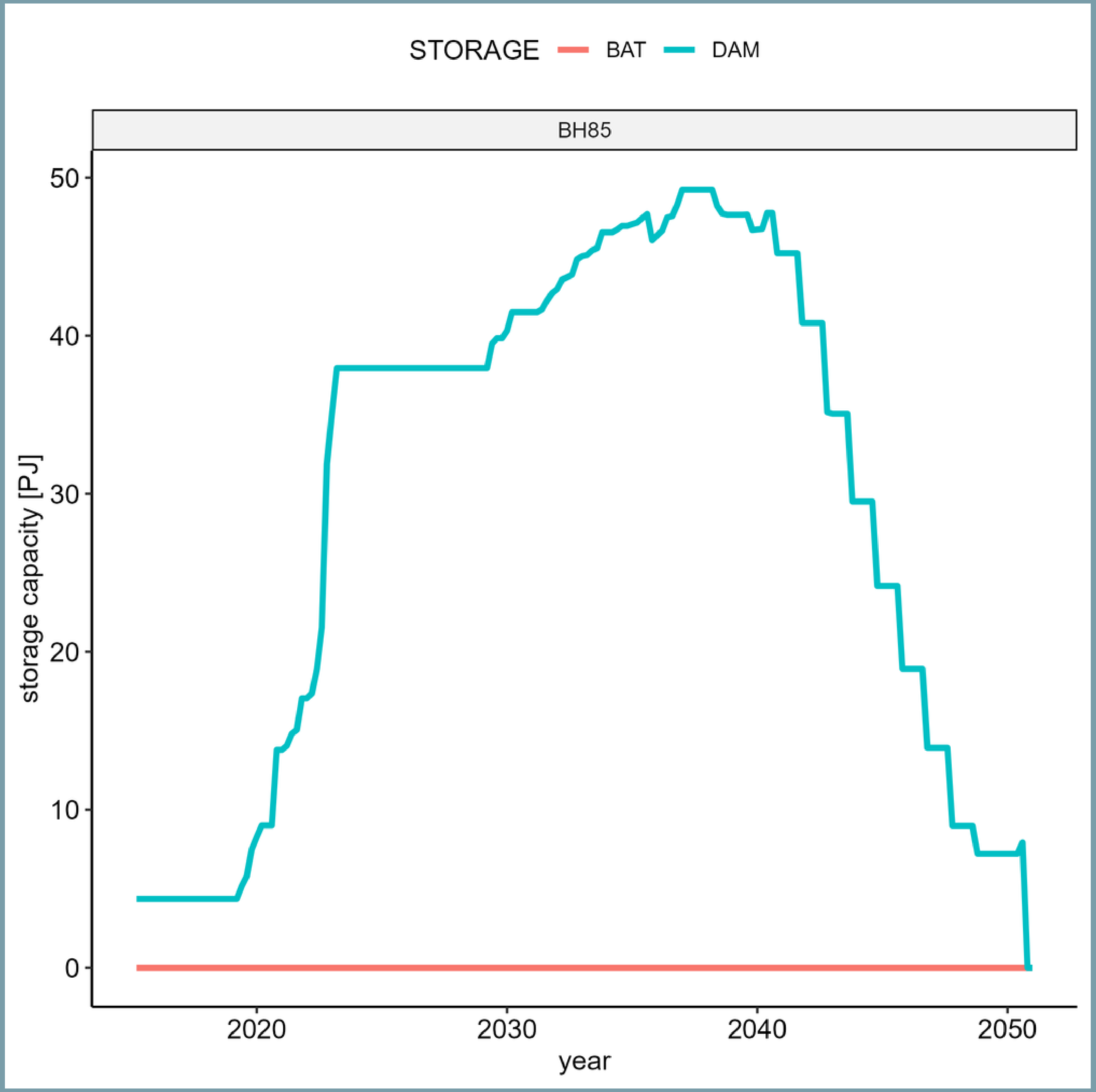
Water Results





Storage


STORAGE BAT DAM
BL26
storage capacity [PJ]
0
10
20
30
40
50
2020
2030
2040
2050
year


STORAGE BAT DAM
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year

Conclusions

What did we understand?

Better use of the resurce and losses reduction

Possibility to improve storage systems also for water in draught periods

Drowbacks and improvements of our model:

Water system is complex and cannot be concentrated into a "point", there are limits in spatial distribution

Include spatial distribution of the resurce and describe the system in a more detailed level respect to the actual formulation

THANKS FOR THE ATTENTION

WATERGAMS