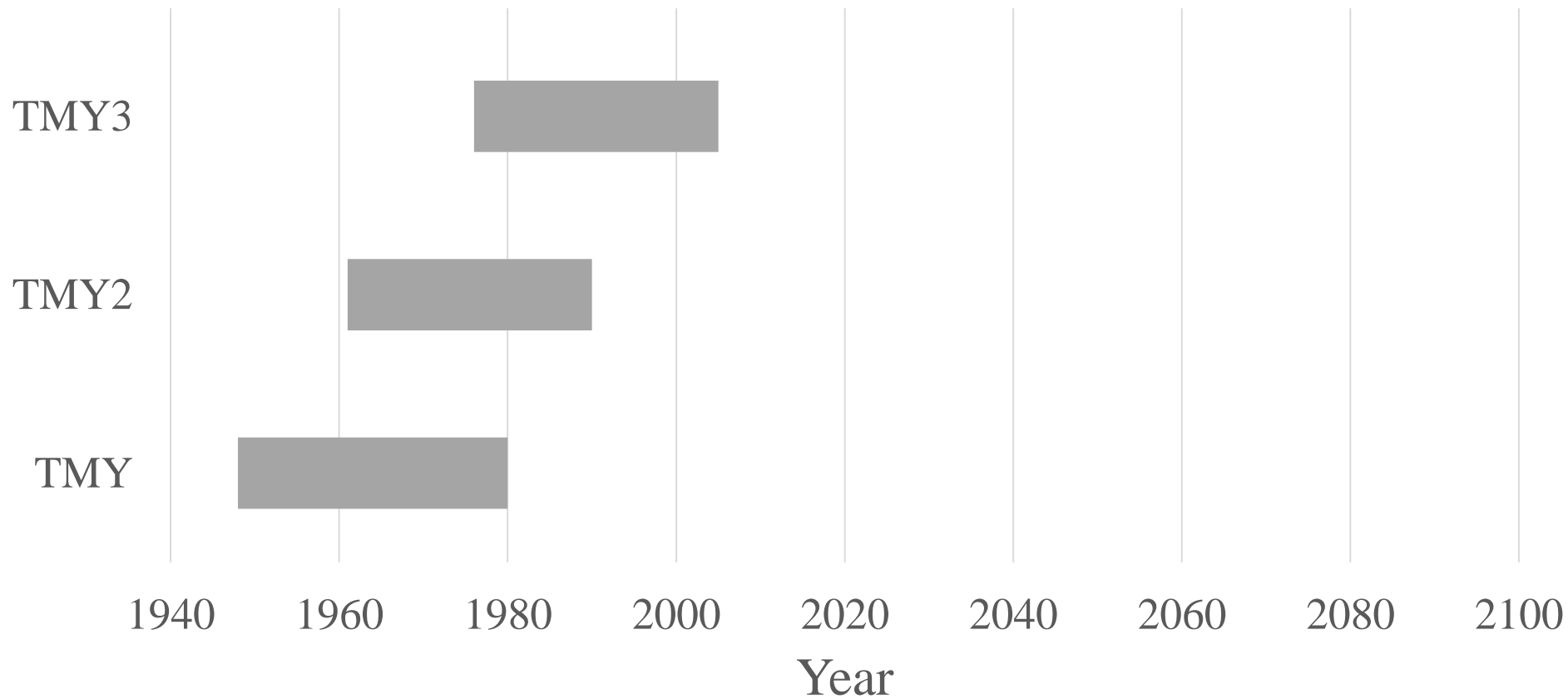


# Why design with old data?

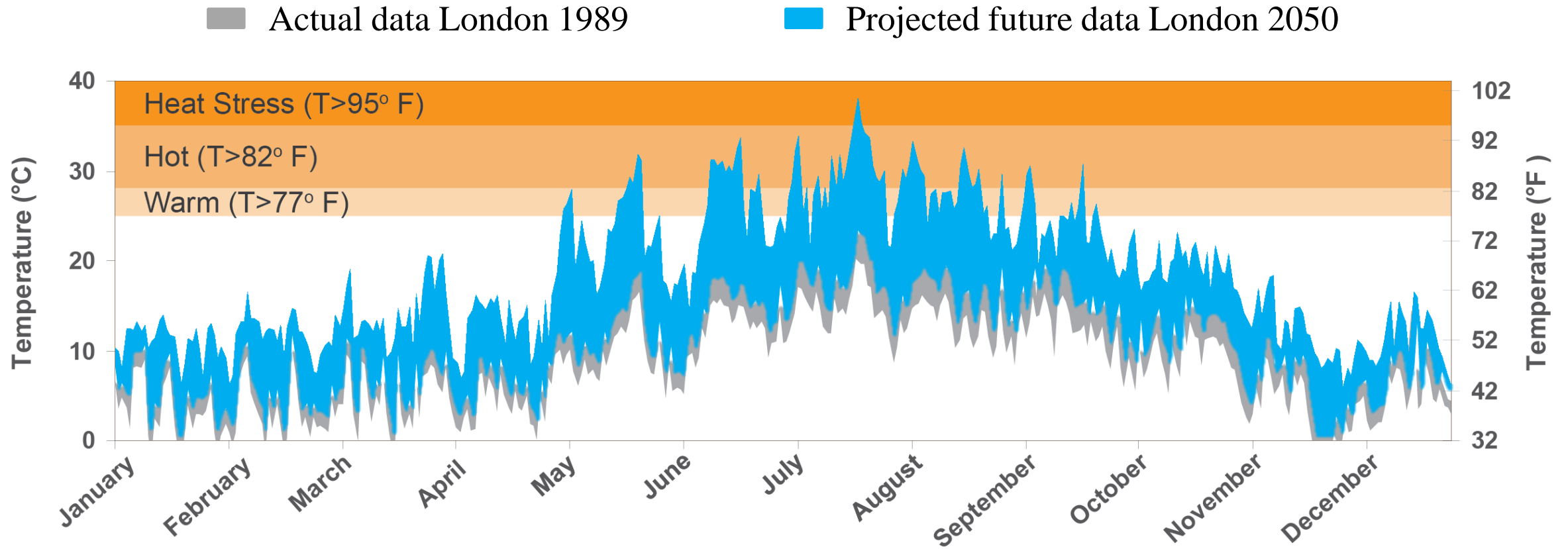
Alexandra Calvén, Arup

Every day in the US  
100,000 Architects &  
250,000 Engineers  
are using weather data that is  
decades outdated.

# Outdated design weather files



# Why does it matter?



Why does this matter to district energy?

# System sizing

1990

Cooling (1%)		Heating (99%)
Dry bulb (DB)	Wet bulb (WB)	Dry bulb (DB)
89.7°F	74.0°F	15.6°F



~ 4,000  
Tons

~ 25  
MMBH

2090

Cooling (1%)		Heating (99%)
Dry bulb (DB)	Wet bulb (WB)	Dry bulb (DB)
93.8°F	78.2°F	18.3°F

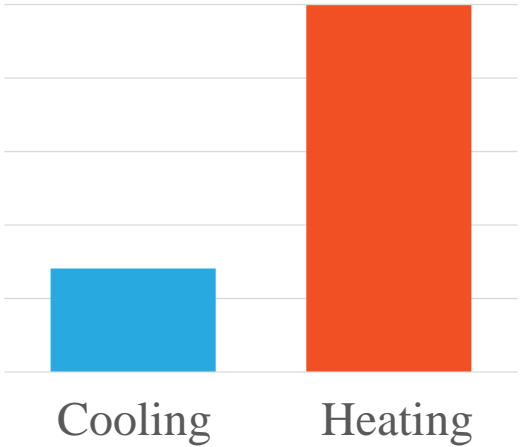


~ 5,000  
Tons

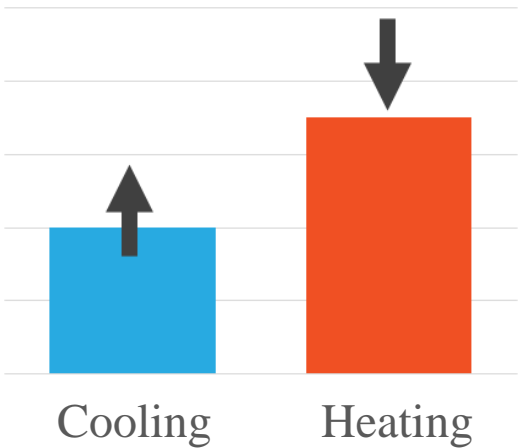
~ 20  
MMBH

# System selection

1990

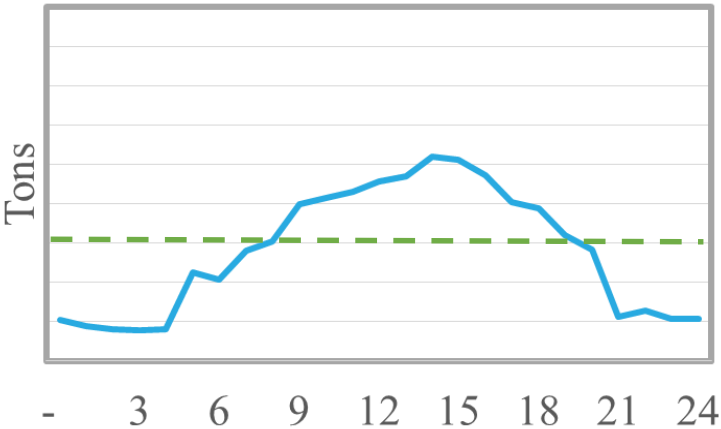


2090

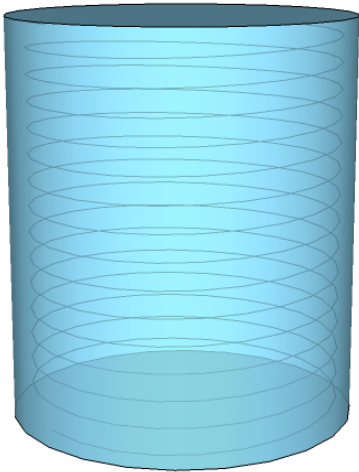
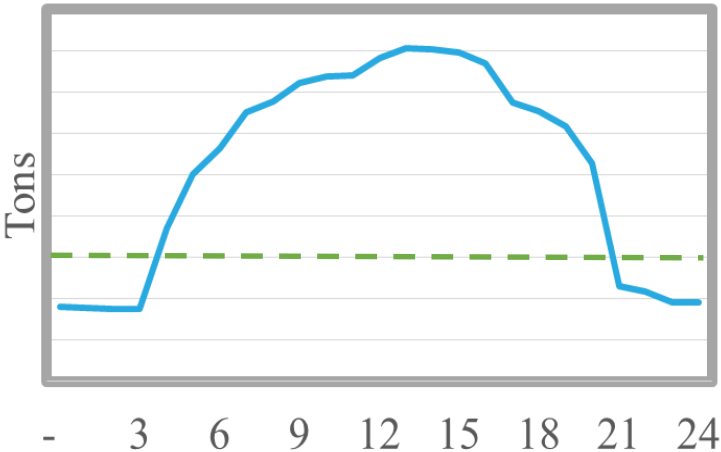


# Thermal storage

1990



2090



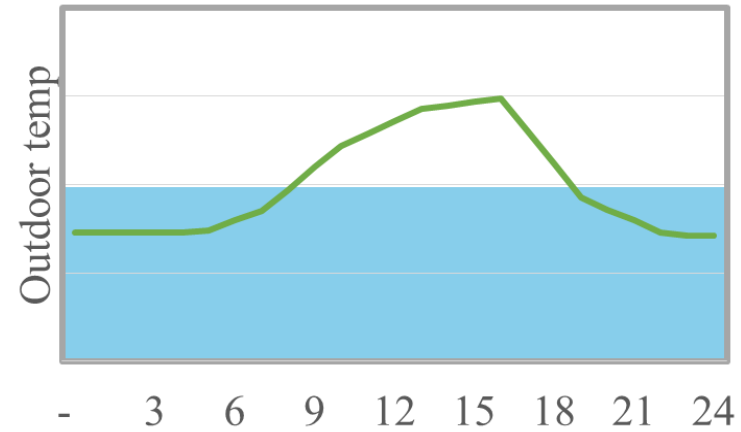
4,000  
Ton-hrs

6,500  
Ton-hrs

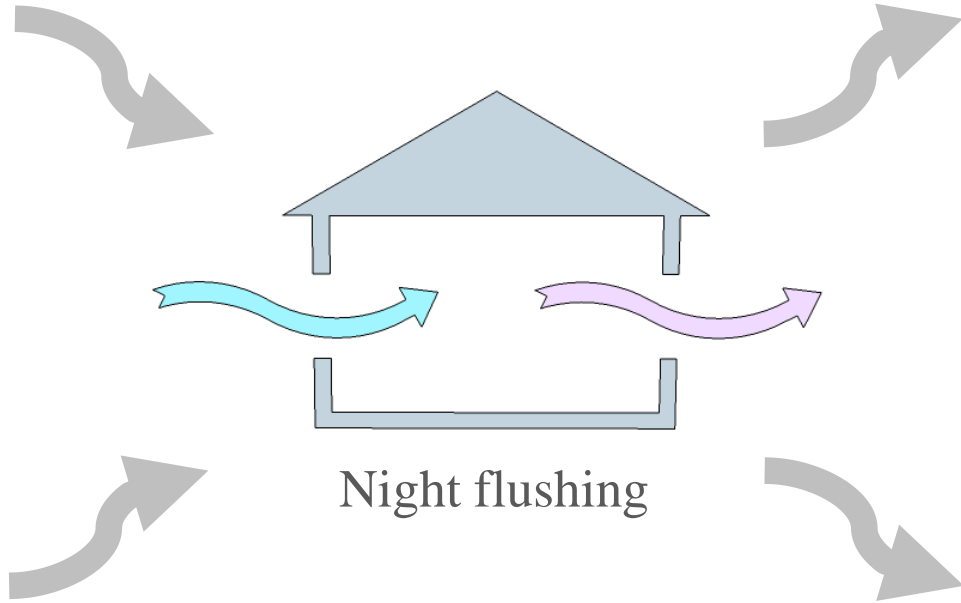
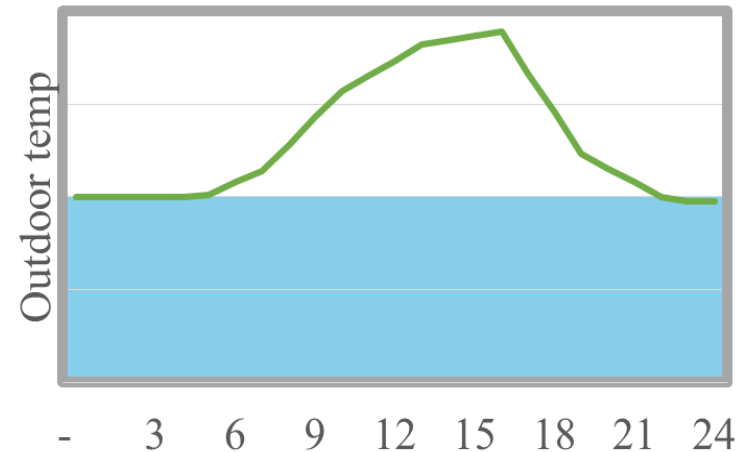


# Resilience of passive design strategies

1990



2090

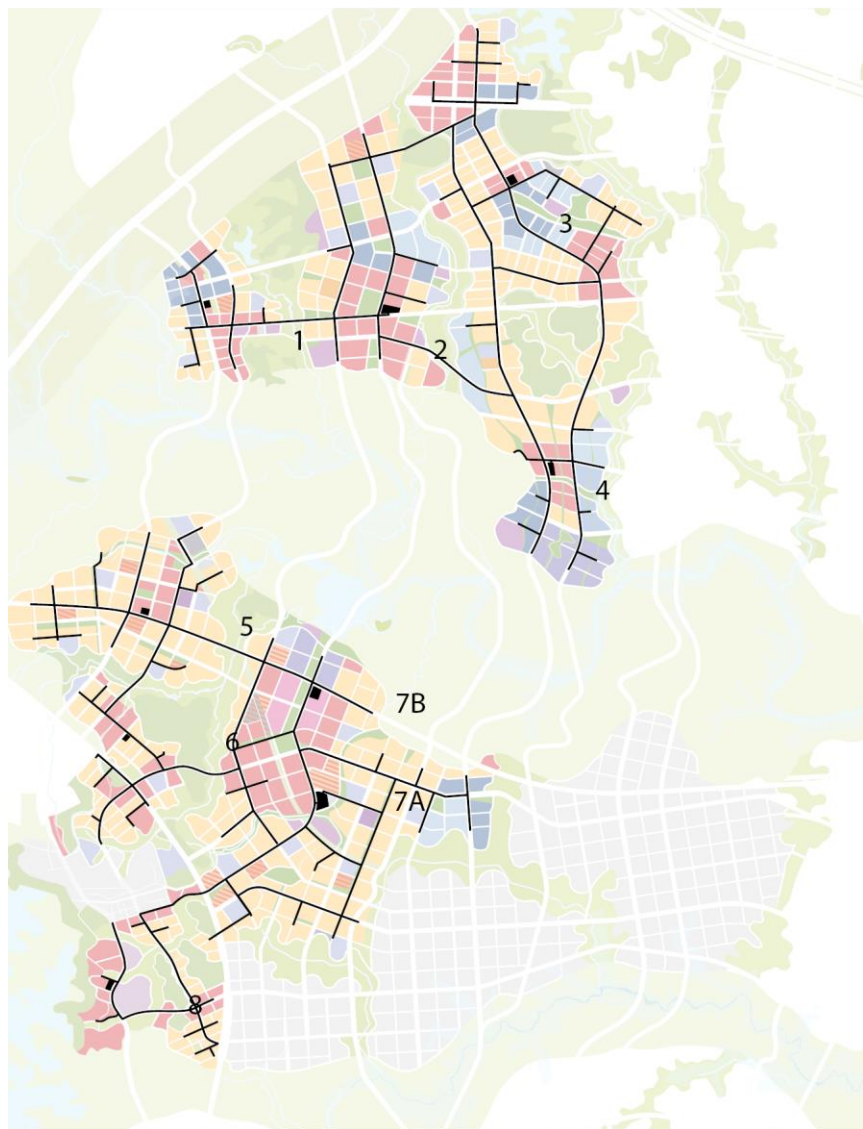


**2000**  
hours/year

**1000**  
hours/year

# Case study: City-scale energy master plan

# Thermal plant locations, sizes, and distribution

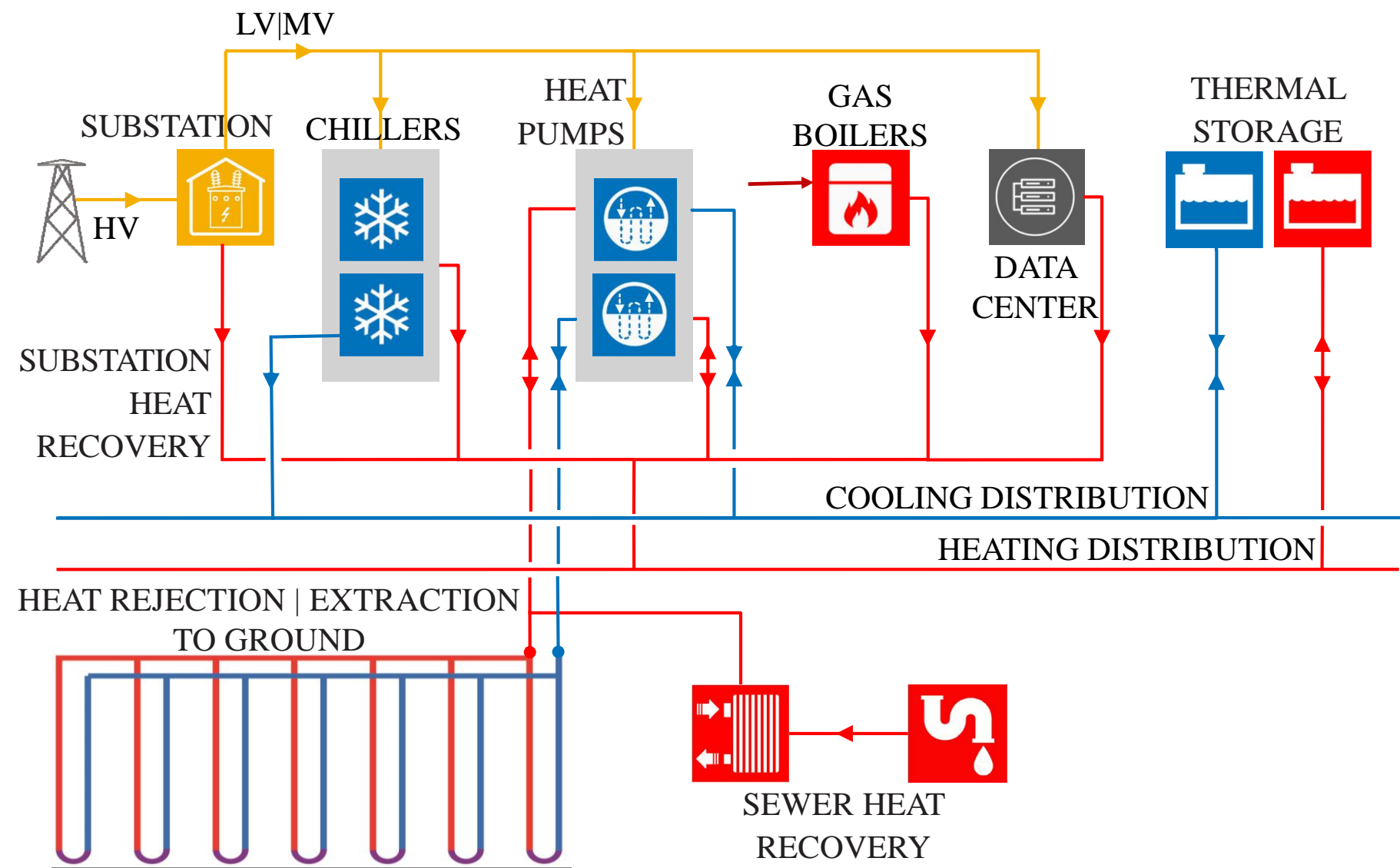


Plant	Peak Heating Load	Peak Cooling Load	Plant Area
	MW	MW	sqm
1	33	55	2,137
2	125	197	7,454
3	94	143	5,485
4	28	59	2,221
5	62	79	3,186
6	19	22	1,001
7A	94	129	5,000
7B	74	102	3,960
8	59	59	2,548

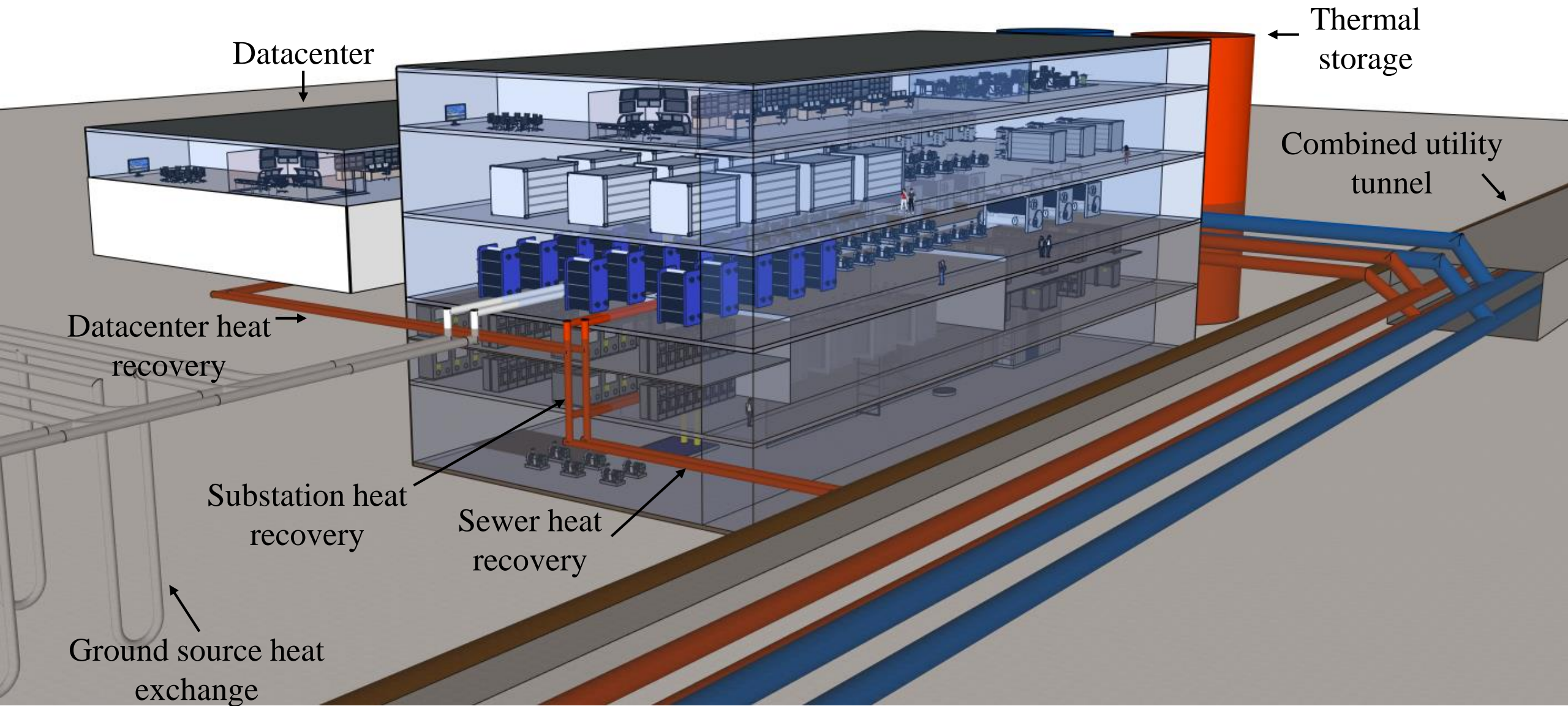
— Thermal piping (heating and cooling)

■ Central plant (assumes 2 floors)

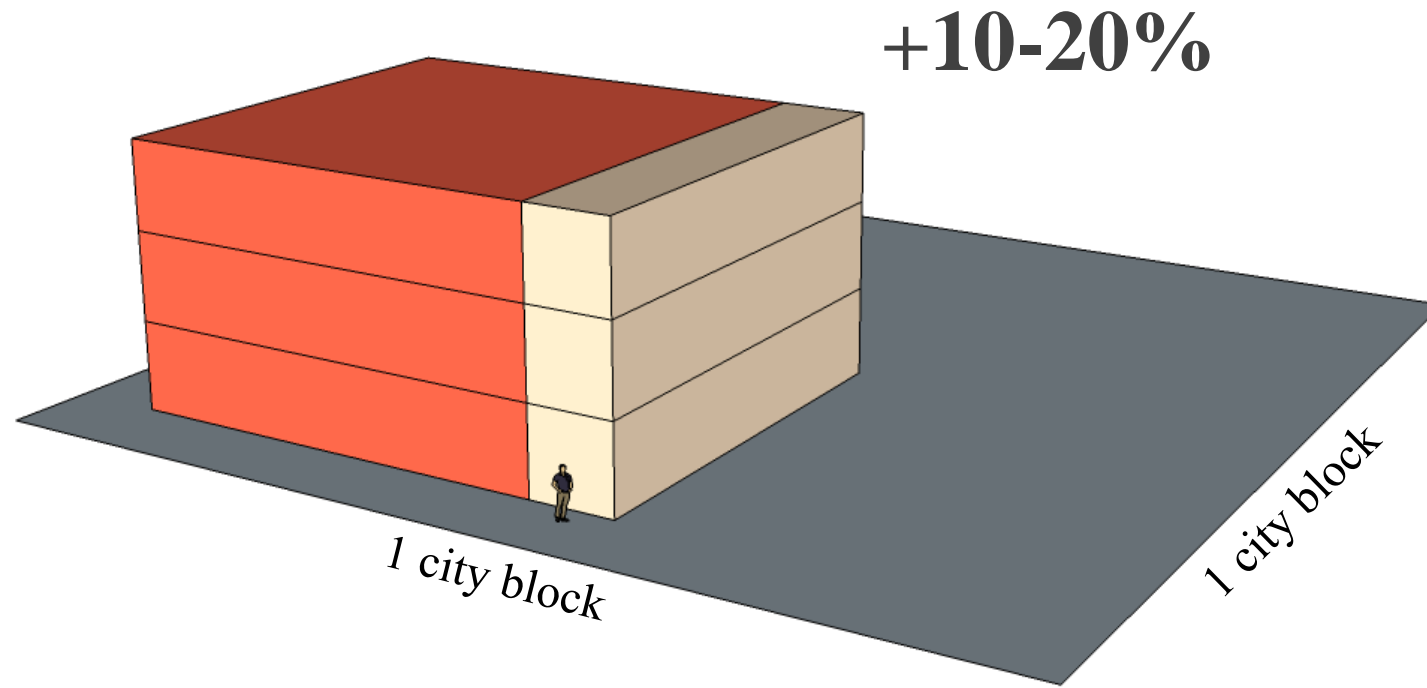
# Integrated thermal strategies



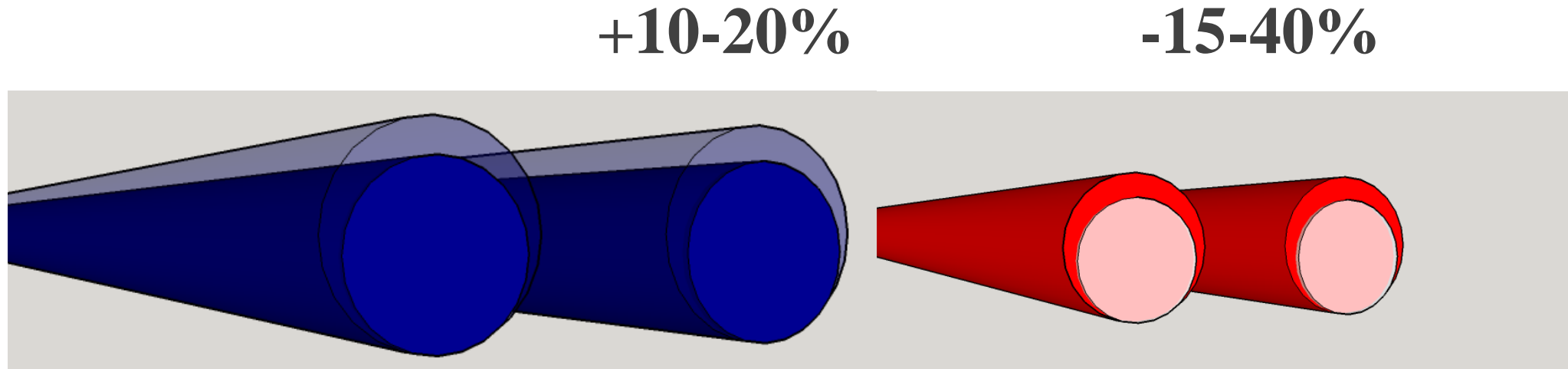
# Integrated central utility plant



# Impact on plant massing



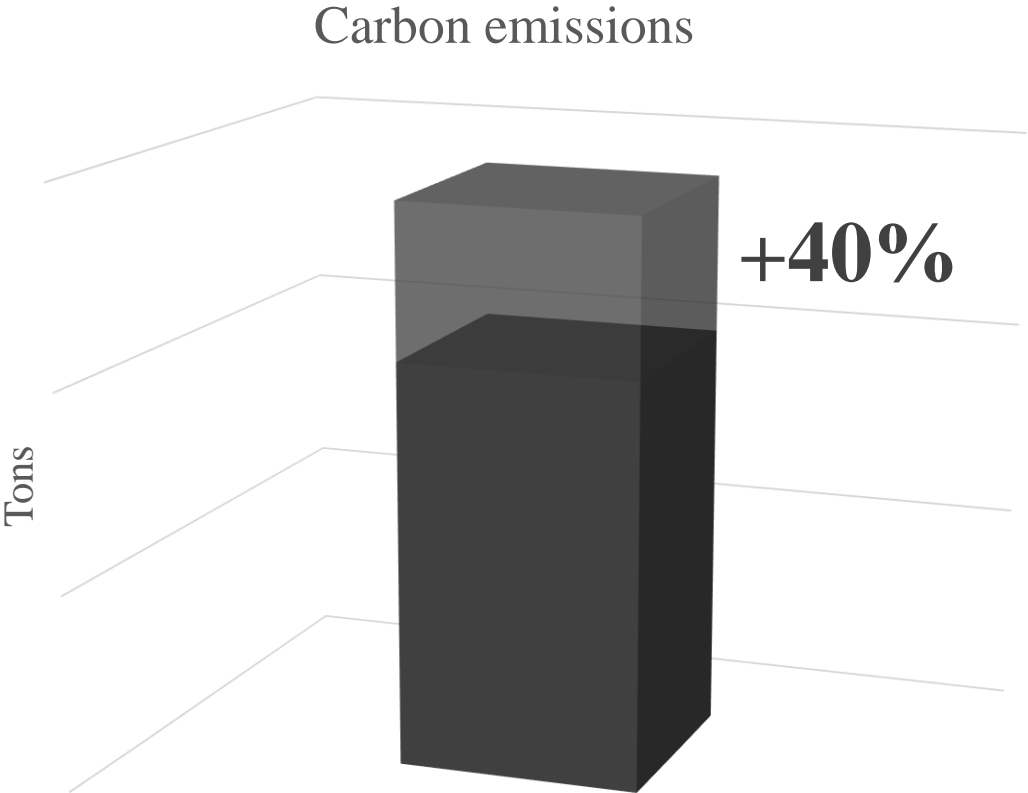
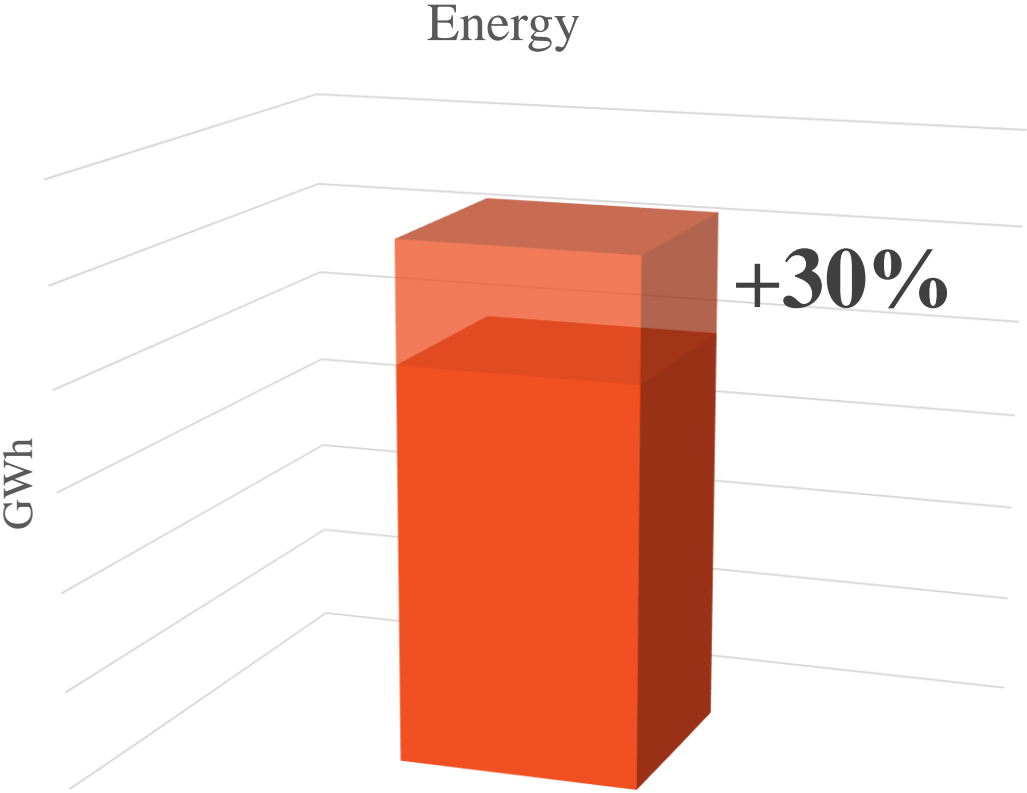
# Impact on pipe sizing



- Challenging to upgrade pipes
- Lower chilled water temperature instead?
  - Impact on design buffer
  - Higher operational costs
- Heating system already oversized?



# Impact on energy use and carbon emissions



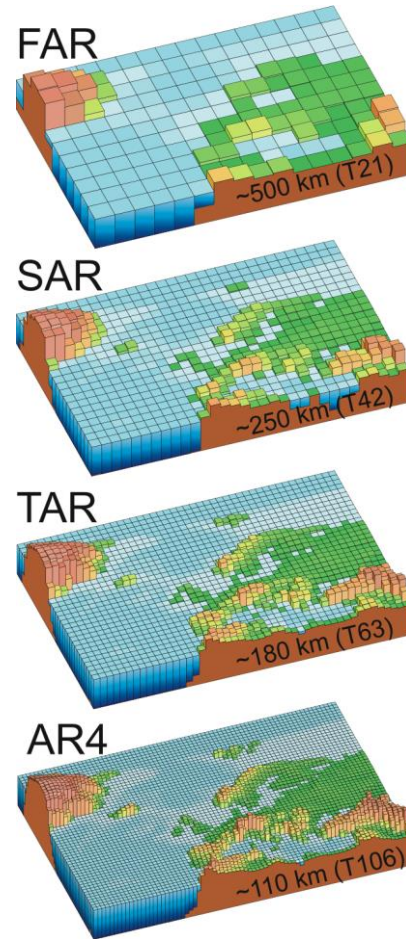


# Climate science: Background and future weather projection

# Global climate model spatial resolution

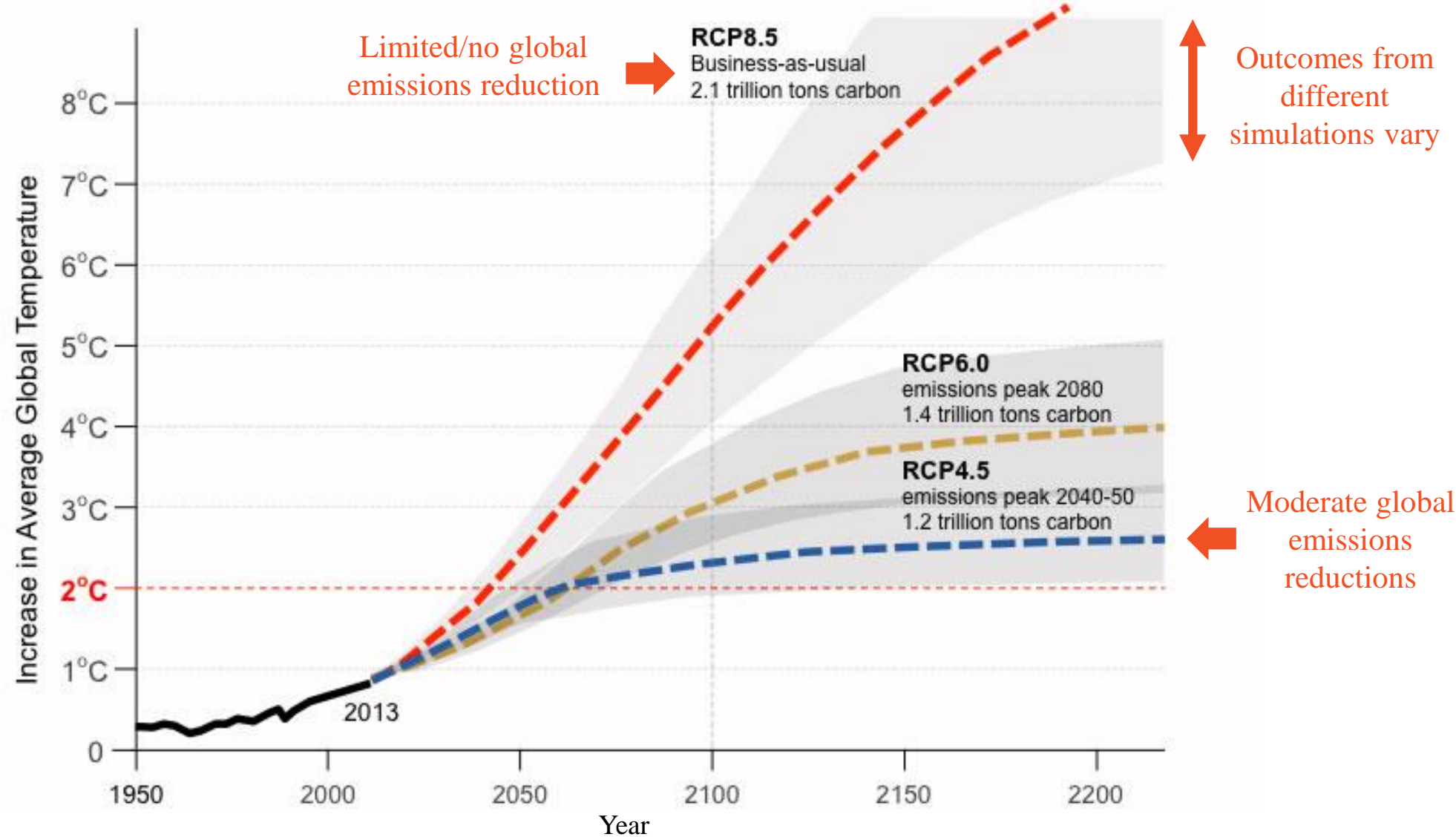
Evolution of IPCC Reports:

1. FAR – 1990
2. SAR – 1995
3. TAR – 2001
4. AR4 – 2007
5. AR5 – 2013

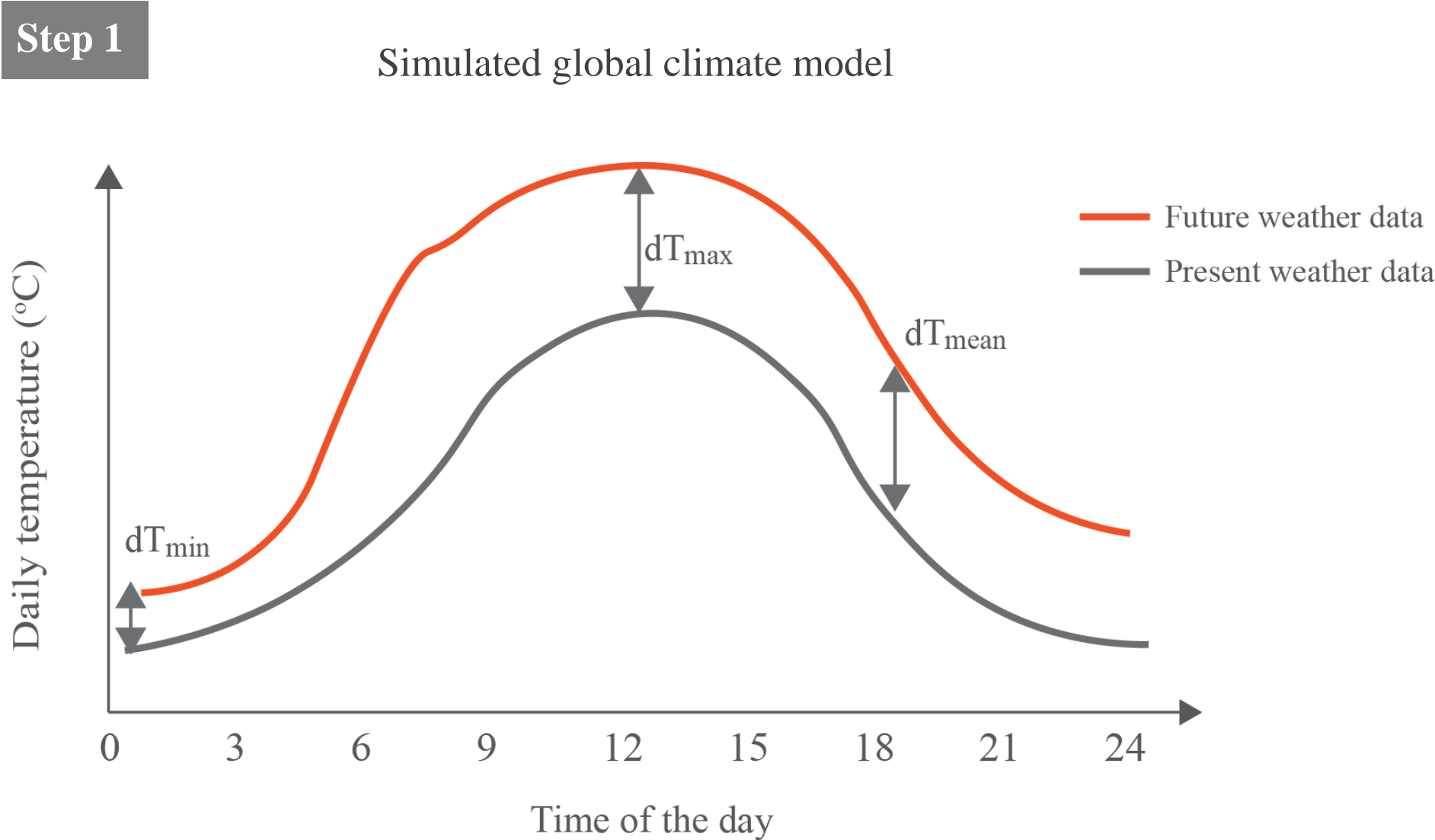


@ IPCC AR4 (2007)

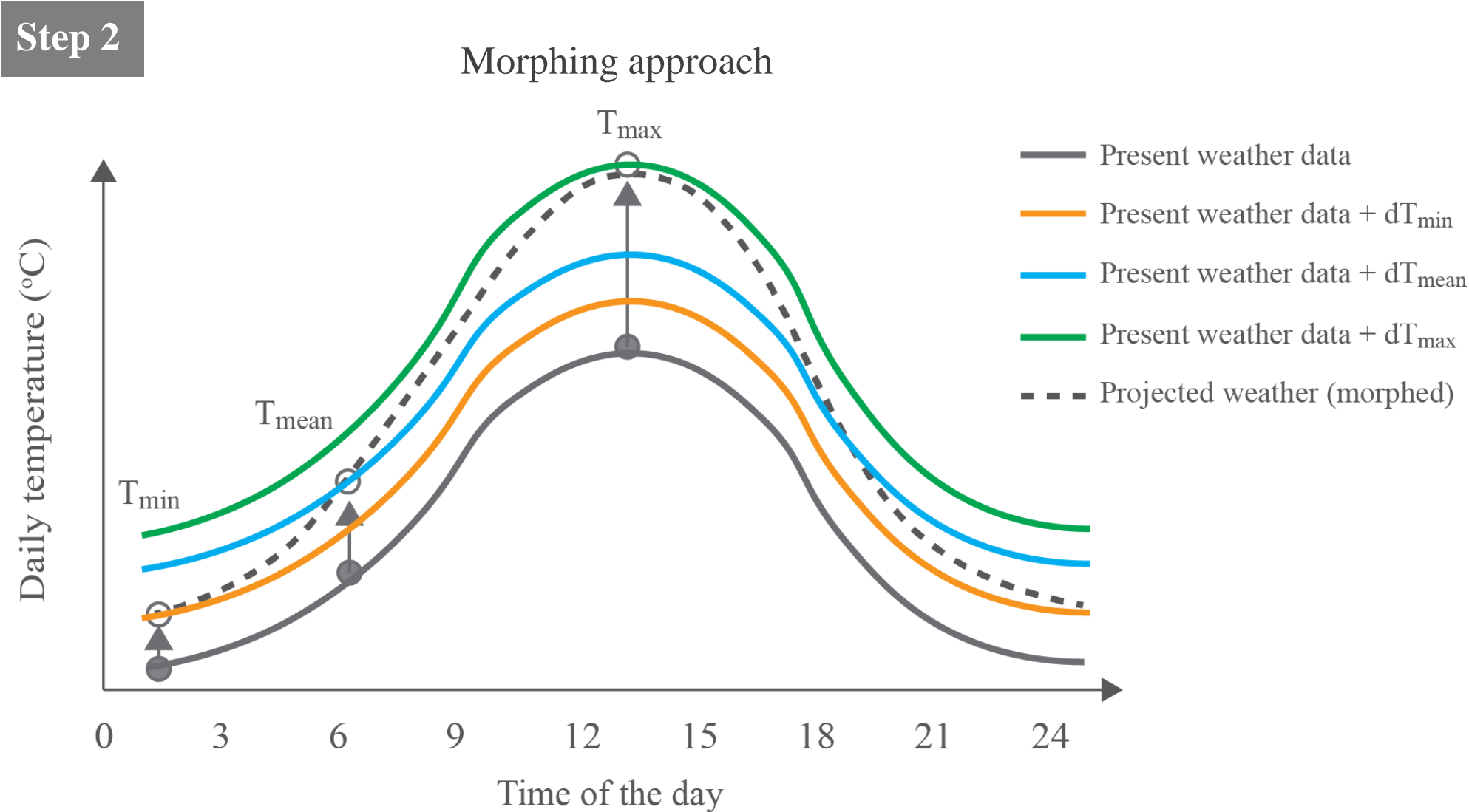
# Emissions scenarios



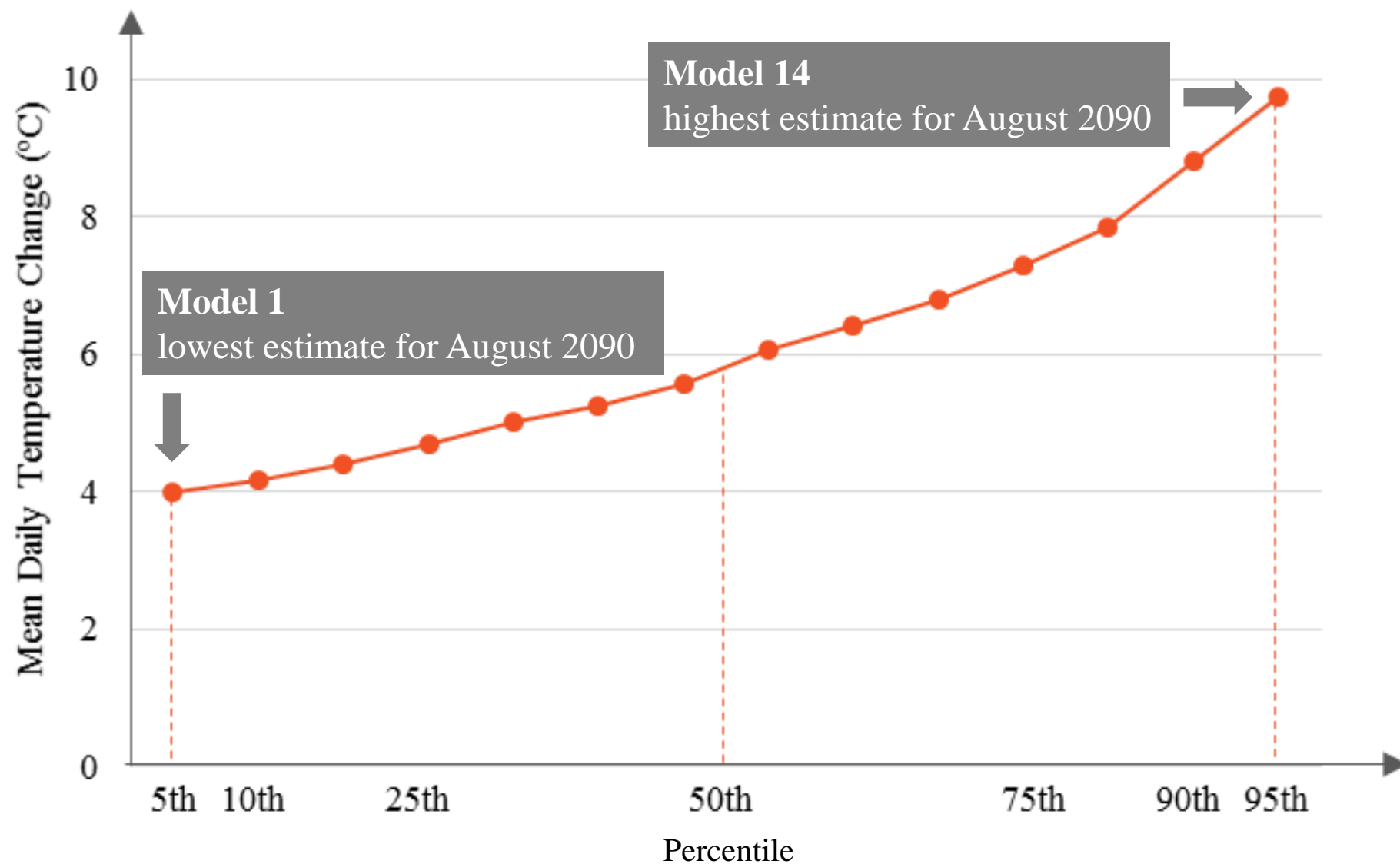
# Morphing approach



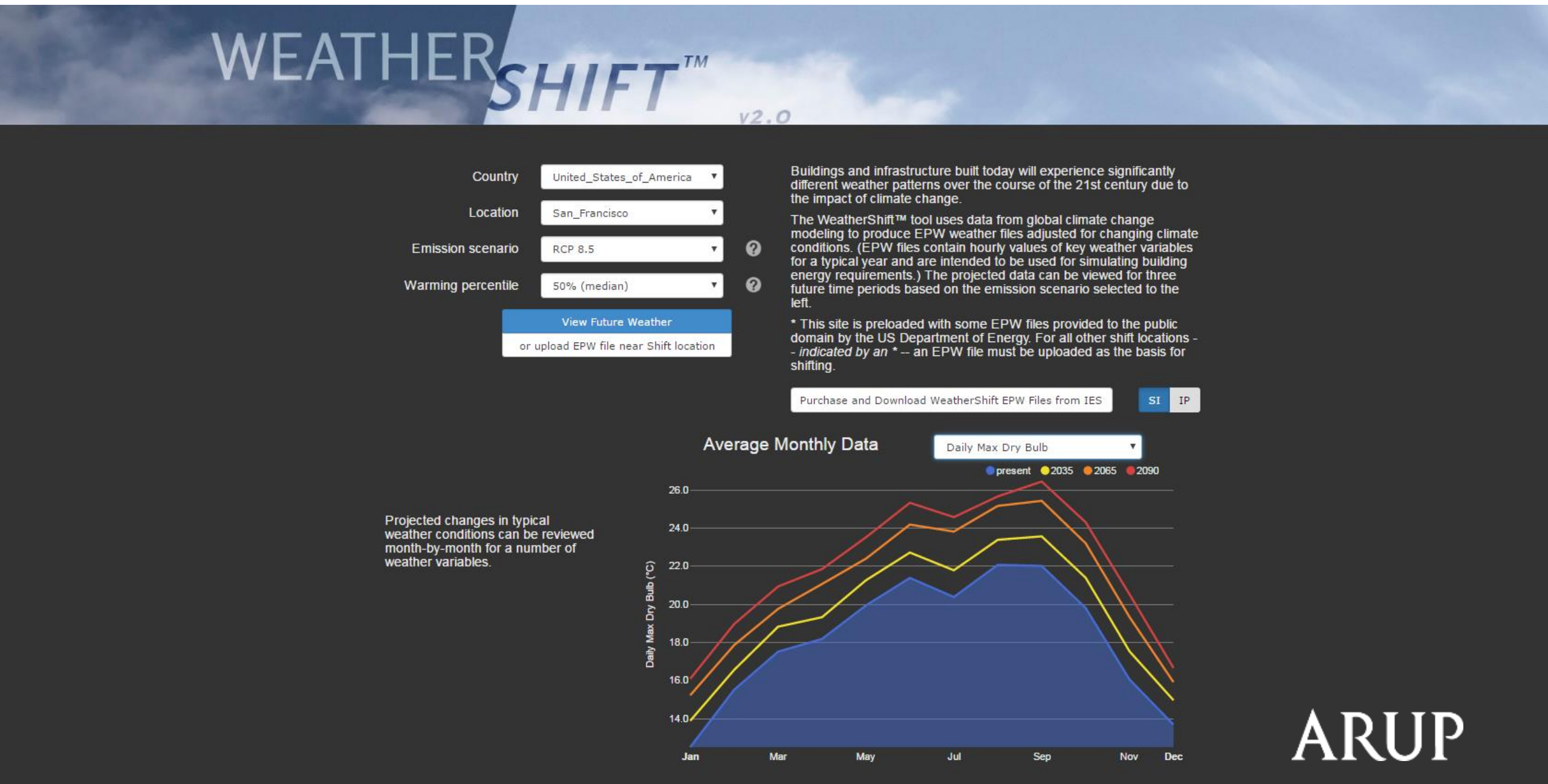
# Morphing approach



# Ensemble of climate models

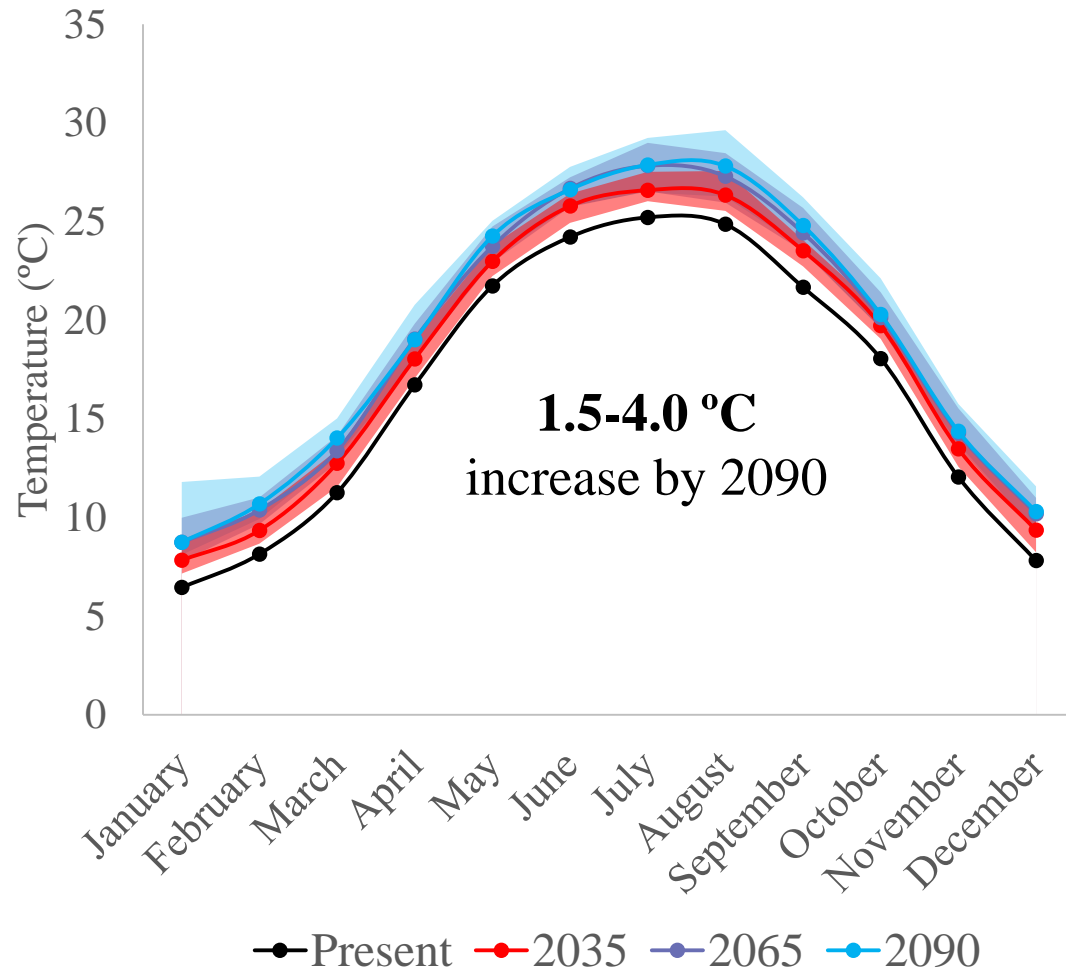


# Free visualization on [www.weathershift.com](http://www.weathershift.com)

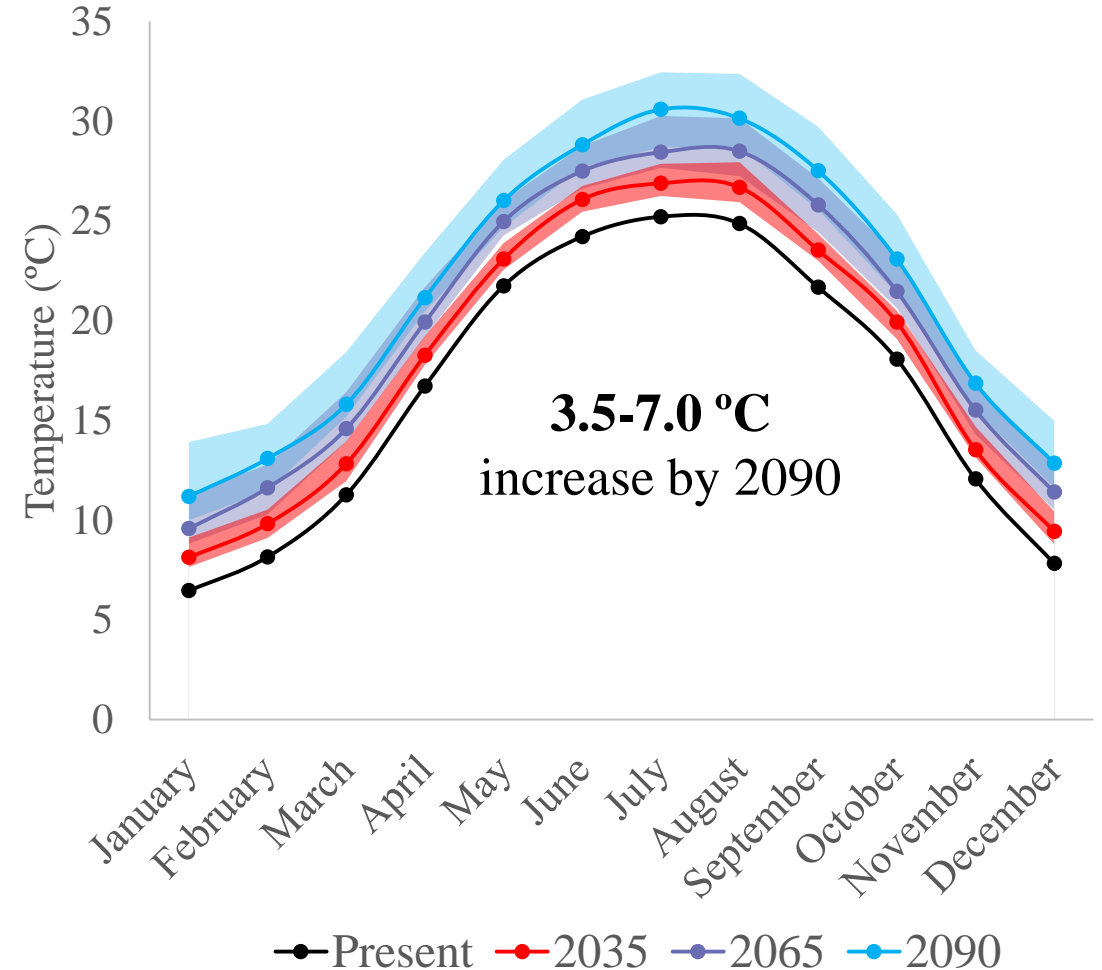


# Weathershift analysis

Average monthly temperature  
RCP 4.5



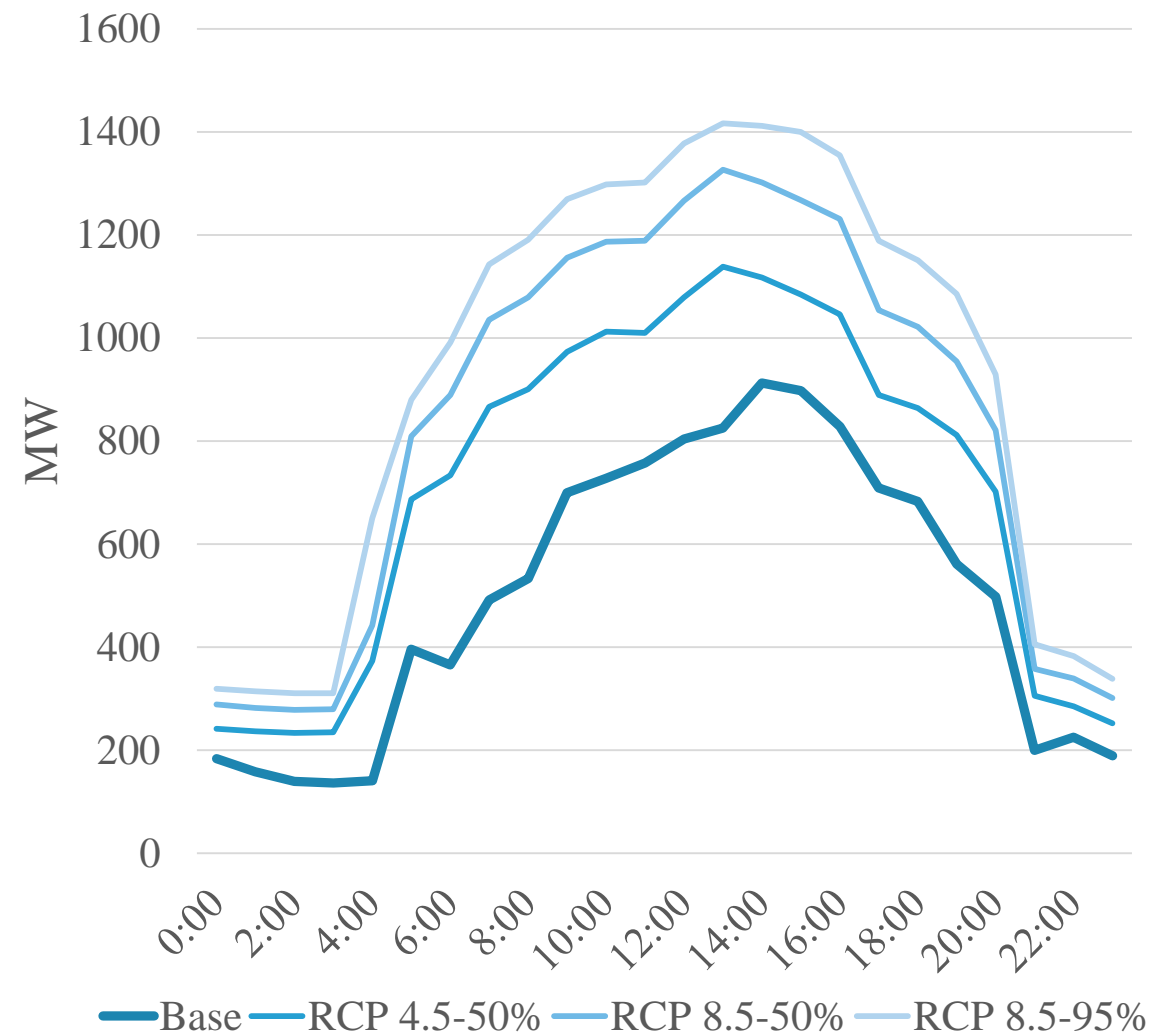
Average monthly temperature  
RCP 8.5





# Impact on loads

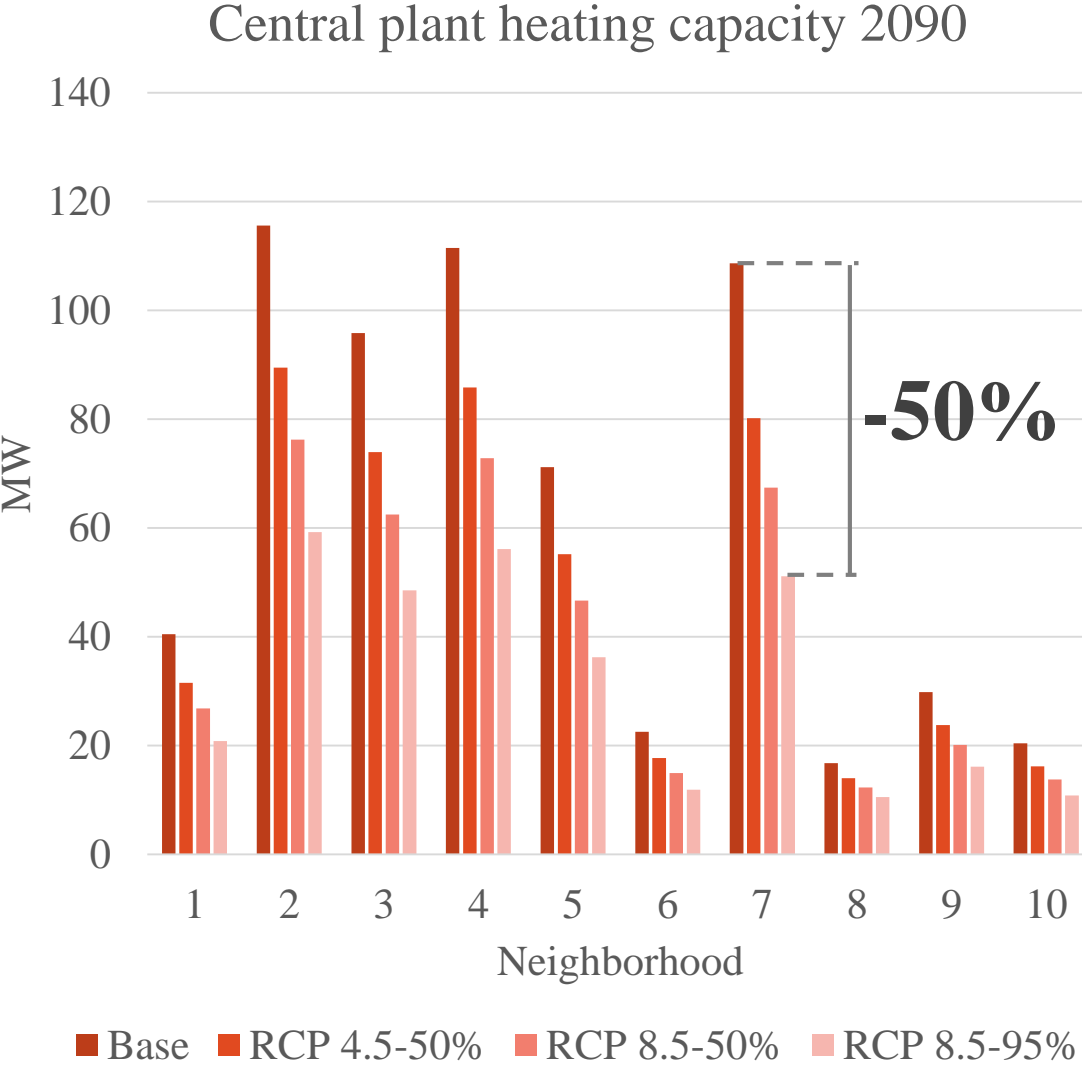
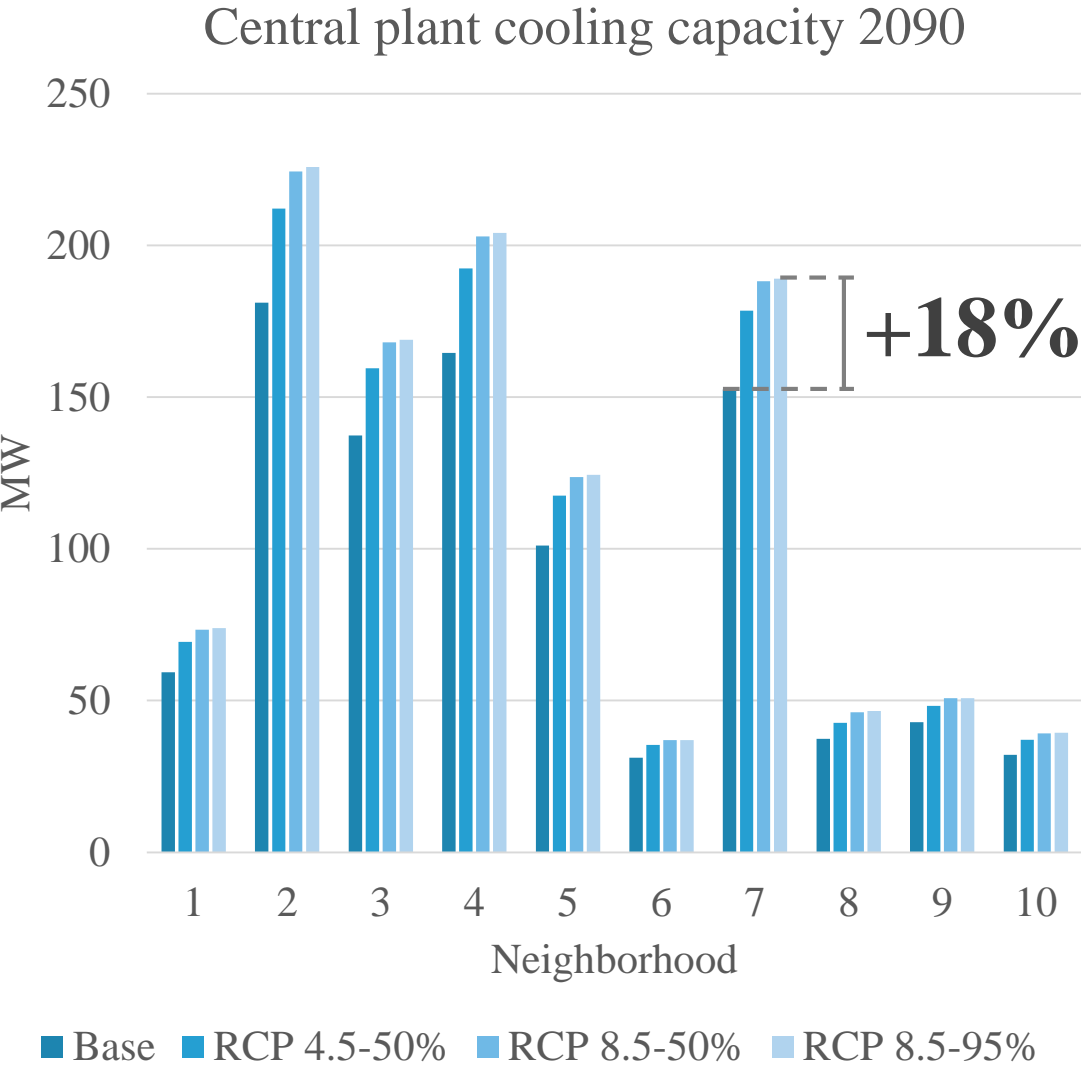
Typical summer cooling profile 2090



Typical winter heating load profile 2090



# Impact on plant sizing



# Summary

- District energy systems will operate for a long time
- Design for change
- Emerging best practices
  - Solar shift for PV
  - Wind shift for wind power
- Stress test your system

Thank you!

