Investigation of cooling demand in Rotterdam and mitigation strategies for 2050

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DigiTwins4PEDs

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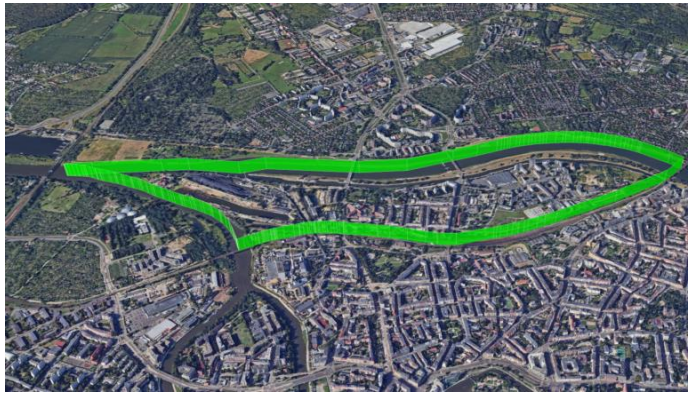
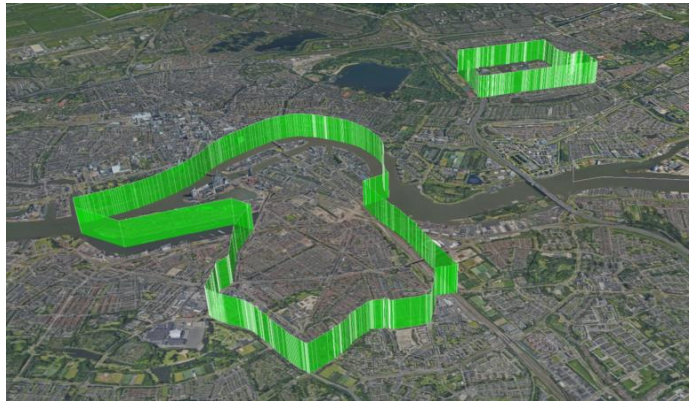
Stuttgart – Nordbanhnhofviertel

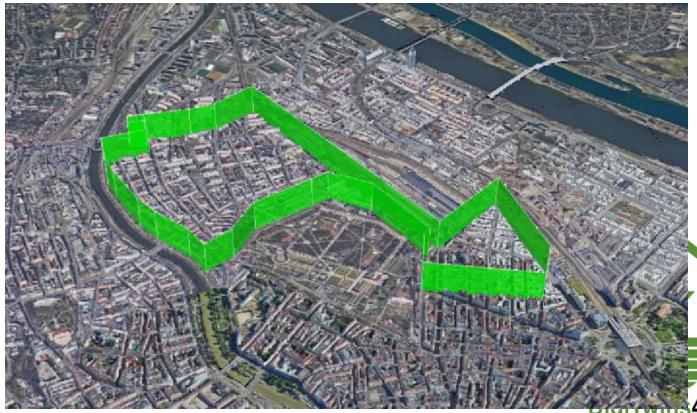
Wrocław District – Kleczków



Rotterdam – Prinsenland and Feijenoord



Vienna “Grätzl 20 + 2”



Why do we care about cooling?

Extremely hot weather. - Credit: MingPhoto / DepositPhotos - License: DepositPhotos

HEALTH HOMEOWNERS HOT WEATHER HOMEOWNERS ASSOCIATION VEH
OVERHEATING » MORE TAGS

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SATURDAY, 20 JUNE 2026 - 07:15

Quarter of homeowners struggle with heat, also after taking measures

https://nltimes.nl/2026/06/20/quarter-homeowners-struggle-heat-also-taking-measures

		Max.	Min.	Precipitation	Chance of precipitation	Wind force	Sunshine	Sun power	
Sunday June 21		28°	17°	0/5 mm	30%	W2	70%	7	!
Code yellow more information	Heat								
Monday June 22		28°	17°	0 mm	10%	SO 2	70%	7	!
Code yellow more information	Heat								
Tuesday June 23		30°	18°	0 mm	10%	W3	90%	7	!
Code yellow more information	Heat								
Wednesday 24 June		33°	17°	0 mm	0%	W3	90%	8	!
more information	Possible heat								
Thursday 25 June		34°	18°	0 mm	0%	No. 2	90%	7	!
more information	Possible heat								
Friday June 26		36°	19°	0 mm	20%	O 3	80%	7	!
more information	Possible heat								
Saturday June 27		29/33°	22°	0/4 mm	50%	W2	70%	7	!
more information	Possible heat								

https://www.knmi.nl/nederland-nu/weer/verwachtingen

Context

- **Study area(s):**
  - **Ten** study areas
- **Challenges:**
  - Higher cooling demand will lead to higher demand of electricity
  - Current power grid network is already experiencing congestion
  - How far can renewables (e.g. PV) cover the new demand? What is their effect on the power grid?
  - What are the viable alternatives to *reduce* the cooling demand? E.g. more urban greening, more urban shadowing, further building refurbishment?
  - What is the possible social impact of such measures?

DigiTwins4PEDs - Rotterdam

Architecture

Gemeente Rotterdam

CityGML

CityDoctor

Geometry repair

FME

Data Enrichment

kadaster

BAG data

QGIS

TABULA

TABULA WebTool

Building typology

SimStadt

3D CityDB

Koninklijk Nederlands Meteorologisch Instituut

Ministerie van Infrastructuur en Waterstaat

Weather data

CESIUM 3DTiles

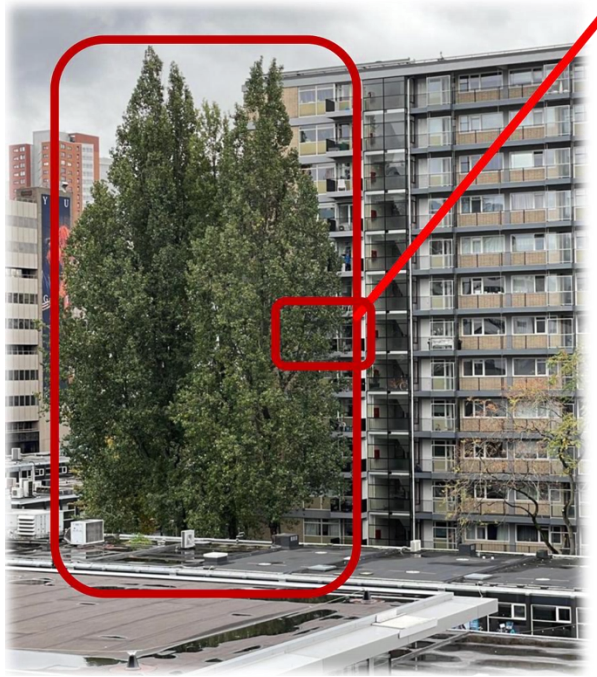
Visualization / Interaction

DigiTwins4PEDs

Scenario-based simulations

Nature-based solution

Modelling tree-planting strategy to reduce heating and cooling demand under 2050 climate conditions



You would like the view of the tree in general

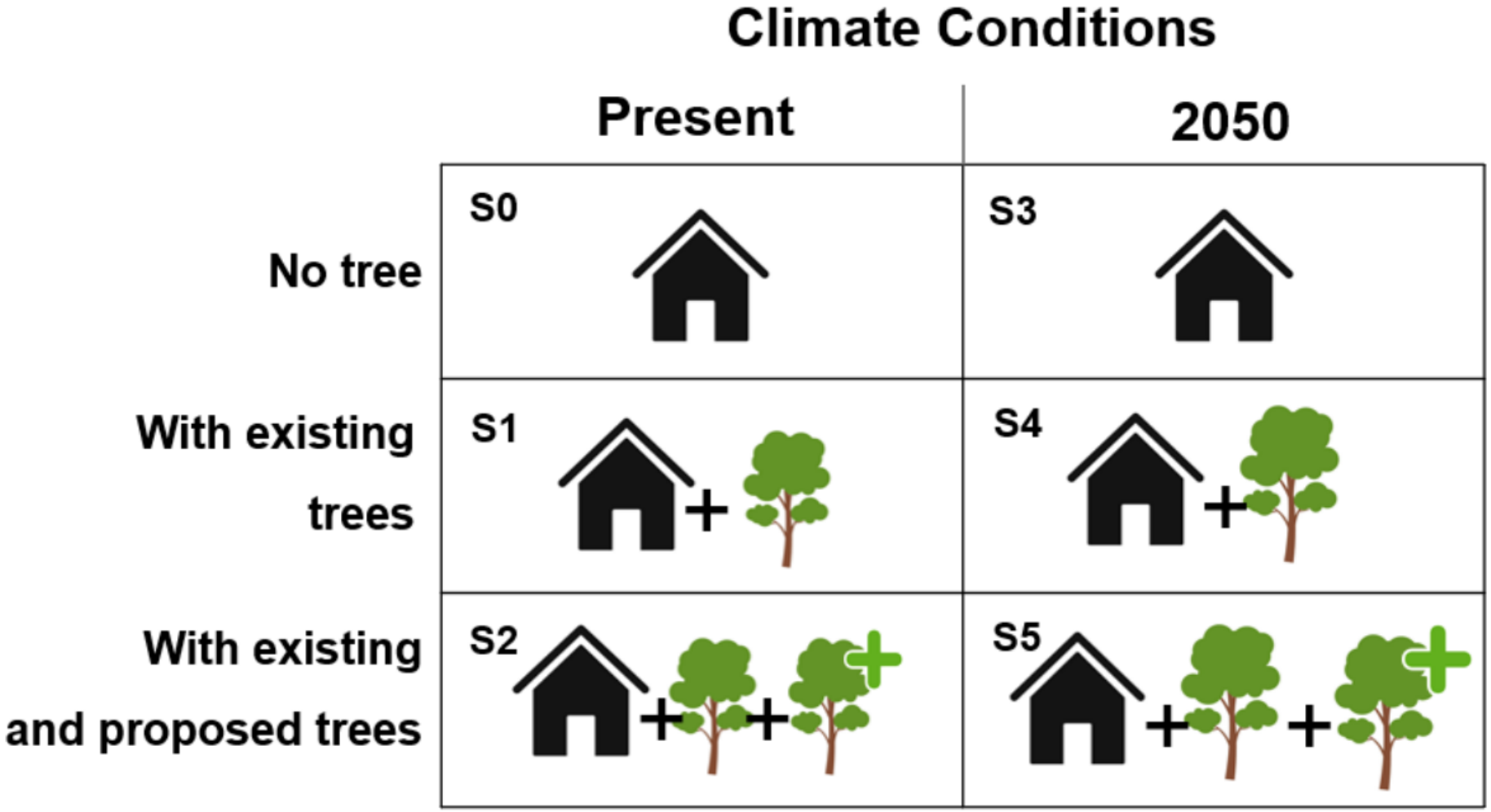
In summer, you'd appreciate the coolness the tree brings

But in winter, the tree blocks the warmth you long for

The tree causes higher electricity costs due to higher usage of heater

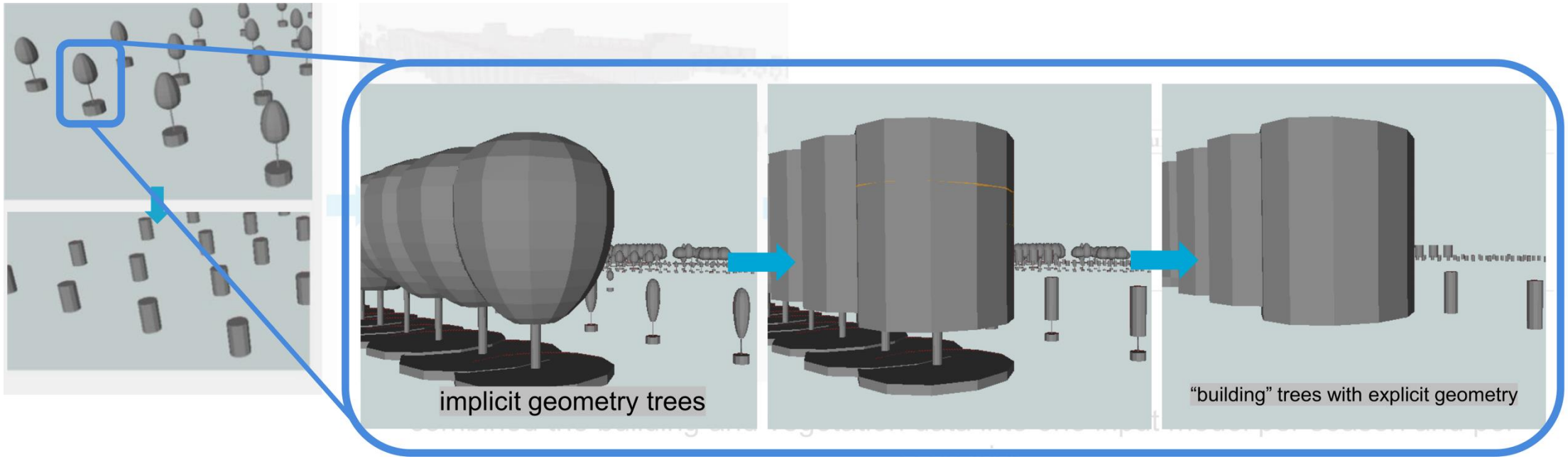
Modelling tree-planting strategy to reduce heating and cooling demand under 2050 climate conditions

Scenarios development



Modelling tree-planting strategy to reduce heating and cooling demand under 2050 climate conditions

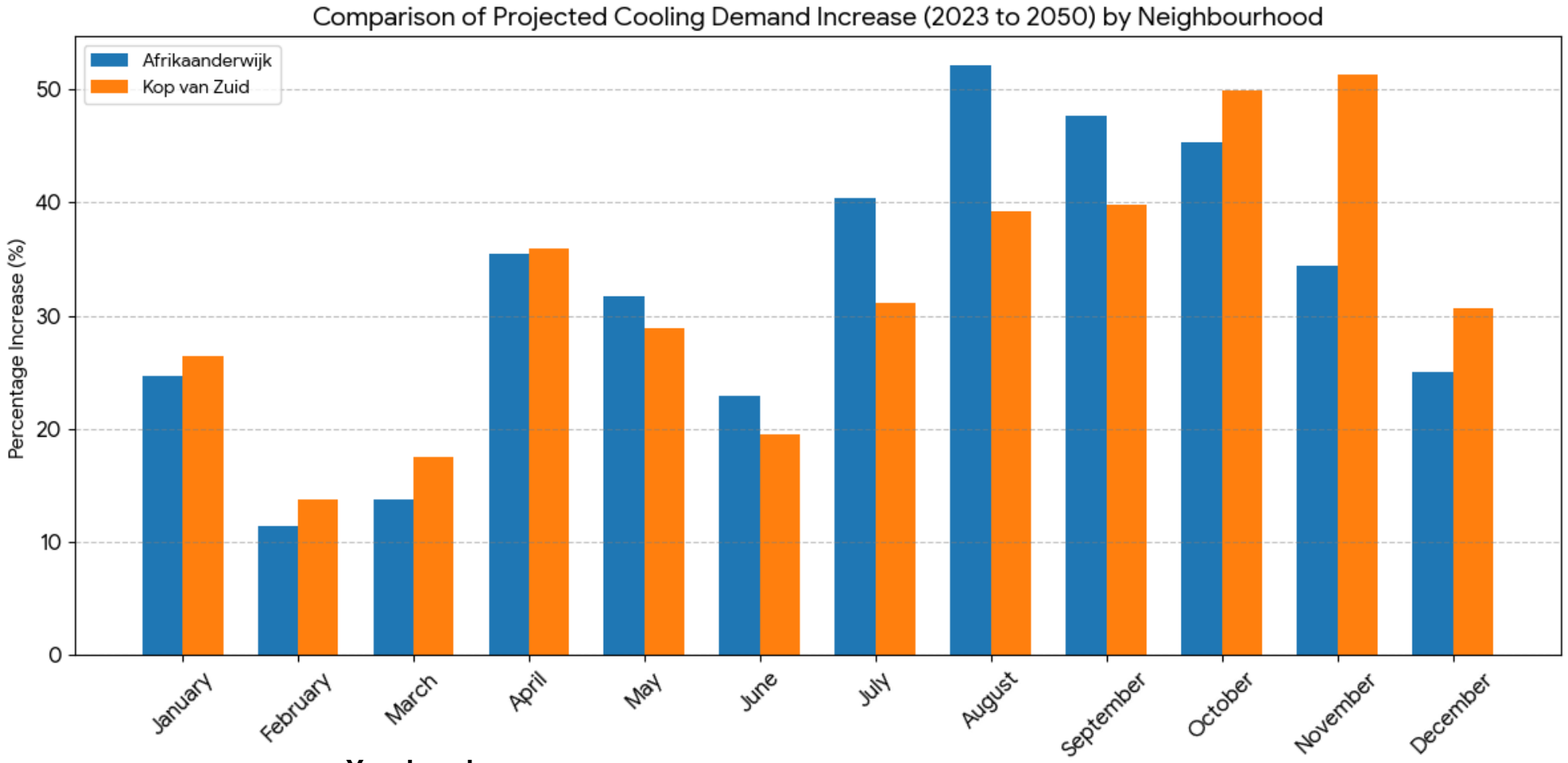
Modelling simplifications and assumptions



- All trees were assumed to be deciduous
- Crown diameter (D_c) in Summer
- Crown diameter $0.64 \cdot D_c$ in Winter
- Larger trees for 2050 scenarios

Modelling tree-planting strategy to reduce heating and cooling demand under 2050 climate conditions

Results



S0 vs S3

Yearly values:

cooling demands increase 32% – 39%

Heating demand decrease ~12%

Modelling tree-planting strategy to reduce heating and cooling demand under 2050 climate conditions

Results

Current climate

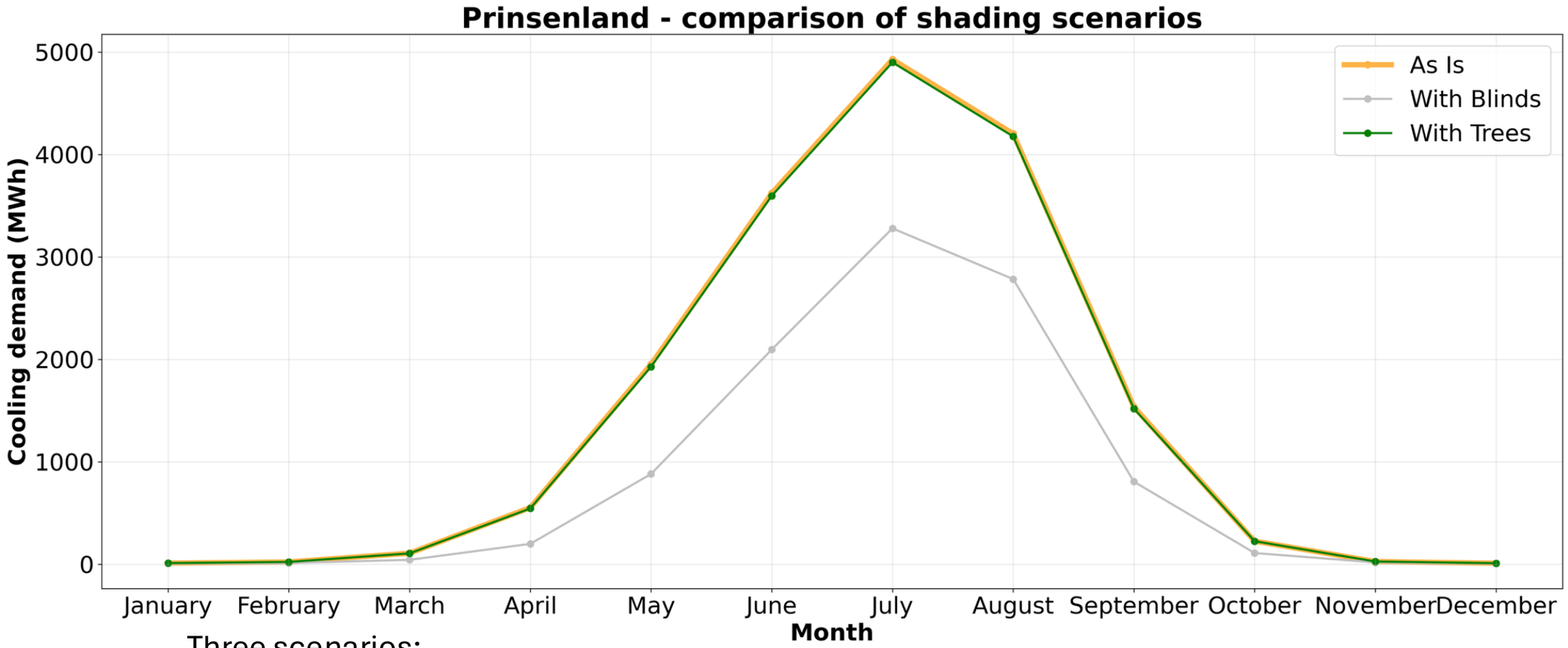
Scenario	Cooling (MWh/a)	Heating (MWh/a)	Total (MWh/a)
Afrikaanderwijk			
Existing trees	6,207	29,857	36,064
Existing + proposed trees	6,019	30,053	36,072
Change	-187	195	7
% Change	-3.03%	0.66%	0.02%
Kop van Zuid			
Existing trees	10,561	20,613	31,174
Existing + proposed trees	10,429	20,728	31,157
Change	-132	115	-16
% Change	-1.25%	0.56%	-0.05%

2050 climate

Scenario	Cooling (MWh/a)	Heating (MWh/a)	Total (MWh/a)
Afrikaanderwijk			
Existing trees	8,574	26,339	34,913
Existing + proposed trees	7,717	26,869	34,587
Change	-856	530	-325
% Change	-9.99%	2.01%	-0.93%
Kop van Zuid			
Existing trees	13,943	17,942	31,885
Existing + proposed trees	13,711	18,060	31,771
Change	-231	117	-113
% Change	-1.66%	0.66%	-0.36%

Scenario-based simulations

Influence of shading in reducing the cooling demand of buildings

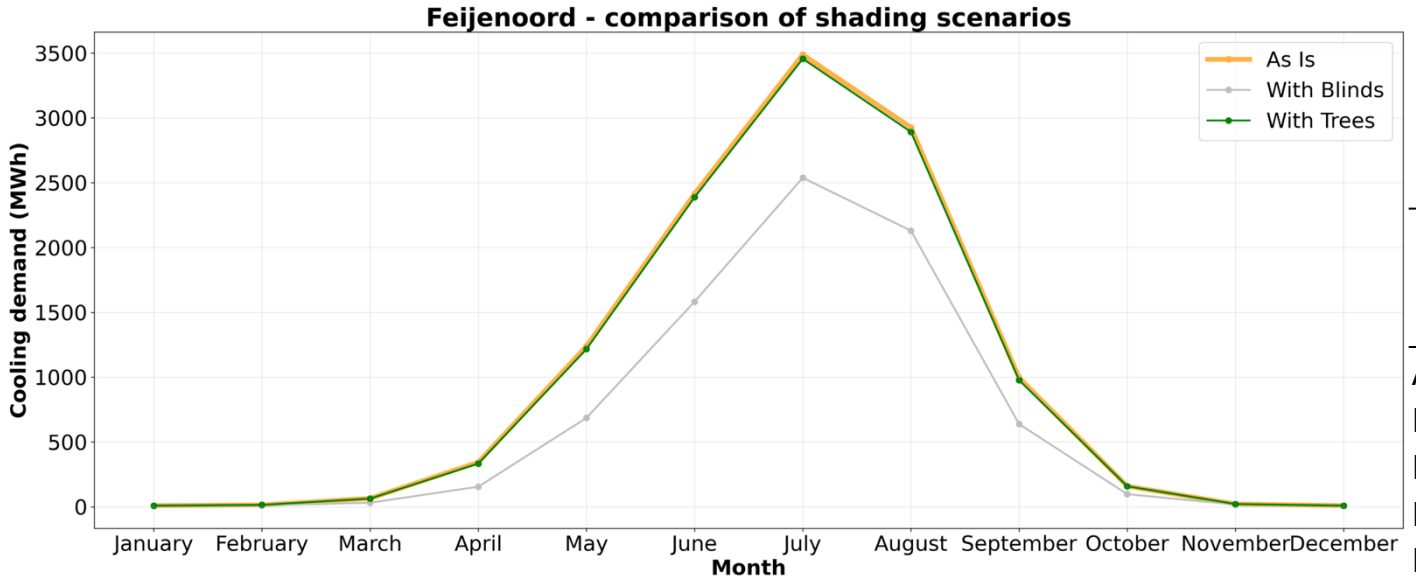


Three scenarios:

- As is (Archetypes)
- With Blinds (curtains)
- With Trees (as shadowing elements)

Scenario-based simulations: shading

Influence of shading in reducing the cooling demand of buildings



location	Cooling		
	Energy demand (MWh)	Blinds	Trees
Afrikaanderwijk	11,226	-34.43%	-0.93%
Bloemhof	14,378	-34.31%	-1.44%
Feijenoord	11,684	-32.40%	-1.27%
Hillesluis	15,265	-33.09%	-1.23%
Katendrecht	13,688	-35.14%	-0.38%
Kop van Zuid - Entrepot	16,513	-31.37%	-0.33%
Kop van Zuid	23,115	-19.17%	-0.02%
Noordereiland	5,183	-33.77%	-1.09%
Prinsenland	17,197	-40.43%	-0.77%
Vreewijk	23,275	-32.97%	-1.58%

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Scenario-based simulations

Detailed Window to wall ratio

Scenario-based simulation: Window to wall ratios

Provided data

Feijenoord

Surfaces: 20129
Surfaces with >0 WindowRatio: 7249

Prinsenland

Surfaces: 38074
Surfaces with >0 WindowRatio: 14242

Scenario-based simulation: Window to wall ratios

Methodology

- Run Simulations with WindowRatio in SimStadt (supports this param)
- Compare difference in Heating and Cooling demand between WindowRatio and fixed values
  - Average per district
  - Fixed standardized value (20%)

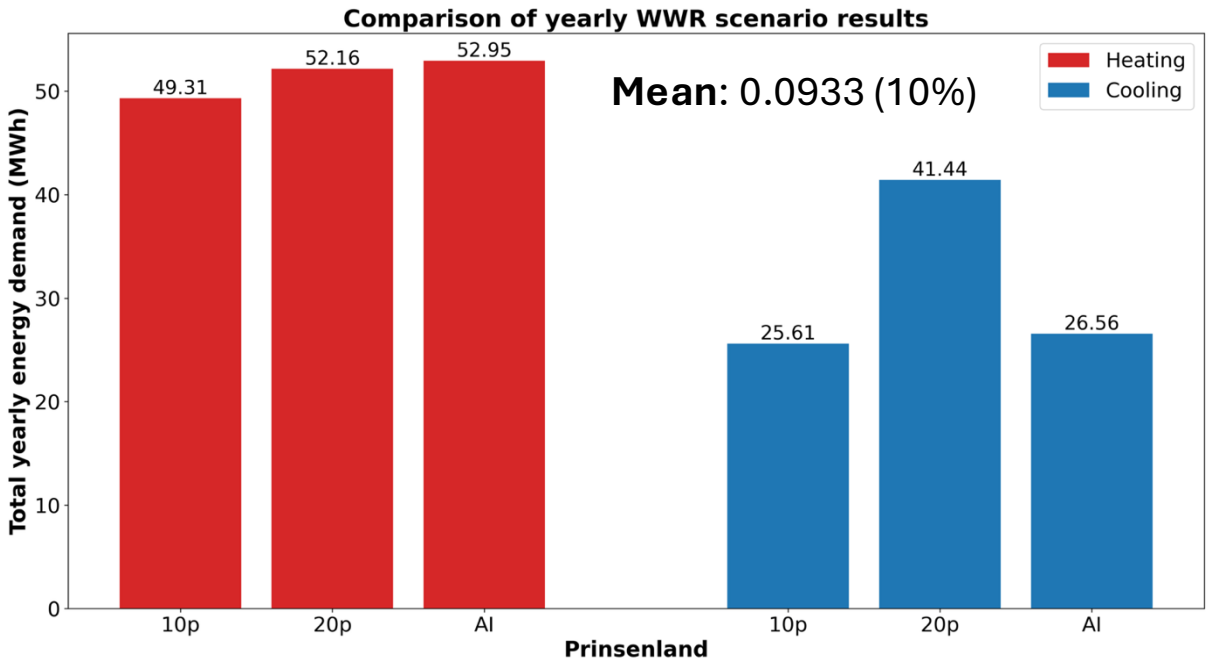
Findings:

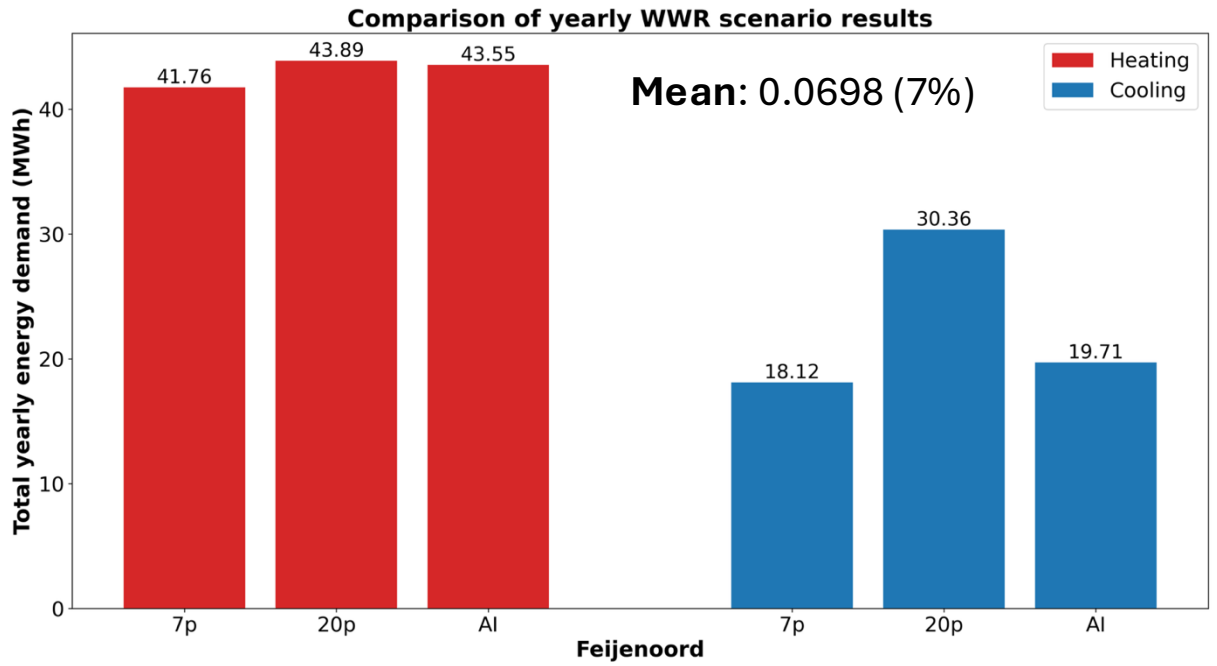
Knowing the WindowRatio has greatest influence on cooling.

If no prior knowledge of WindowRatio present, simulations could show drastict different results. (**60 % difference!**)

Scenario-based simulation: Window to wall ratios

- **Enriched** our 3D models with the new received values
- **Conducted** simulations and analysis of Heating and Cooling





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Scenario-based simulation: Window to wall ratios

Cooling Outlier **+1505.3%**

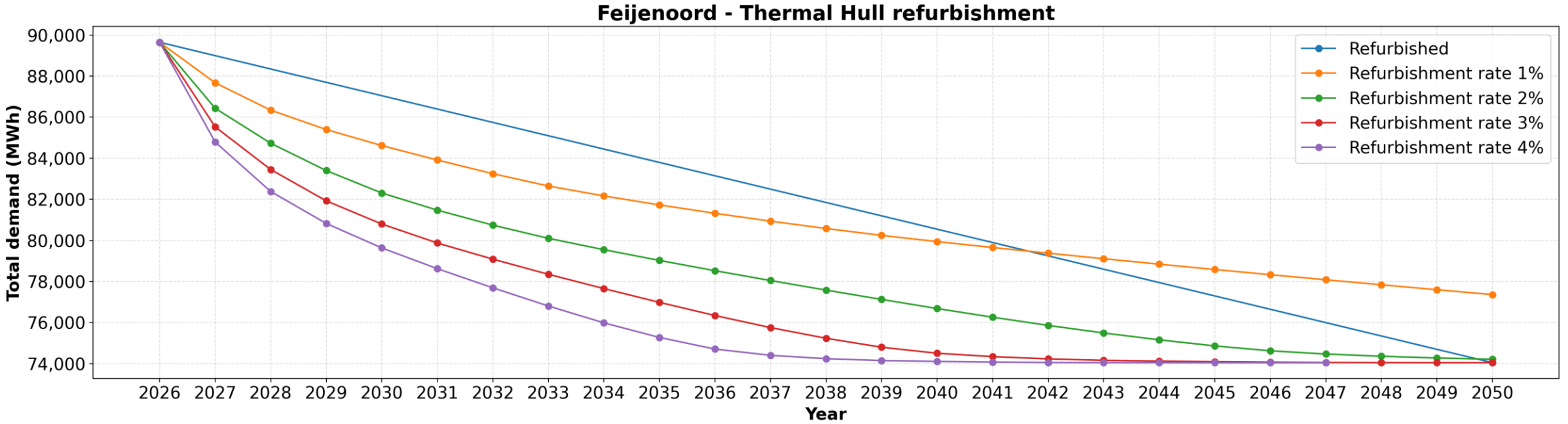
Heating Outlier **+103.5%**

Cooling Outlier: **+685.5%**

Scenario-based simulations: Refurbishment of the building stock

Scenario-based simulations: Refurbishment of the building stock

- Refurbishment type: Whole Thermal Hull as built in 2025
- Weather data: 2050 forecasting from KNMI
- Analyses: Renovation rate of the building stock (1 – 4% per annum)



DigiTwins4PEDs results

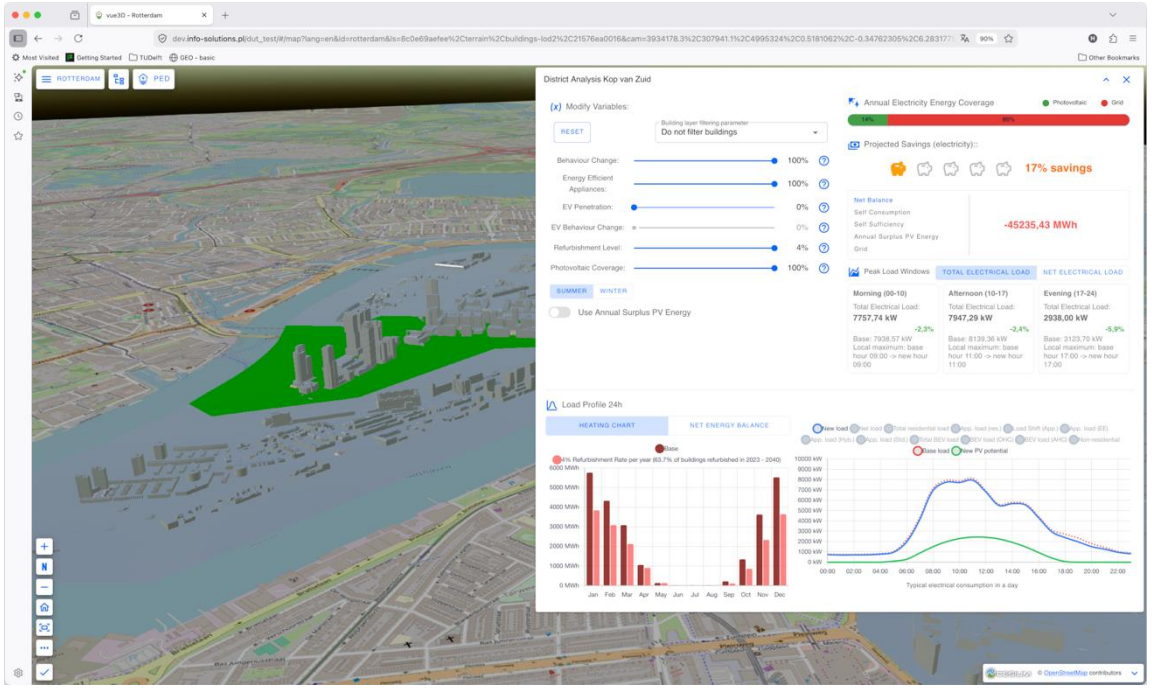
Cooling demand

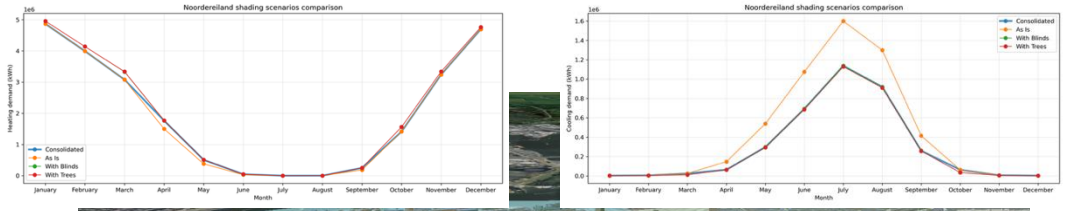
DigiTwins4PEDs results

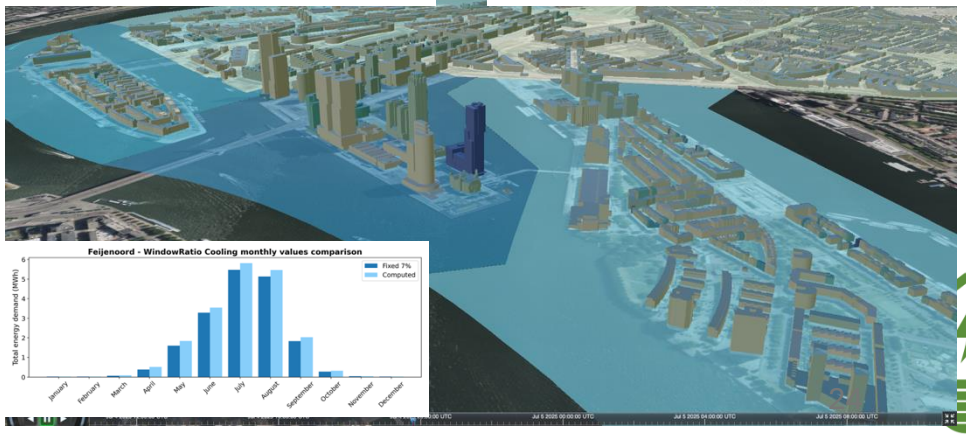
Heating demand

Final remarks

- This is only the technical aspects
- A realistic PED involves Co-creation activities
  - Citizen participation!
  - Only with their implication PEDs are feasible







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