THE COSTS AND BENEFITS OF HEAT STRESS MITIGATION IN ROTTERDAM'S SOCIAL HOUSING

Analyzing the (Societal) Costs and Benefits of Heat Stress Mitigation in the Existing Social Housing Stock

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30-6-2025

Master Thesis
Management in the Built Environment

TU Delft

Gemeente Rotterdam

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INTRODUCTION

Nederlandse steden niet gebouwd op hitte: 'Te veel ongezond warme huizen'

NU.nl / 18 aug 2024 om 05:00

Amsterdam wapent nu al ouderen tegen snikhete zomer: ‘Bij een hittegolf is het hier binnen 30 graden’

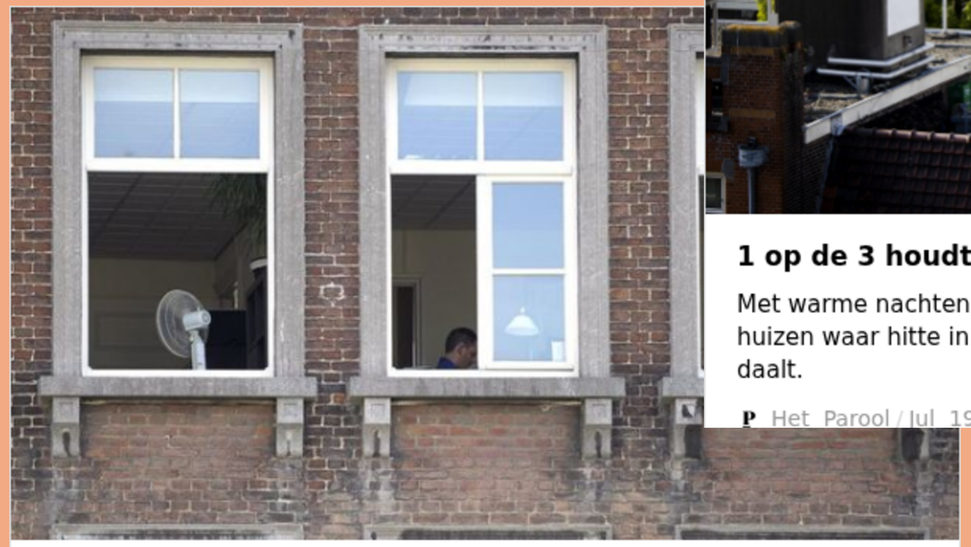
De zomers worden steeds warmer - ook in Amsterdam. Met zonweringen, ventilators en klamboes worden ouderen in West al in de eerste juniweek voorbereid op de risico’s van hitte.

Het Parool / Jun 3

1 op de 3 houdt woning niet koel op hete dagen

Met warme nachten op komst is het een crime voor veel Nederlanders: huizen waar hitte in blijft hangen en de temperatuur ’s avonds nauwelijk daalt.

Het Parool / Jul 19, 2024



Niet kunnen slapen door de hitte: 'Koelte-ongelijkheid steeds groter probleem'

Het maakt nogal wat uit of je in een goed geïsoleerd huis woont of bijvoorbeeld in een stadse woning waarbij het binnen nog warmer is dan buiten.

NOS Nieuws / Aug 12, 2024

3,6 miljoen huurders kans op hitte in huis

Investico berekende dat 3,6 miljoen huurders wonen in een woning die het risico loopt om oververhit te raken in de zomer. Woonbond pleit voor beter beleid.

Woonbond / Jul 10, 2024

PROBLEM STATEMENT

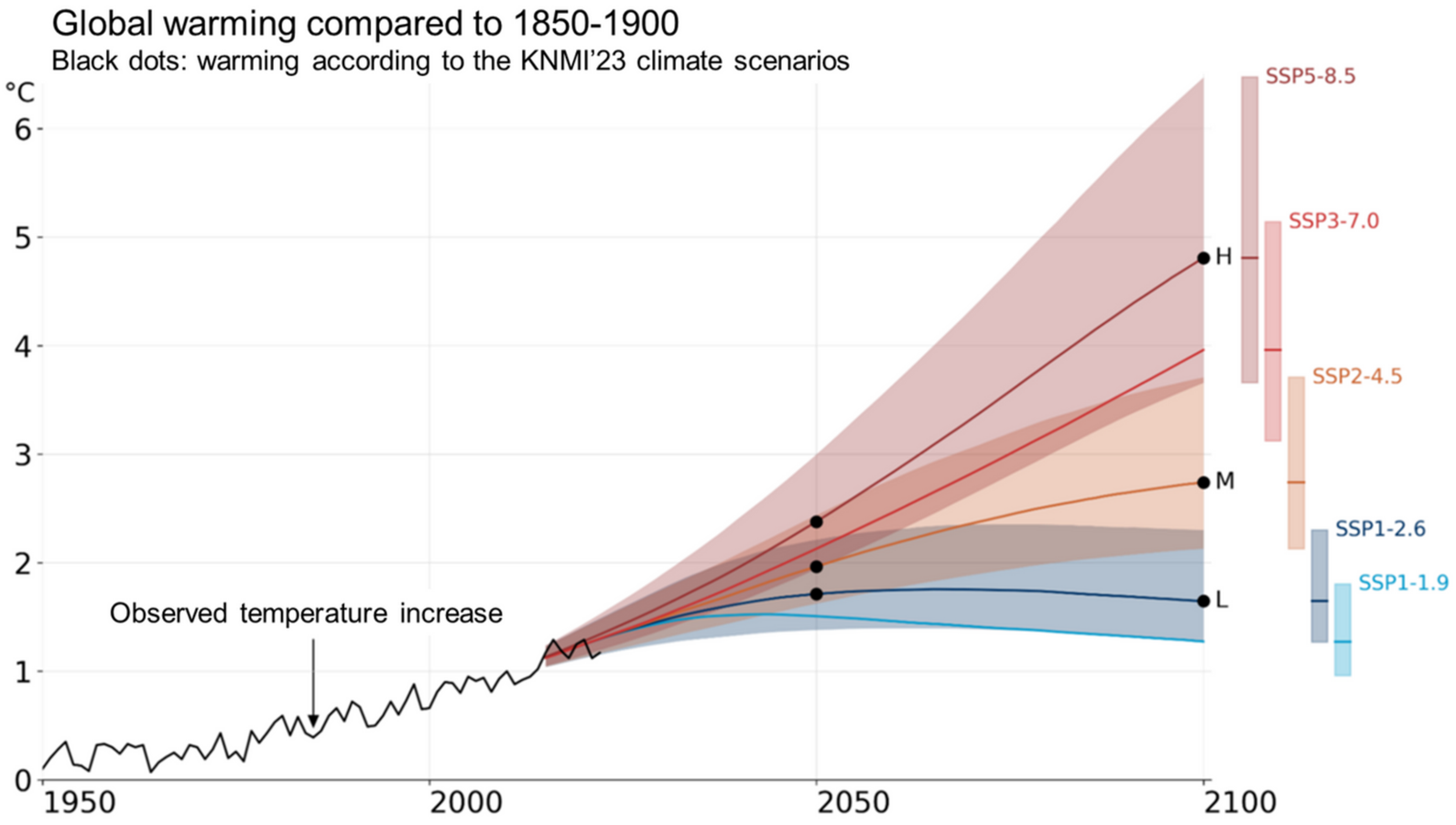
RISING TEMPERATURES

URBAN HEAT STRESS

VULNERABILITY OF SOCIAL HOUSING TENANTS

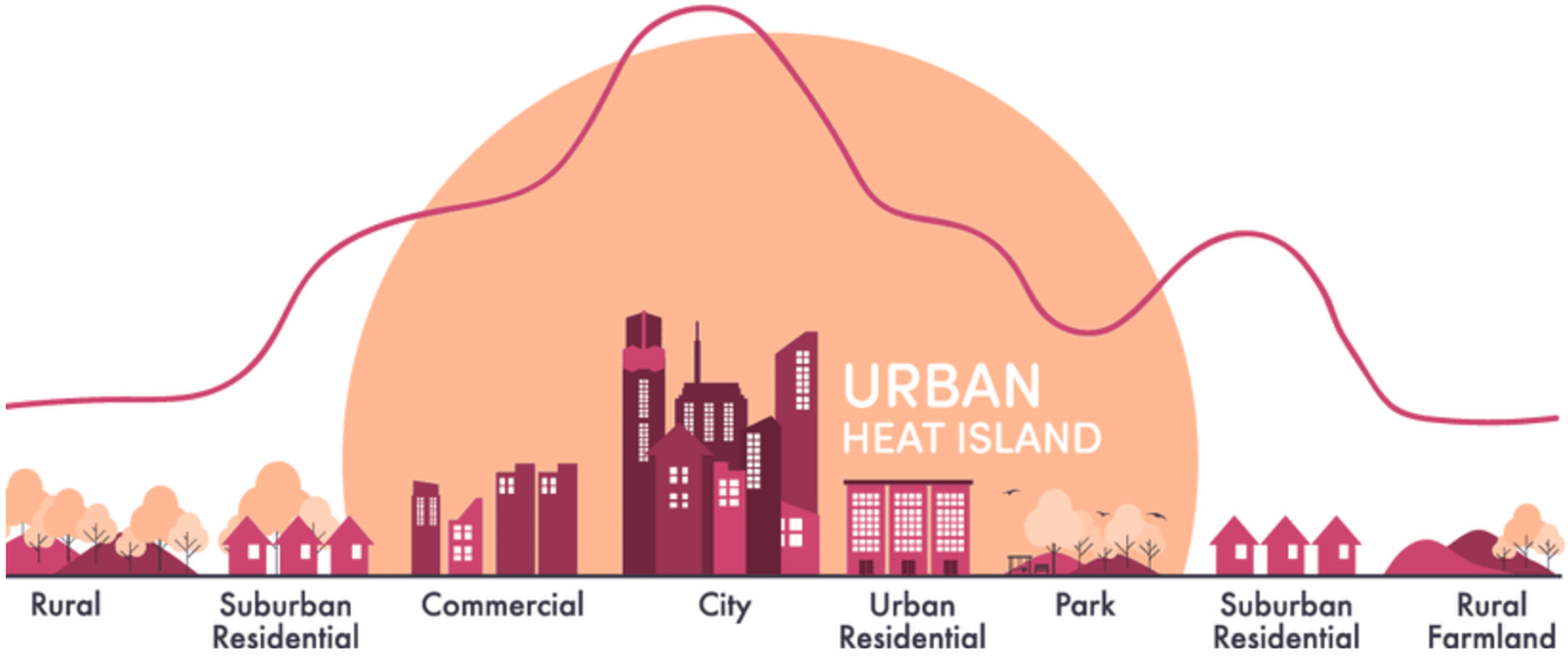
PROBLEM STATEMENT

RISING TEMPERATURES



PROBLEM STATEMENT

URBAN HEAT STRESS



PROBLEM STATEMENT

VULNERABILITY OF SOCIAL HOUSING TENANTS

- Lower quality of housing
- Lower socioeconomic status
- Pre-existing health conditions

PROBLEM STATEMENT

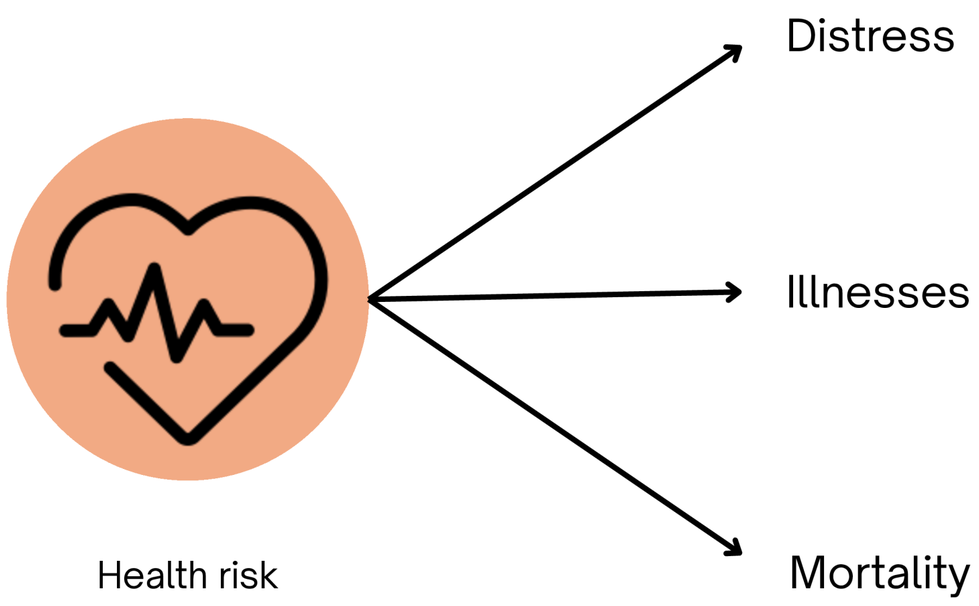
Lower quality of housing

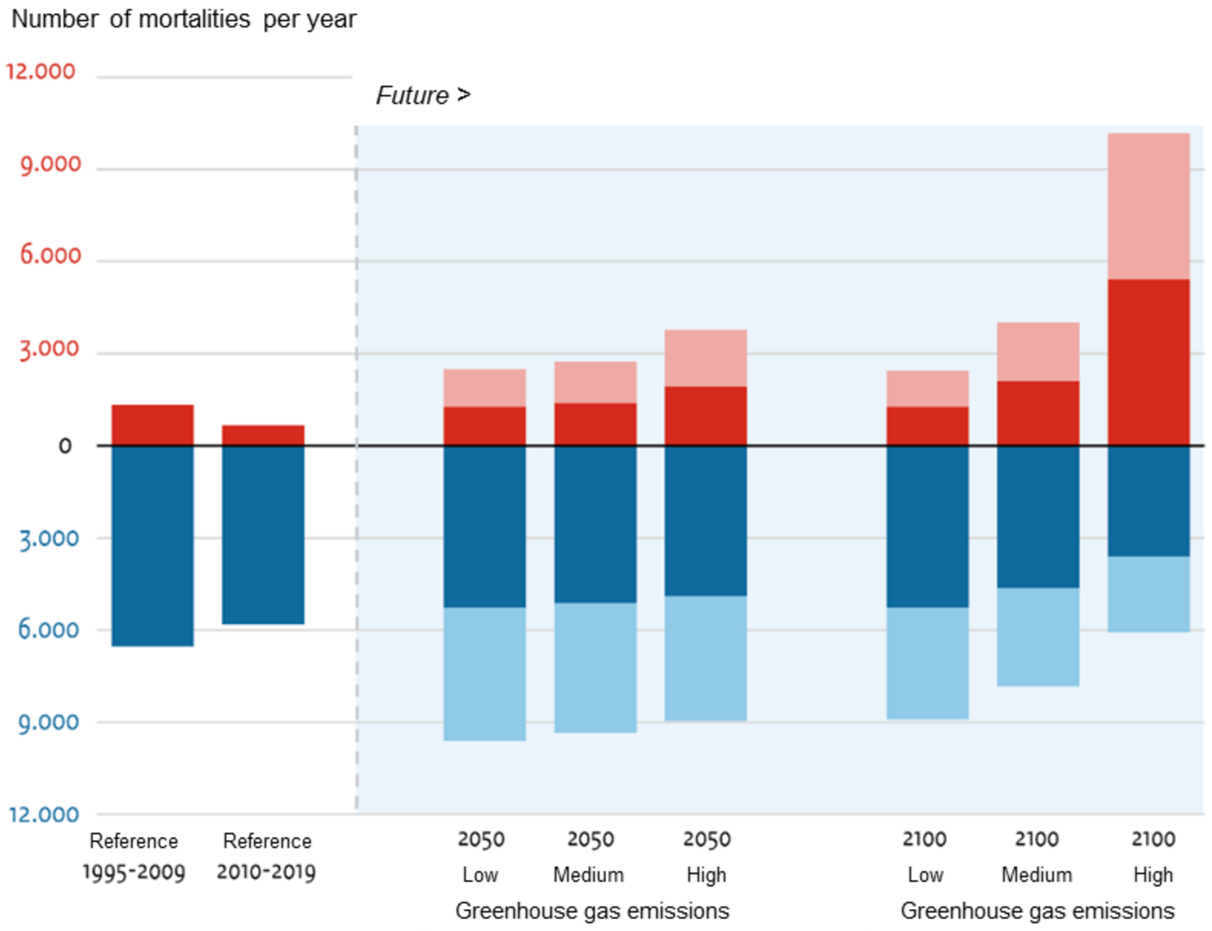
Lower socioeconomic status

Pre-existing health conditions

CLIMATE INEQUALITY

RISKS OF HEAT STRESS





(RIVM, 2024)

RISKS OF HEAT STRESS

Health risk

Increase energy consumption

RISKS OF HEAT STRESS

Health risk

Increase energy consumption

Strain on infrastructure

RISKS OF HEAT STRESS

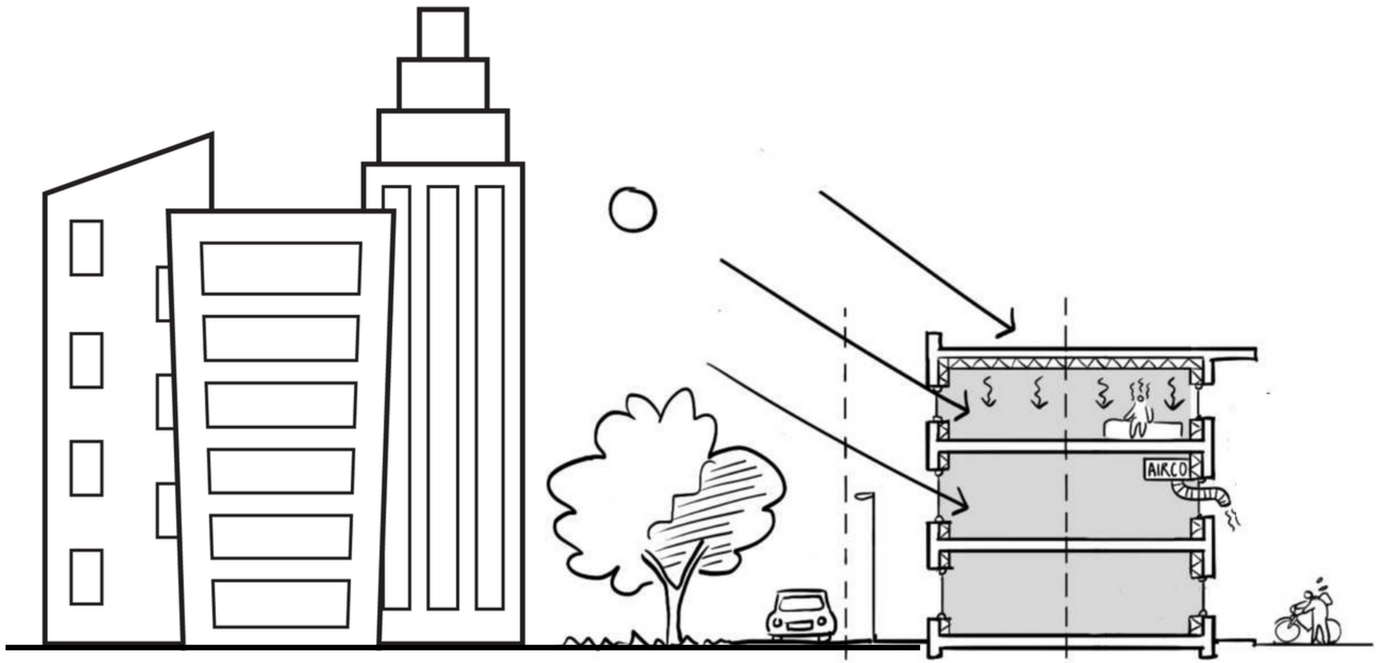
Health risk

Increase energy consumption

Strain on infrastructure

Decrease labor productivity

HEAT STRESS ON DIFFERENT LEVELS

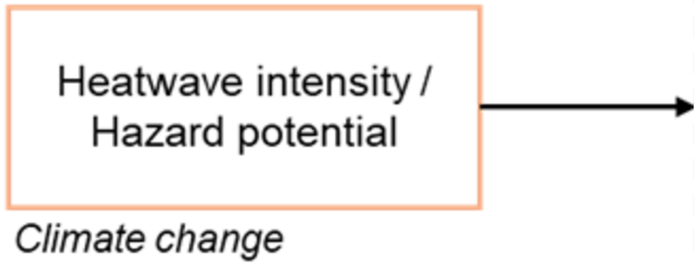


Area | **Building** | Behaviour / user

↓

TO July < 1,2

THEORETICAL FRAMEWORK



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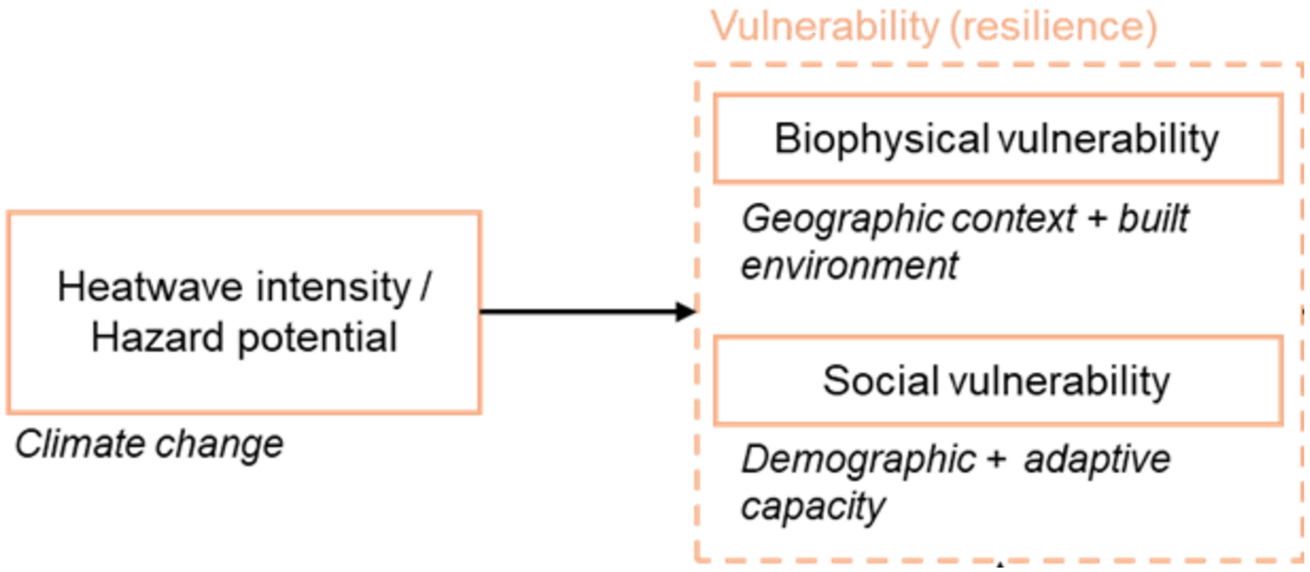
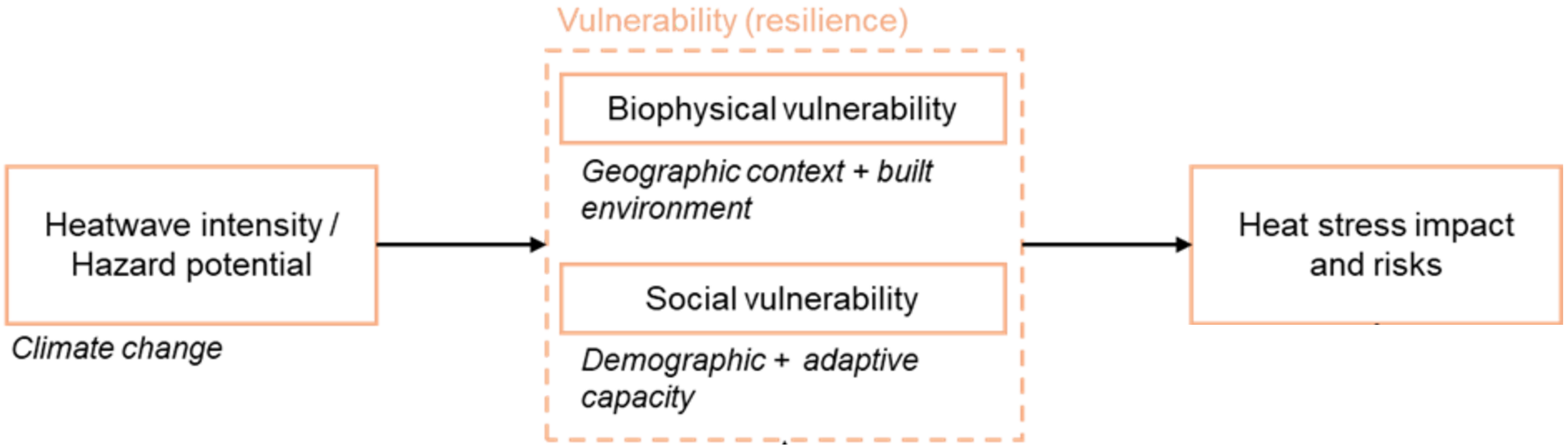
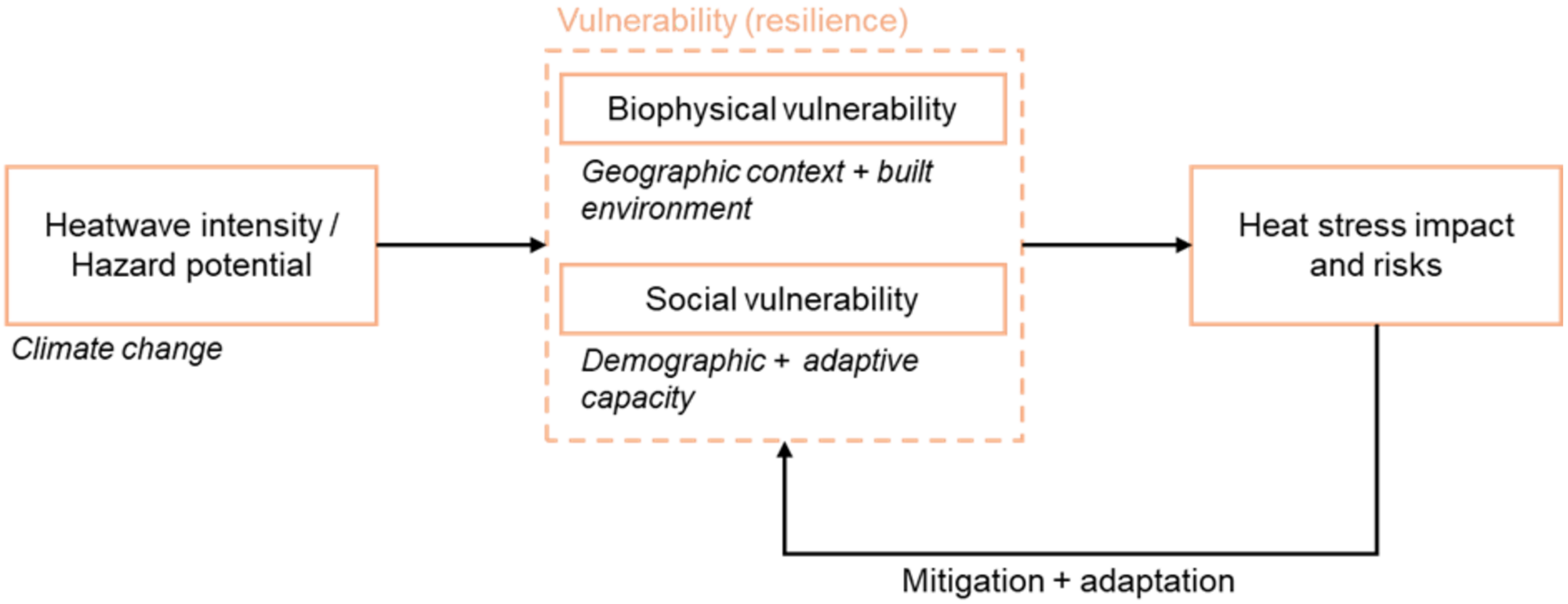


THEORETICAL FRAMEWORK



THEORETICAL FRAMEWORK



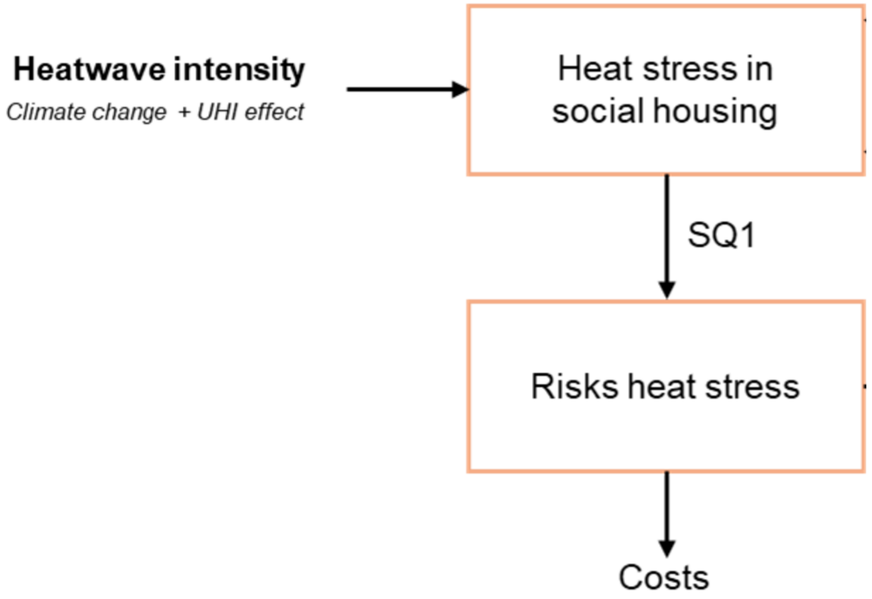
RESEARCH QUESTIONS

RESEARCH QUESTION

'What are the long-term costs and benefits of mitigating heat stress in the existing social housing stock?'

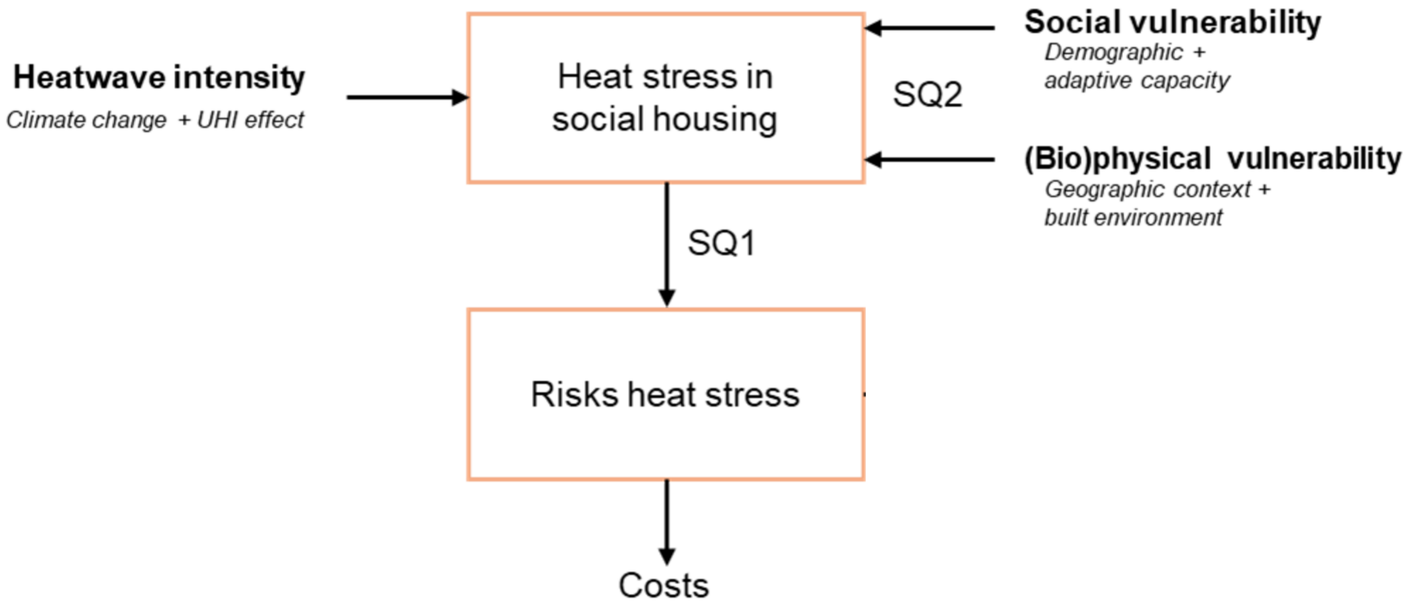
SUB-QUESTIONS

SQ1: *'What <u>risks and costs</u> could arise if <u>heat stress</u> is <u>not addressed</u> in the current social housing stock?'*



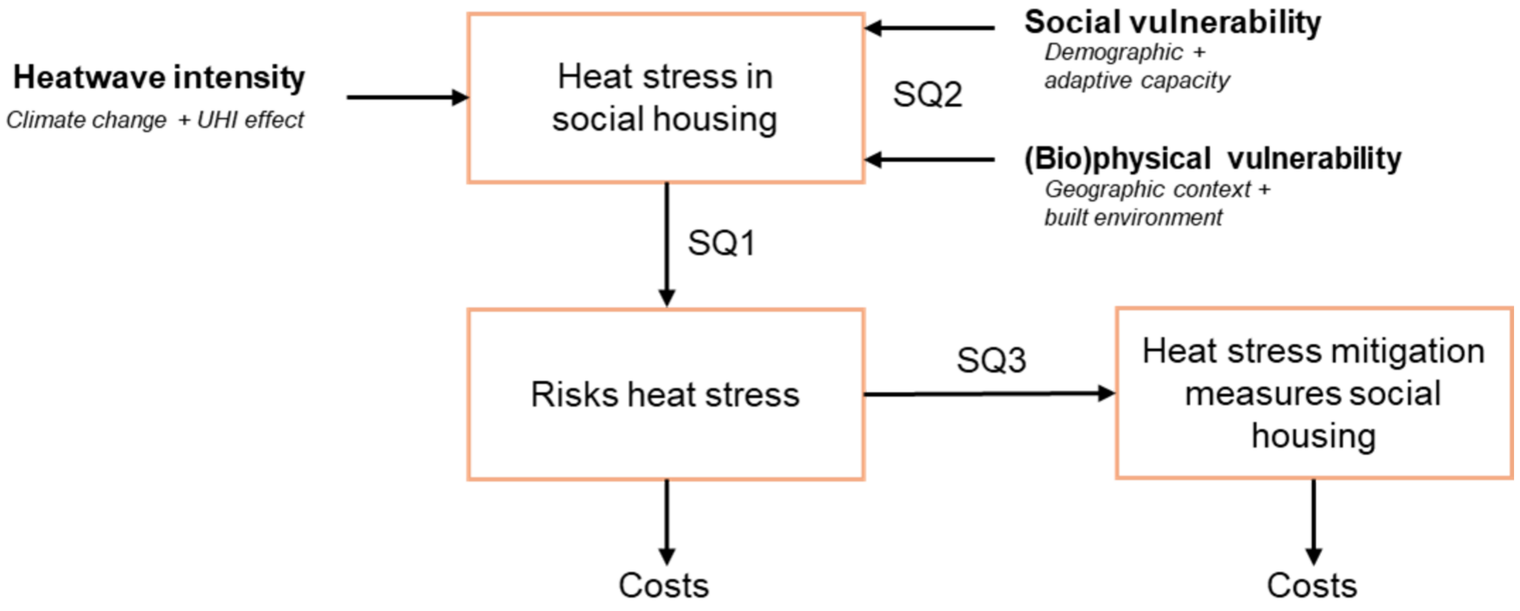
SUB-QUESTIONS

SQ2: *'What areas are most vulnerable to the risks of heat stress?'*



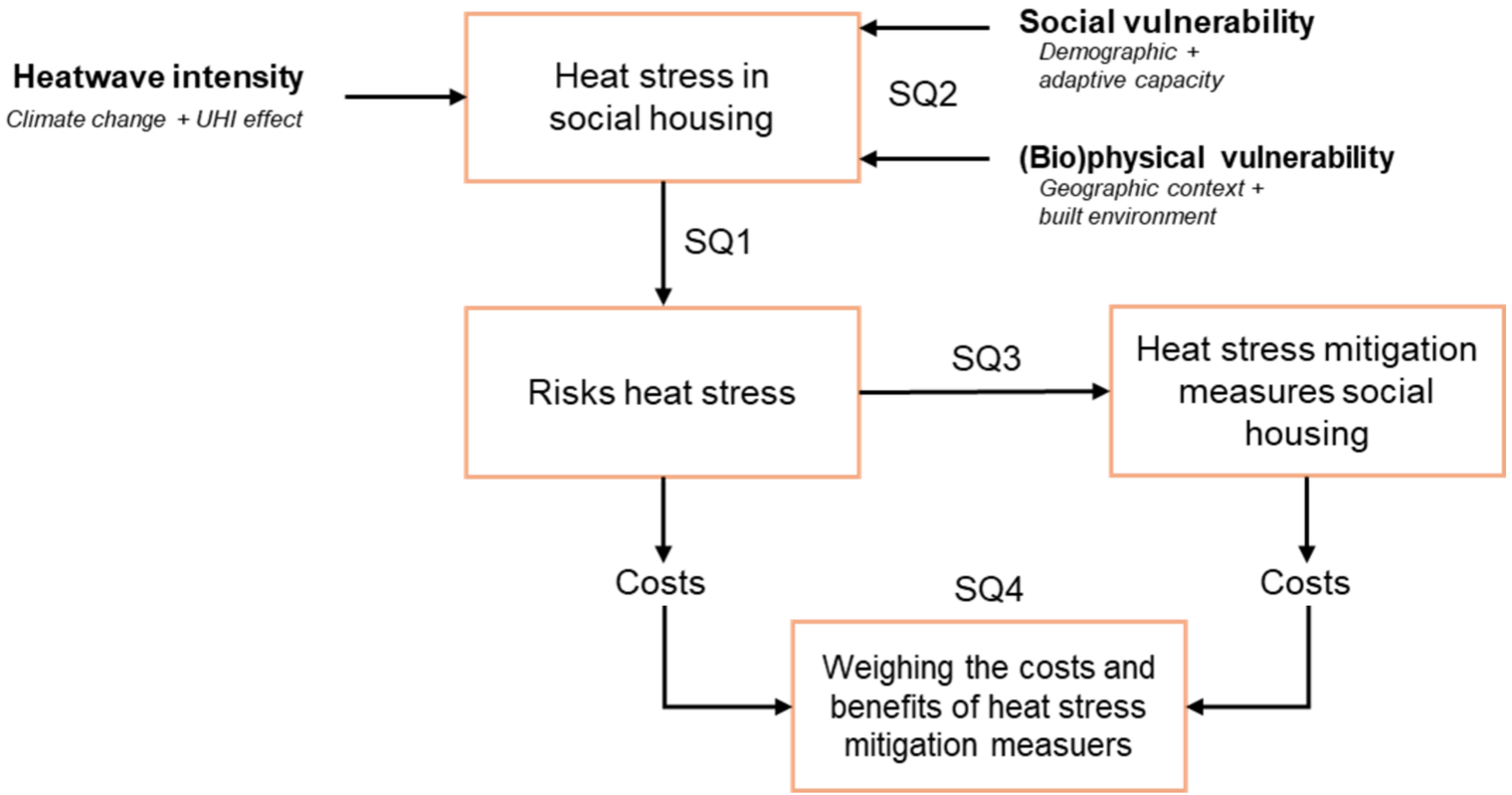
SUB-QUESTIONS

SQ3: *'What measures can be taken to mitigate the heat stress of existing properties of housing corporations and what are the costs of implementing these measures?'*



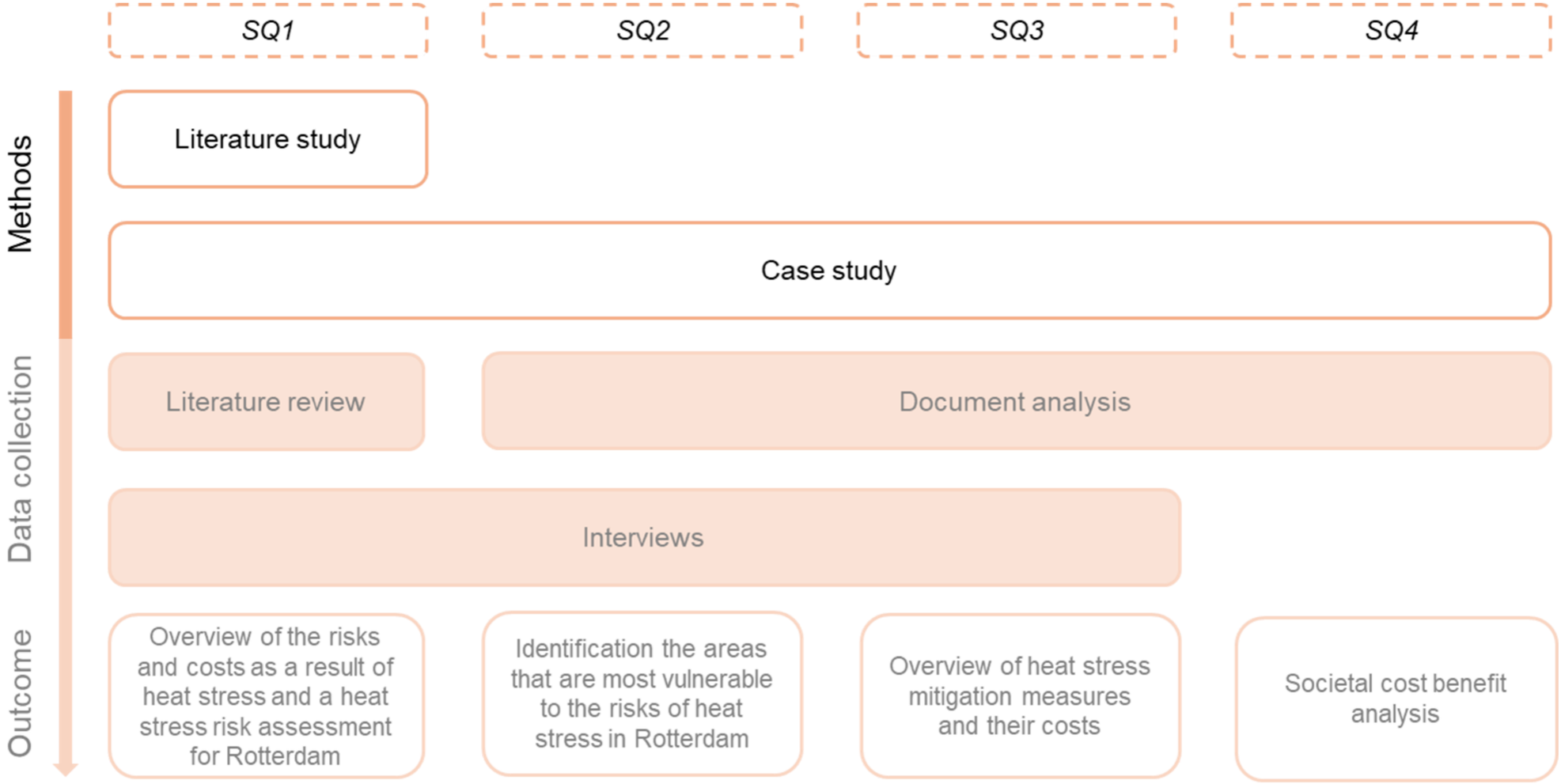
SUB-QUESTIONS

SQ4: *'How do the <u>economic and social benefits</u> of implementing <u>heat stress mitigation measures</u> into social housing <u>demonstrate the value of the costs</u> of the mitigation measures?"*

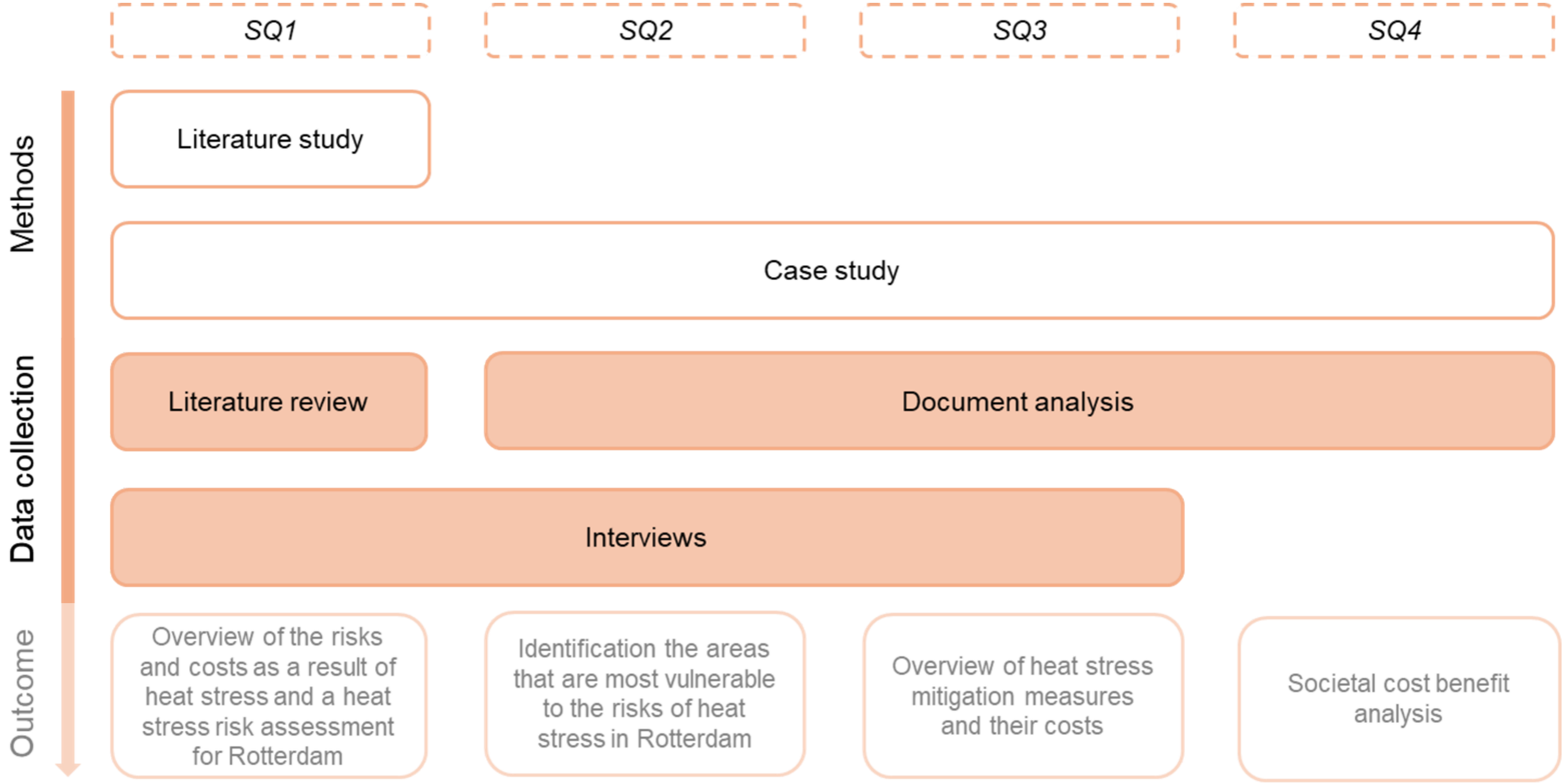


RESEARCH DESIGN

RESEARCH APPROACH



RESEARCH APPROACH



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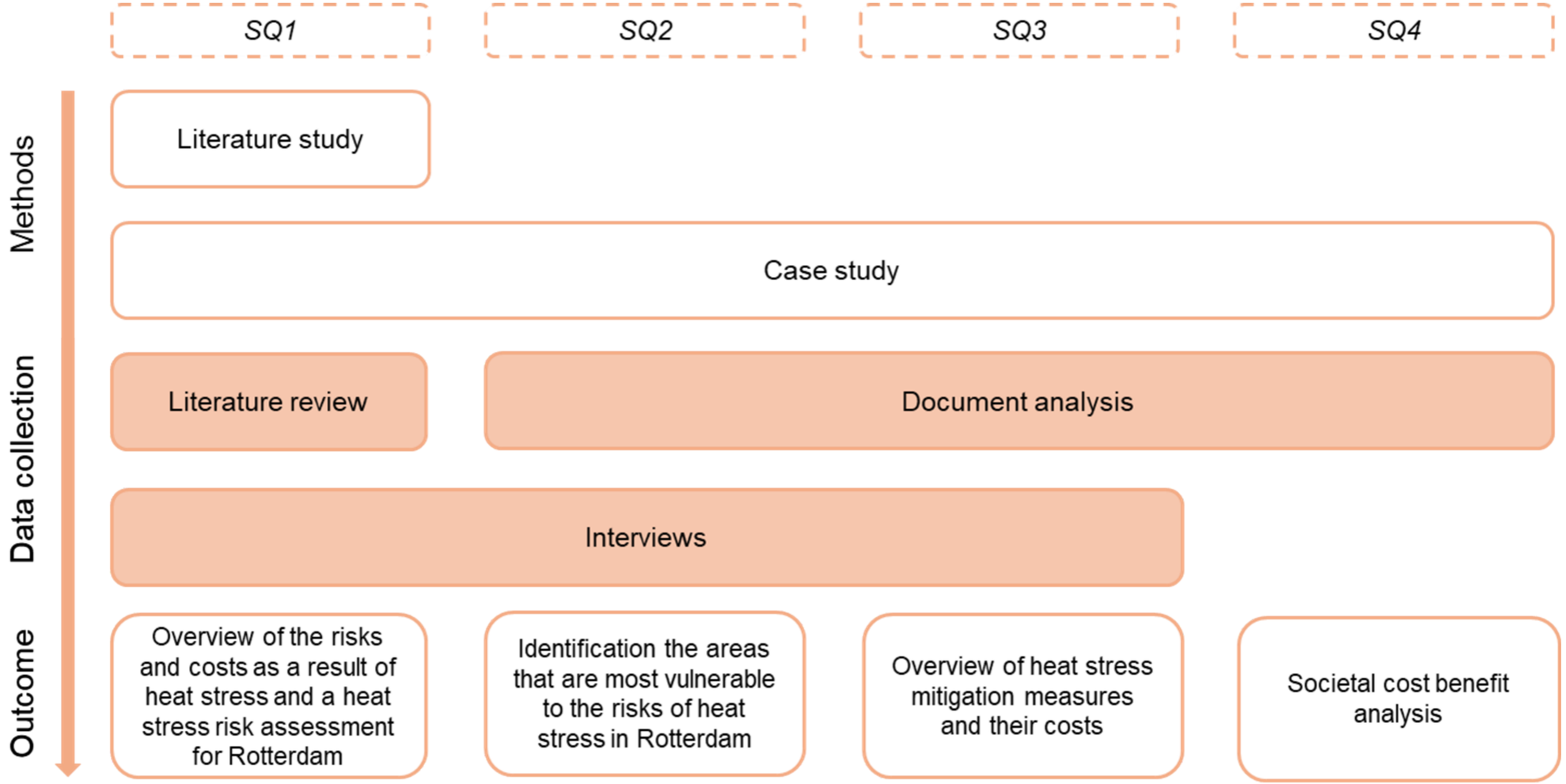
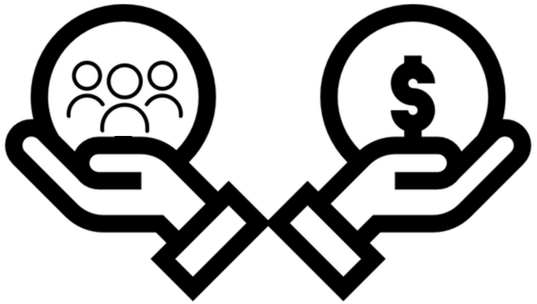


SOCIETAL COST BENEFIT ANALYSIS



Financial and societal effects

Monetized

Equal comparison

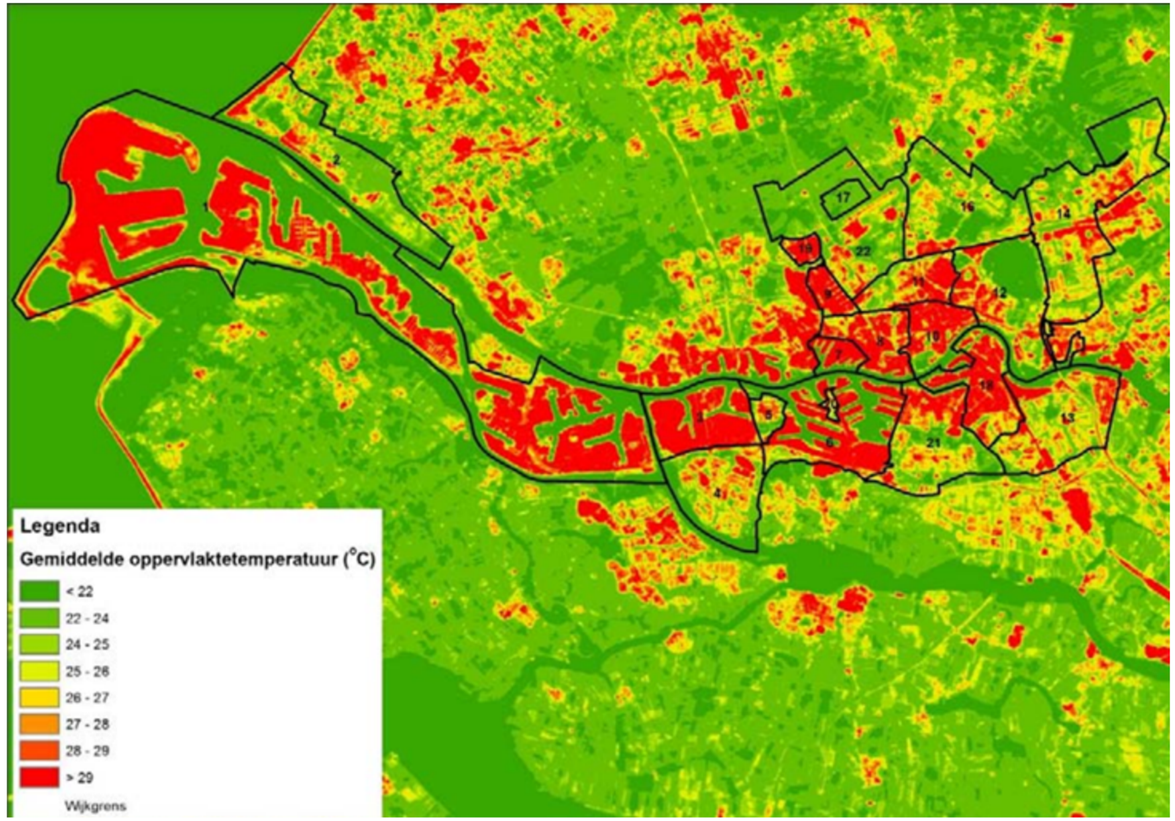
CASE STUDY: ROTTERDAM

CASE SELECTION CRITERIA

Exposure to high temperatures

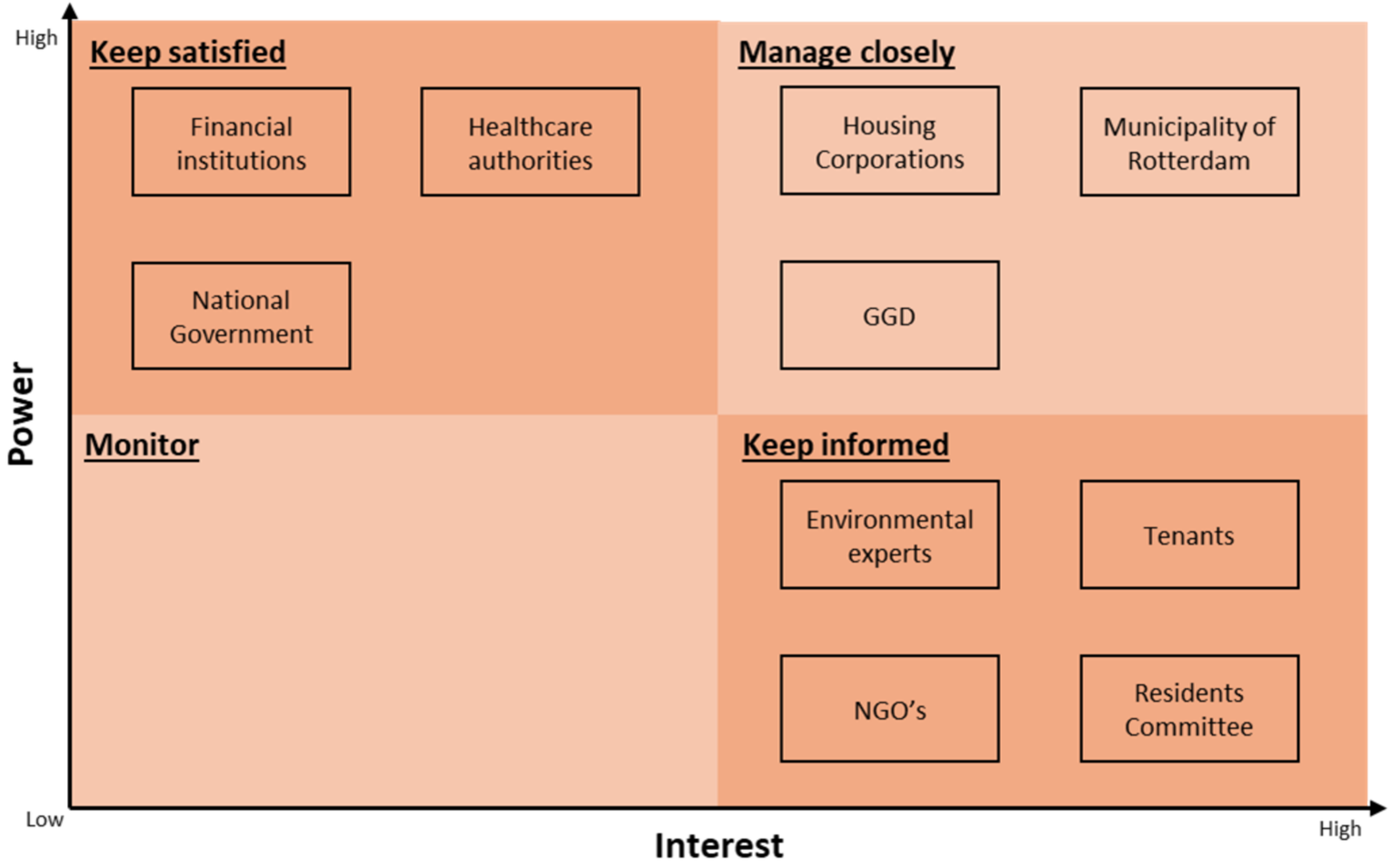
High percentage of social housing

Data available

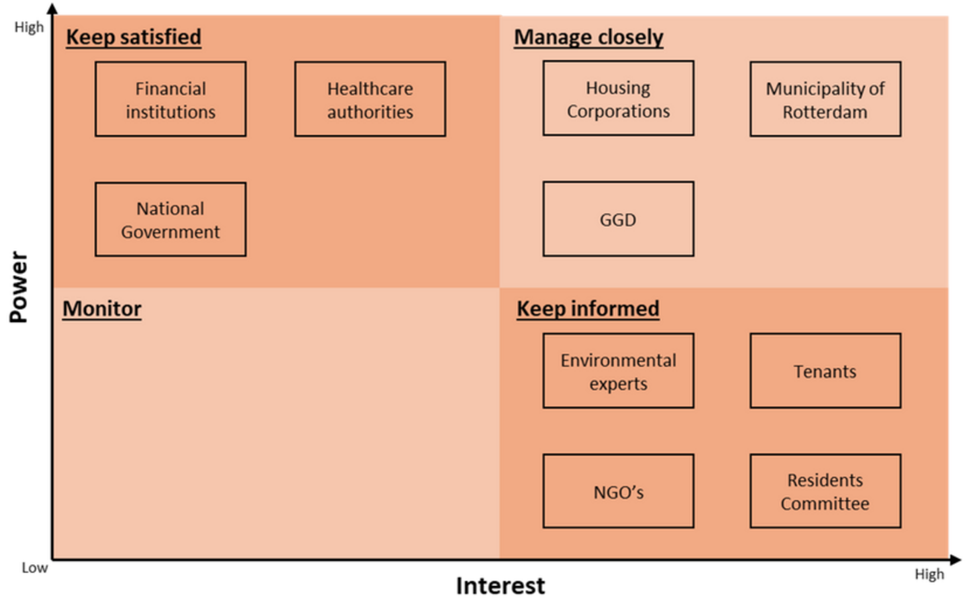


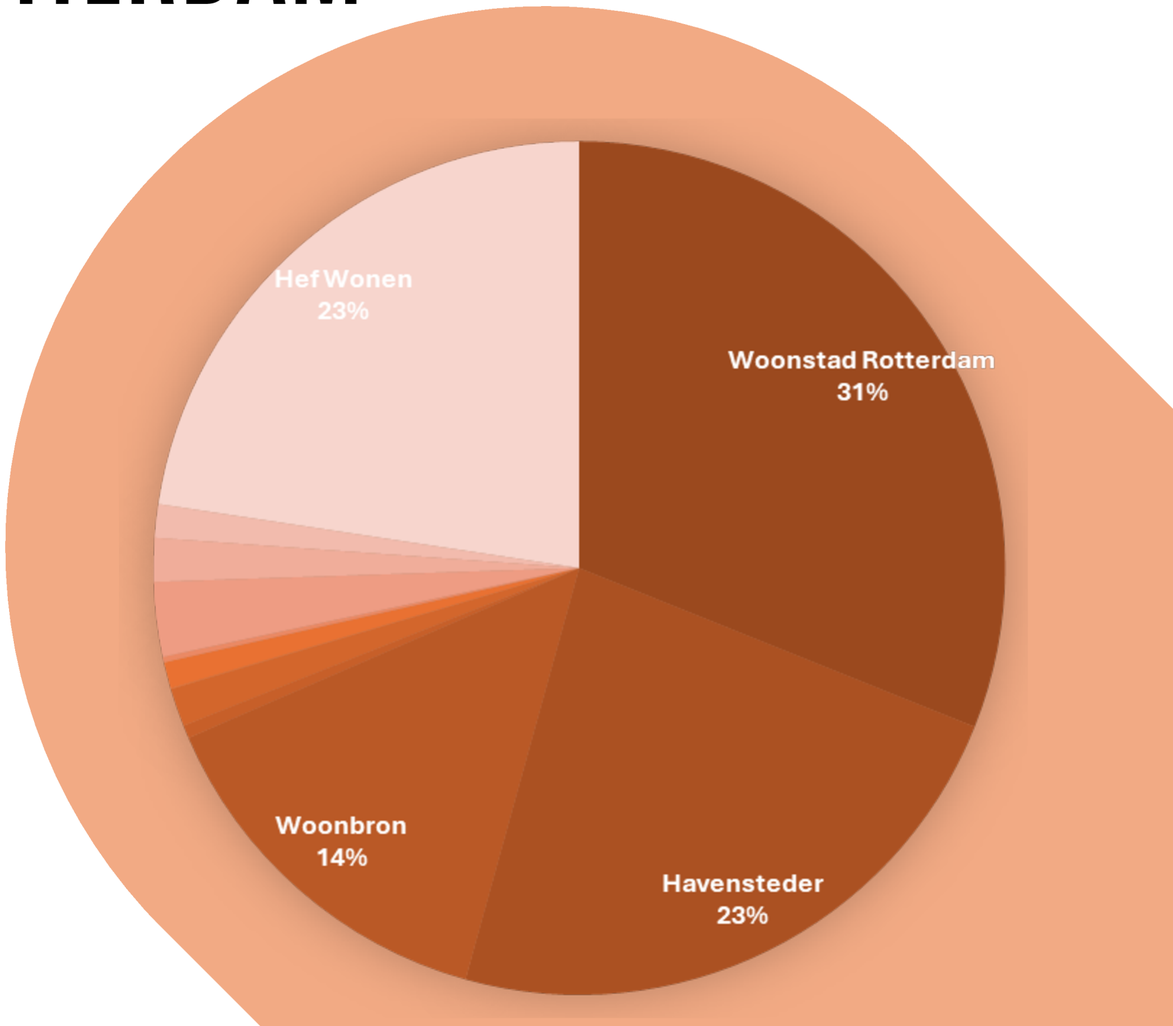
Source: (Gemeentewerken Rotterdam, 2011)

STAKEHOLDERS HEAT STRESS ROTTERDAM



STAKEHOLDERS HEAT STRESS ROTTERDAM





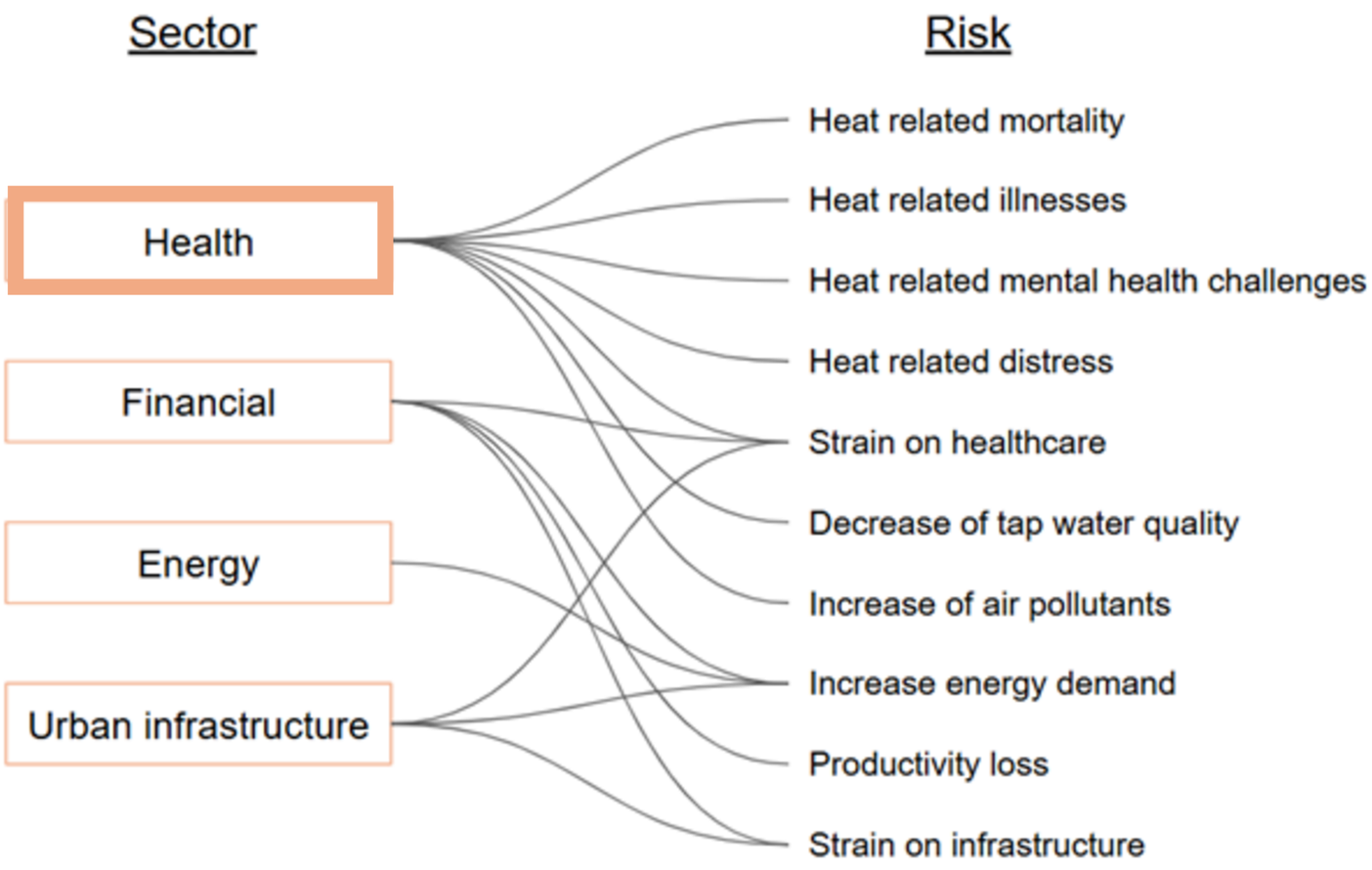
RESULTS

RESULTS RQ 1

“What risks and costs could arise if heat stress is not addressed in the current social housing stock?”

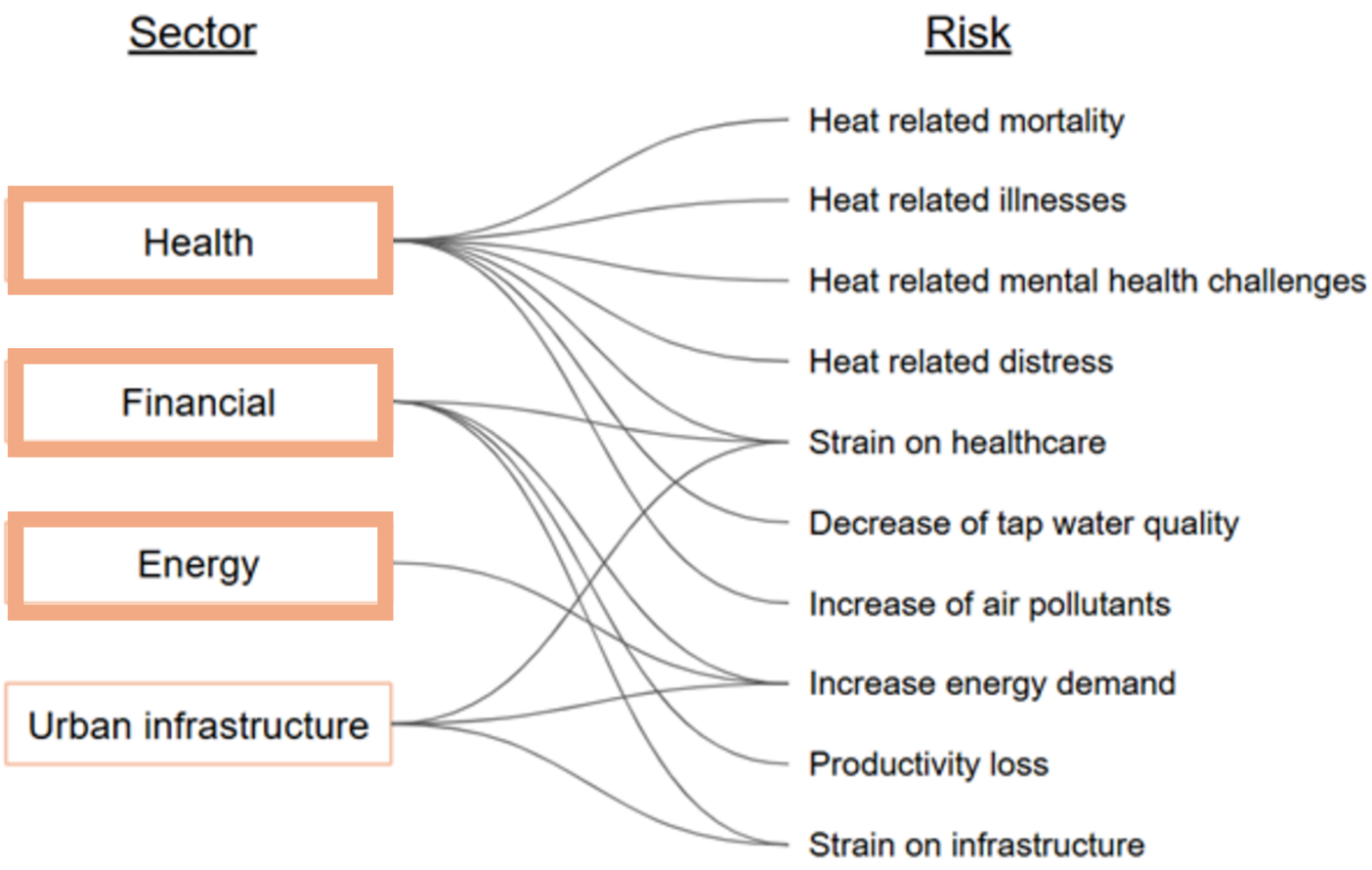
RISKS OF HEAT STRESS

RQ 1



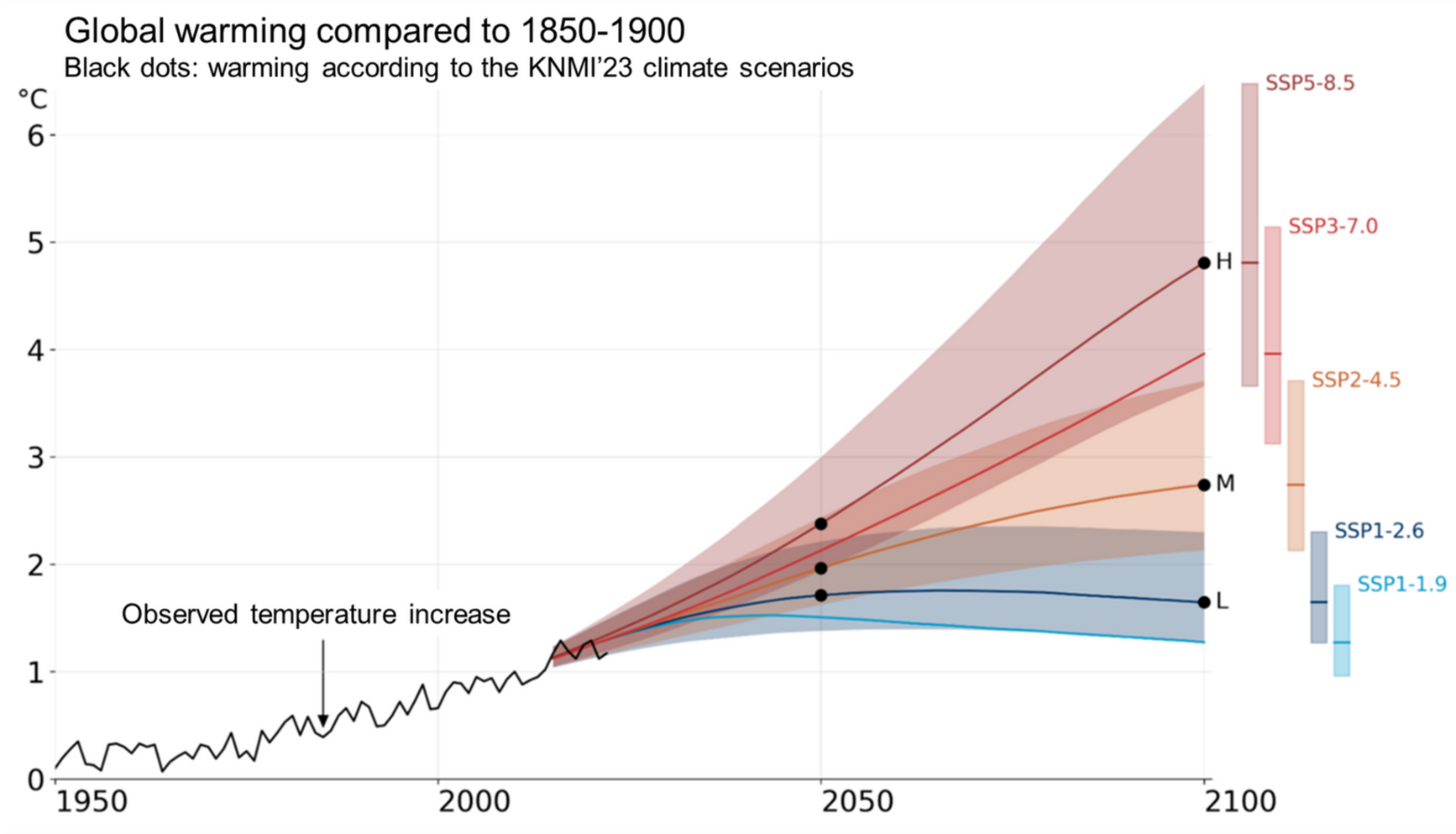
ECONOMIC IMPACT OF THE RISKS

RQ 1



CLIMATE SCENARIOS

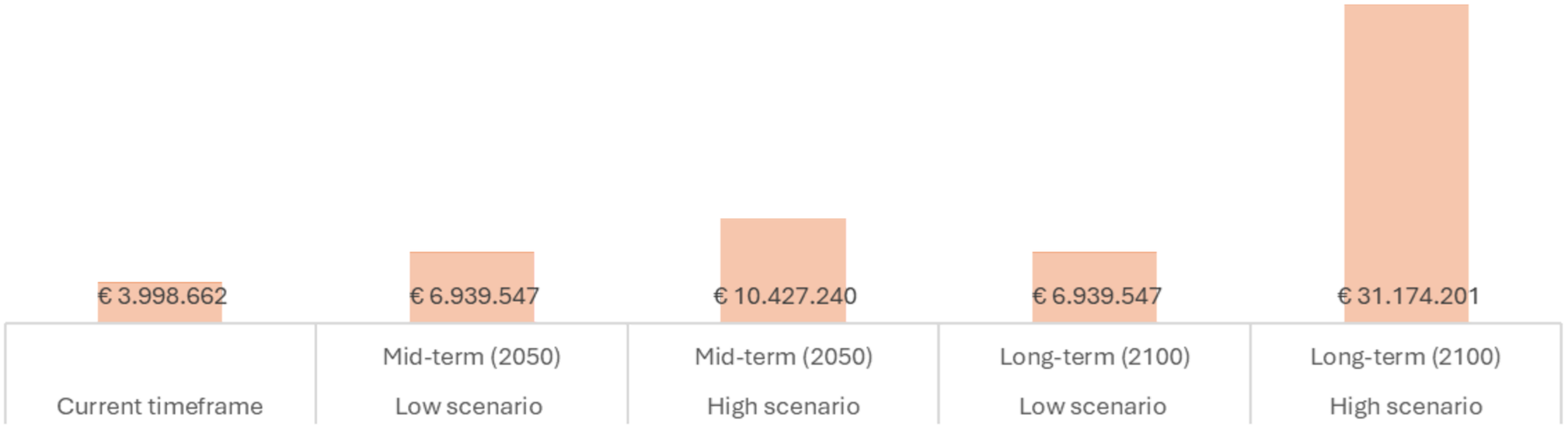
RQ 1



ECONOMIC IMPACT RISKS

RQ 1

Health sector > Costs mortality & hospitalizations

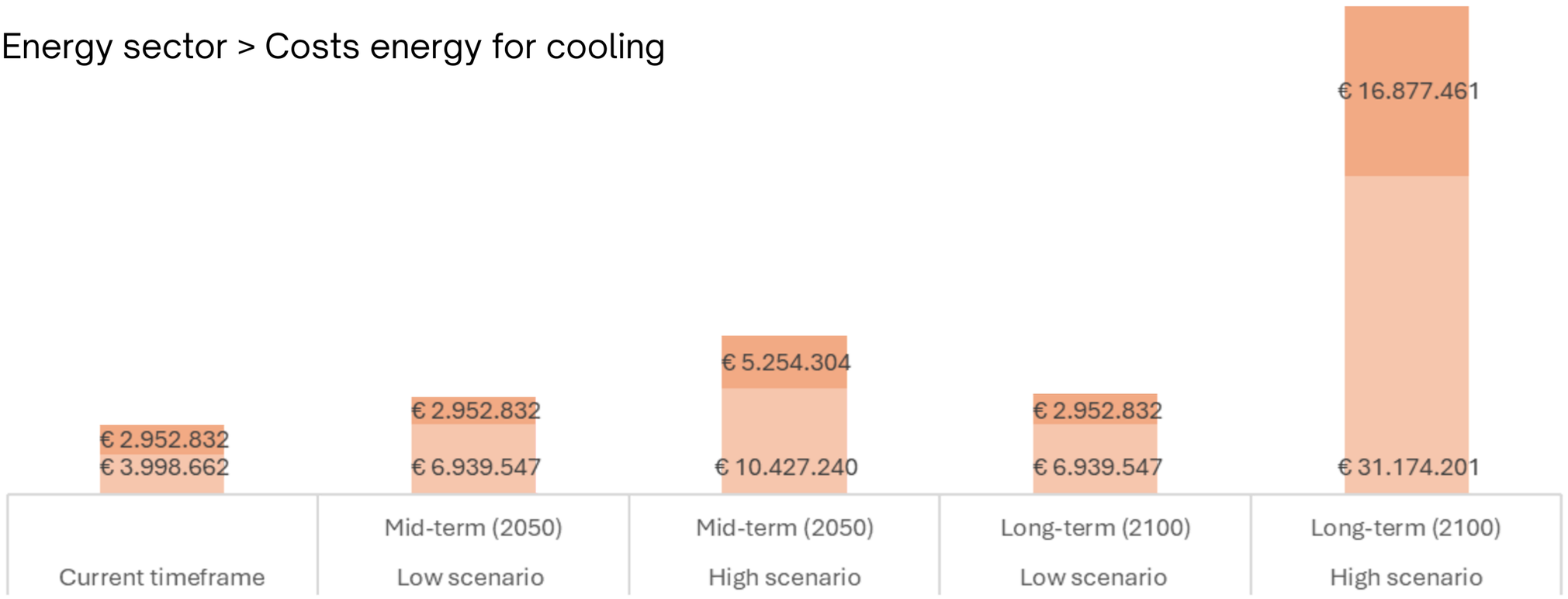


ECONOMIC IMPACT RISKS

RQ 1

Health sector > Costs mortality & hospitalizations

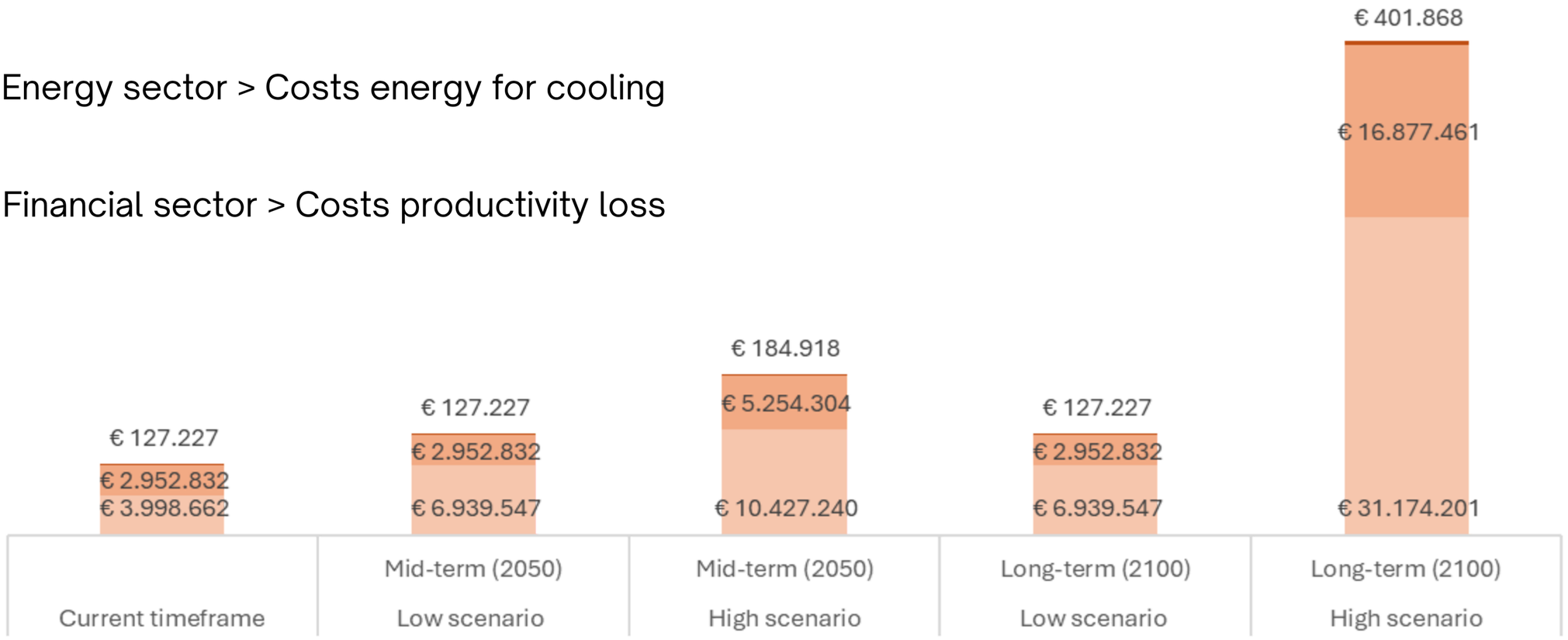
Energy sector > Costs energy for cooling



ECONOMIC IMPACT RISKS

RQ 1

- Health sector > Costs mortality & hospitalizations
- Energy sector > Costs energy for cooling
- Financial sector > Costs productivity loss

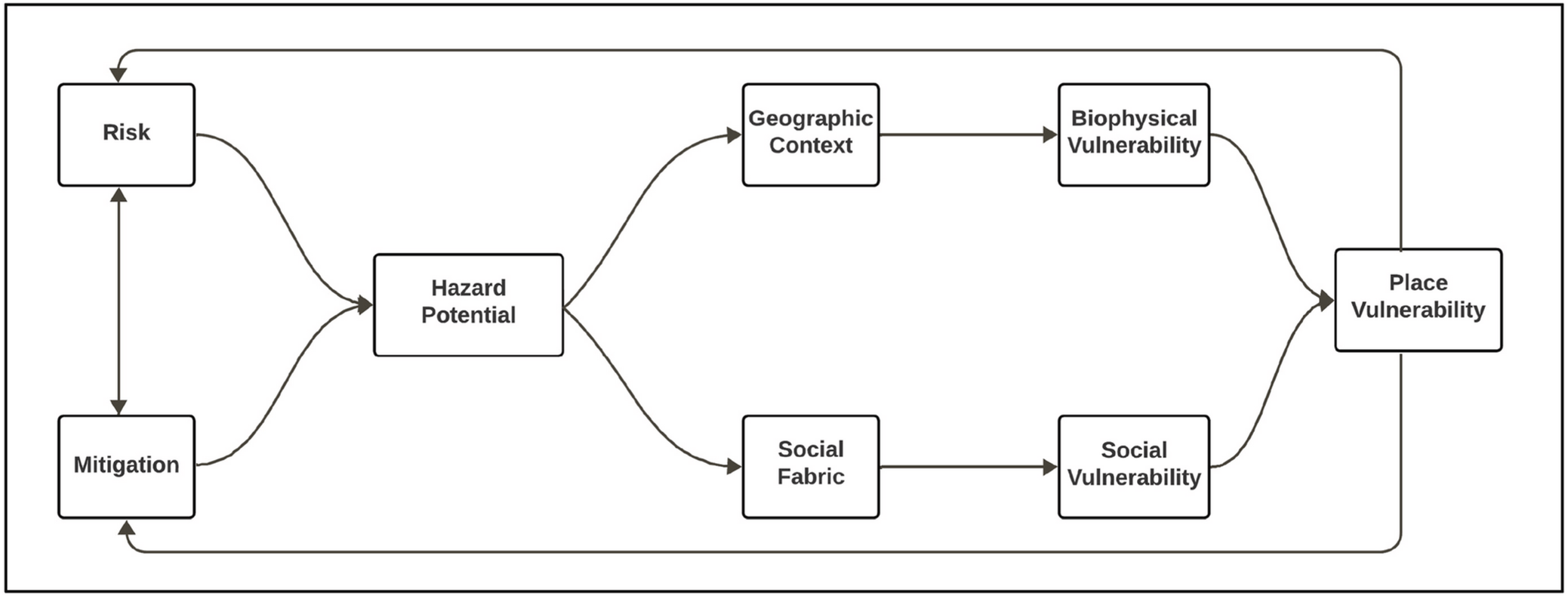


RESULTS RQ 2

“What areas are most vulnerable to the risks of heat stress?”

HEAT STRESS VULNERABILITY

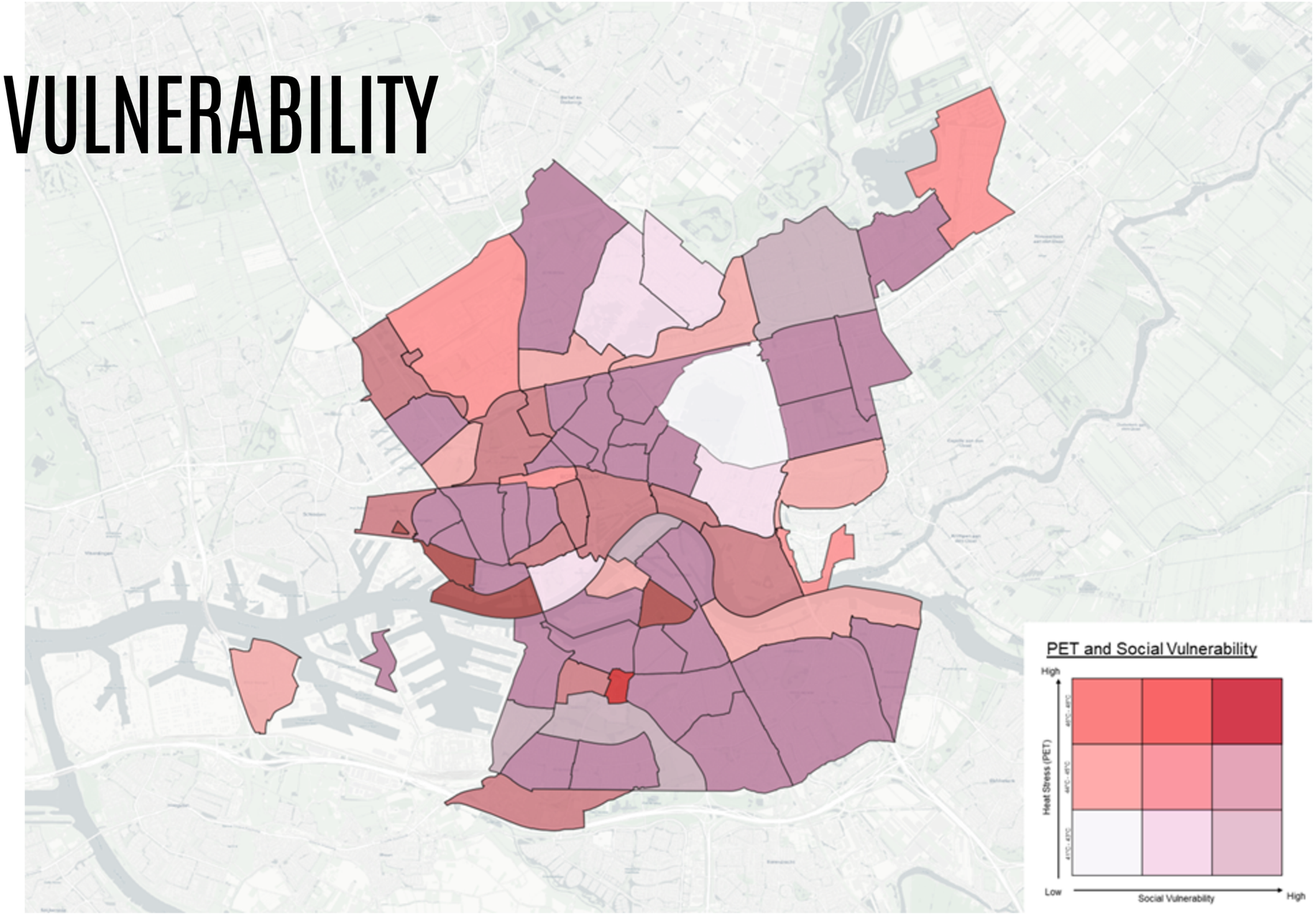
RQ 2



Source: (Cutter, 2024)

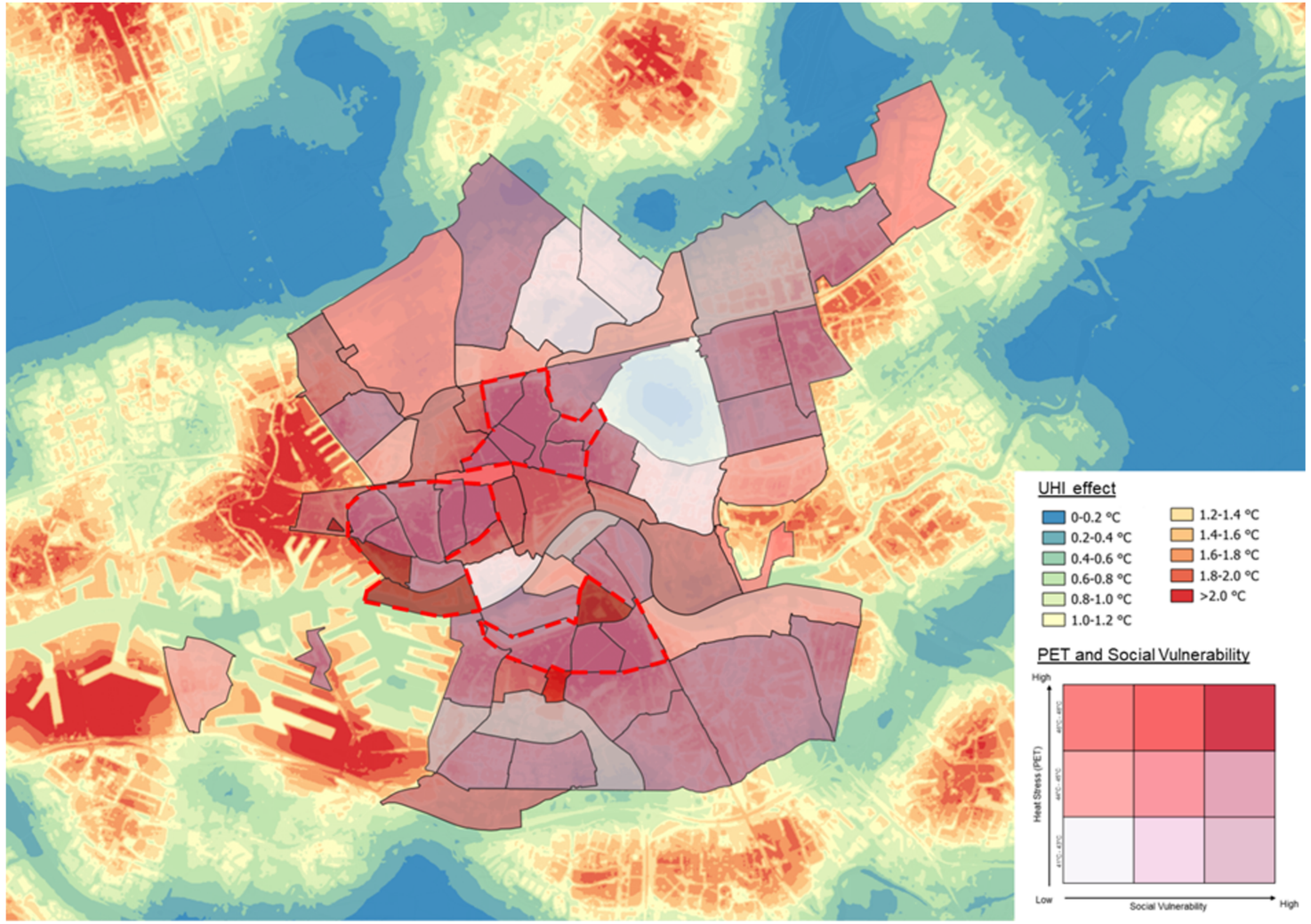
PLACE VULNERABILITY

RQ 2



VULNERABLE AREAS IDENTIFIED

RQ 2



RESULTS RQ 3

“What measures can be taken to mitigate the heat stress of existing properties of housing corporations and what are the costs of implementing these measures?”

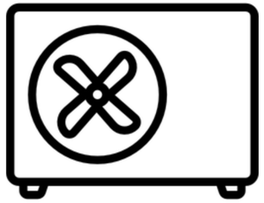
MITIGATION MEASURES

RQ 3

Shading

Ventilation

Roof and facade additions



Cooling installations

Insulation

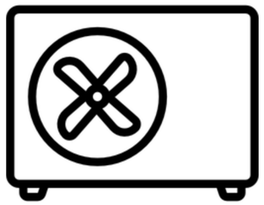
MITIGATION MEASURES

RQ 3

Shading

Ventilation

Roof and facade additions



Cooling installations

Insulation

Effectiveness **Cost of implementation** **Cost of maintenance** **Lifespan**

INTERVIEW RESULTS HOUSING CORPORATIONS

RQ 3

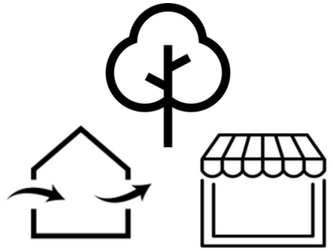
Growing awareness

Identification of dwellings in need of mitigation

- TO July above 4,8
- Presence of sun shading
- Roof insulation rate below 2,5

} **15.000 dwellings**

Passive mitigation measures



Financial challenges

MITIGATION VARIANTS

RQ 3

Variant 1 | Shading

90% Shading	13.500 dwellings
10% Solar reflective foils	1.500 dwellings

Variant 2 | Ventilation

50% Tilt and turn windows	7.500 dwellings
50% Ventilation rosters	7.500 dwellings

Variant 3 | Shading & ventilation

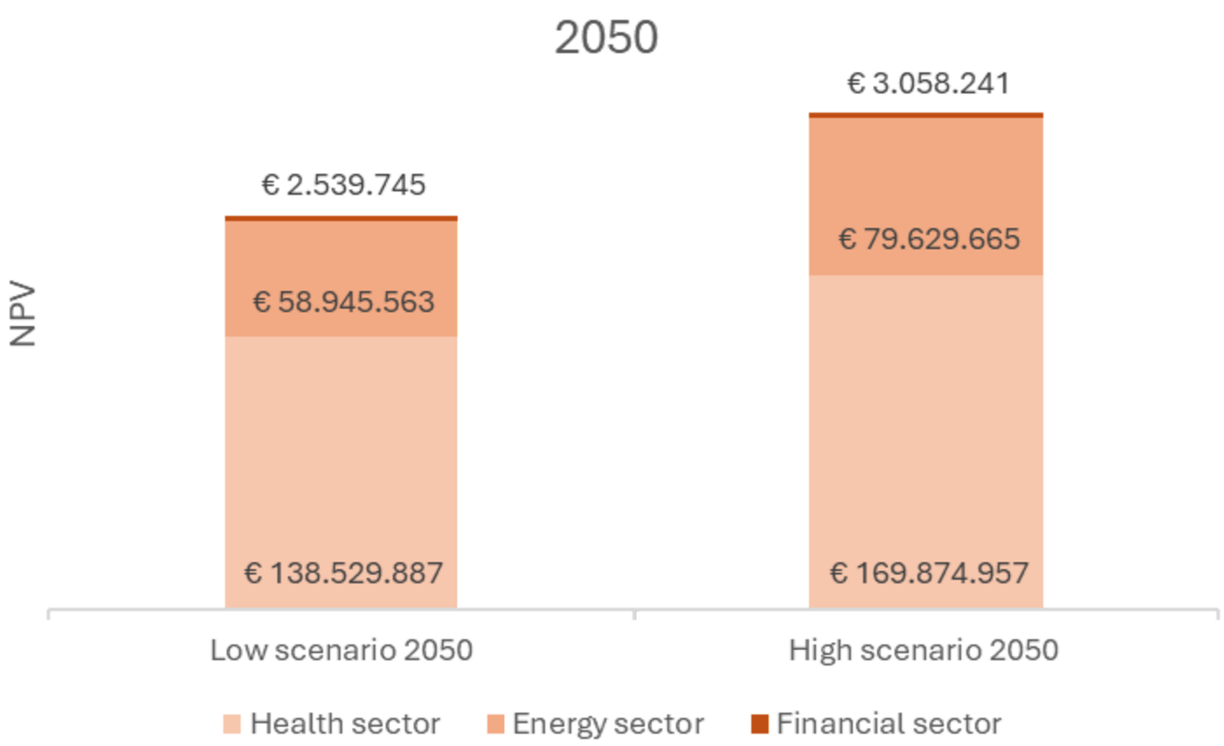
45% Shading	6.750 dwellings
5% Solar reflective foils	750 dwellings
50% Tilt and turn windows + Solar glazing	7.500 dwellings
50% Ventilation rosters	7.500 dwellings

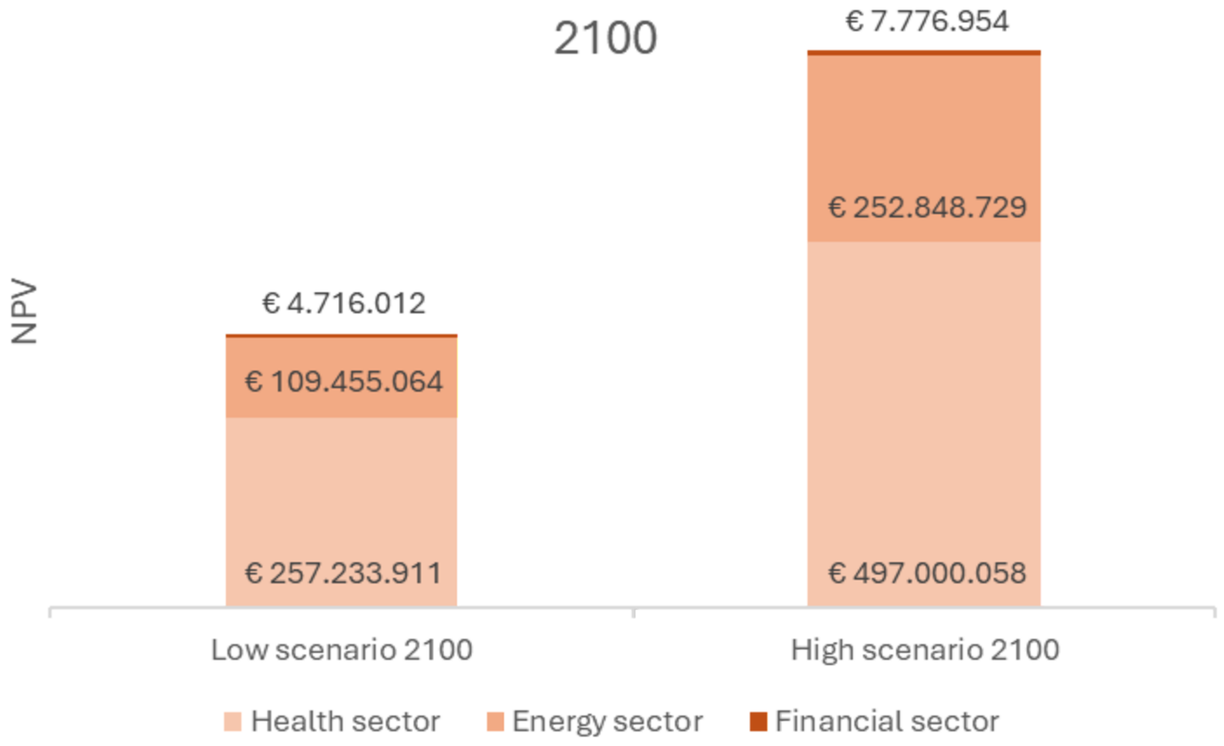
RESULTS RQ 4

“How do the economic and social benefits of implementing heat stress mitigation measures into social housing demonstrate the value of the implementation costs?”

BENEFITS SCBA

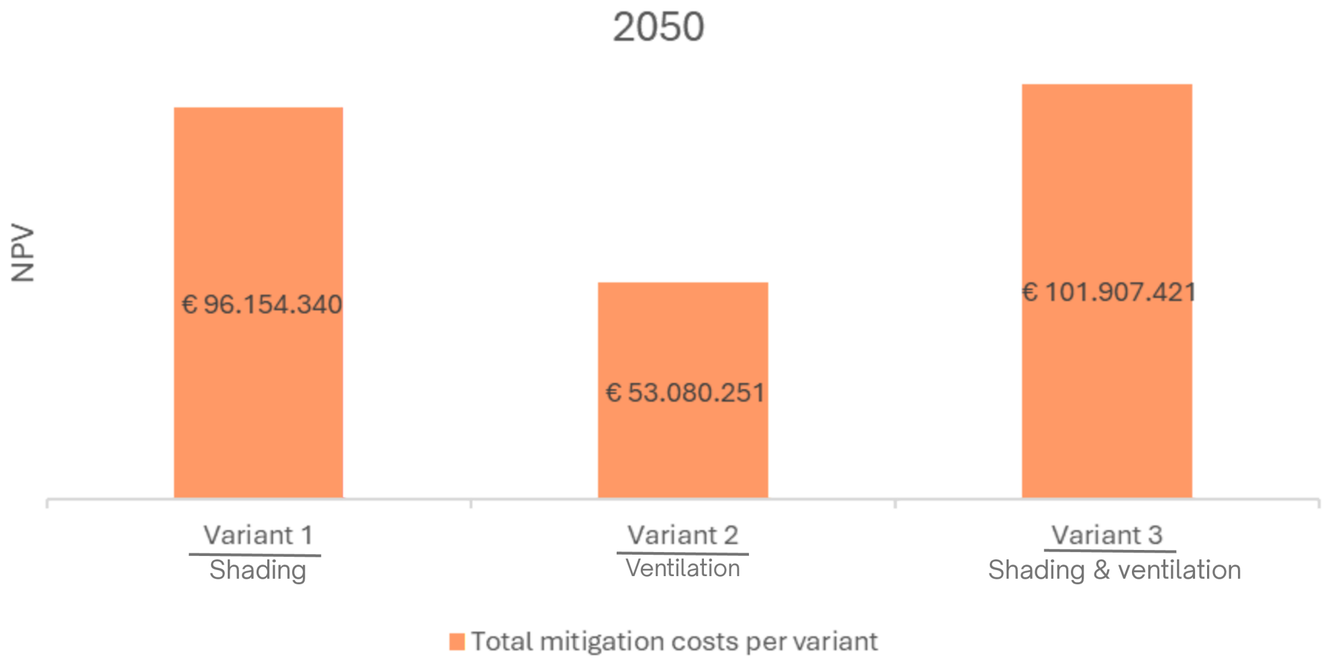
RQ 4

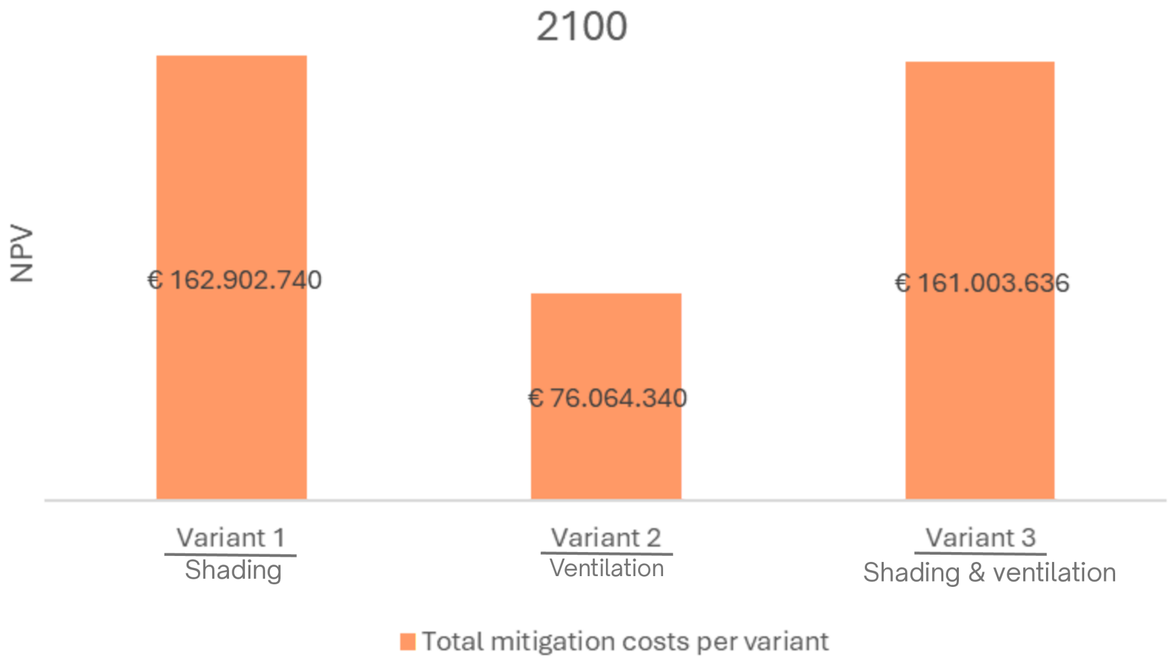




COSTS SCBA

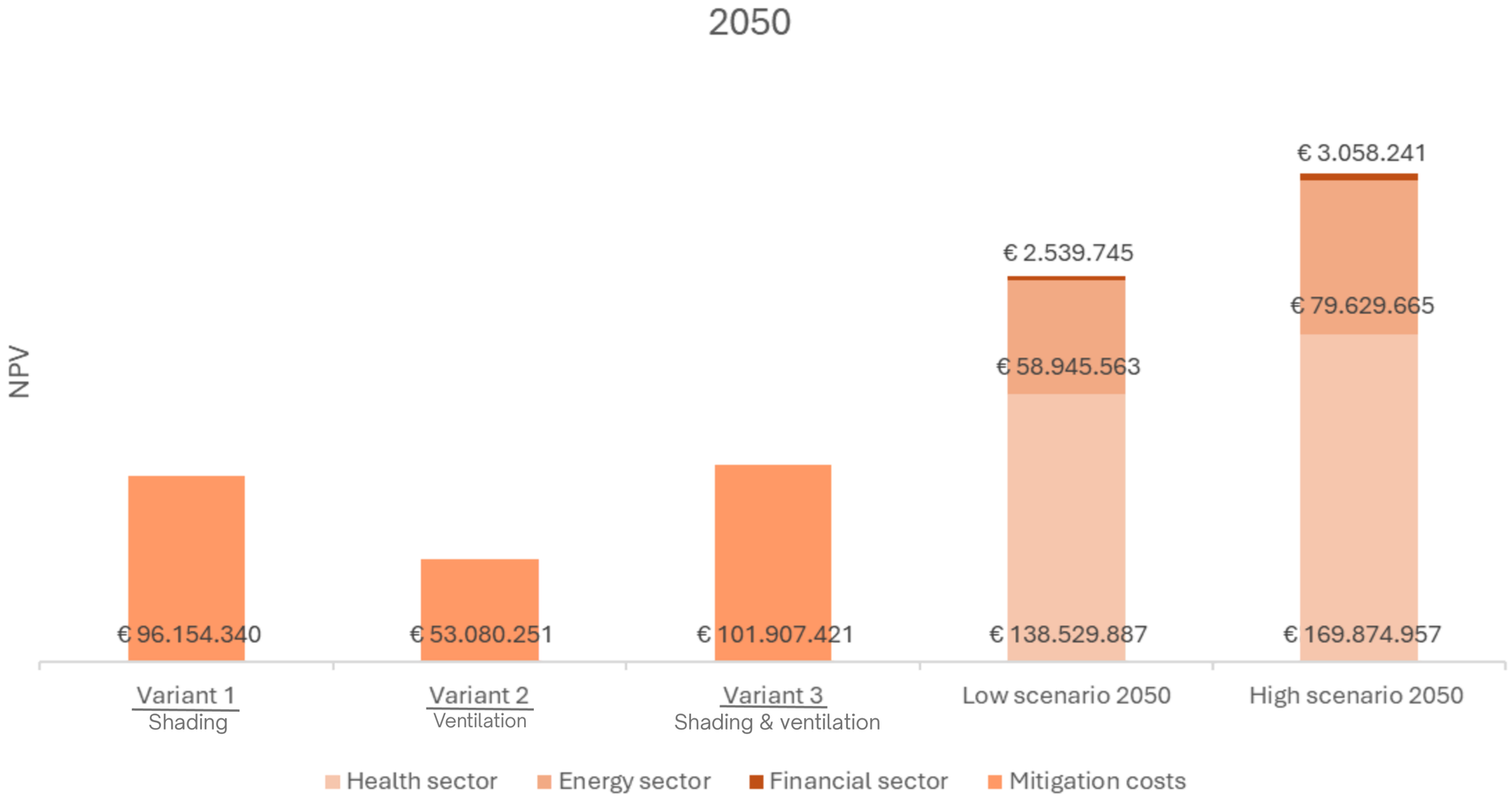
RQ 4





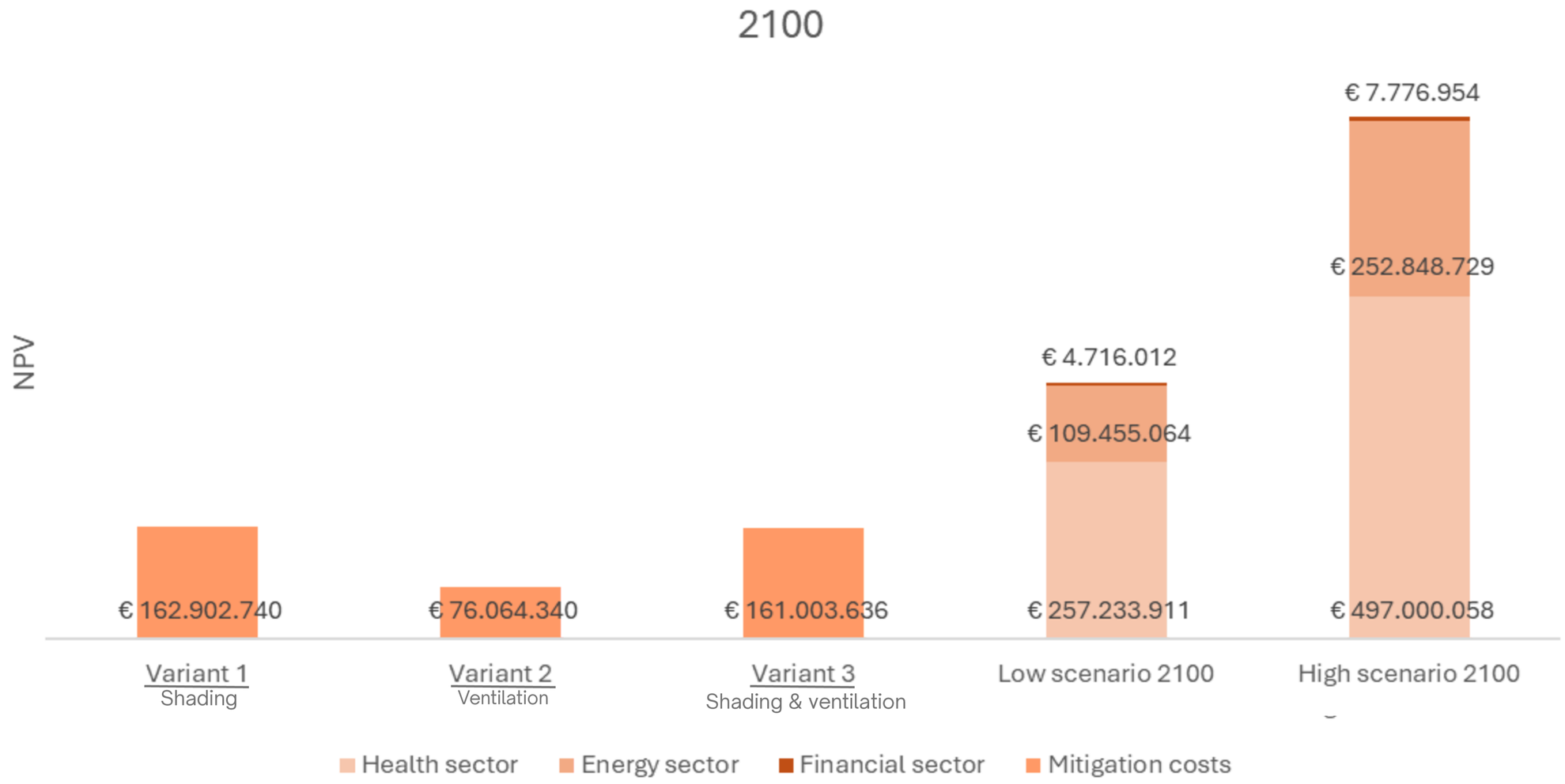
SCBA: 2050

RQ 4



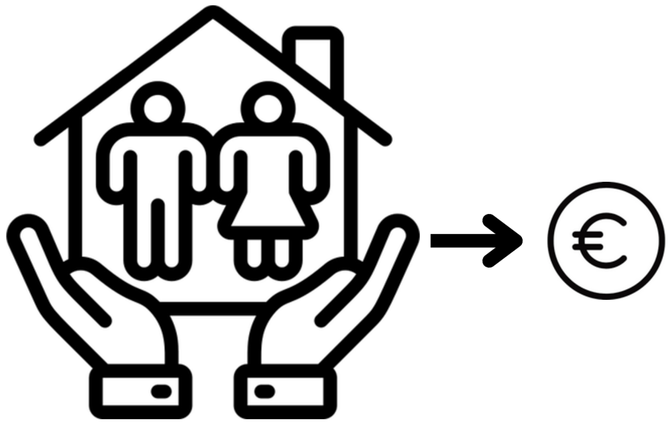
SCBA: 2100

RQ 4

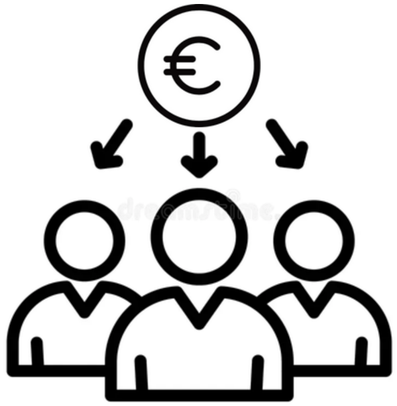


SPLIT INCENTIVE

RQ 4



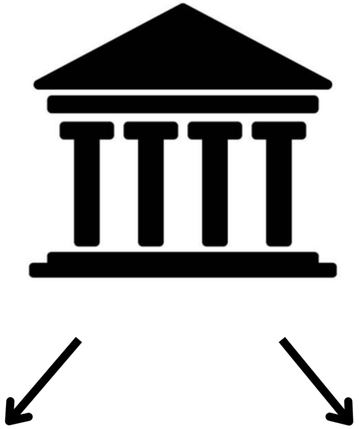
Housing corporations



Health sector
Energy sector
Financial sector

RESPONSIBILITY

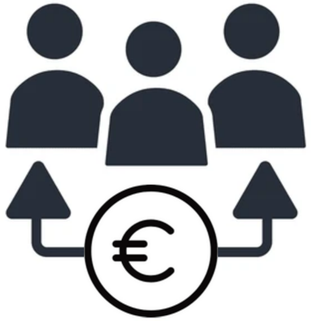
Local and national government



Subsidies

Policies and policy instruments

Beneficiary stakeholders

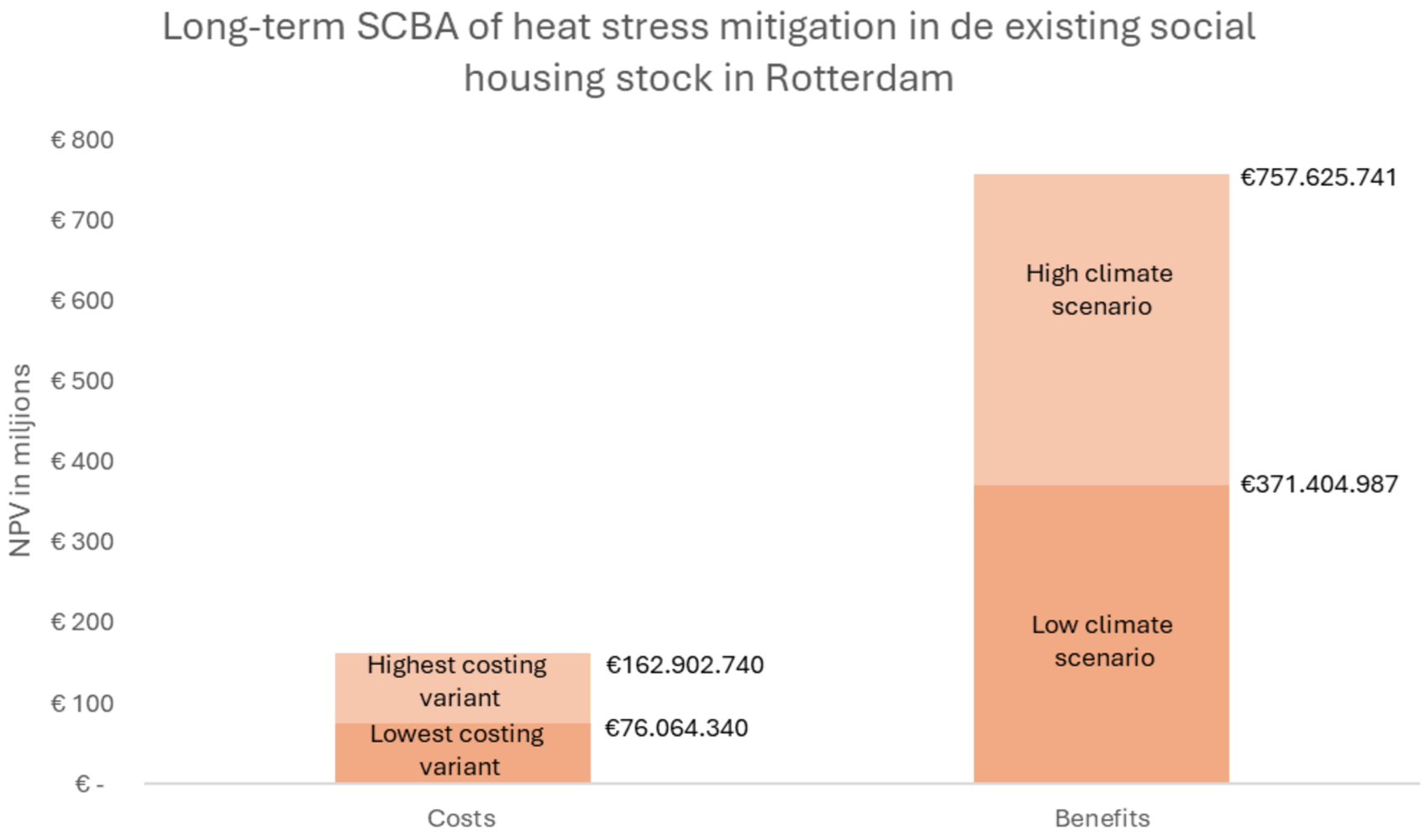


CONCLUSION

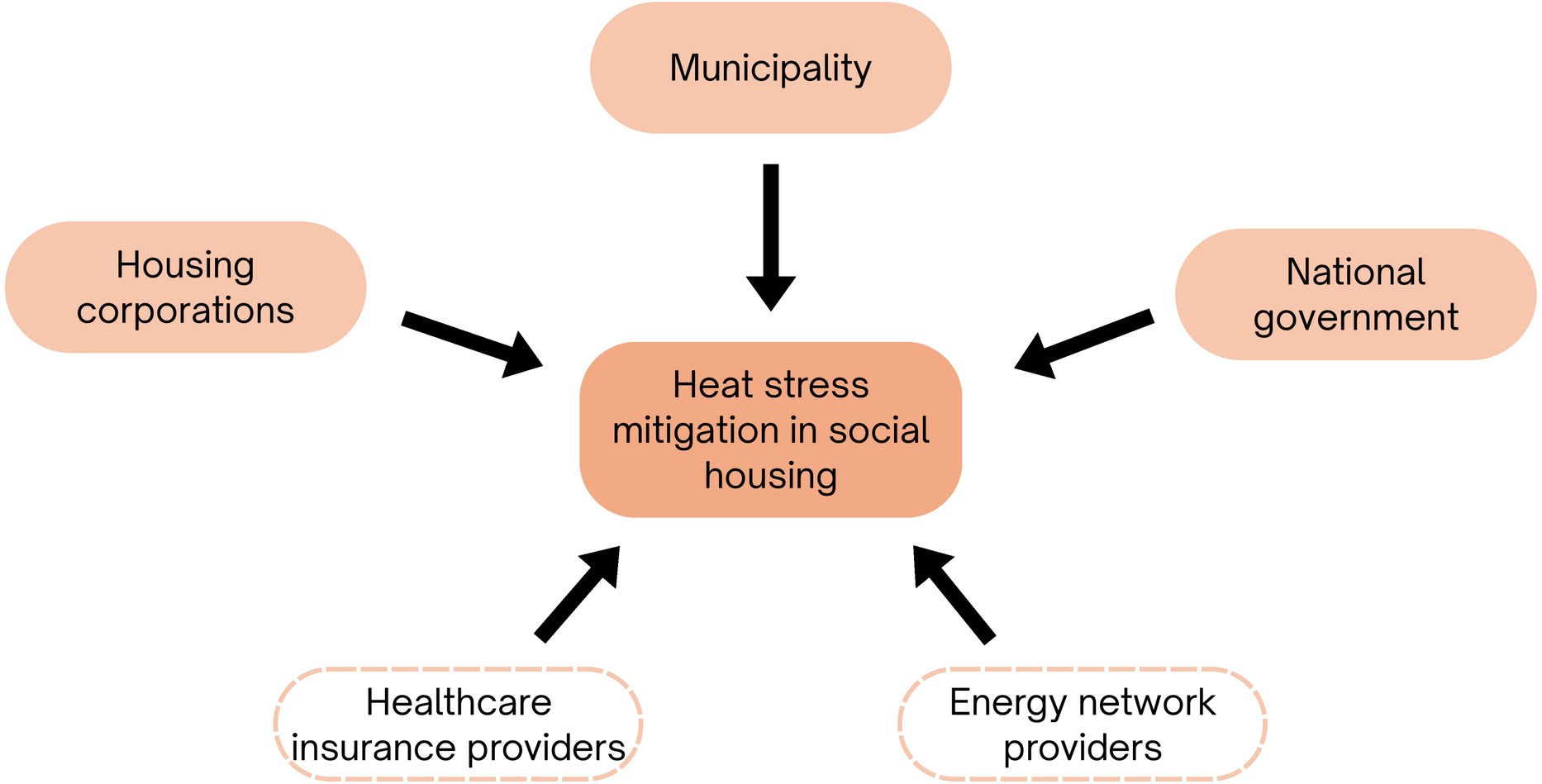
RESEARCH QUESTION

'What are the long-term costs and benefits of mitigating heat stress in the existing social housing stock?'

CONCLUSION

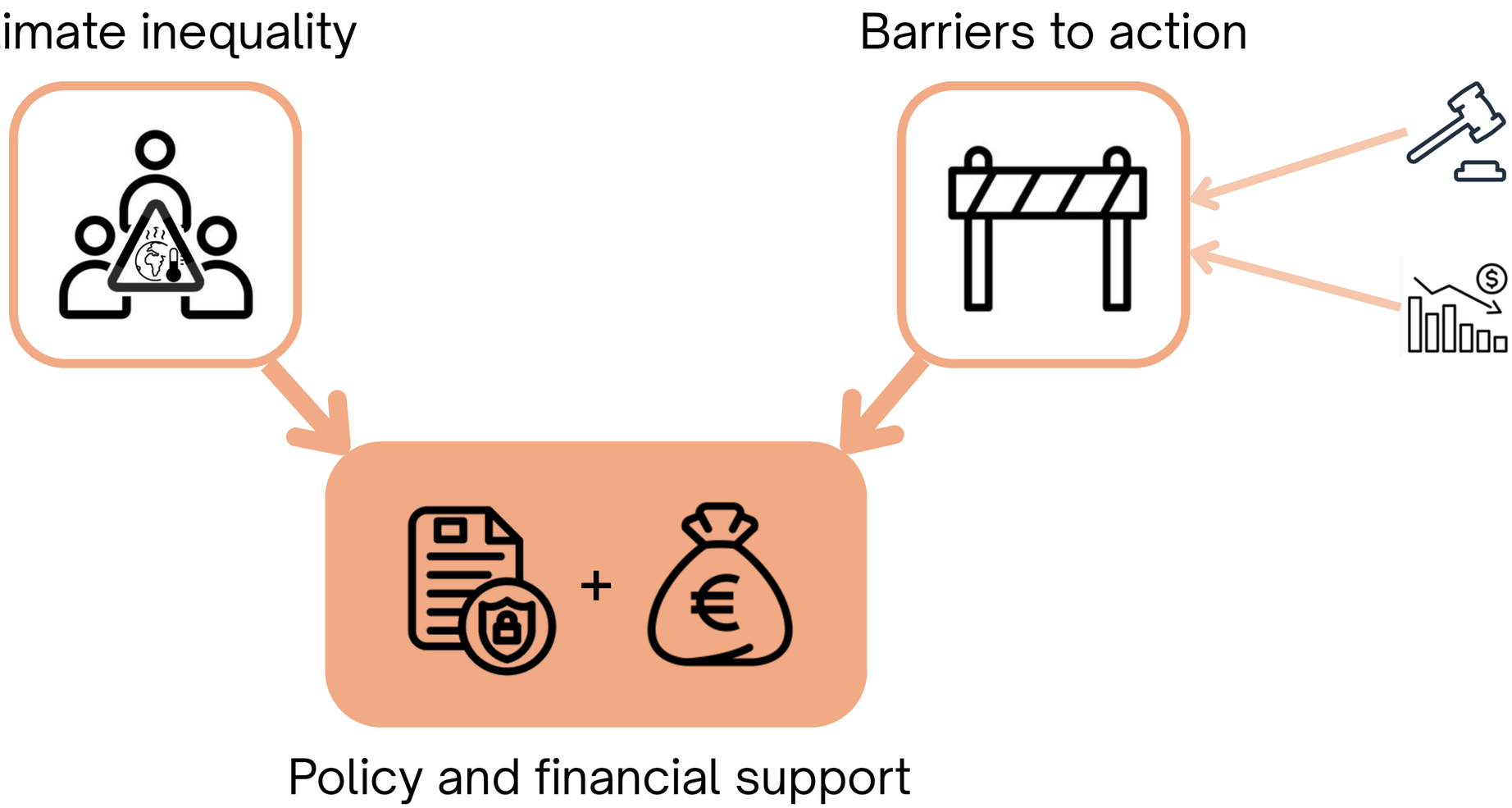

Long-term SCBA of heat stress mitigation in de existing social housing stock in Rotterdam
NPV in miljions
€ 800
€ 700
€ 600
€ 500
€ 400
€ 300
€ 200
€ 100
€ -
Highest costing variant
Lowest costing variant
€162.902.740
€76.064.340
High climate scenario
Low climate scenario
€757.625.741
€371.404.987
Costs
Benefits

RECOMMENATIONS FOR PRACTICAL IMPLEMENTATION



DISCUSSION

INTERPRETATION



A BROADER CLIMATE LENS

Rain

Floods

Heat

Drought

Groundwater

Subsidence

HEAT ACTION DAY

QUESTIONS ?