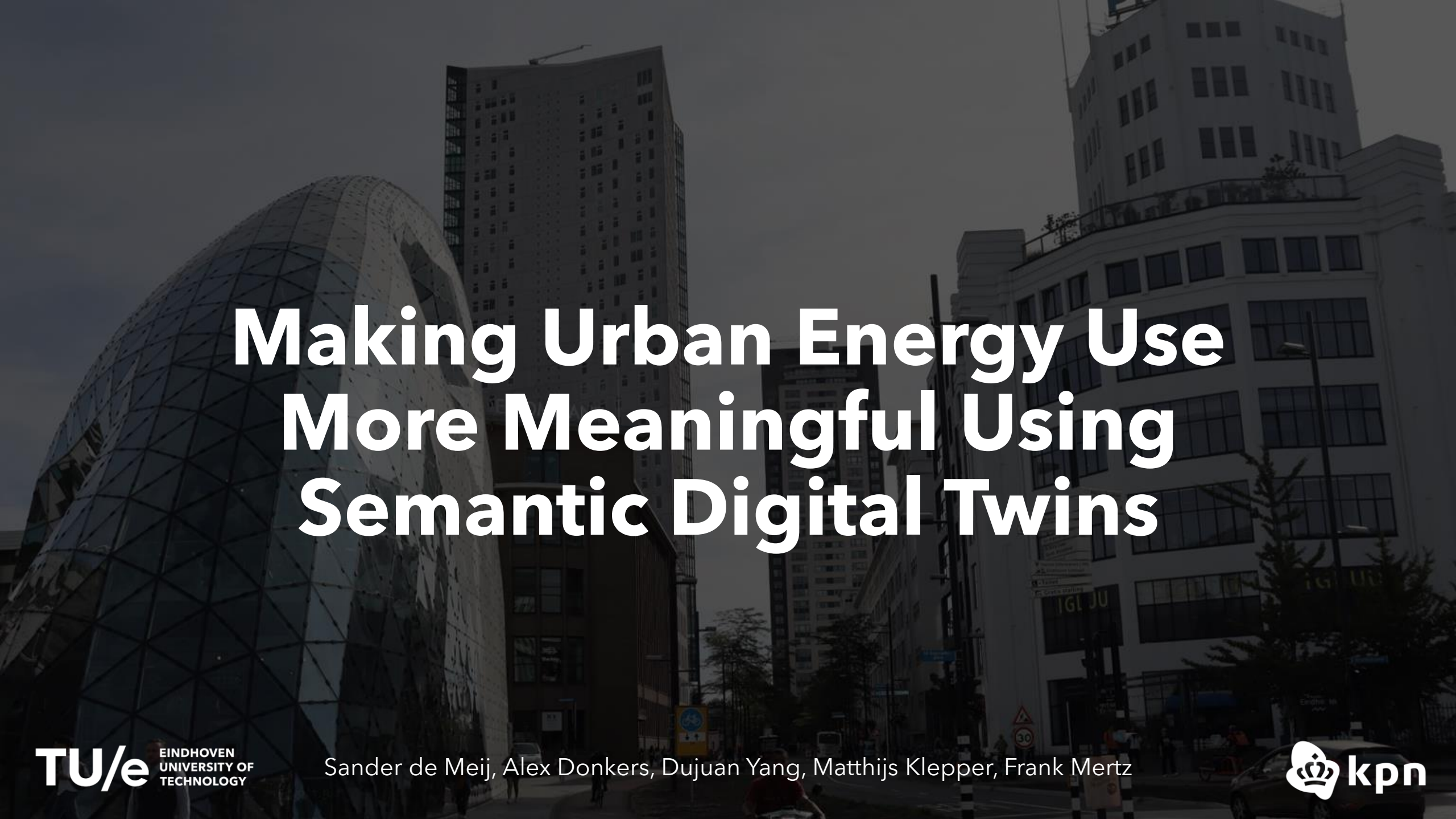


Making Urban Energy Use More Meaningful Using Semantic Digital Twins

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Sander de Meij, Alex Donkers, Dujuan Yang, Matthijs Klepper, Frank Mertz

kpn

TNO innovation for life

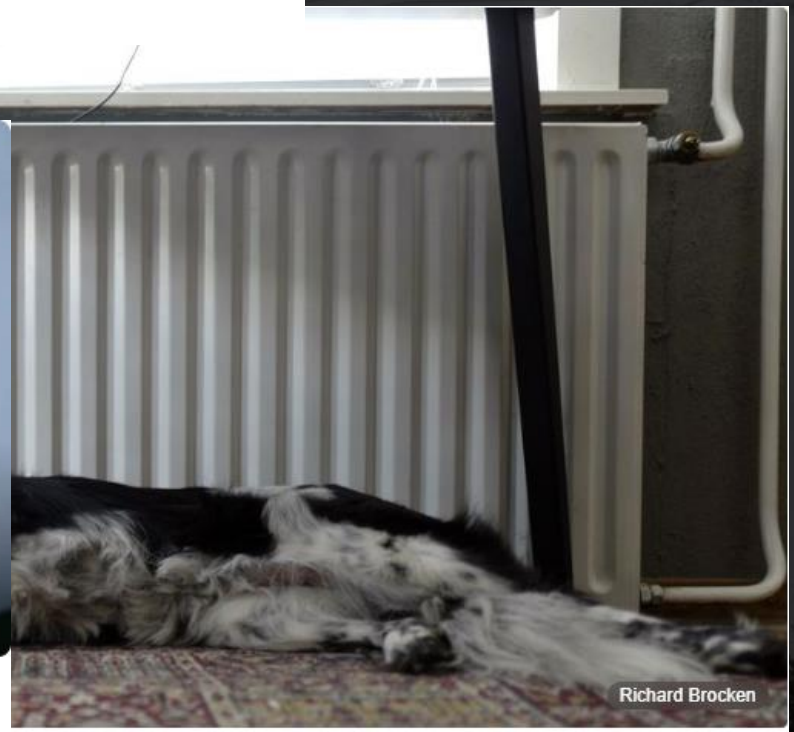
Duurzaam Gezond Veilig Digitaal Sectoren Werken bij Meer NL

Home / Newsroom /

Steunmaatregelen energiearmoede hebben positieve effecten

Inclusieve energietransitie 4 juli 2023

Energierekening gemiddeld ruim 600 euro hoger dan jaar eerder



Richard Brocken

NOS Nieuws • Woensdag 10 augustus 20

Energie dreigt onbetaall
de rekening op?

N Door onze economieredactie
A

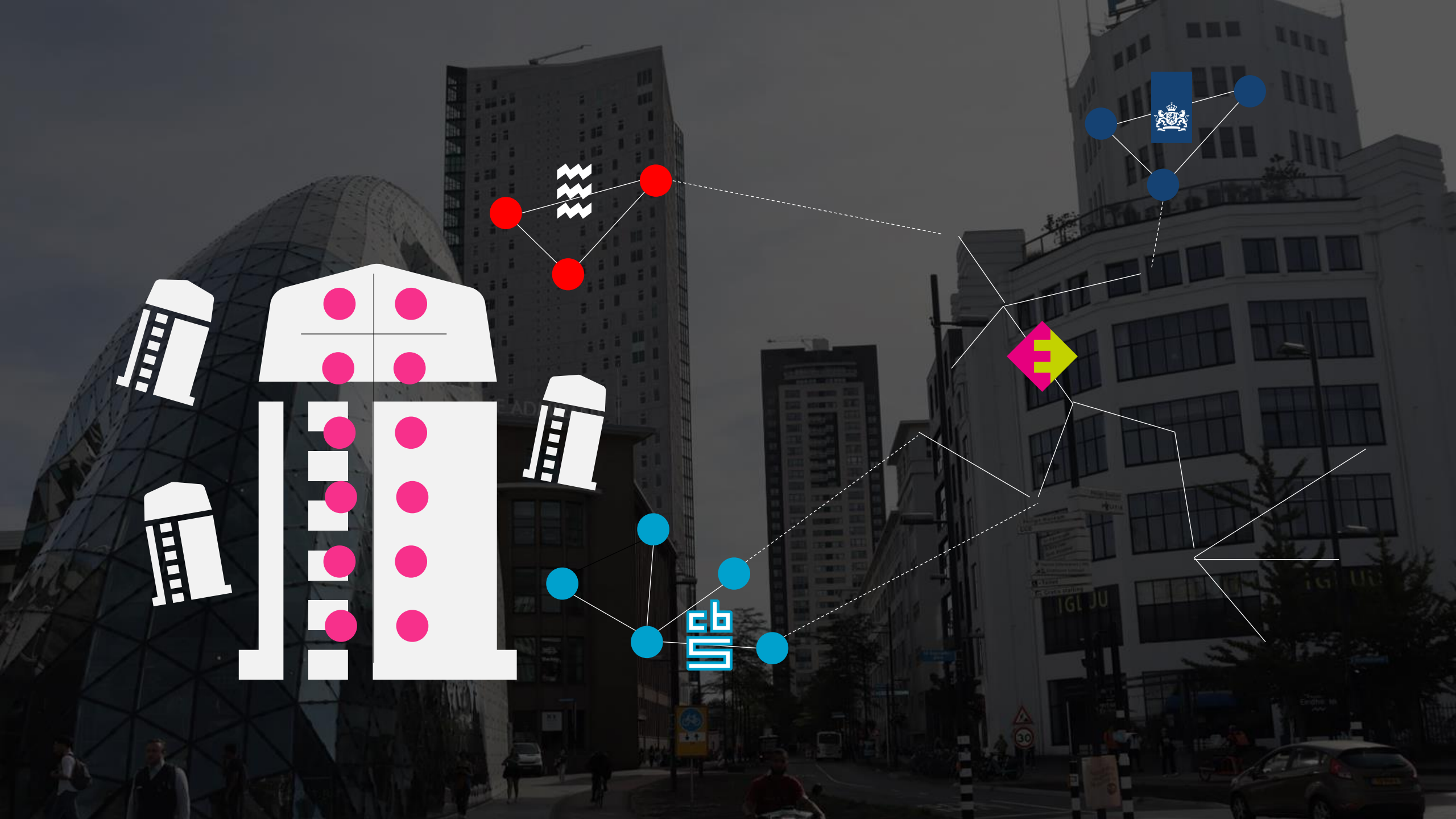
20 jul 2023 om 00:04
Update: 10 dagen geleden

426 reacties Delen

Een huishouden met een gemiddeld energieverbruik betaalde in juni 2.320 euro per jaar aan energie. Dat betekent een stijging van 37 procent (630 euro) ten opzichte van dezelfde periode vorig jaar.

ptember 2022, 16:59

ie helpt miljoenen
doende'

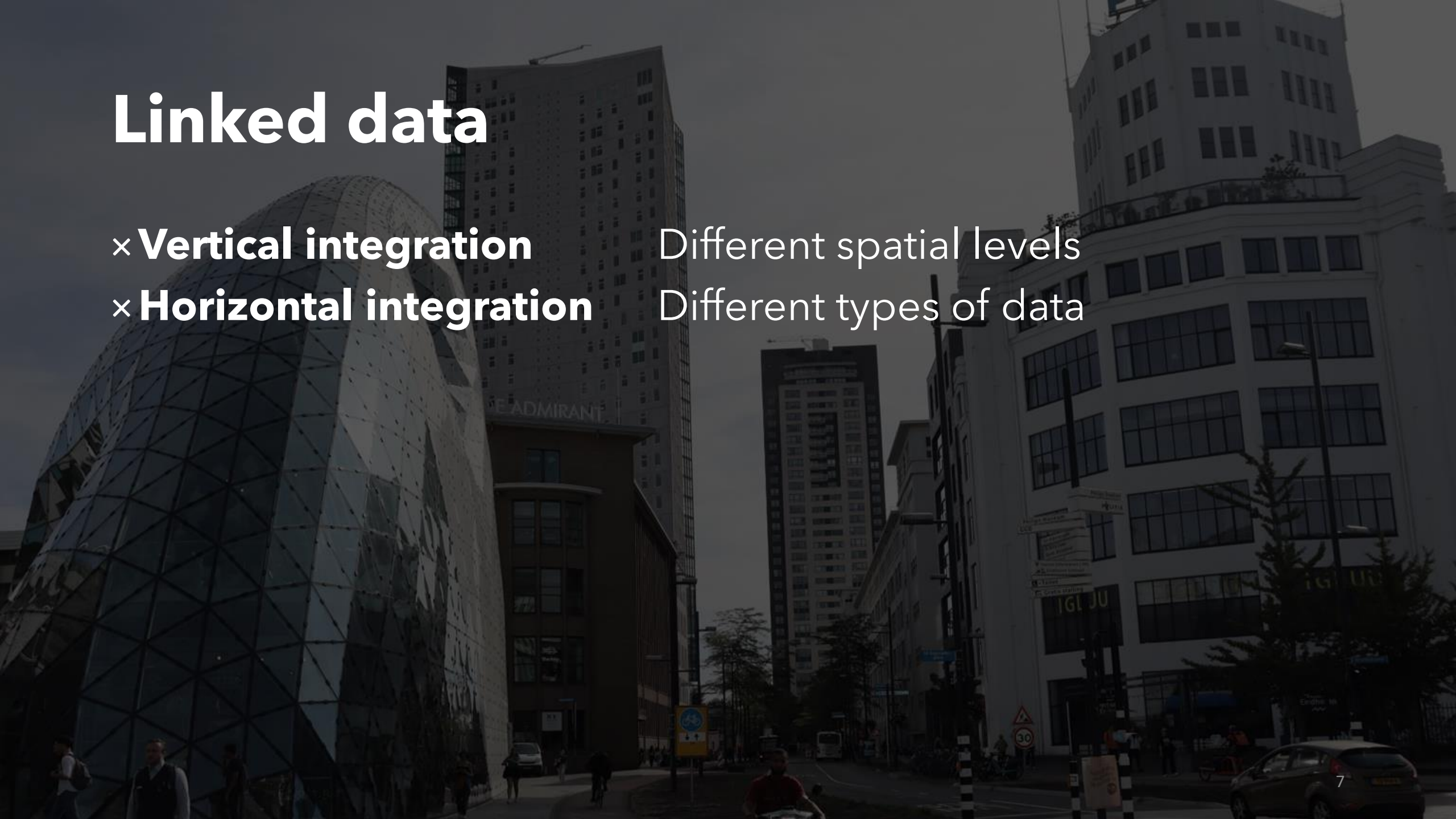


1. Linked data
2. Neo Dash
3. Use cases

1. Linked data
2. Neo Dash
3. Use cases

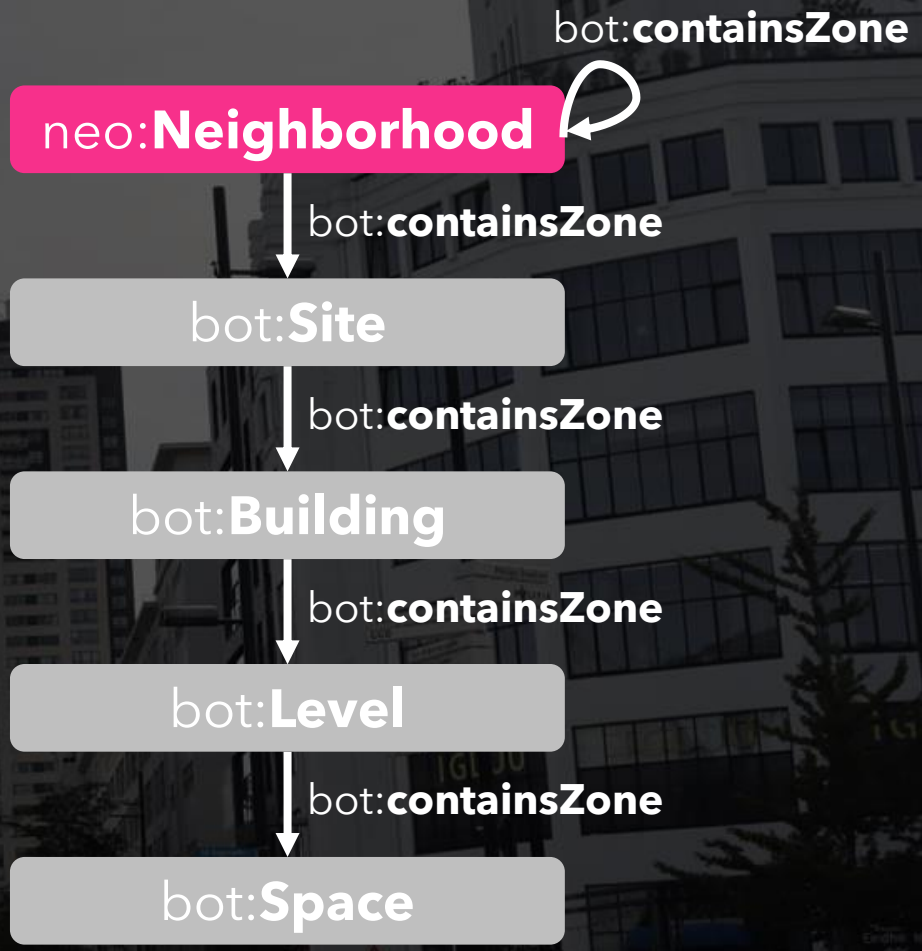
Linked data

- **Vertical integration** Different spatial levels
- **Horizontal integration** Different types of data



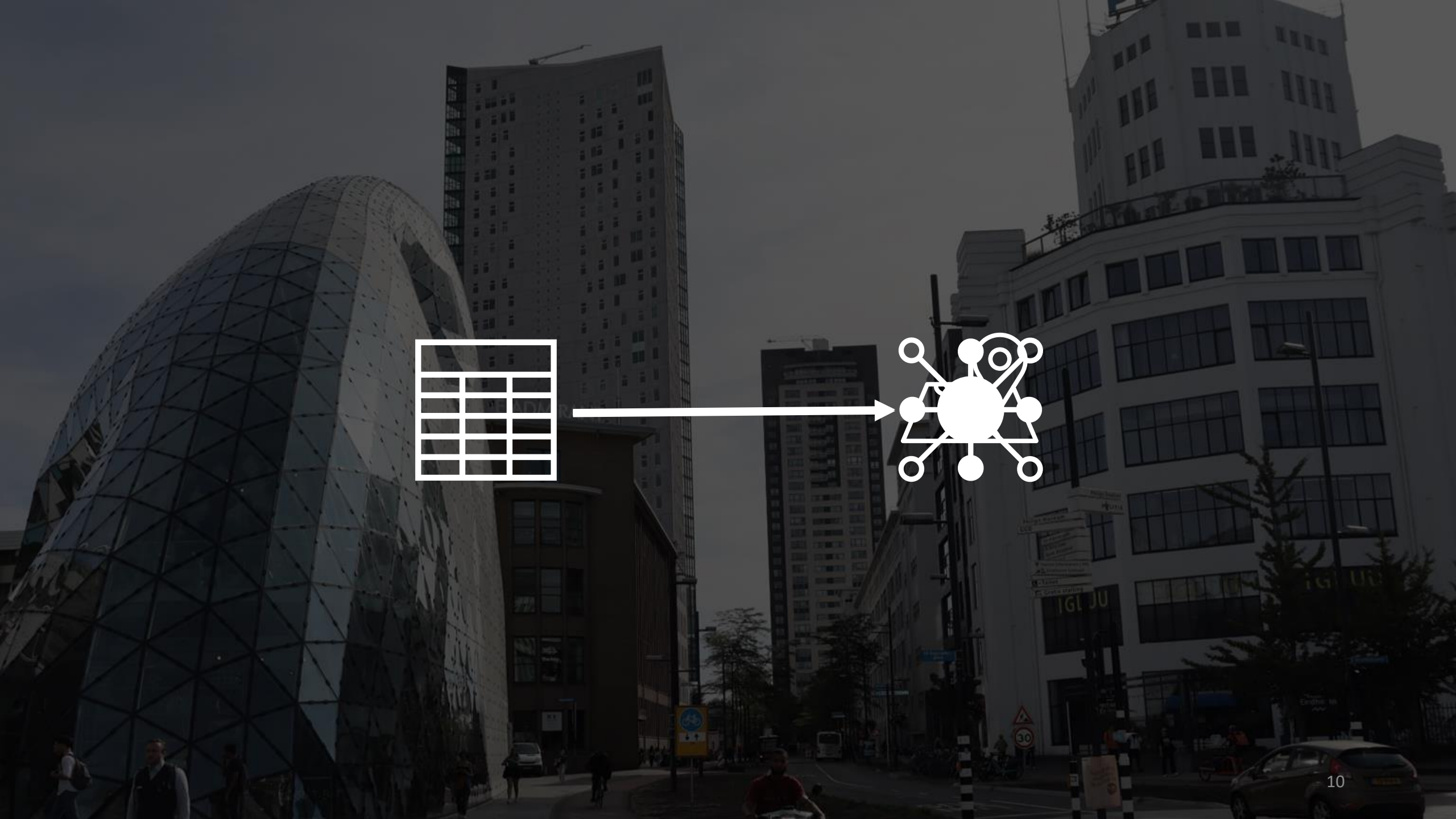
Linked data Vertical integration

- Extension of BOT
- Neighborhoods can contain other Neighborhoods



Linked data Horizontal integration

× Reusing BOP to describe properties of neighborhoods



1. Linked data
2. Neo Dash
3. Use cases

NEODash Query

Energy Poverty Time Series

Map

Disable Neigbhorhoods | Disable Geometry | Reset view

Query

SPARQL ×

Variable: gasUse (m3)
Definition: *Average gas use per connection to the grid in the area.*
Postal Code Level: *6*

2022-01-01 - 2023-01-01

Min 1200

Max 21254.4

Undo Visualization | Remove

Select Energy Variable

Variable: rented (%)
Definition: *Percentage of total dwellings which is occupied by a renter*
Postal Code Level: *6*

2020-01-01 - 2021-01-01

Min 90

Max 100

Visualize Results | Remove

Variable: dwellings (dwelling)
Definition: *Amount of dwellings in the area*
Postal Code Level: *6*

2020-01-01 - 2021-01-01

Min 50

Max 615

Visualize Results | Remove

Select Query Variable

Table

Maximize View | Hide Results | Export

Postal Code	electricityUse	urbanDensity
5611AC	14995.29	4297.0
5611AD	14995.29	4297.0
5611CA	4376.47	3777.0
5611CB	3292.6	3777.0
5611CC	4762.86	3777.0
5611CH	5555.76	3777.0

Graph

Maximize View | Hide Graph | false Graph

Map

Disable Neigbhorhoods | Disable Geometry | Reset view

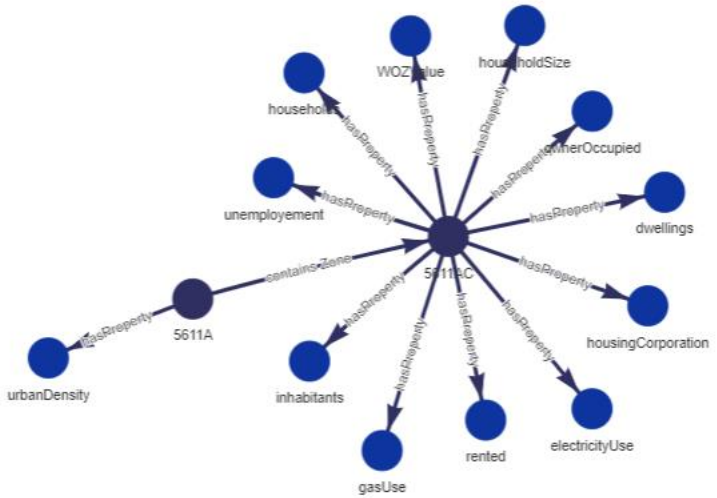
5612AV

Electricity Use Areas | Gas Use Areas | Neigbhorhood | Postal Code 4 | Postal Code 5 | Postal Code 6

Property	Value	Procedure	Begin	End
				2021-01-01T00:00:00
				2021-01-01T00:00:00
				2021-01-01T00:00:00
				2021-01-01T00:00:00
				2023-01-01T00:00:00
				2022-01-01T00:00:00
				2020-01-01T00:00:00
				2021-01-01T00:00:00
				2023-01-01T00:00:00
				2020-01-01T00:00:00
				2021-01-01T00:00:00
				2022-01-01T00:00:00
				2021-01-01T00:00:00
				2020-01-01T00:00:00
				2020-01-01T00:00:00
				2021-01-01T00:00:00
				2021-01-01T00:00:00
				2020-01-01T00:00:00
				2021-01-01T00:00:00
				2020-01-01T00:00:00
				2021-01-01T00:00:00
				2020-01-01T00:00:00
				2021-01-01T00:00:00

Graph

Maximize View | Data Graph | Hide 5611AC Graph



Let’s use this!

1. Linked data
2. Neo Dash
3. Use cases

Energy Poverty

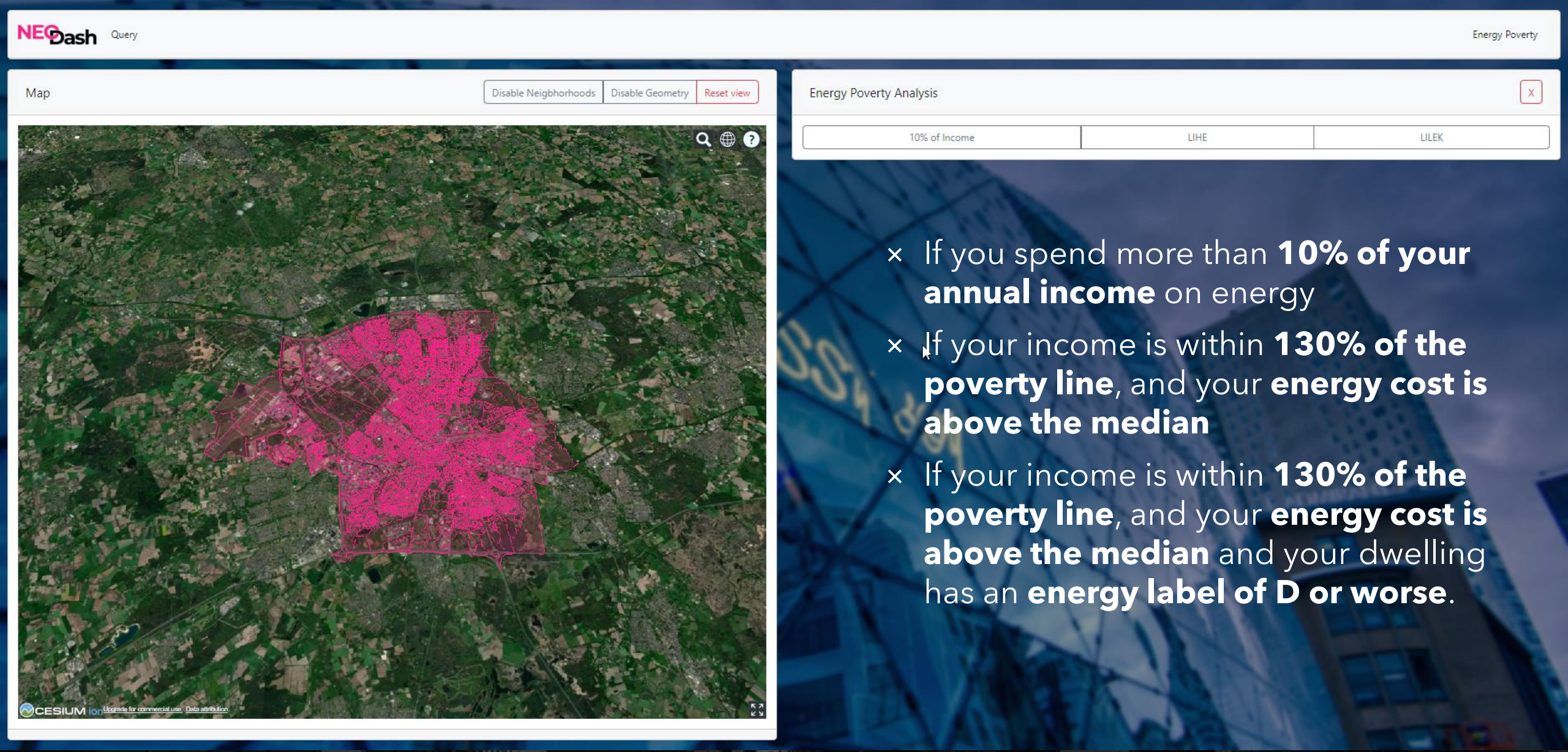
Energy data

Predictive Analytics

Energy Poverty

Energy data

Predictive Analytics



- If you spend more than **10% of your annual income** on energy
- If your income is within **130% of the poverty line**, and your **energy cost is above the median**
- If your income is within **130% of the poverty line**, and your **energy cost is above the median** and your dwelling has an **energy label of D or worse**.

Map

Disable Neighborhoods | Disable Geometry | Reset view

Energy Poverty Analysis

10% of Income | LIHE | LILEK

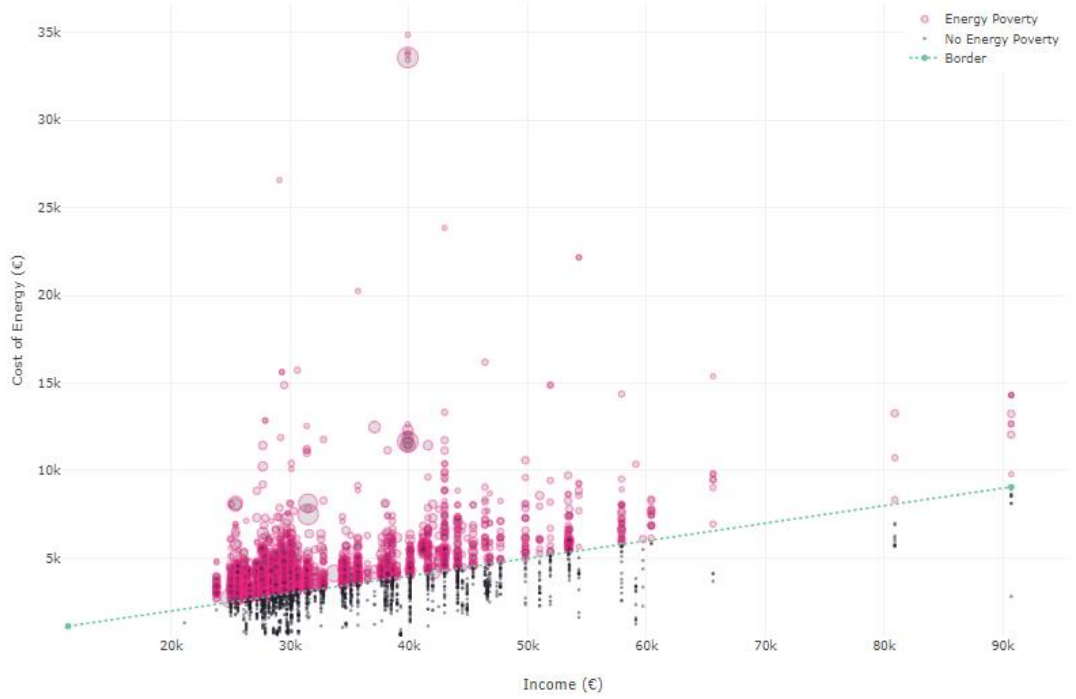
This analysis defines energy poverty as spending more than 10% of annual income on energy.

Horizontal Axis: This axis shows the annual income of the neighborhood. Income data is from 2021 and gathered from CBS. If no income was registered, the median income of Eindhoven is used (€NaN).

Vertical Axis: This axis shows an estimation of the cost of energy for the neighborhood. Energy consumption is taken from Enexis, and represents the average energy use per connection in the area in 2022. Energy price is adopted from the CBS and is taken as the average of 2022.

Neighborhoods at Risk: 2843 **Households at Risk:** 57170

Adjust Poverty Line: Income Spent on Energy (>10%)



× If you spend more than **10% of your annual income** on energy

Map

Disable Neighborhoods | Disable Geometry | Reset view

Energy Poverty Analysis

10% of Income | LIHE | LILEK

This analysis defines energy poverty as having an income within 130% of the poverty line, while having an above average energy bill.

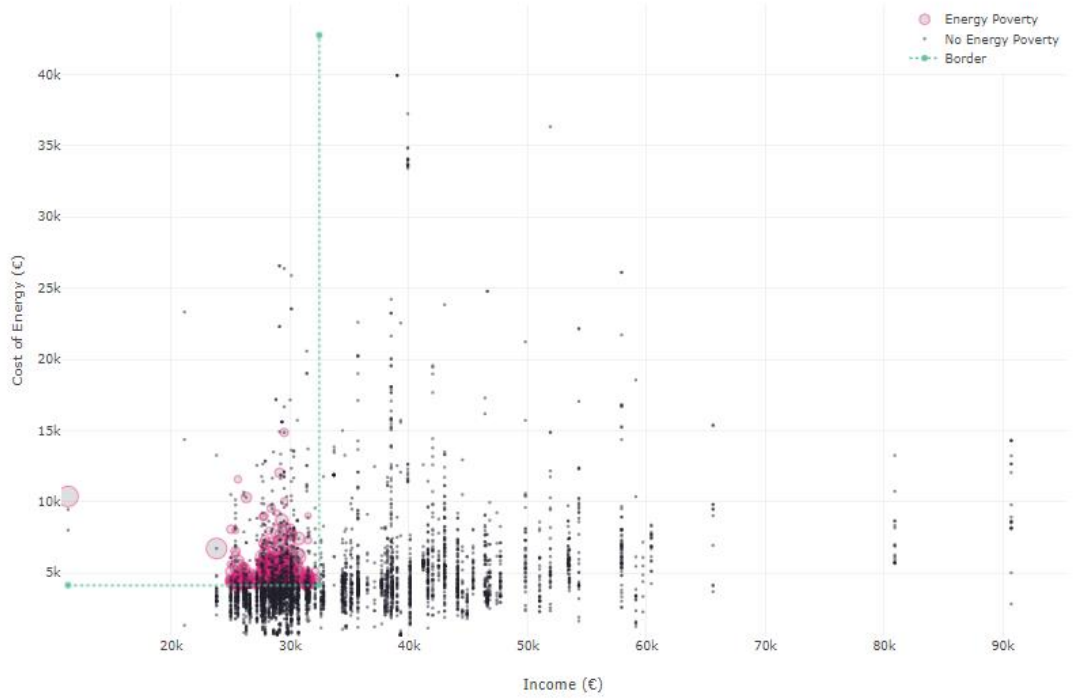
Horizontal Axis: This axis shows the annual income of the neighborhood. Income data is from 2021 and gathered from CBS.

Vertical Axis: This axis shows an estimation of the cost of energy for the neighborhood. Energy consumption is taken from Enexis, and represents the average energy use per connection in the area in 2022. Energy price is adopted from the CBS and is taken as the average of 2022.

Neighborhoods at Risk: 356 **Households at Risk:** 7820

Adjust Poverty Line: Income within 130% of poverty line

Adjust Energy Line: Median Energy Cost



× If your income is within **130% of the poverty line**, and your **energy cost is above the median**

Map

Energy Poverty Analysis

10% of Income | LIHE | LILEK

This analysis defines energy poverty as having an income within 130% of the poverty line, while having an above average energy bill.

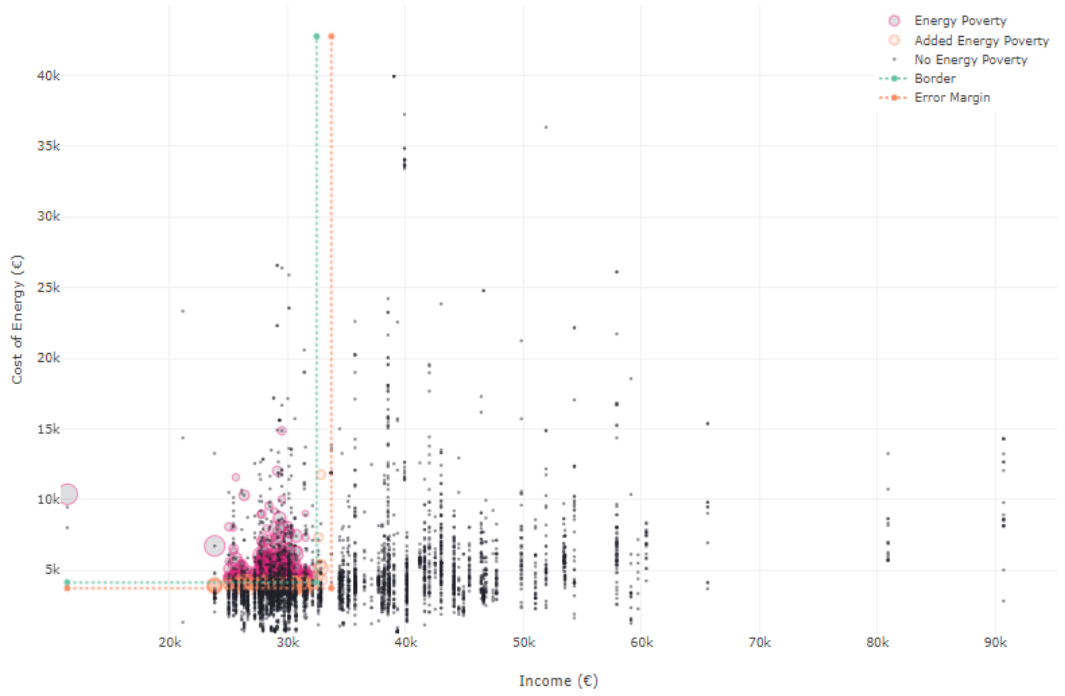
Horizontal Axis: This axis shows the annual income of the neighborhood. Income data is from 2021 and gathered from CBS.

Vertical Axis: This axis shows an estimation of the cost of energy for the neighborhood. Energy consumption is taken from Enexis, and represents the average energy use per connection in the area in 2022. Energy price is adopted from the CBS and is taken as the average of 2022.

Neighborhoods at Risk: 591 (+235) **Households at Risk:** 8370 (+550)

Adjust Poverty Line: Income within 135% of poverty line

Adjust Energy Line: Median Energy Cost -10%

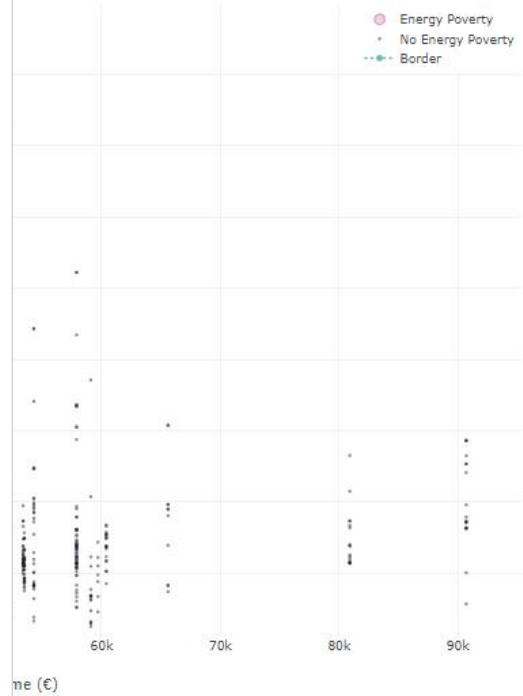


LIHE | LILEK

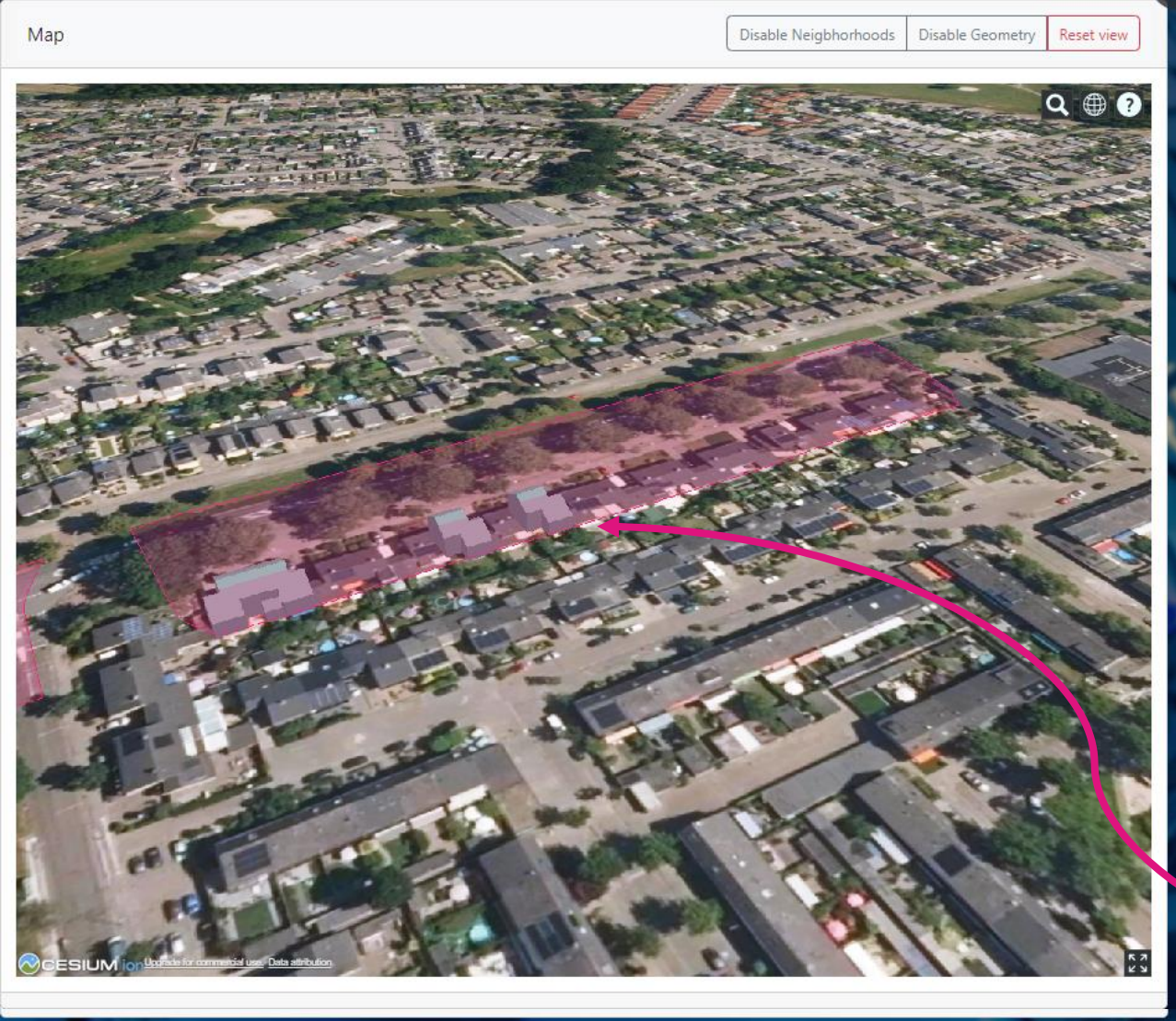
erty line, while having an above average energy bill.

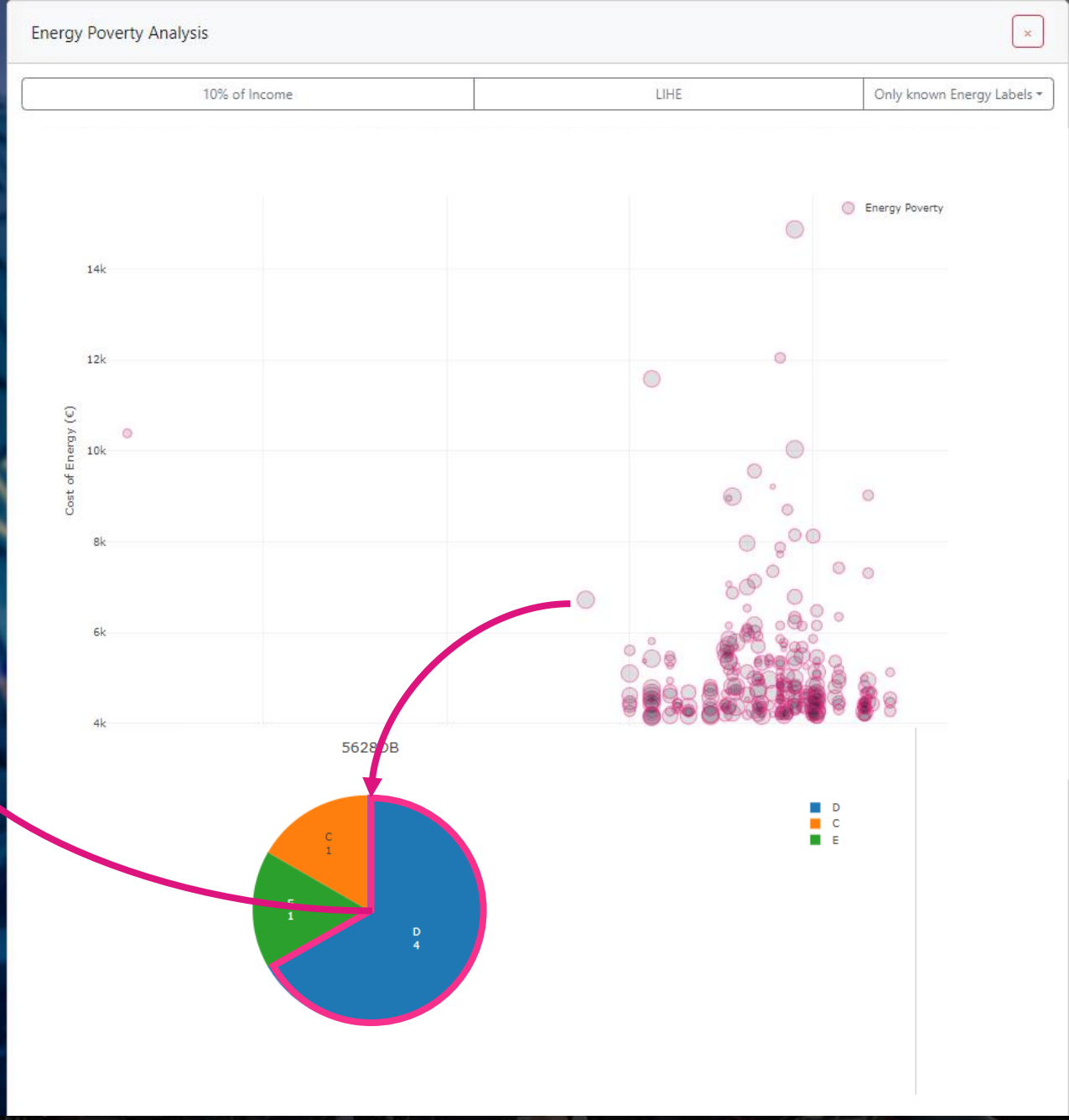
e data is from 2021 and gathered from CBS.

orhood. Energy consumption is taken from Enexis, and represents the average energy
d is taken as the average of 2022.



× If your income is within **130% of the poverty line**, and your **energy cost is above the median**





× If your income is within **130% of the poverty line**, and your **energy cost is above the median** and your dwelling has an **energy label of D or worse**.

Energy Poverty

Energy data

Predictive Analytics

Missing Data

Of **136122 buildings** in Eindhoven, **51099 (37,5%)** have an **unknown energy label**

Using **construction year**, **footprint**, **building value (WOZ)**, **electricity and gas use**, can we predict the unknown energy labels?

No.

Missing Data

LILEK: ‘Same as LIHE, except with dwelling **energy label below C**.’

Can we predict these **two categories** (above or below C)?

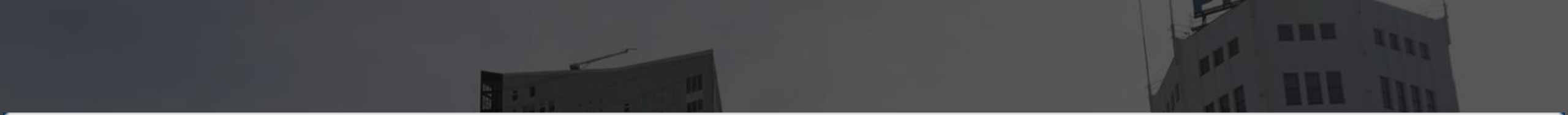
Yes!

Missing Data

Using **Random Forest Classification**

		Predicted	
		<C	>= C
Actual	<C	7373	677
	>= C	626	3146

Accuracy 89%
Precision: 92%
Recall: 92%



Selected Building

Electricity Use Areas | Gas Use Areas | Neigbhorhood | Postal Code 4 | Postal Code 5 | Postal Code 6

Energy Data

#	Postal-code	House Number	Area (m2)	Build Year	Purpose of Use	Energy Label
			75	1963	Woonfunctie	D
			75	1963	Woonfunctie	D
			75	1963	Woonfunctie	D
			75	1963	Woonfunctie	Worse than C
			75	1963	Woonfunctie	Worse than C
			75	1963	Woonfunctie	D

Map

Disable Neigbhorhoods | Disable Geometry | Reset view

Energy Poverty Analysis

10% of Income | LIHE | Include predicted Energy Labels

This analysis defines energy poverty as having an income within 130% of the poverty line, while having an above average energy bill and a dwelling with below average energy performance (i.e. energy label below C).

Horizontal Axis: This axis shows the annual income of the neighborhood. Income data is from 2021 and gathered from CBS.

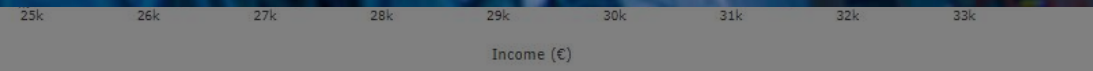
Vertical Axis: This axis shows an estimation of the cost of energy for the neighborhood. Energy consumption is taken from Enexis, and represents the average energy use per connection in the area in 2022. Energy price is adopted from the CBS and is taken as the average of 2022.

Neighborhoods at Risk: 477 **Households at Risk:** 7110

Adjust Poverty Line: Income within 130% of poverty line

Adjust Energy Line: Median Energy Cost

5654GA



Energy Poverty

Energy data

Predictive Analytics

NEODash Query

Energy Poverty Time Series

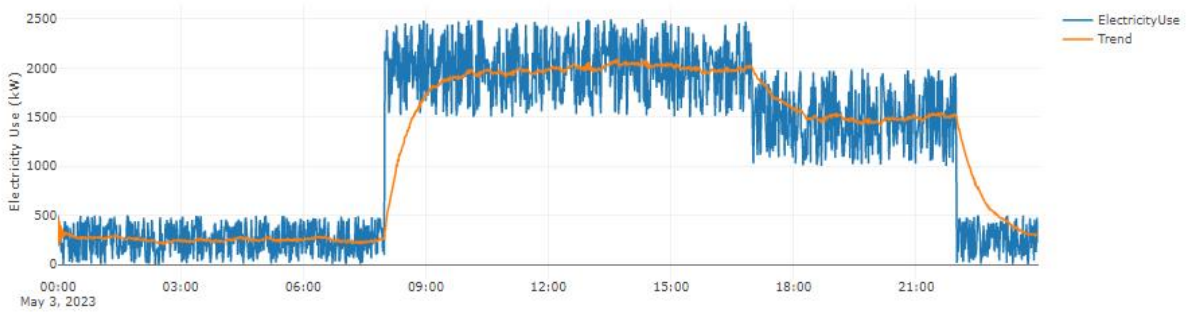
Map

Disable Neigbhorhoods | Disable Geometry | Reset view

Selected Building

Electricity Use Areas | Gas Use Areas | Neigbhorhood | Postal Code 4 | Postal Code 5 | Postal Code 6

Energy Data



#	Postal-code	House Number	Area (m2)	Build Year	Purpose of Use
0772100001003373	5612AV	6	23859	2001	Onderwijsfunctie

NEODash Query

Energy Poverty Time Series

Map

Disable Neigbhorhoods | Disable Geometry | Reset view

Time Series

Time Series Electricity Use | Postal Code Electricity Use | Use Combination

Time Series

Start Date: 2023-05-03T00:00:00Z

End Date: 2023-05-03T23:59:00Z

NEODash Query

Energy Poverty Time Series

Map

Disable Neighborhoods | Disable Geometry | Reset view

Time Series

Time Series Electricity Use | Postal Code Electricity Use | Use Combination

Time Series

TStart Date 2023-05-03T00:00:00Z

TEnd Date 2023-05-03T23:59:00Z

Time Series

Start Date: 2022-01-01T00:00:00

End Date: 2023-01-01T00:00:00

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