Neuried

This project has received funding from the EU's Horizon 2020 programme under grant agreement no 101033706.

www.actionheat.eu

Contents

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Local heating planning

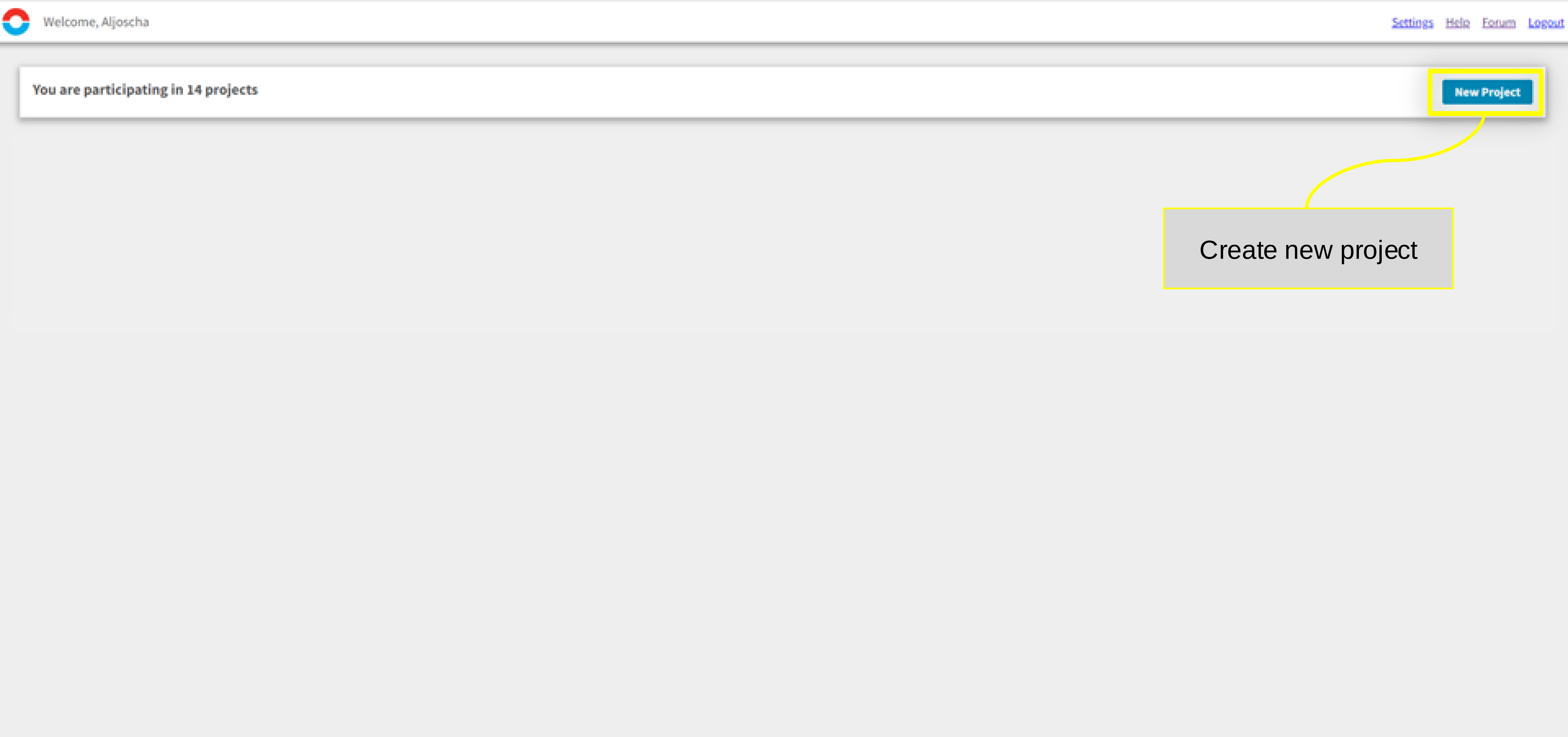
FNP

THERMOS

1. How was t

Local heating planning

ERMOS


Welcome, Aljoscha
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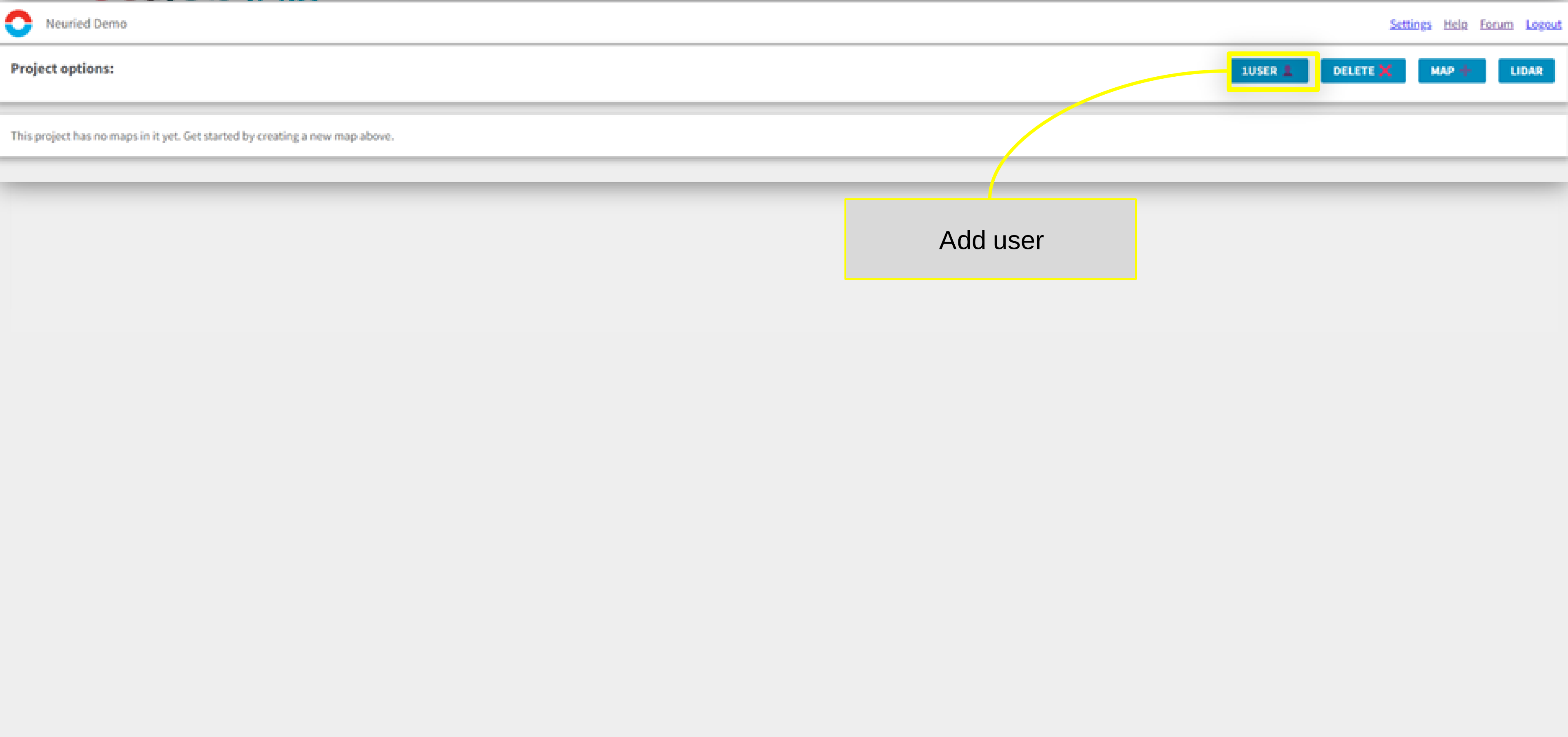
Help
Forum
Logout
You are participating in 14 projects
New Project
Create new project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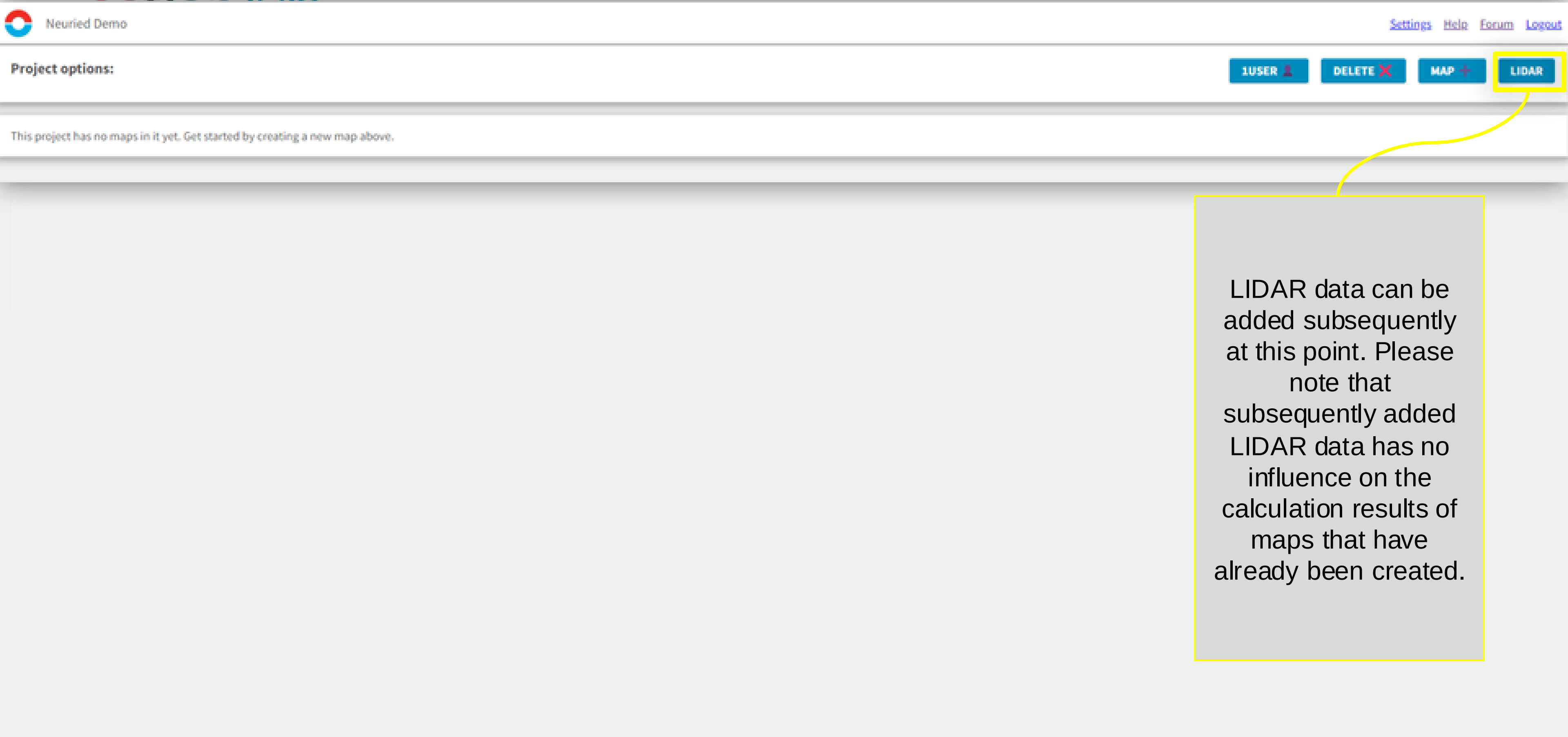
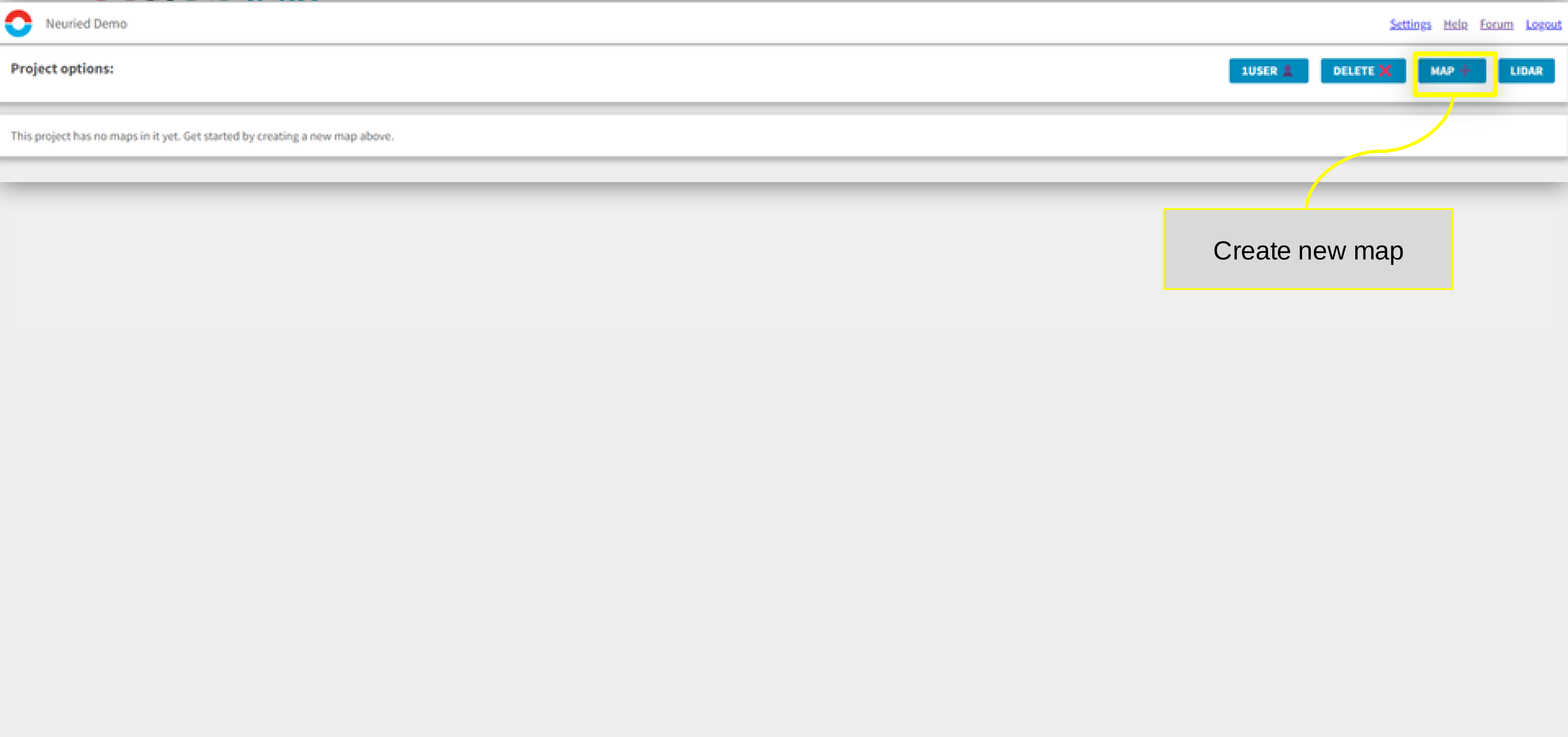
Settings Help Forum Logout
Project options:
1USER
DELETE
MAP
LIDAR
This project has no maps in it yet. Get started by creating a new map above.
Add user



LIDAR data can be added subsequently at this point. Please note that subsequently added LIDAR data has no influence on the calculation results of maps that have already been created.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LIDAR
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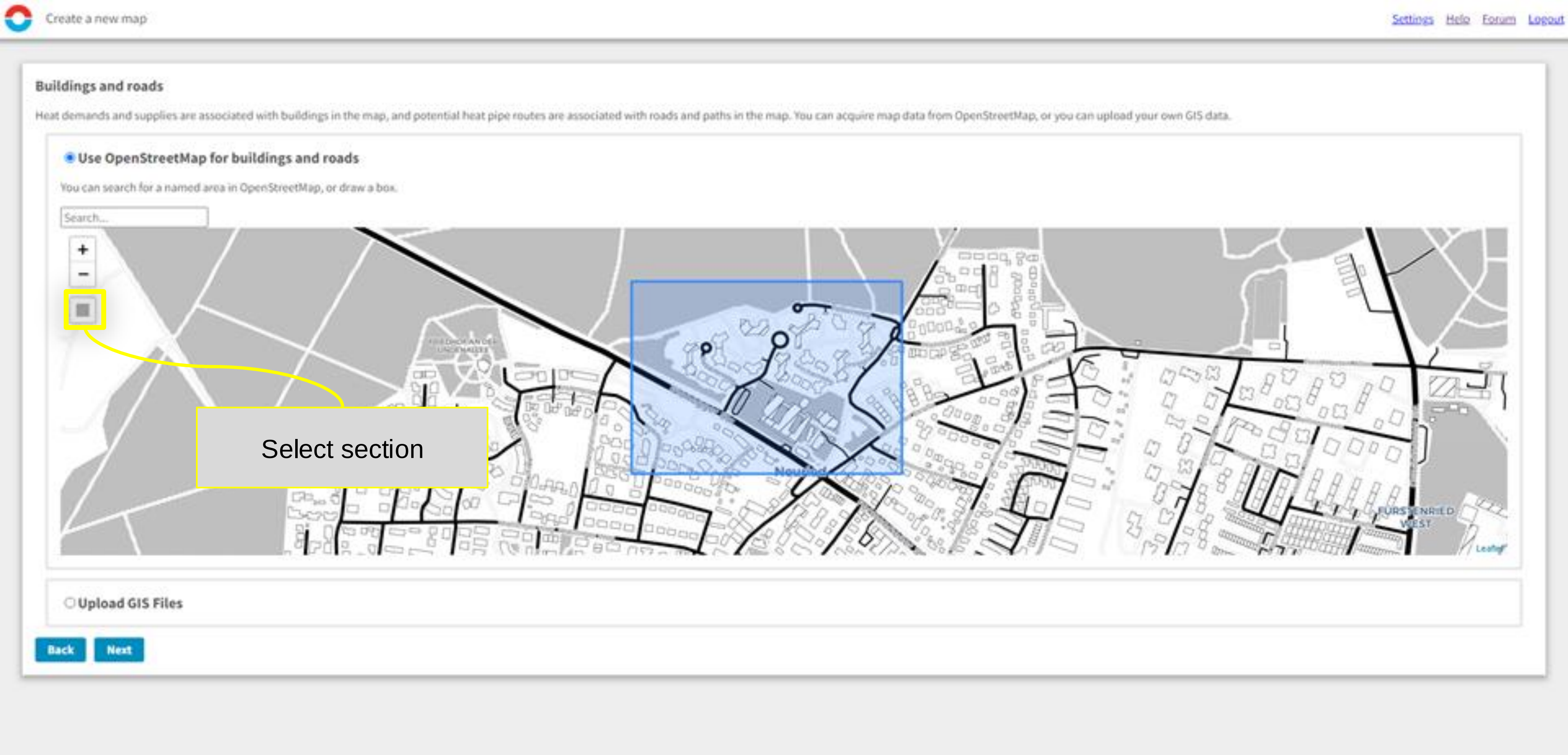
Create new map


Create a new map
Settings Help Forum Logout
Buildings and roads
Heat demands and supplies are associated with buildings in the map, and potential heat pipe routes are associated with roads and paths in the map. You can acquire map data from OpenStreetMap, or you can upload your own GIS data.
Use OpenStreetMap for buildings and roads
You can search for a named area in OpenStreetMap, or draw a box.
Search...
Select section
Neuried
FURSTENRIED WEST
Leaflet
Upload GIS Files
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Create a new map
Settings Help Forum Logout
Buildings and roads
Heat demands and supplies are associated with buildings in the map, and potential heat pipe routes are associated with roads and paths in the map. You can acquire map data from OpenStreetMap, or you can upload your own GIS data.
Use OpenStreetMap for buildings and roads
You can search for a named area in OpenStreetMap, or draw a box.
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Create a new map

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Buildings and roads

THERMOS has various estimation models. Depending on the information available, the appropriate model is selected individually for each demand point! This means that different estimation accuracies can be mapped in one project.
The share of the respective model in the overall project is displayed in the project overview. This currently looks as follows for the potential area:

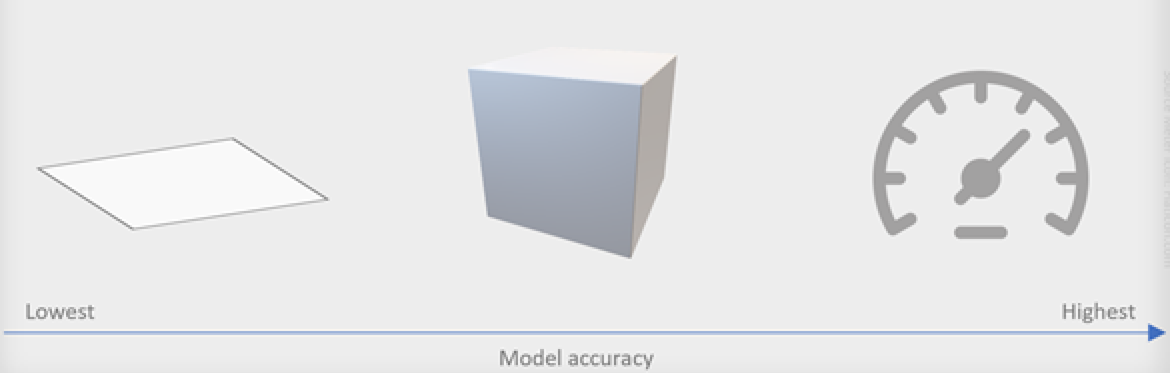
Demand estimates: 51% 3d-lm, 26% 2d-lm, 23% 3d-svm

The higher the proportion of measured estimates based on the 3D model, the more accurate the estimate of total demand.

The exact calculation methods can be found in the THERMOS documentation: https://action-heat-thermos.cse.org.uk/help/demand/demand-model.html

Estimation accuracy

2D	3D	Measured
Building polygon data is derived from OSM or a GIS file. THERMOS estimates the demand without height data.	Building polygon data is derived from OSM or a GIS file and height data is added manually or via LIDAR data.	Building polygon data is derived from OSM or a GIS file. Demand data is user-specified based on measured data.



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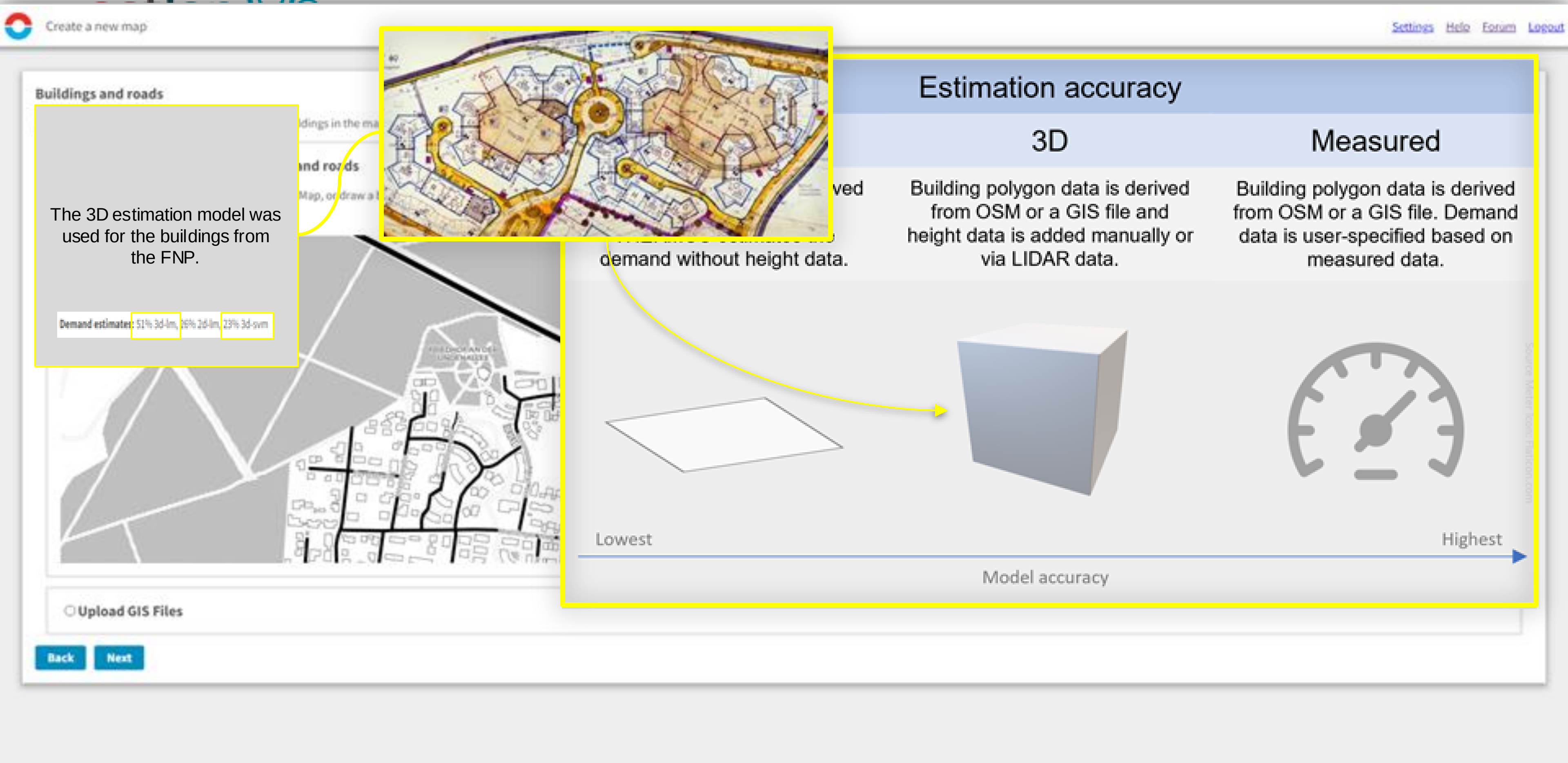

Create a new map
Settings Help Forum Logout
Buildings and roads
The 3D estimation model was used for the buildings from the FNP.
Demand estimates: 51% 3d-lm, 26% 2d-lm, 23% 3d-svm
Estimation accuracy
3D
Measured
demand without height data.
Building polygon data is derived from OSM or a GIS file and height data is added manually or via LIDAR data.
Building polygon data is derived from OSM or a GIS file. Demand data is user-specified based on measured data.
Lowest
Highest
Model accuracy
Upload GIS Files
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Create a new map

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As no height data is available for the other buildings (e.g. gymnasium, school), the estimates are currently based on the less precise 2d model

Demand estimates: 51% 3d-lm, 26% 2d-lm, 23% 3d-svm

ildings in the map, and potential heat pipe routes ar

nd roads

tMap, or draw a box.

Upload GI

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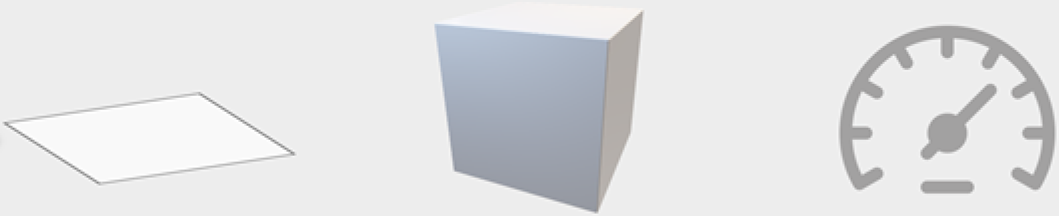
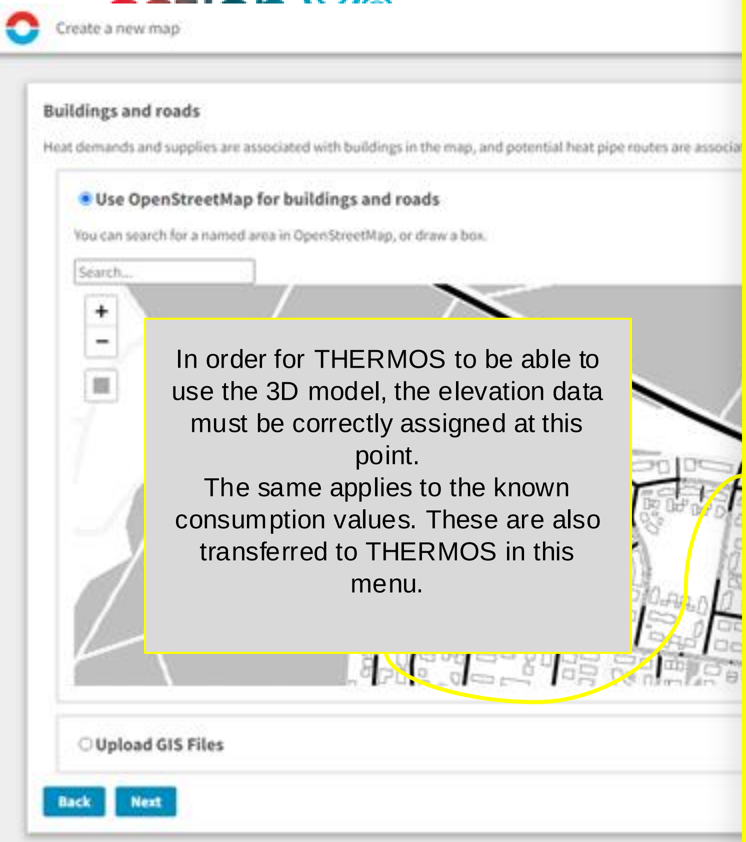
Estimation accuracy

2D	3D	Measured
Building polygon data is derived from OSM or a GIS file. THERMOS estimates the demand without height data.	Building polygon data is derived from OSM or a GIS file and height data is added manually or via LIDAR data.	Building polygon data is derived from OSM or a GIS file. Demand data is user-specified based on measured data.



Lowest — Highest

Model accuracy



In order for THERMOS to be able to use the 3D model, the elevation data must be correctly assigned at this point.
The same applies to the known consumption values. These are also transferred to THERMOS in this menu.

Buildings

Field	Meaning
@id	None
Gesamthoeh	Building height (m)
Nutzflaech	Floor area (m2)
addr_city	None
addr_count	None
addr_house	None
addr_postc	None
addr_stree	None
amenity	None
building	None
building_c	None
building_l	None
building_m	None
building_p	None
constructi	None
height	None
id	None
name	None
note	None
roof_colou	None
roof_direc	None
roof_heigh	None
roof_level	None
roof_mater	None
roof_shape	None
toilets_wh	None
url	None
wheelchair	None
wikidata	None
wikipedia	None

Work steps

1. The building heights result from the number of storeys (known from the FNP) multiplied by a storey height of 2.8 m (assumption).

1. Using the spreadsheet programme in QGIS, the corresponding values per demand point were calculated and assigned to each individual polygon.

1. The altitude information was transferred to THERMOS using the import function and the corresponding attribute assignment.


THERMOS
Neuried
Save
Optimise
Project title
Search...
None
Maps
Satellite
Candidates
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Labels
Required
Optional
Forbidden
Network supply
Map view:
Constraints
Solution
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Search...
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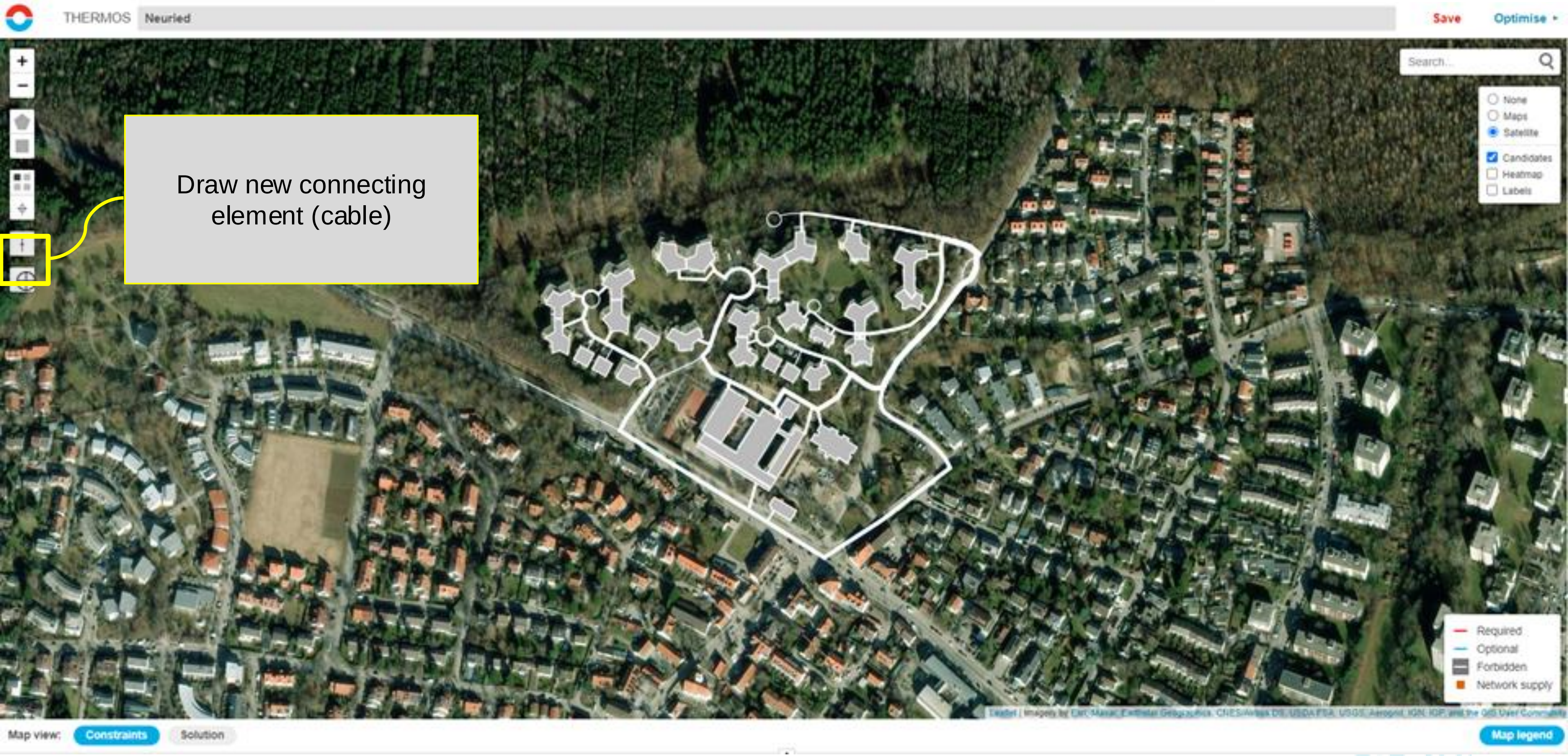
Network supply
Map view:
Constraints
Solution
Map legend

Above: Hide unselected objects

below: centre on selection



Draw new connecting element (cable)


THERMOS
Neuried
Save
Optimise
Draw new object
(Building)
Search...
None
Maps
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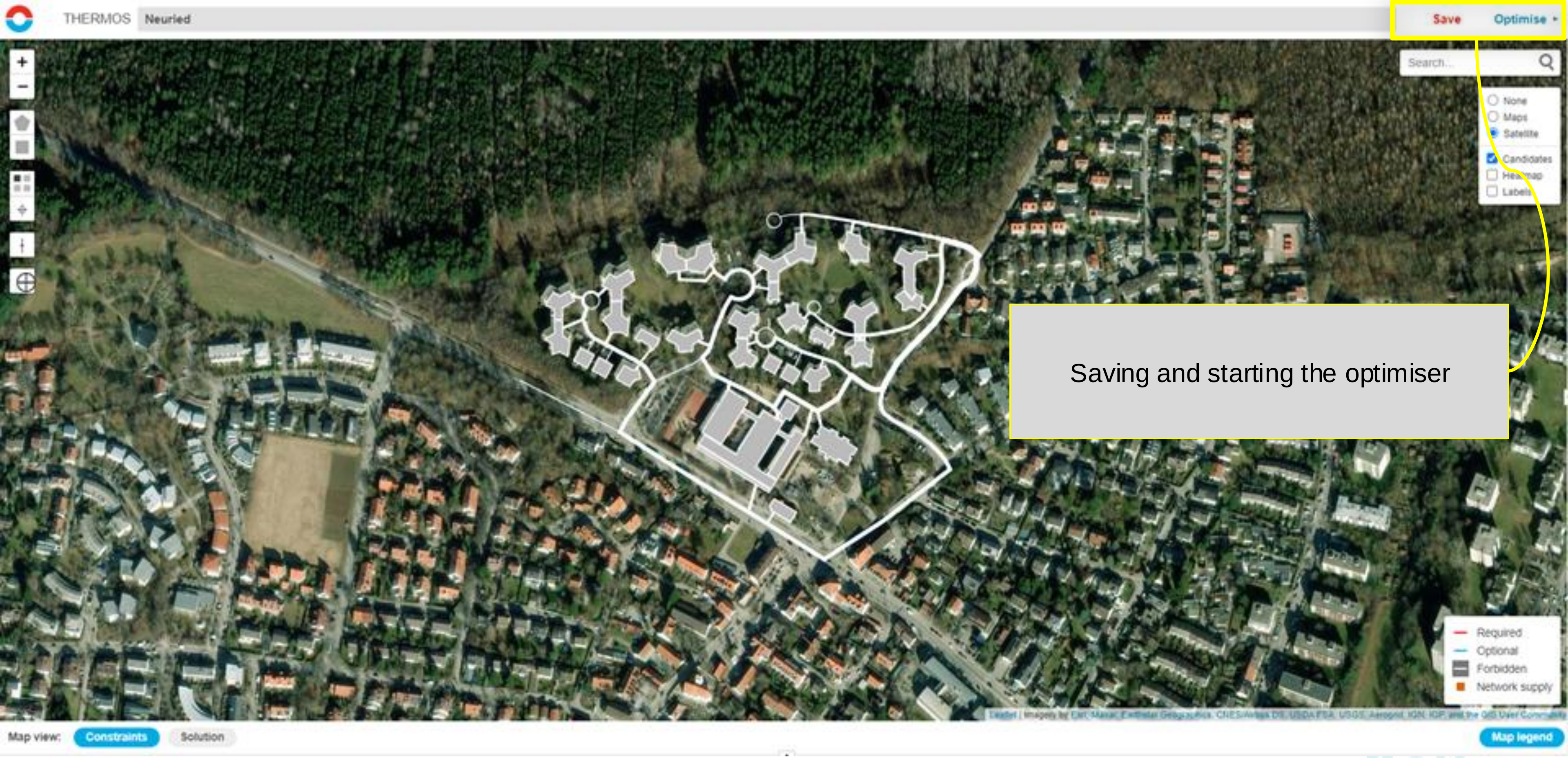
Labels
Required
Optional
Forbidden
Network supply
Map view:
Constraints
Solution
Map legend

Switch map view

Constraints: View of candidates and constraints

Solution: Solution view



Saving and starting the optimiser


THERMOS
Neuried
Save
Optimise
Search...
None
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Satellite
Candidates
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Labels
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Required
Optional
Forbidden
Network supply
Map view:
Constraints
Solution
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THERMOS
Neuried
Save
Optimise
Search...
None
Maps
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Candidates
Heatmap
Labels
Show main menu
Required
Optional
Forbidden
Network supply
Map view:
Constraints
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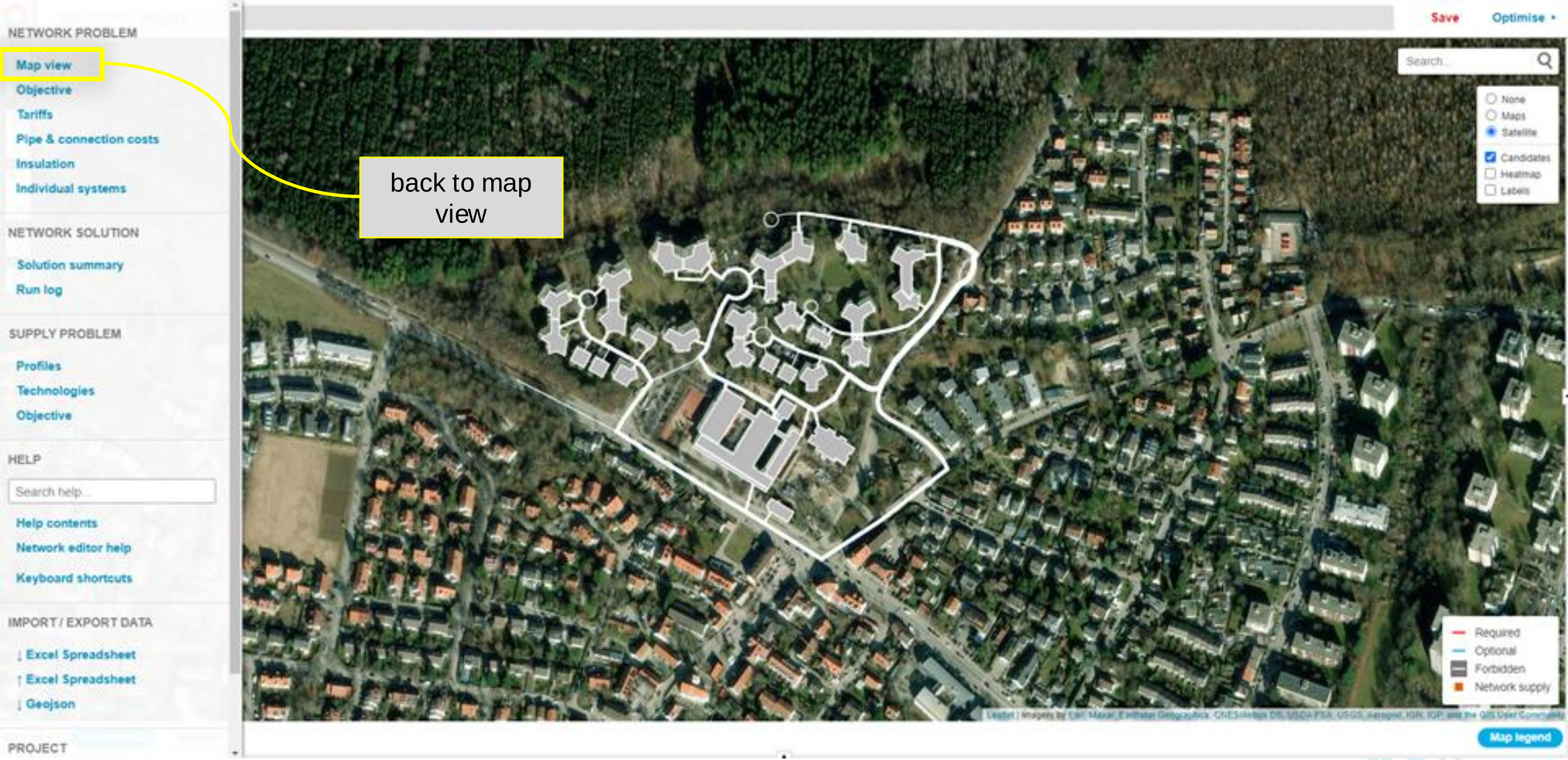
Map legend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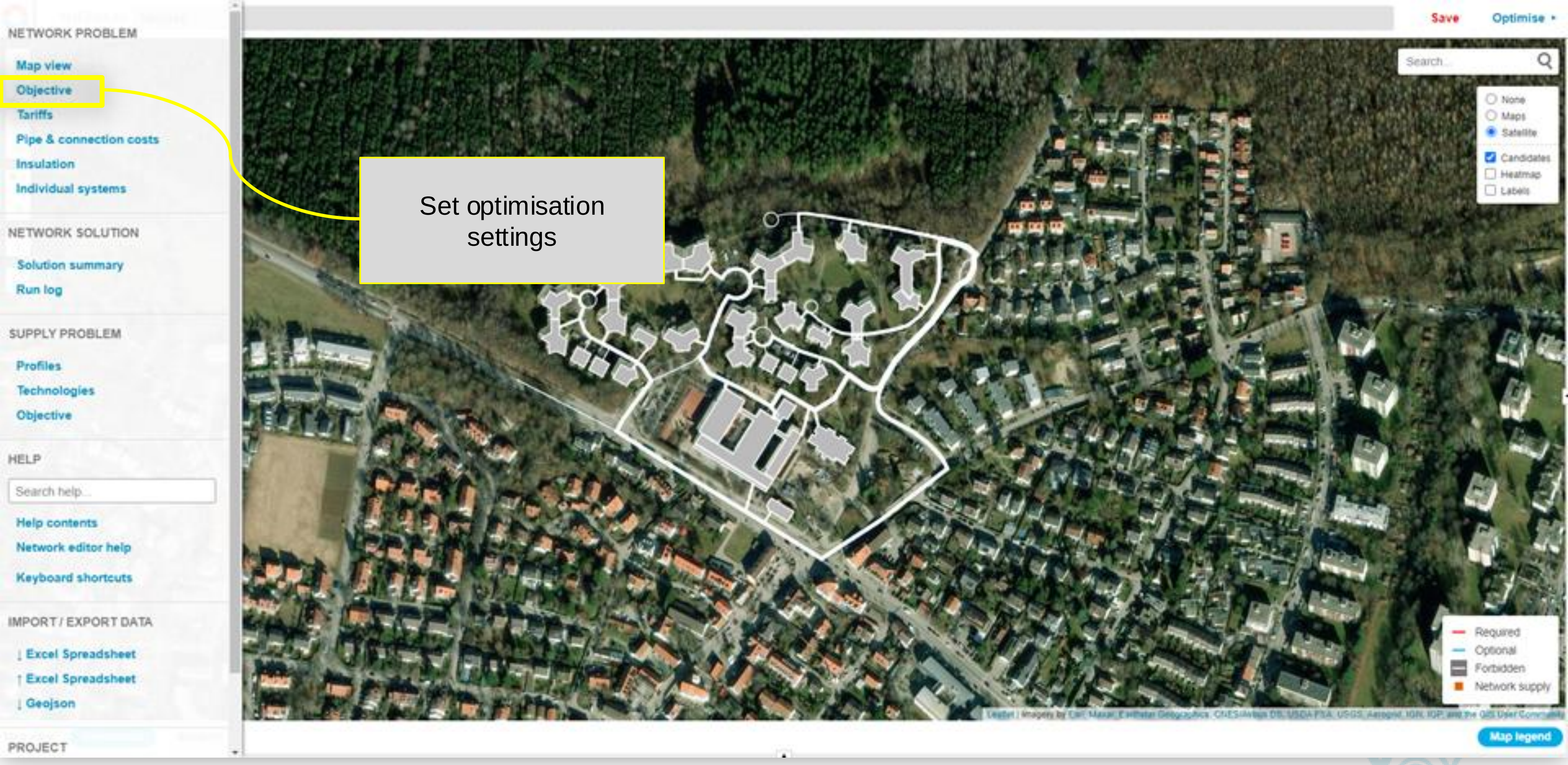
Forbidden
Network supply
Map legend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Optional
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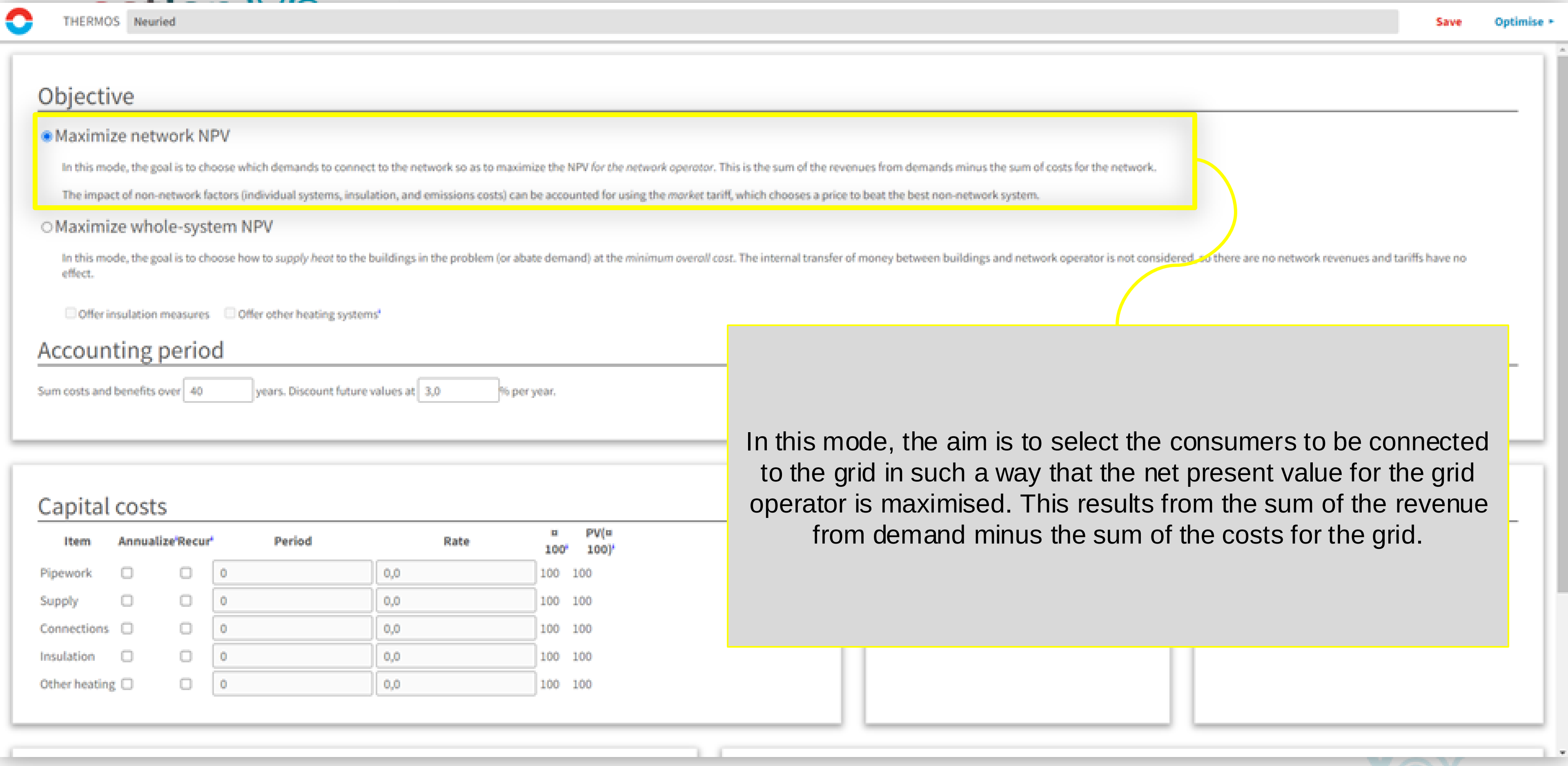
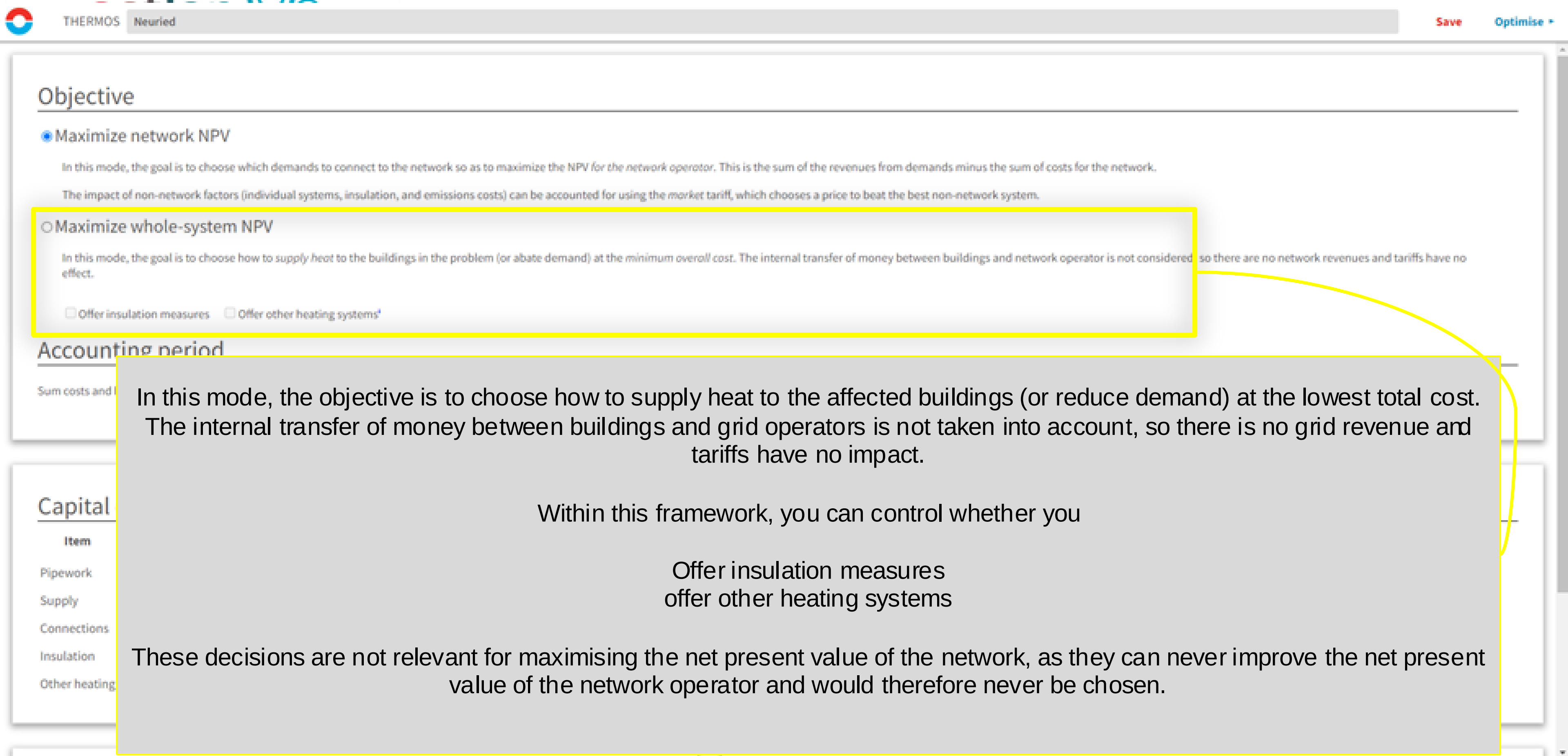
Network supply
Map legend
Set optimisation settings



In this mode, the aim is to select the consumers to be connected to the grid in such a way that the net present value for the grid operator is maximised. This results from the sum of the revenue from demand minus the sum of the costs for the grid.

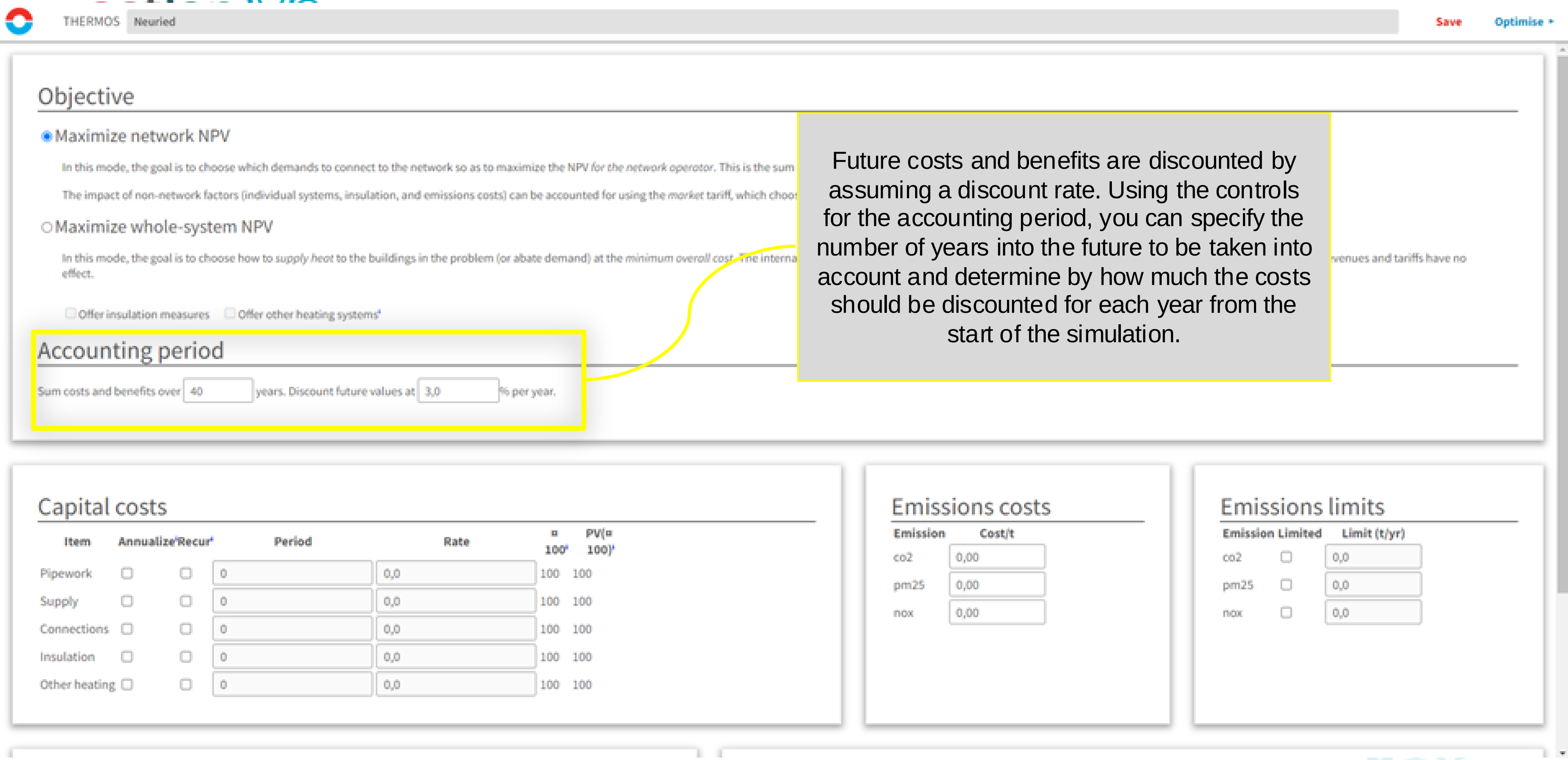


In this mode, the objective is to choose how to supply heat to the affected buildings (or reduce demand) at the lowest total cost. The internal transfer of money between buildings and grid operators is not taken into account, so there is no grid revenue and tariffs have no impact.

Within this framework, you can control whether you

Offer insulation measures
offer other heating systems

These decisions are not relevant for maximising the net present value of the network, as they can never improve the net present value of the network operator and would therefore never be chosen.



Future costs and benefits are discounted by assuming a discount rate. Using the controls for the accounting period, you can specify the number of years into the future to be taken into account and determine by how much the costs should be discounted for each year from the start of the simulation.

THERMOS Neuried Save Optimise

Objective

Maximize network NPV

In this mode, the goal is to choose which demands to connect to the network so as to maximize the NPV *for the network operator*. This is the sum of the revenues from dema

The impact of non-network factors (individual systems, insulation, and emissions costs) can be accounted for using the *market* tariff, which chooses a price to beat the best

Maximize whole-system NPV

In this mode, the goal is to choose how to *supply heat* to the buildings in the problem (or abate demand) at the *minimum overall cost*. The internal transfer of money betwe effect.

Offer insulation measures   Offer other heating systems

Accounting period

Sum costs and benefits over 40 years. Discount future values at 3,0 % per year.

Capital costs

Item	Annualize	Recur	Period	Rate	¤ 100	PV(¤ 100)
Pipework	☐	☐	0	0,0	100	100
Supply	☐	☐	0	0,0	100	100
Connections	☐	☐	0	0,0	100	100
Insulation	☐	☐	0	0,0	100	100
Other heating	☐	☐	0	0,0	100	100

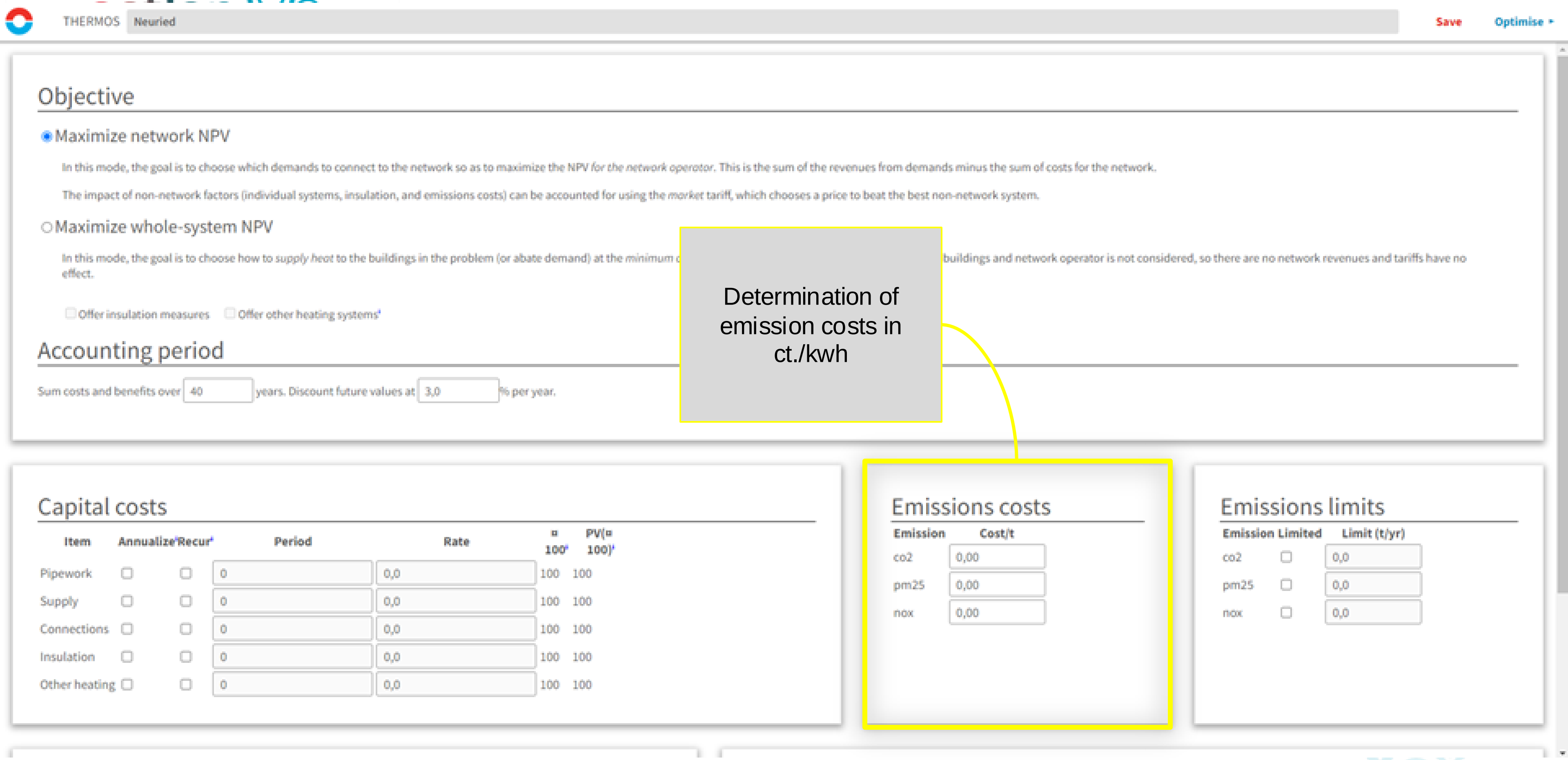
Emi

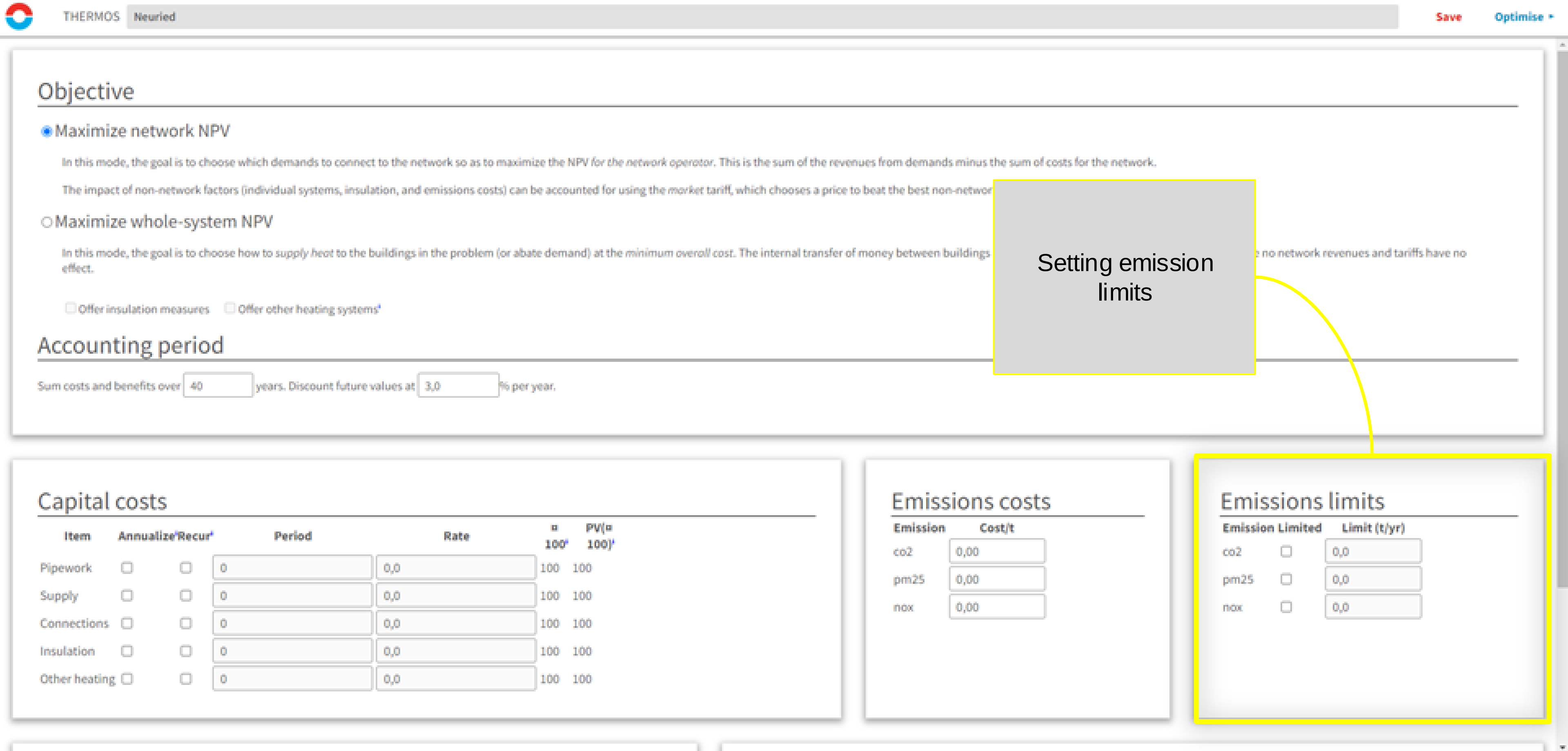
Emission	Cost/t
co2	0,00
pm25	0,00
nox	0,00

Emission	Limited	Limit (t/yr)
co2	☐	0,0
pm25	☐	0,0
nox	☐	0,0

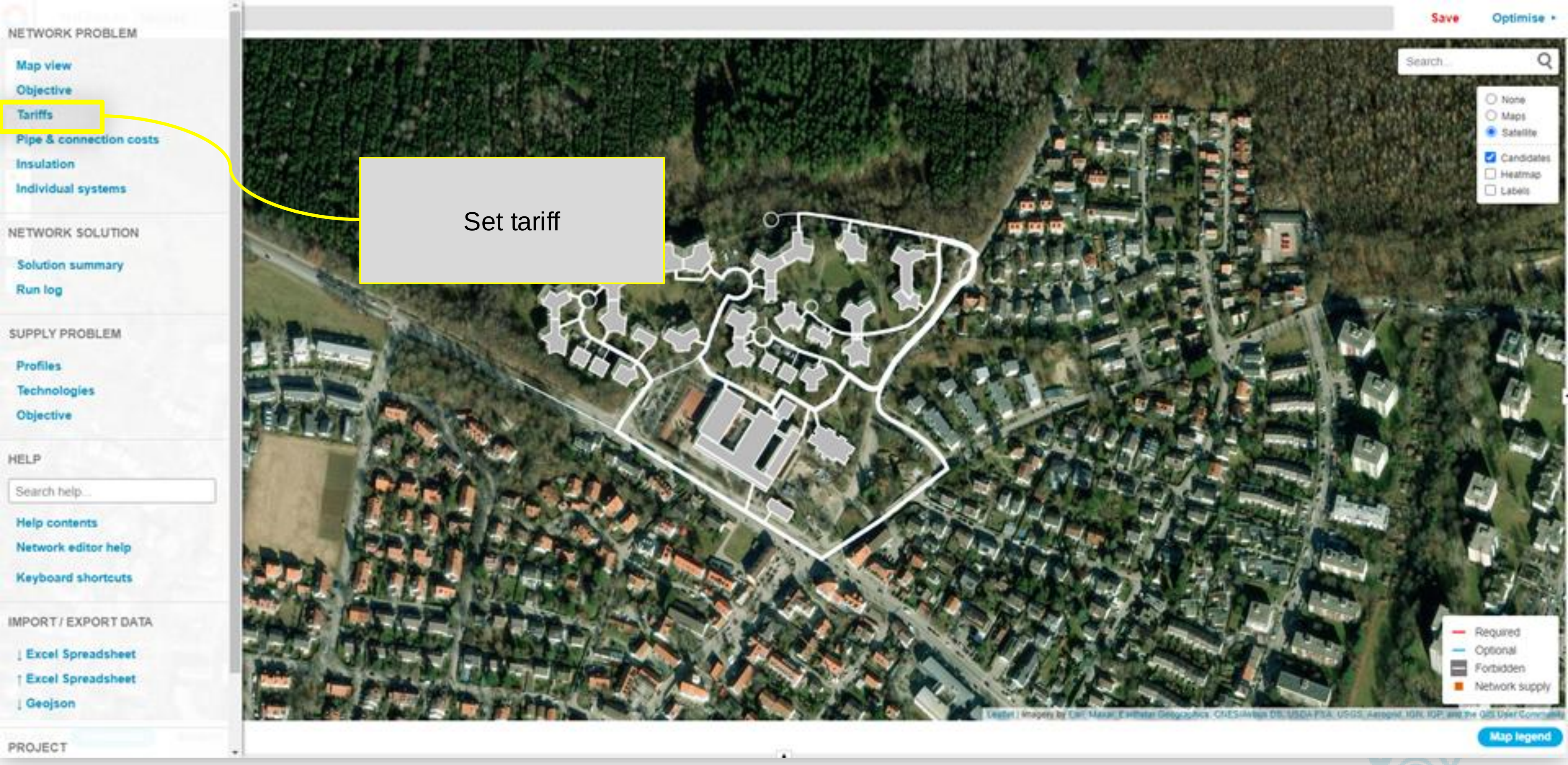
Capital costs can be annuitised, which means that they are converted into a fixed amortising loan.

Capital costs can be recurring, which means that the equipment they represent must be replaced at regular intervals, so that the original capital costs are incurred again after this time.


THERMOS
Neuried
Save
Optimise
Objective
Maximize network NPV
In this mode, the goal is to choose which demands to connect to the network so as to maximize the NPV for the network operator. This is the sum of the revenues from demands minus the sum of costs for the network.
The impact of non-network factors (individual systems, insulation, and emissions costs) can be accounted for using the market tariff, which chooses a price to beat the best non-network system.
Maximize whole-system NPV
Offer insulation measures
Offer other heating systems
Accounting period
Sum costs and benefits over 40 years. Discount future values at 3,0 % per year.
Determination of emission costs in ct./kwh
Capital costs
Item
Annualize
Recur
Period
Rate
Pipework
Supply
Connections
Insulation
Other heating
Emissions costs
Emission
Cost/t
co2
pm25
nox
0,00
Emissions limits
Emission Limited
Limit (t/yr)
0,0



Setting emission limits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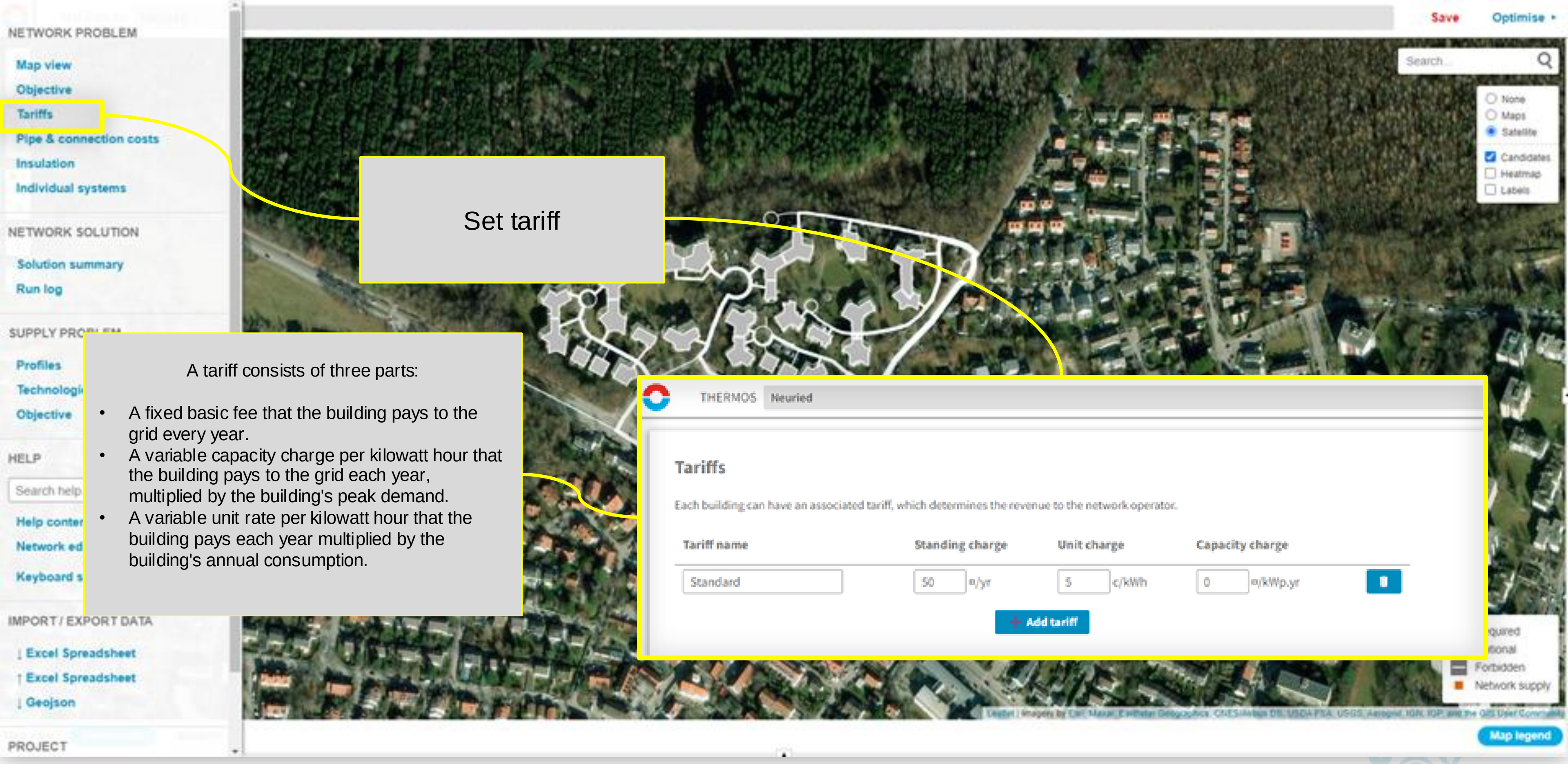

Set tariff

A tariff consists of three parts:

- A fixed basic fee that the building pays to the grid every year.
- A variable capacity charge per kilowatt hour that the building pays to the grid each year, multiplied by the building's peak demand.
- A variable unit rate per kilowatt hour that the building pays each year multiplied by the building's annual consumption.

Setting the costs for pipes and labour as well as the water temperature

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Save Optimise

Capacity & loss model

- Hot water
- Saturated steam

Flow temperature: 90 °C

Return temperature: 60 °C

Ground temperature: 8 °C

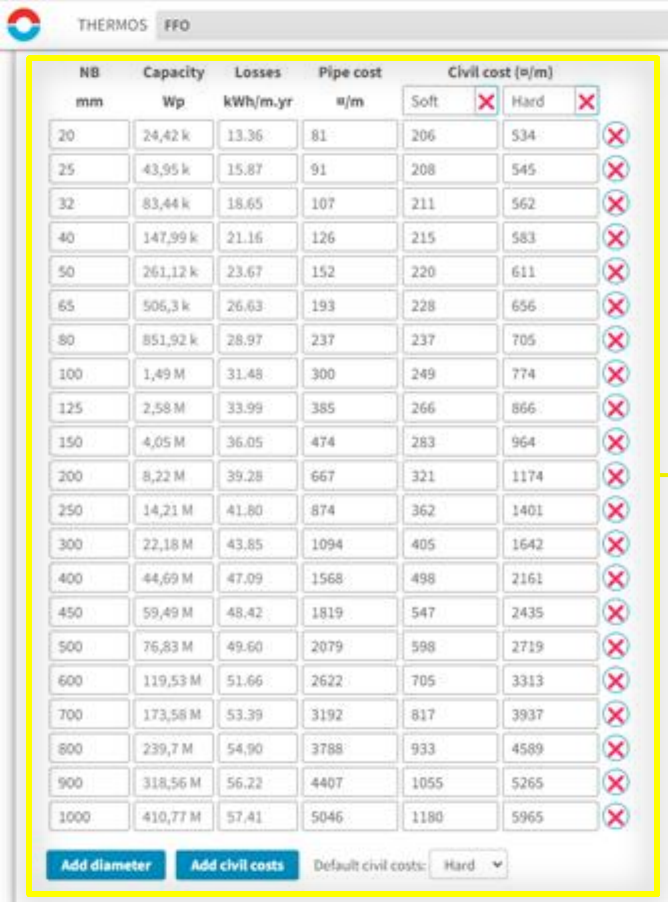
Pipe capacity is calculated from diameter using recommended flow rates for the diameter, the specific heat of water, and the flow/return difference.

Heat losses are calculated from diameter using this model.

Pipe costs

NB mm	Capacity Wp	Losses kWh/m.yr	Pipe cost ¤/m	Civil cost (¤/m) Soft	Civil cost (¤/m) Hard
20	24,42 k	13.36	81	206	534
25	43,95 k	15.87	91	208	545
32	83,44 k	18.65	107	211	562
40	147,99 k	21.16	126	215	583
50	261,12 k	23.67	152	220	611
65	506,3 k	26.63	193	228	656
80	851,92 k	28.97	237	237	705
100	1,49 M	31.48	300	249	774
125	2,58 M	33.99	385	266	866
150	4,05 M	36.05	474	283	964
200	8,22 M	39.28	667	321	1174
250	14,21 M	41.80	874	362	1401
300	22,18 M	43.85	1094	405	1642

Setting the water temperature and the soil temperature. THERMOS uses the soil temperature to estimate the loss rates per pipe diameter.



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150	4,05 M	36.05	474	283	964
200	8,22 M	39.28	667	321	1174
250	14,21 M	41.80	874	362	1401
300	22,18 M	43.85	1094	405	1642
400	44,69 M	47.09	1568	498	2161
450	59,49 M	48.42	1819	547	2435
500	76,83 M	49.60	2079	598	2719
600	119,53 M	51.66	2622	705	3313
700	173,58 M	53.39	3192	817	3937
800	239,7 M	54.90	3788	933	4589
900	318,56 M	56.22	4407	1055	5265
1000	410,77 M	57.41	5046	1180	5965

Standard values for costs and diameters are stored in THERMOS, but these can be customised.

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Save Optimise

200	8,22 M	39.28	667	321	1174
250	14,21 M	41.80	874	362	1401
300	22,18 M	43.85	1094	405	1642
400	44,69 M	47.09	1568	498	2161
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800	239,7 M	54.90	3788	933	4589
900	318,56 M	56.22	4407	1055	5265
1000	410,77 M	57.41	5046	1180	5965

Add diameter Add civil costs Default civil costs: Hard

The costs for heat transfer stations in the individual buildings can be set here.

Connection Costs

Each building also has associated connection costs, which determine the capital costs of connecting the building to the network. These costs are borne by the network operator.

Add connection cost

Pumping costs

Pumping costs are taken to be a proportion of the system output. In a heat network they offset supply output. In a cooling network, they add to the required supply output.

Pumping overheads are 2 % of system output, and cost 27,04 c/kWh. They cause emissions of 0 g/kWh co2, 0 mg/kWh pm25, 0 mg/kWh nox

THERMOS Neuried

Save Optimise

200	8,22 M	39.28	667	321	1174
250	14,21 M	41.80	874	362	1401
300	22,18 M	43.85	1094	405	1642
400	44,69 M	47.09	1568	498	2161
450	59,49 M	48.42	1819	547	2435
500	76,83 M	49.60	2079	598	2719
600	119,53 M	51.66	2622	705	3313
700	173,58 M	53.39	3192	817	3937
800	239,7 M	54.90	3788	933	4589
900	318,56 M	56.22	4407	1055	5265
1000	410,77 M	57.41	5046	1180	5965

Add diameter Add civil costs Default civil costs: Hard

The pump costs represent the proportion of the system power required to operate the pumps. As the pumps are usually operated with electricity, an individual electricity tariff for the pump can also be set here.

From the literature, a value of 2% of the system output is assumed at this point for the operation of the pumps.

Connection Costs

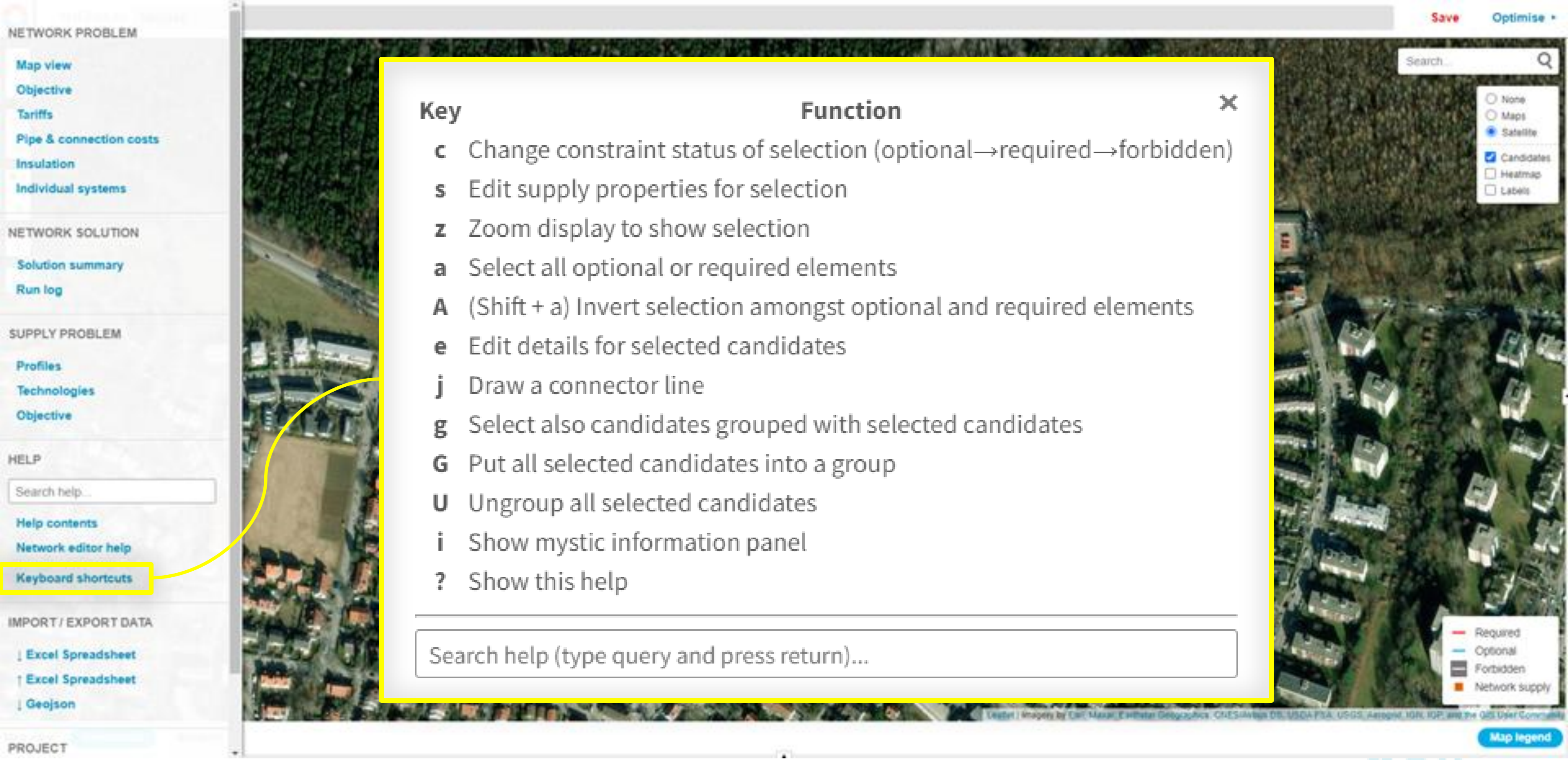
Each building also has associated connection costs, which determine the capital costs of connecting the building to the network. These costs are borne by the network operator.

+ Add connection cost

Pumping costs

Pumping costs are taken to be a proportion of the system output. In a heat network they offset supply output. In a cooling network, they add to the required supply output.

Pumping overheads are 2 % of system output, and cost 27,04 c/kWh. They cause emissions of 0 g/kWh co2, 0 mg/kWh pm25, 0 mg/kWh nox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A (Shift + a) Invert selection amongst optional and required elements
e Edit details for selected candidates
j Draw a connector line
g Select also candidates grouped with selected candidates
G Put all selected candidates into a group
U Ungroup all selected candidates
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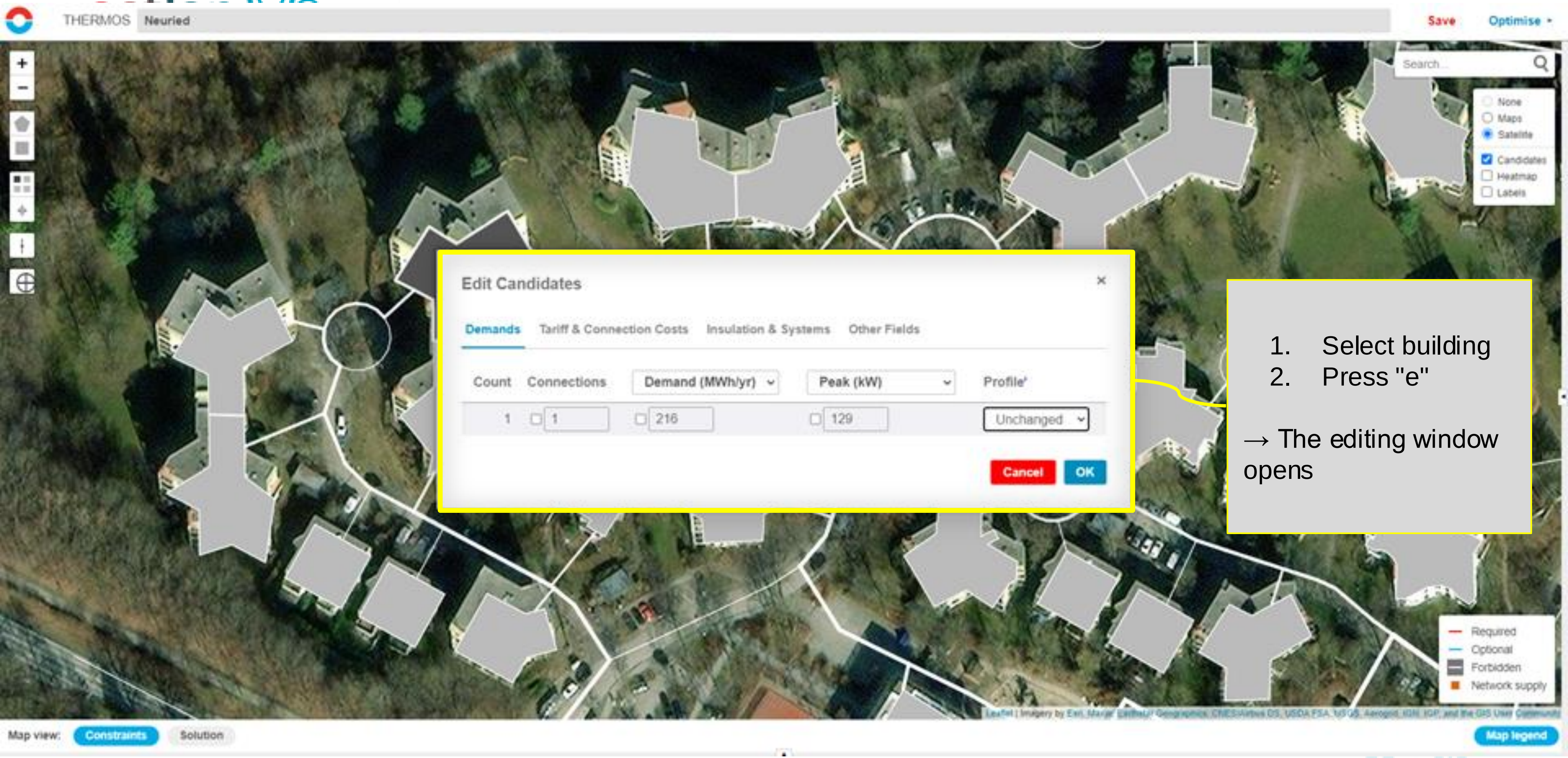
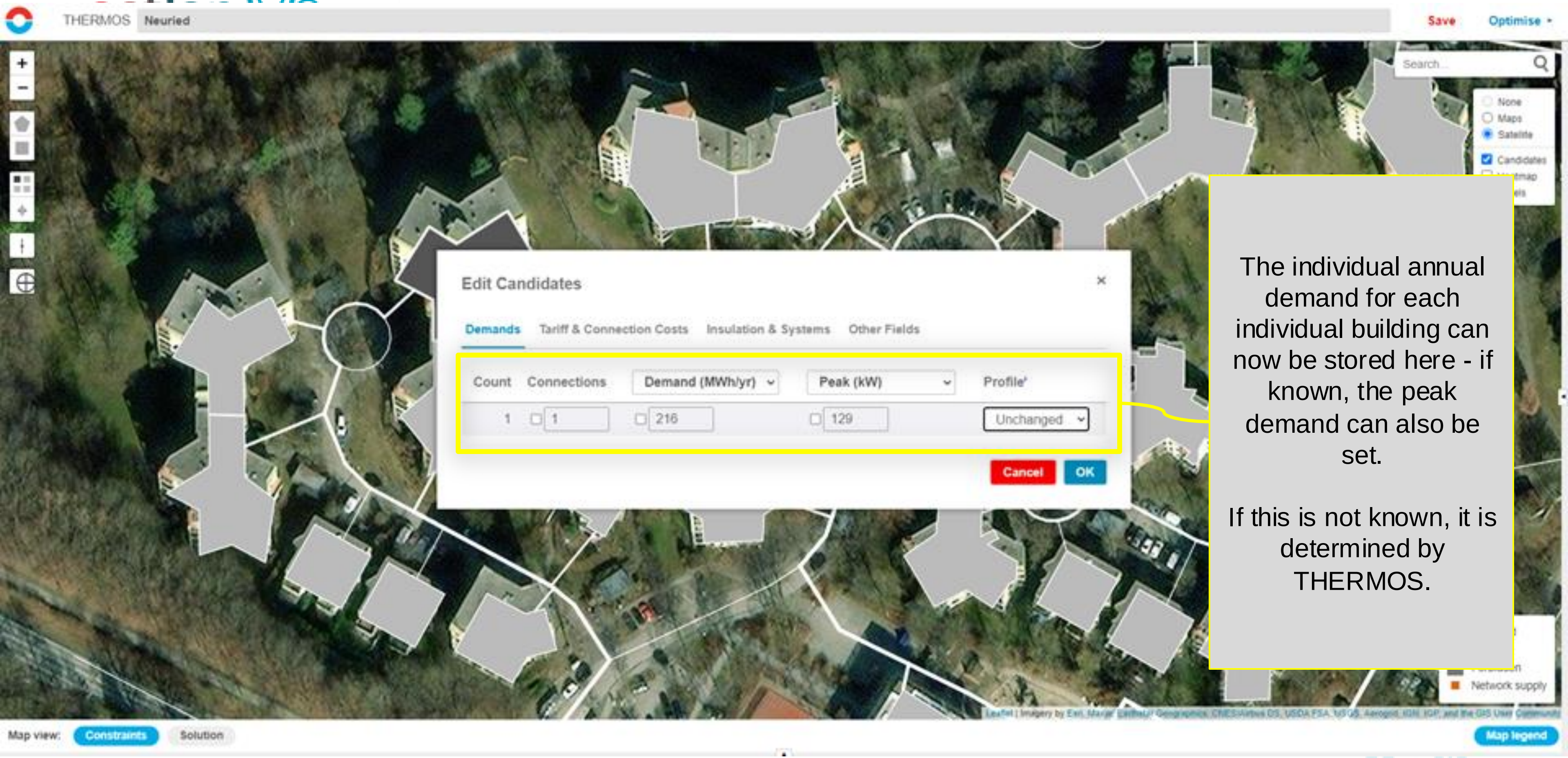
Solution
Map legend



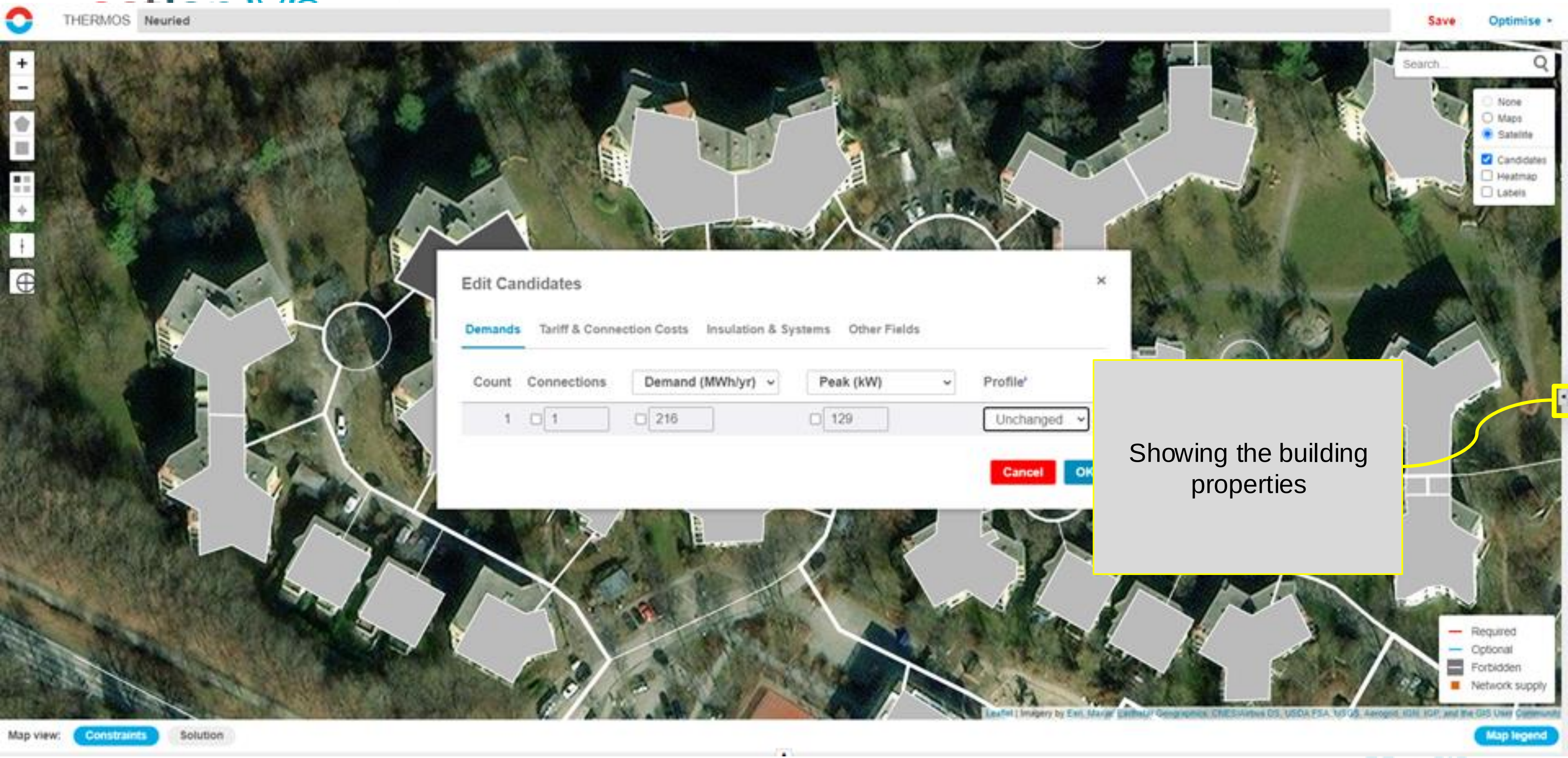
1. Select building
2. Press "e"

→ The editing window opens



The individual annual demand for each individual building can now be stored here - if known, the peak demand can also be set.

If this is not known, it is determined by THERMOS.

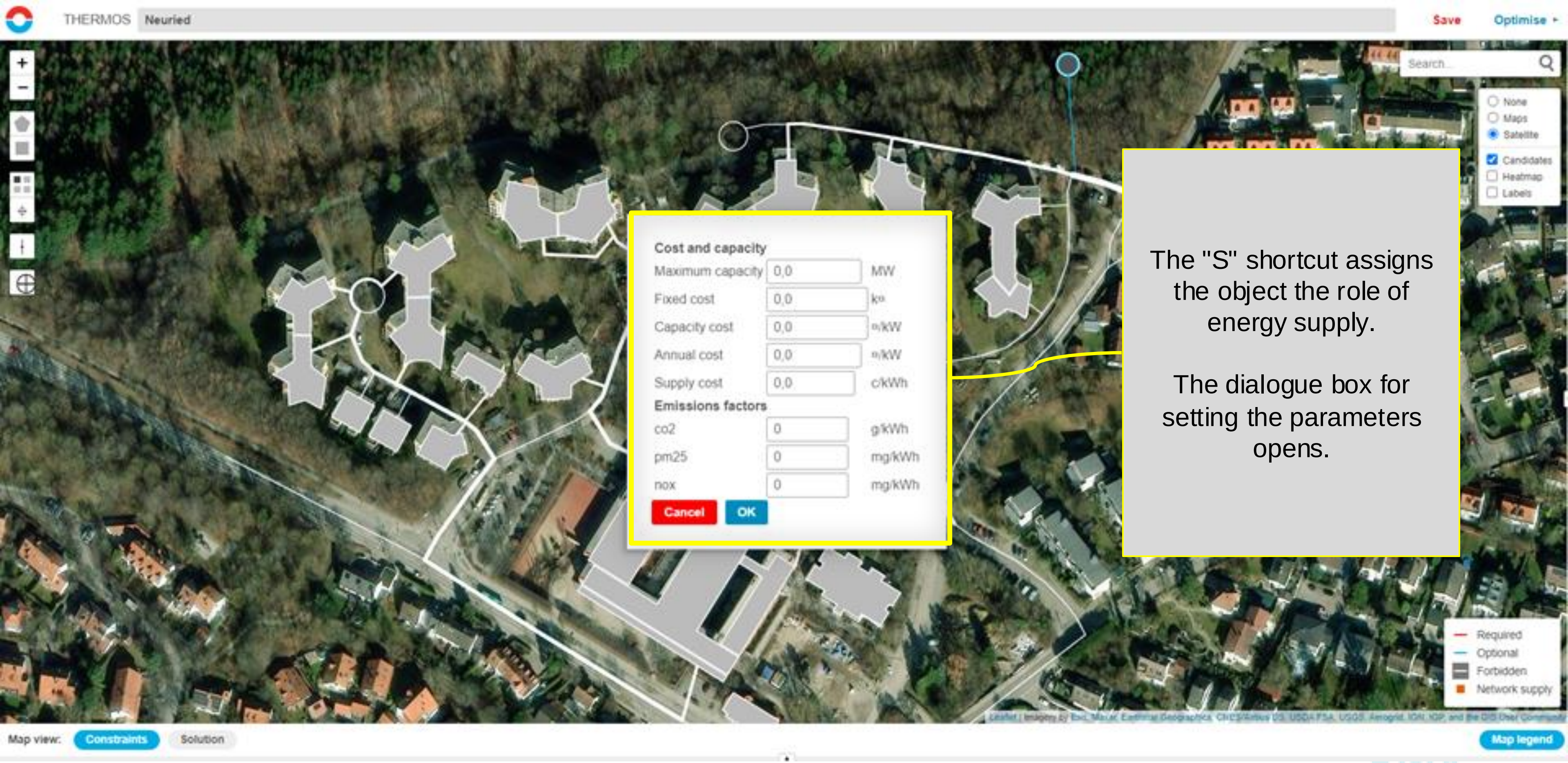


Showing the building properties

THERMOS
Neuried
Save
Optimise
Search...
None
Maps
Satellite
Candidates
Heatmap
Labels
One candidate selected
Type
1 demand
building_I
8
Constraint
1 forbidden
Tariff
1 Standard
Edited
1 no
Profile
1 Residential
Base cost
0¤
Heat demand
216,34 MWh/yr
Heat peak
129,21 kWp
In solution
1 network
Principal
0
Revenue
10,87 k¤/yr
Map view:
Constraints
Solution
Map legend

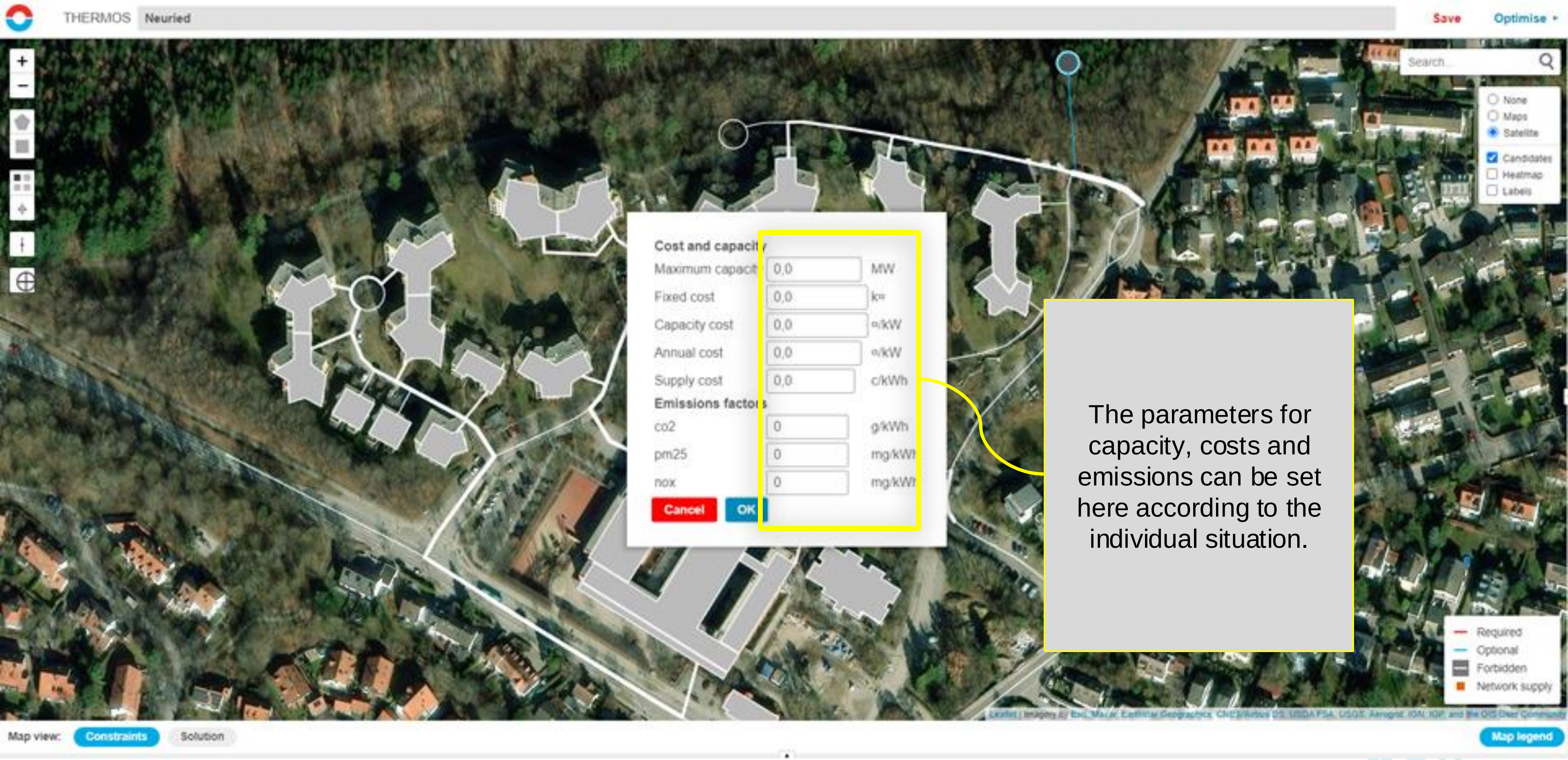

THERMOS
Neuried
Save
Optimise
Search...
None
Maps
Satellite
Candidates
Heatmap
Labels
Required
Optional
Forbidden
Network supply
Map view:
Constraints
Solution
Map legend

A new object was created using the "Create object" tool.



The "S" shortcut assigns the object the role of energy supply.

The dialogue box for setting the parameters opens.



The parameters for capacity, costs and emissions can be set here according to the individual situation.


THERMOS
Neuried
Save
Optimise
Search...
None
Maps
Satellite
Candidates
Heatmap
Labels
Required
Optional
Forbidden
Network supply
Map view:
Constraints
Solution
Map legend


THERMOS
Neuried
Save
Optimise
Search...
None
Maps
Satellite
Candidates
Heatmap
Labels
Cancel
Release mouse to finish drawing
Required
Optional
Forbidden
Network supply
Map view:
Constraints
Solution
Map legend


THERMOS
Neuried
Save
Optimise
Search...
None
Maps
Satellite
Candidates
Heatmap
Labels
Required
Optional
Forbidden
Network supply
Map view:
Constraints
Solution
Map legend

Once all settings have been made, the network optimisation can be started. To do this, click on "Optimise" and then on "Network".

2. what results are available?

2. what results are available?

General Assumptions	
Objective	NPV
Flow temperature	90 ℃
Return temperature	60 ℃
Ground temperature	8 ℃
Financial Assumptions	
Accounting period	40 yrs
Discount value	3,0 %
Tariff	5 c/kWh
Connection Costs	-
Emission Costs	-
Pumping costs	2%
Supply costs	-

The current calculation is based on these assumptions

Once the calculation has been completed, the first results can be interpreted using the map

A new section appears in the main menu to display the detailed calculation results

THERMOS Neuried Save Optimise

Solution Summary

Display Options

Capital costs: Total / Principal / Present value

Other costs: Total / Annual / Present value

Cost summary | Network | Individual systems | Insulation | Emissions | Optimisation

Item	Capital cost (¤)	Operating cost (¤)	Operating revenue (¤)	LCH (c/kWh)	NPV (¤)
Pipework	1,66 M	--	--	--	-1,66 M
Heat supply	0	1,13 M	--	--	-670,04 k
Demands	0	--	9,67 M	--	5,76 M
Emissions	--	0	--	--	0
Network	**1,66 M**	**1,13 M**	**9,67 M**	**2,04**	**3,43 M**
Emissions	--	0	--	--	0
Individual Systems	**--**	**0**	**--**	**--**	**0**
Insulation	**--**	**--**	**--**	**--**	**--**
Whole system	**1,66 M**	**1,13 M**	**--**	**--**	**-2,33 M**

THERMOS Neuried Save Optimise

Solution Summary

Display Options

Capital costs: Total Principal Present value

Other costs: Total Annual Present value

Cost summary Network Individual systems Insulation Emissions Optimis...

The operating revenue results from the balance of revenues (from the assumed tariffs).
It has no influence on the LCH.

Item	Capital cost (¤)	Operating cost (¤)	Operating revenue (¤)	LCH (c/kWh)¹	NPV (¤)
Pipework	1,66 M	--	--	--	-1,66 M
Heat supply	0	1,13 M	--	--	-670,04 k
Demands	0	--	9,67 M	--	5,76 M
Emissions	--	0	--	--	0
Network	**1,66 M**	**1,13 M**	**9,67 M**	**2,04**	**3,43 M**
Emissions	--	0	--	--	0
Individual Systems	--	0	--	--	0
Insulation	--	--	--	--	--
Whole system	**1,66 M**	**1,13 M**	--	--	**-2,33 M²**

Levelised Cost of Heat (LCH)

Heat distribution costs (ct./kWh) based on infrastructure costs + pumping costs

THERMOS Neuried Save Optimise

Solution Summary

Display Options

Capital costs: Total / Principal / Present value

Other costs: Total / Annual / Present value

Cost summary | **Network** | Individual systems | Insulation | Emissions | Optimisation

Pipework | Demands | Supplies

Civils	ø mm	Length m	Cost ¤	Cost ¤/m	Losses Wh/yr	Capacity W
Hard (default)	20	47,04	28,93 k	615	5,51 M	1 k
Hard (default)	25	52,7	33,51 k	636	6,95 M	37,82 k
Hard (default)	32	143,84	96,23 k	669	21,71 M	71,67 k
Hard (default)	40	566,88	401,92 k	709	99,66 M	140,26 k
Hard (default)	50	374,9	286,05 k	763	73,64 M	255,09 k
Hard (default)	65	302,95	257,2 k	849	65,53 M	505,92 k
Hard (default)	80	37,19	35,03 k	942	9,38 M	822,1 k
Hard (default)	100	155,52	167,02 k	1,07 k	40,96 M	1,31 M
Hard (default)	125	283,51	354,67 k	1,25 k	78,78 M	1,96 M
All		**1,96 k**	**1,66 M**	**845,28**	**402,12 M**	**1,96 M**

THERMOS Neuried

Save Optimise

Solution Summary

Display Options

Capital costs:

◉ Total ○ Principal ○ Present value

Other costs:

◉ Total ○ Annual ○ Present value

Cost summary | **Network** | Individual systems | Insulation | Emissions | Optimisation

Pipework | **Demands** | Supplies

Category	Count	Capacity W	Demand Wh/yr	Conn. cost ¤	Revenue ¤
Unclassified	33	3,1 M	4,8 G	0	9,67 M
User-created building	1	0	0	0	2 k

THERMOS Neuried Save Optimise

Solution Summary

Display Options

Capital costs:

- Total
- Principal
- Present value

Other costs:

- Total
- Annual
- Present value

Cost summary | Network | Individual systems | Insulation | Emissions | Optimisation

Pipework | Demands | Supplies

Category	Capacity Wp	Output Wh/yr	Pumping Wh/yr	Capital ¤	Capacity ¤	Heat ¤	Pumping ¤	Coincidence %
User-created building	1,96 M	5,1 G	104,08 M	0	0	0	1,13 M	63

3. Possible next steps

3. Possible next steps

- Add user to THERMOS project (done)

- Feedback loop (within two weeks of receiving this presentation)

Thank you for your attention

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