



Research Centre on
ZERO EMISSION
NEIGHBOURHOODS
IN SMART CITIES



ZEN KPI TOOL USER GUIDE

A visual guide to using the ZEN KPI tool

ZEN REPORT No. 71 – 2024



Shabnam Homaei, Marianne Kjendseth Wiik | SINTEF Community



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ZEN KPI Tool – User Guide

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Preface

Acknowledgements

This report has been written within the Research Centre on Zero Emission Neighbourhoods in Smart Cities (FME ZEN). The authors gratefully acknowledge the support from the Research Council of Norway, the Norwegian University of Science and Technology (NTNU), SINTEF, the municipalities of Oslo, Bergen, Trondheim, Bodø, Bærum, Elverum and Steinkjer, Trøndelag county, Norwegian Directorate for Public Construction and Property Management, Norwegian Water Resources and Energy Directorate, Norwegian Building Authority, ByBo, Elverum Tomteselskap, TOBB, Snøhetta, AFRY, Asplan Viak, Multiconsult, Civitas, FutureBuilt, Heidelberg Materials, Skanska, GK, NTE, Smart Grid Services Cluster, Statkraft Varme, Renewables Norway and Norsk Fjernvarme.

The Research Centre on Zero Emission Neighbourhoods (ZEN) in Smart Cities

The ZEN Research Centre develops solutions for future buildings and neighbourhoods with no greenhouse gas emissions and thereby contributes to a low carbon society.

Researchers, municipalities, industry and governmental organizations work together in the ZEN Research Centre in order to plan, develop and run neighbourhoods with zero greenhouse gas emissions. The ZEN Centre has nine pilot projects spread over all of Norway that encompass an area of more than 1 million m² and more than 30 000 inhabitants in total.

In order to achieve its high ambitions, the Centre will, together with its partners:

- Develop neighbourhood design and planning instruments while integrating science-based knowledge on greenhouse gas emissions;
- Create new business models, roles, and services that address the lack of flexibility towards markets and catalyze the development of innovations for a broader public use; This includes studies of political instruments and market design;
- Create cost effective and resource and energy efficient buildings by developing low carbon technologies and construction systems based on lifecycle design strategies;
- Develop technologies and solutions for the design and operation of energy flexible neighbourhoods;
- Develop a decision-support tool for optimizing local energy systems and their interaction with the larger system;
- Create and manage a series of neighbourhood-scale living labs, which will act as innovation hubs and a testing ground for the solutions developed in the ZEN Research Centre. The pilot projects are Furuset in Oslo, Fornebu in Bærum, Sluppen and Campus NTNU in Trondheim, Mære agricultural school, Ydalir in Elverum, Campus Evenstad, Ny by-Ny flyplass Bodø, and Zero Village Bergen.

The ZEN Research Centre will last eight years (2017-2024), and the budget is approximately NOK 380 million, funded by the Research Council of Norway, the research partners NTNU and SINTEF, and the user partners from the private and public sector. The Norwegian University of Science and Technology (NTNU) is the host and leads the Centre together with SINTEF.



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FME ZEN (page)

Norwegian Summary

Dette dokumentet er en brukerveiledning for ZEN KPI-verktøyet, utviklet ved forskningscenteret for nullutslippsområder i smarte byer (FME ZEN) i perioden 2017–2024. Verktøyet gir brukerne mulighet til å spore, rapportere, og visualisere ytelsen til et nullutslippsnabolag gjennom både i den strategiske planleggingsfasen og i implementeringsfasen. Verktøyet dekker ulike KPI-er innen seks kategorier: klimagassutslipp, energi, effekt, byform og arealbruk, mobilitet og økonomi. Denne veiledningen inneholder en detaljert, trinnvis forklaring for å bruke ZEN KPI-verktøyet effektivt.

Summary

This document serves as a user guide for the ZEN KPI tool, which has been developed at the research center for zero emission neighbourhoods in smart cities (FME ZEN) between 2017 and 2024. The tool empowers users to track, report, and visualize the performance of a zero emission neighbourhood throughout both the strategic planning and the implementation phases. It encompasses various KPIs across six categories: greenhouse gas (GHG) emissions, energy, power, urban form and land use, mobility, and economy. Within this guide, you will find a detailed, step-by-step explanation for effective use of the ZEN KPI tool.

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1. Introduction

This ZEN KPI tool user guide is provided alongside the zero emission neighbourhood key performance indicator (ZEN KPI) tool. The ZEN KPI tool has been developed in form of an MS Excel-based tool in the research centre on Zero Emission Neighbourhoods in Smart Cities (FME ZEN) during 2017 – 2024. Any questions concerning the ZEN KPI tool should be directed to Shabnam Homaei (shabnam.homaei@sintef.no) or Marianne Kjendseth Wiik (marianne.wiik@sintef.no).

1.1. Why was the ZEN KPI tool developed?

The ZEN KPI tool serves as a tracking, reporting, and visualization tool, designed to offer a clear and accessible presentation of zero emission neighbourhood (ZEN) performance across multiple categories (greenhouse gas (GHG) emissions, energy, power, urban form and land use, mobility, and economy). The primary objective of the ZEN KPI tool is to operationalize the ZEN definition [1], and aid ZEN stakeholders through the planning and implementation of zero emission neighbourhoods, see Figure 1.

It is important to emphasize that the ZEN KPI tool, while a powerful resource, **does not serve as a stand-alone/direct calculation tool**. Instead, it serves as a **decision support tool**, providing stakeholders with the necessary knowledge and insights to make informed decisions towards achieving the goal of ZEN. ZEN KPI tool users may use the following supporting ZEN reports to operationalize the tool:

- ZEN definition report version 5.0 [1]
- ZEN definition guideline report version 4.0 [2]
- ZEN process guideline report [3]

1.2. Who can use the ZEN KPI tool?

The ZEN KPI tool can provide benefits to all ZEN stakeholders engaged in the strategic planning and implementation phases of a ZEN project. Some examples of potential tool users include:

- Ambition/project owners,
- Planning authorities (such as ministries, legislative organizations, municipalities, etc.),
- Private and public property developers,
- Consulting firms,
- Research organizations.



Figure 1. Key questions about the ZEN KPI tool.

1.3. How can the ZEN KPI tool be used?

ZEN KPI tool users should have a general understanding with regards to the concept of ZEN (ZEN definition report [1]), the ZEN key performance indicators (KPIs) (ZEN definition guideline report [2]), and the ZEN toolbox, which includes new and existing calculation tools and software for calculating the various ZEN KPIs, see Figure 2.

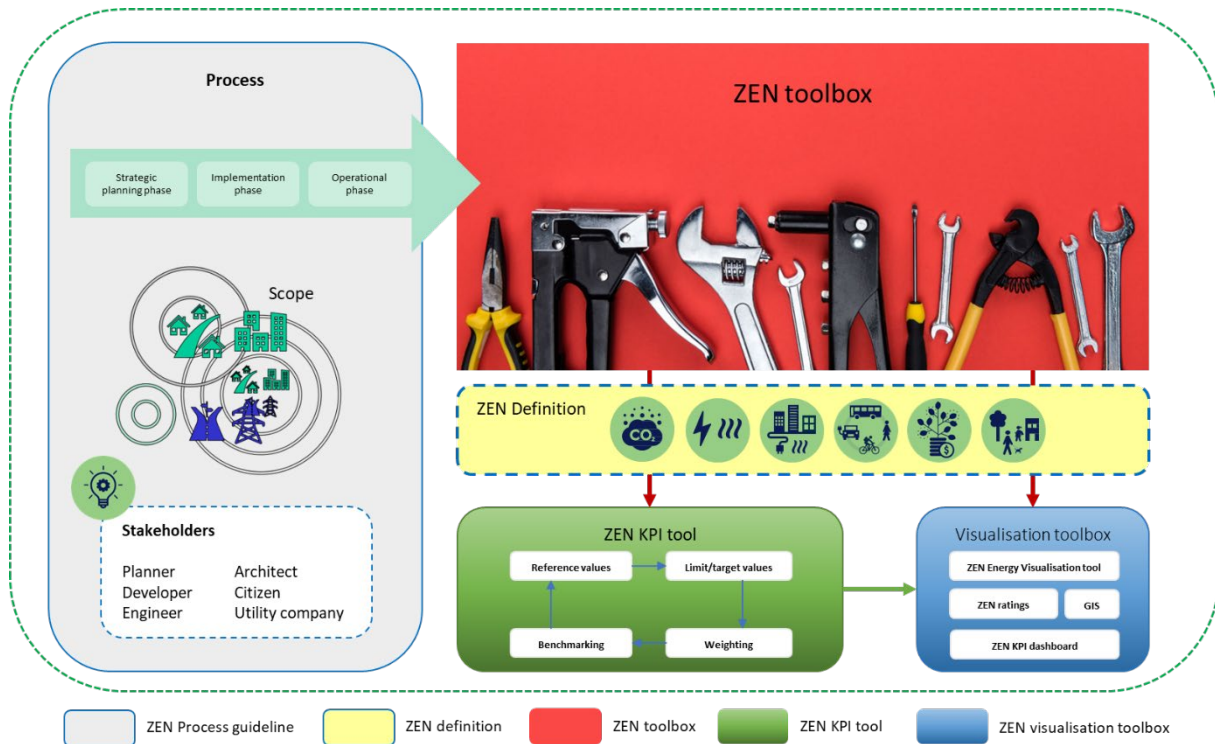


Figure 2. ZEN KPI conceptual framework [1]

Upon calculating ZEN KPIs, the ZEN KPI tool users can input KPI results into the ZEN KPI tool. The ZEN KPI tool facilitates visualization of the neighbourhood's performance and provides decision support for ZEN stakeholders. The process of utilizing the ZEN KPI tool may be iterative, requiring tool users to employ it repeatedly until they achieve their desired level of ambition regarding ZEN. This process is illustrated in Figure 3. An overview of the data inputs required in the ZEN KPI tool can be found in Appendix A.

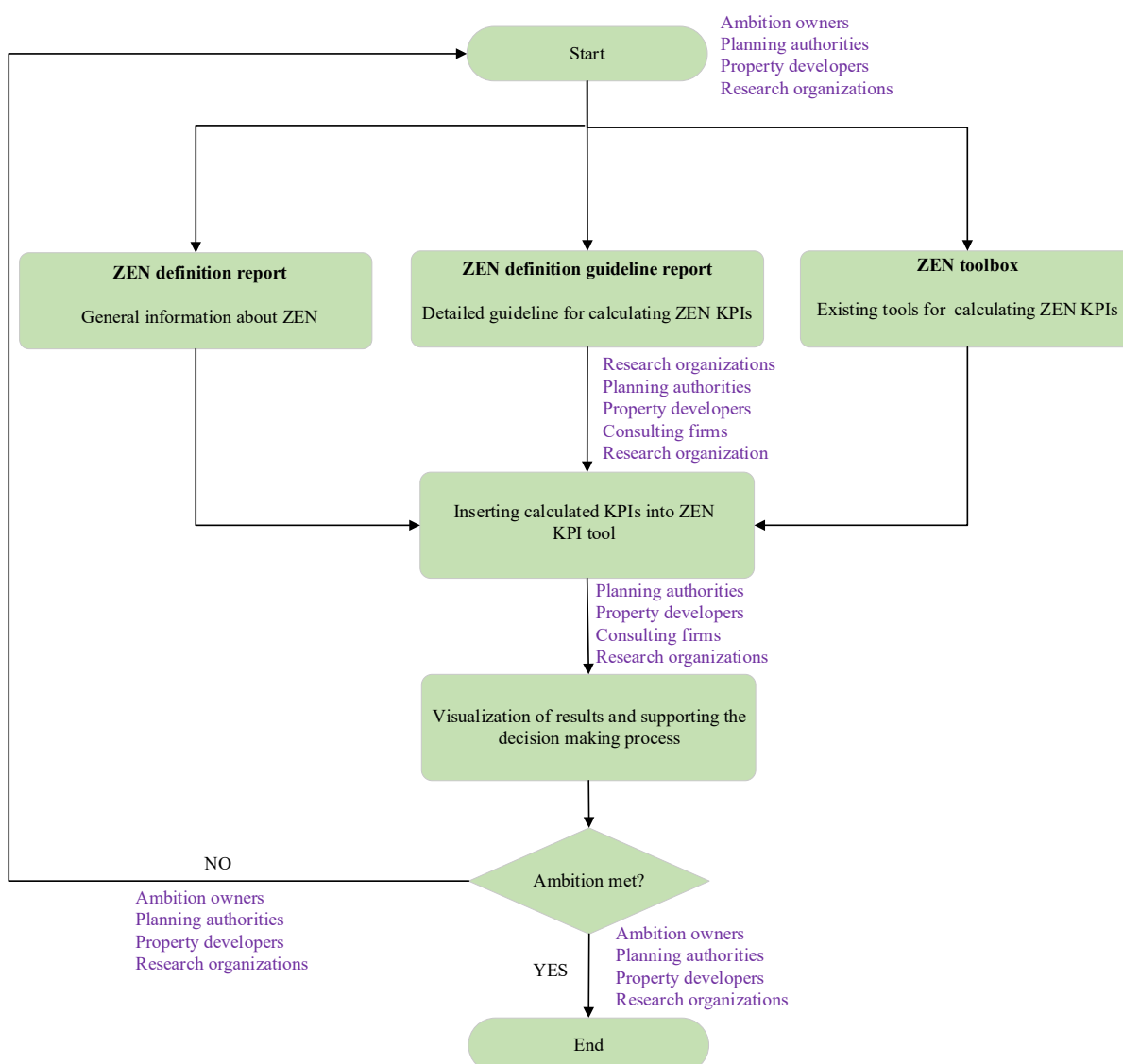


Figure 3. Flowchart showing the process behind the ZEN KPI tool.

1.4. When can the ZEN KPI tool be used?

The ZEN KPI tool can be used to track, report, and visualize the performance of a ZEN during the strategic planning and implementation phases. The ZEN KPI tool does not include the neighbourhood's performance during the operational phase; this aspect is addressed by the ZEN Dashboard, which allows users to monitor (amongst other things) operational energy use, mobility and GHG emissions during the operational phase.

1.5. What information does the ZEN KPI tool provide?

The objective of a zero emission neighbourhood is to create a net zero GHG emission balance. This can be achieved by reducing and compensating for GHG emissions through implementing different ZEN measures such as efficient energy systems, increased resource efficiency through the implementation of circular economy principles, as well as through the export of local, renewable energy production. To evaluate the process of achieving this balance, FME ZEN has defined six different categories shown in

Figur 4 (greenhouse gas emissions (GHG), energy (ENE), power (POW), urban form and land use (URB), mobility (MOB), and economy (ECO)) and 42 KPIs connected to these categories to comprehensively assess neighbourhood performance.

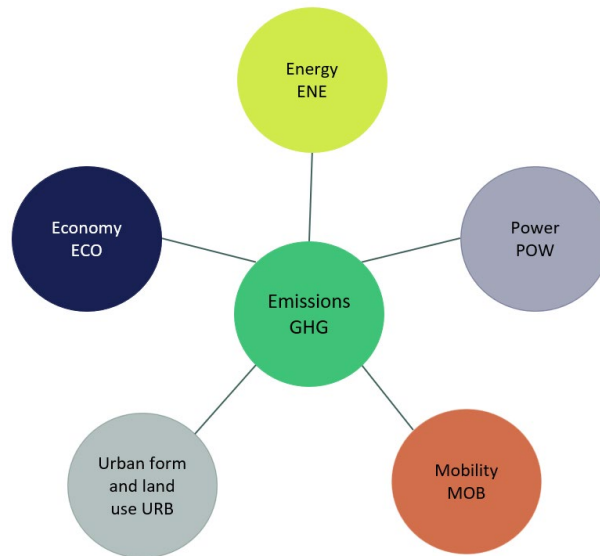


Figure 4. Six categories in ZEN definition [1]

The ZEN KPI tool is developed as a decision support tool to facilitate the tracking, reporting, and visualization of these categories and KPIs for aspiring zero emission neighbourhoods. For each category except GHG, 20 points are available for a category rating. Results for each category rating are *not* summed up to a single point score. Tool users can set ambition levels and track the progress of a ZEN through the different project phases according to how many points they achieve for each category.

The ZEN KPI tool collaborates with other essential components within the ZEN definition framework. The ZEN KPI results can be calculated by ZEN stakeholders using the ZEN definition report [1] and ZEN definition guideline [2]. Once the ZEN KPI tool users are familiar with the ZEN KPIs and have effectively applied the calculation tools from the ZEN KPI toolbox, they can proceed to input their calculated KPIs into the ZEN KPI tool. During this process:

- The ZEN KPI tool utilizes input data from the tool user to allocate points to each category (except the GHG category) based on the predefined point allocation systems given in the ZEN definition guideline [2].
- The ZEN KPI tool presents the neighbourhood's performance across the predefined assessment criteria and KPIs through a spider diagram, offering a comprehensive perspective on the neighbourhood's strengths and areas for improvement.
- The ZEN KPI tool evaluates the net zero GHG emission balance (nZEN balance) for the whole neighbourhood in terms of a bar chart.

It is important to recognize that the rationale behind the point allocation system and benchmark values in the ZEN KPI tool align with the ZEN definition guideline [2] and may in the future require periodic review and adjustment.

2. General features of the ZEN KPI tool

The ZEN KPI tool is an MS Excel-based tool and consists of eight worksheets with colour-coded tabs. Figure 5 shows these worksheets and Table 1 provides a summary of the contents of each worksheet.

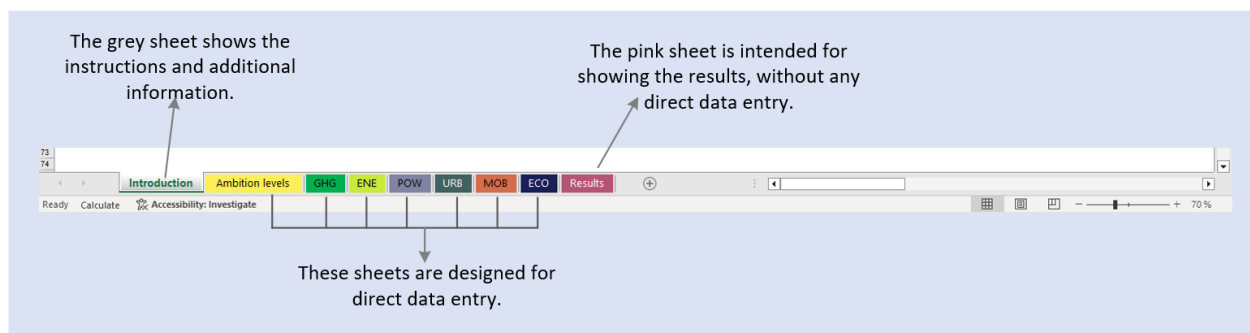


Figure 5. Overview of the worksheets in the ZEN KPI tool.

Table 1. Description of the different worksheets found in the ZEN KPI tool.

Worksheet	Description
Introduction	Provides some basic information on the ZEN KPI tool.
Ambition levels	This worksheet has two sections: <ul style="list-style-type: none"> General information on the ZEN project. Ambition levels, which can be set for each category in the ZEN definition.
GHG	This worksheet is for entering data on the GHG emissions (GHG) category. The GHG KPIs can be entered into this worksheet at four different levels (building envelope, technical systems, infrastructure, and neighbourhood) for two project phases (strategic planning and implementation phase).
ENE	This worksheet is for entering data on the energy (ENE) category. ENE KPIs can be entered for a reference and a ZEN scenario in implementation phase.
POW	This worksheet is for entering data on the power (POW) category. POW KPIs can be entered for a reference and a ZEN scenario in the implementation phase.
URB	This worksheet is for entering data on the urban form and land use (URB) category. URB KPIs can be entered for the strategic planning phase.
MOB	This worksheet is for entering data on the mobility (MOB) category. MOB KPIs can be entered for the strategic planning phase implementation phase.
ECO	This worksheet is for entering data on the economy (ECO) category. ECO KPIs can be entered for a reference and a ZEN scenario in two project phases (strategic planning and implementation phase).
Results	This sheet is intended to evaluate the results of all ZEN KPIs based on the inserted data in each category worksheet. Results are displayed graphically at the category level.

Cells are colour-coded to help identify how to use them. An example from the "Urban form and land use" category worksheet is shown in Figure 6. White cells require data inputs, light-coloured cells calculate results, whilst dark-coloured cells contain text or background information. The same colour coding of cells is used across all worksheets.

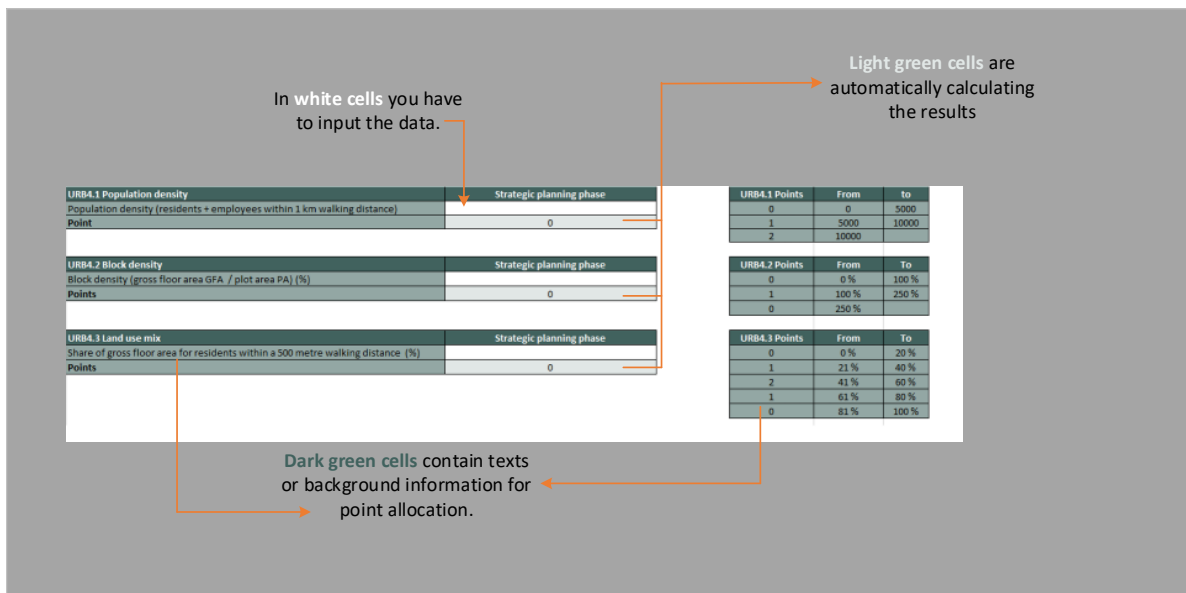


Figure 6. Description of colour codes used in the ZEN KPI tool (example from the urban form and land use category worksheet).

3. Step-by-step user guide

3.1. How to fill in the ZEN KPI tool?

Before going into detail on each category on how to fill in the worksheets, the ZEN KPI tool user should be familiar with the following elements from the ZEN definition guideline [2]:

- **Project phase:** strategic planning phase and implementation phase
- **Level:** building envelope, technical systems, infrastructure, and neighbourhood level
- **Scenario:** reference and ZEN scenario
- **Type of input data:** drop down menu and numeric data

Step 1: General information

When using the ZEN KPI tool, the tool user can start with the "Ambition levels" worksheet. An overview of this worksheet is shown in Figure 7.

The tool user can start by inserting the data in the "General Information" section at the top of the "Ambition levels" worksheet. The input data in the general information section provides some information about the ZEN project, including project name, total gross floor area of all the buildings in the neighbourhood, total heated floor area of all the buildings in the neighbourhood, number of the users, as well as share of new and existing buildings within the neighbourhood. It should be noted that the data in the general information section is necessary for the calculation of some KPIs in the other worksheets.

The second section of this worksheet is called "Ambition levels" and gives the tool user an opportunity to state how big a share of the allocated points they plan to achieve in the different categories. The GHG emission category has two ambition levels, which is differentiated between the amount of GHG emission reduction and the amount of GHG emission compensation. All the data required in this work sheet is numeric except for the project name.

	A	B	C	D	E
1	General information				
2	Project name				
3	Gross floor area of buildings (m2)				
4	Total heated floor area of buildings (m2)				
5	Number of users (#)				
6	Share of new buildings in neighborhood (%)				
7	Share of existing buildings in the neighbourhood (%)				
8	Ambition levels				
9	GHG	Reduction(%)			
10		Compensation (%)			
11	ENE (%)				
12	POW (%)				
13	URB (%)				
14	MOB (%)				
15	ECO (%)				
16					
17					
18					
19					
20					

Figure 7. Screenshot of the Ambition levels worksheet in the ZEN KPI tool.

User's actions:

- Insert General information and Ambition levels in the white cells.
- Please note that some of these data are necessary for calculating KPIs in the other worksheets.

Step 2. GHG KPIs

Figure 5 shows the content of the GHG worksheet in the ZEN KPI tool. The worksheet has two main sections: the first section is for inserting KPI results, and the second section is for the visualization of results. The tool user can insert GHG emission results into the ZEN KPI tool in the white cells.

GHG1.1, GHG1.2, GHG1.3, GHG1.6, and GHG 1.7 can be inserted in three different levels, which are Level 1: building envelope, Level 2: technical installation, and Level 3: infrastructure. GHG1.4 and GHG1.5 are only inserted for Level 4: neighbourhood. The ZEN KPI tool automatically calculates GHG KPIs for the whole neighbourhood and assesses the ZEN GHG emission balance once all KPI results are inserted at the various levels.

The results of this assessment are visualized for both project phases in two separate figures, one focusing on life cycle modules, and the other one reflecting the ZEN GHG KPIs. Figure 5 shows an example of the nZEN balance, the amount of GHG emission reduction between the strategic planning and implementation phases, and the amount of GHG emission compensation between the strategic planning and implementation phases.

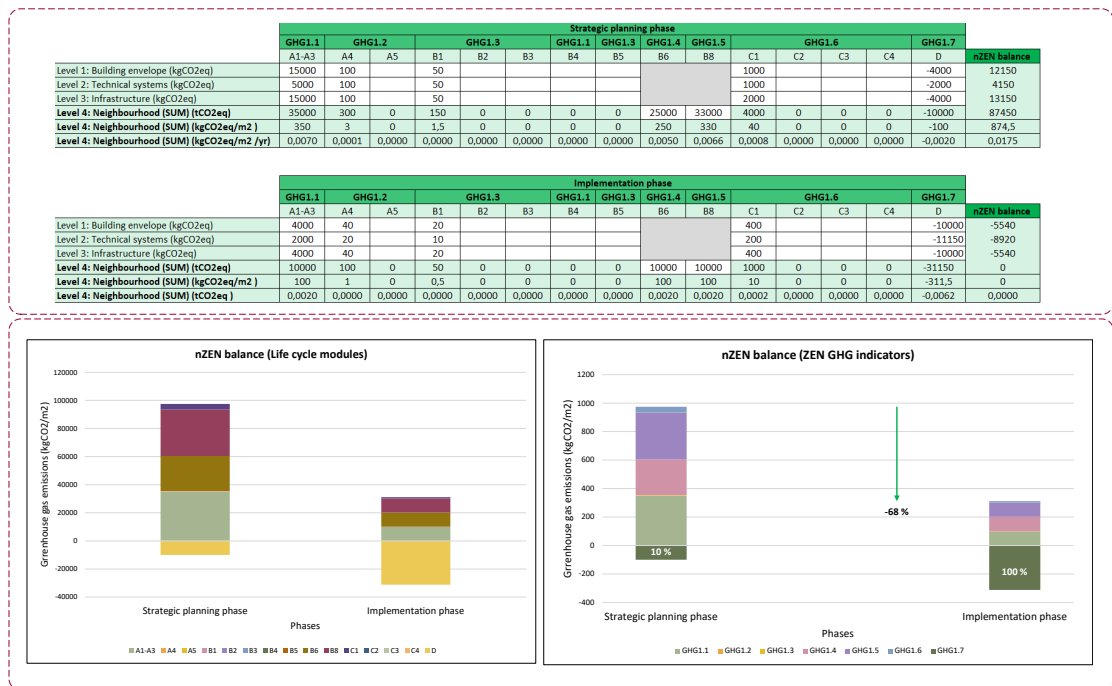


Figure 8. Screenshot of the GHG KPI worksheet in the ZEN KPI tool.

User's actions:

- Insert ZEN GHG KPI results into the white cells.
- Please make sure that the KPI results have been inserted with the correct units.

Step 3. ENE KPIs

The energy worksheet consists of five KPIs which can be filled out for the implementation phase, see Figure 6. This worksheet has two different sections: the first section relates to the ENE KPIs, whilst the second section presents the point allocation system for the ENE KPIs. The tool user can insert the energy KPI results into the white cells which have both numeric data and drop-down listed data. The light green cells automatically calculate results. The energy KPIs can be reported for the reference and ZEN scenario considering different energy carriers (e.g. electricity, district heating, and bio heat). The first three KPIs (ENE2.1, ENE2.2 and ENE2.3) are numeric KPIs, whilst ENE2.4 and ENE2.5 are based on a drop-down menu.

	A	B	D	H	I	J
1	ENE2.1 Energy need in buildings	Scenario	Implementation phase	ENE2.1 points	From	To
2	Energy need in buildings	ZEN (Z)		1	0%	0%
3	(kWh/m2/yr)	REFERENCE (R)		2	0%	0%
4		Difference	#DIV/0!	3	0%	0%
5	Points		#DIV/0!	4	0%	0%
6				5	0%	0%
7				6	0%	0%
8				7	0%	0%
9				8	0%	0%
10						
11	ENE2.2 Delivered energy	Scenario	Implementation phase	ENE2.2 Points	From	To
12	Electricity (kWh/yr)	ZEN (Z)		1	0%	6%
13		REFERENCE (R)		2	7%	13%
14	District heating (kWh/yr)	ZEN (Z)		3	14%	19%
15		REFERENCE (R)		4	20%	25%
16	Bio heat (kWh/yr)	ZEN (Z)		5	26%	31%
17		REFERENCE (R)		6	32%	38%
18	Total (kWh/yr)	ZEN (Z)	0	7	39%	44%
19		REFERENCE (R)	0	8	45%	50%
20		Difference	#DIV/0!			
21	Points		#DIV/0!			
22						
23						
24	ENE2.3 Self-consumption			ENE2.3 Points	From	To
25	Self-consumption (%)			0	0%	25%
26	Points		0	1	26%	50%
27				2	51%	100%
28	ENE2.4 Net load profiles	Scenario	Implementation phase	ENE2.4 Points	Calculated	
29	Electricity	ZEN (Z)		0	NO	
30		REFERENCE (R)		1	YES	
31	District heating	ZEN (Z)				
32		REFERENCE (R)				
33	Points		0			
34						
35	ENE2.5 Color coded carpet plot	Scenario	Implementation phase	ENE2.5 Points	Calculated	
36	Electricity	ZEN (Z)		0	NO	
37		REFERENCE (R)		1	YES	
38	District heating	ZEN (Z)				
39		REFERENCE (R)				
40	Points		0			
41						

Figure 9. Screenshot of the ENE KPI worksheet in the ZEN KPI tool.

User's actions:

- Insert ZEN ENE KPI results for the reference and ZEN scenarios in the white cells.
- Pay attention to the different energy carriers.
- Make sure that the KPIs have been inserted in the correct units.
- Make sure that the share of new and existing buildings is inserted in the "Ambition levels" worksheet to facilitate for point allocation in ENE2.1.

Step 4: POW KPIs

The power worksheet consists of eight KPIs, which are reported in the implementation phase, see Figure 7. The white cells can be filled out by the tool user for both the reference and ZEN scenarios for different energy carriers.

	A	B	C
1	POW3.1 Peak load	Scenario	Implementation phase
2	Electricity (kWh/h)	ZEN (Z)	
3		REFERENCE (R)	
4	District heating (kWh/h)	ZEN (Z)	
5		REFERENCE (R)	
6	Total (kWh/h)	ZEN (Z)	0
7		REFERENCE (R)	
8		Difference	0%
9	Points		0
10			
11	POW3.2 Peak export		Implementation phase
12	Abst./Pexport./Pimport)		0%
13	Peak export (kWh/h)		
14	Peak import (kWh/h)		
15	Points		0
16			
17	POW3.3 Energy stress	Scenario	Implementation phase
18	Electricity consumption during peak	ZEN (Z)	
19	hours (kWh)	REFERENCE (R)	
20	District heating consumption during	ZEN (Z)	
21	peak hours (kWh)	REFERENCE (R)	
22	Total (kWh)	ZEN (Z)	0
23		REFERENCE (R)	
24		Difference	0%
25	Points		0
26			
27	POW3.4 Representative day	Scenario	Implementation phase
28	Electricity	Graph representative days (Z)	
29		Graph representative days (R)	
30		Different seasons/weekdays (Z)	
31		Different seasons/weekdays (R)	
32		Different seasons/weekdays (Z-nD)	
33		Different seasons/weekdays (R-O)	
34	District heating	Graph representative days (Z)	
35		Graph representative days (R)	
36		Different seasons/weekdays (Z)	
37		Different seasons/weekdays (R)	
38		Different seasons/weekdays (Z-nD)	
39		Different seasons/weekdays (R-O)	
40	Points		0
41			
42	POW3.5 Delivered energy difference	Scenario	Implementation phase

	G	H	I	J	K	L	M	N
POW3.1 Points	From	To						
1	0%	8%						
2	9%	17%						
3	18%	25%						
4	26%	33%						
5	34%	42%						
6	43%	50%						

POW3.2 Points	Criteria
0	Peak export of electricity = Peak load of electricity in the ZEN pilot area
2	Peak export of electricity = Peak load of electricity in the ZEN pilot area

POW3.3 Points	From	To
1	0%	8%
2	9%	17%
3	18%	25%
4	26%	33%
5	34%	42%
6	43%	50%

POW3.4 Points	Criteria
1	Graphs for Z and R for both electricity and district heating
2	Graphs for different seasons/weekdays for Z, R and Z-nD and R-O

POW3.5 Points	Criteria

Figure 10. Screenshot of the Power KPI worksheet in the ZEN KPI tool.

This worksheet has two sections: the first section is for inserting the calculated KPI results into the white cells, which have both numeric data and drop-down listed data. The second section presents the point allocation system for the POW KPIs.

User's actions:

- Insert POW KPI results for the reference and ZEN scenarios into the white cells.
- Pay attention to the different energy carriers.
- Make sure that the KPIs have been inserted in the correct units.

Step 5: URB KPIs

The urban form and land use worksheet consists of 13 KPIs, which can be reported in the strategic planning phase. This worksheet has two sections: the first section is the KPIs; whilst the second section presents the point allocation system for the URB KPIs. This category contains both numeric and drop-down list KPIs.

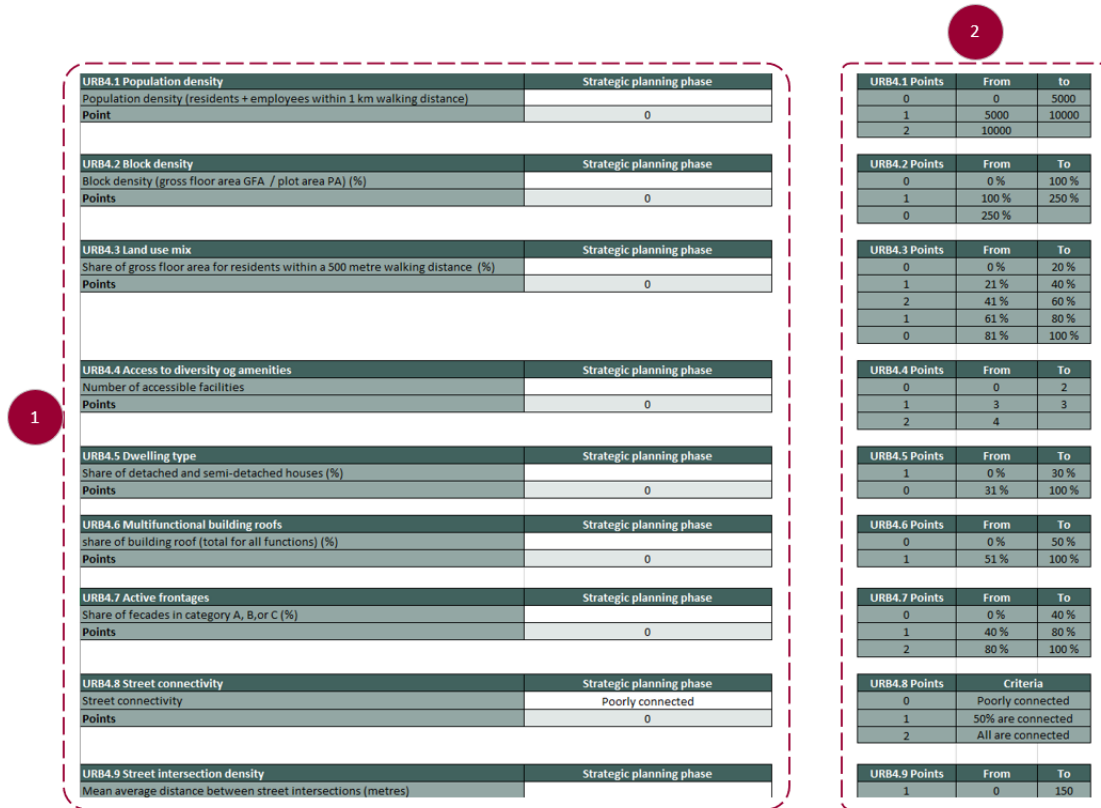


Figure 11. Screenshot of the Urban form and land use worksheet in the ZEN KPI tool.

User's actions:

- Insert URB KPI results into the white cells.

Step 6: MOB KPIs

The mobility worksheet consists of three KPIs that can be reported during the strategic planning phase and implementation phase, see Figure 9. This worksheet is divided into two sections: the first section contains the KPIs, whilst the second section outlines the point allocation system for the MOB KPIs. This category has only numeric KPIs.

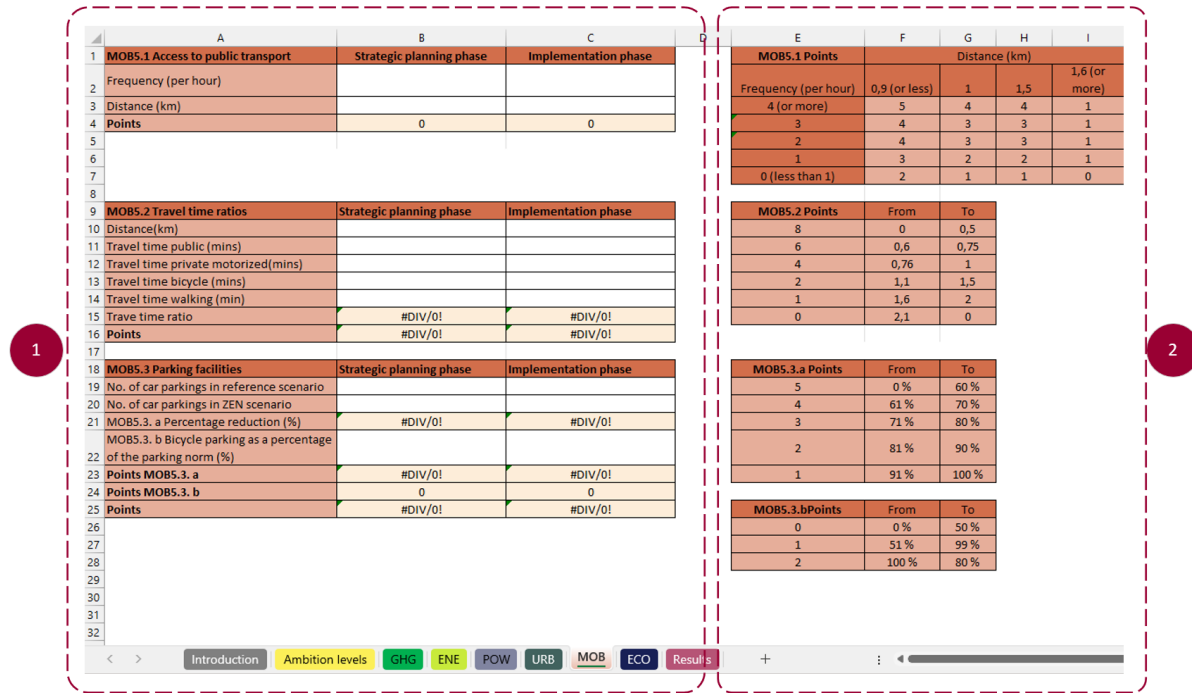


Figure 12. Screenshot of the Mobility worksheet in the ZEN KPI tool.

Regarding the second KPI (MO5.2), there are five blank cells per project phase. Between these five blank cells the user needs to input the distance between the origin and destination, as well as the travel time for private motorized vehicles. The Excel sheet will automatically calculate the travel time ratio and allocate points, accordingly. This will done based on comparing the inserted distance to Table 2.

Table 2. Selection of the required element for calculating MOB5.2 based on the distance.

Distance	Type of travel time
More than 5km	Travel time _{public}
1.5 – 5km	Travel time _{bicycle}
0 – 1.5km	Travel time _{walking}

User’s actions:

- Insert MOB KPIs into the white cells.
- Use Table 2 to select which blank cells can be filled out in MOB5.2.

Step 7: ECO KPIs

The economy worksheet has eight KPIs, which can be reported for the strategic planning and implementation phases. This category has both types of numeric and drop-down list KPIs. It should be noted that ECO 6.1, ECO6.2, and ECO 6.3 can be reported in two different units (NOK or NOK/m²GFA) and the tool user can select the unit from the checklist provided for each KPI.

Step7: ECO KPIs.

ECO6.1 Capital costs (NOK or NOK/m ² GFA)	Scenario	Strategic planning phase	Implementation phase	
Unit	NOK			
01 Shared costs	ZEN (Z)			
02 Building				
03 Heat, ventilation, and sanitation				
04 Electric power				
05 Telecommunications and automation				
06 Other installatinos				
01 - 06 Building cost				
07 Outdoors				
01 - 07 Contractor cost			-	-
08 General costs				
01 - 08 Construction cost			-	-
09 Special costs				
10 Value added tax (VAT)			-	-
01 - 10 Base cost		-	-	
11 Expected addition (incl. VAT)				
01 - 11 Project cost		-	-	
12 Uncertainty provision (incl. VAT)				
01 - 12 Cost framework		-	-	
13 Price regulation (incl. VAT)				
01 -13 TOTAL		-	-	
01 Shared costs	REFERENCE (R)			
02 Building				
03 Heat, ventilation, and sanitation				
04 Electric power				
05 Telecommunications and automation				
06 Other installatinos				
01 - 06 Building cost				
07 Outdoors				
01 - 07 Contractor cost			-	-
08 General costs				
01 - 08 Construction cost			-	-
09 Special costs				
10 Value added tax (VAT)			-	-
01 - 10 Base cost		-	-	
11 Expected addition (incl. VAT)				
01 - 11 Project cost		-	-	
12 Uncertainty provision (incl. VAT)				
01 - 12 Cost framework		-	-	
13 Price regulation (incl. VAT)				
01 -13 TOTAL		-	-	
Points		0	0	

ECO6.1 Points	Criteria
0	Not calculated
1	Calculated

Figure 13. Screenshot of the Economy worksheet in the ZEN KPI tool

User's actions:

- Insert ECO KPIs into the white cells.
- Specify the units for ECO6.1- ECO6.3.

Step 8: Results

Once steps 1 to 7 are complete, the tool user can switch to the "Results" worksheet. Figure 11 provides an overview of the "Results" worksheet, which is divided into eight distinct sections.

The first section displays the total amount of GHG emissions together with the total amount of GHG compensation from the strategic planning phase to the implementation phase. It also evaluates if the net zero emission neighbourhood (nZEN) balance has been achieved.

The second section lists the other categories in the ZEN definition together with the identified KPIs for each category. Each category has a total of 20 points. These points are fixed values, and the tool user is referred to the ZEN definition guideline [2] for a deeper understanding of them.
















The third and fourth sections show the obtained points and percentage fulfillment (obtained points / total points) for the strategic planning phase and implementation phase respectively.

The fifth section shows the nZEN balance based on the ZEN GHG KPIs for both the strategic planning and implementation phases. It also reflects the amount of reduction (e.g. 68%) and compensation (e.g. 10% and 100% in each project phase).

The sixth section visualises the performance of the neighbourhood by showing the nZEN balance and performance of the other categories. The ratings and the associated thresholds are shown in Table 3.

The final section compares the ambition levels (as given in the Ambition level worksheet) with the actual performance of the neighbourhood in the implementation phase for all categories, except for the GHG emission category.

Table 3. Colour codes and rating thresholds for visualization of the neighbourhood's performance when considering categories.

Colour code	Ranges	ENE rating	POW rating	URB rating	MOB rating	ECO rating
Dark green	80-100%					
Green	60-80%					
Light green	40-60%					
None	< 40%	No rating	no raung	No rating	No rating	No rating

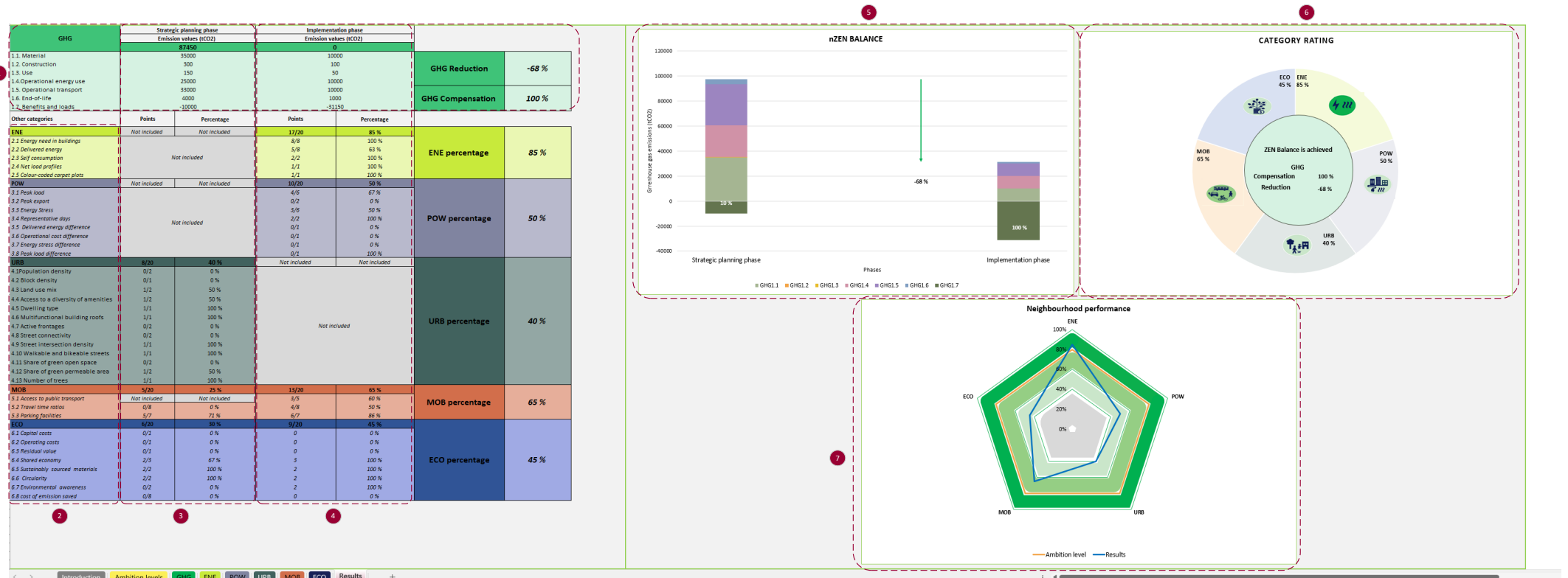


Figure 14. Screenshot of the Results worksheet in the ZEN KPI tool.

User's action:

- No action is needed in this worksheet.

nZEN balance

The nZEN balance result shows how the neighbourhood performs in terms of GHG emission reduction and compensation. Figure 12 shows an example of an nZEN balance. As can be seen from this figure, the example neighbourhood has not achieved the nZEN balance in the strategic planning phase as it has not reduced GHG emissions from the whole life cycle enough and has only compensated for 10% by exporting renewable energy production. During the transition from the strategic planning phase to the implementation phase, and through using more ZEN strategies, the nZEN balance has been achieved since total life cycle GHG emissions are drastically reduced by 68% and 100% of the remaining GHG emissions occurring during the neighbourhood's lifecycle are compensated for through export of renewable energy production.

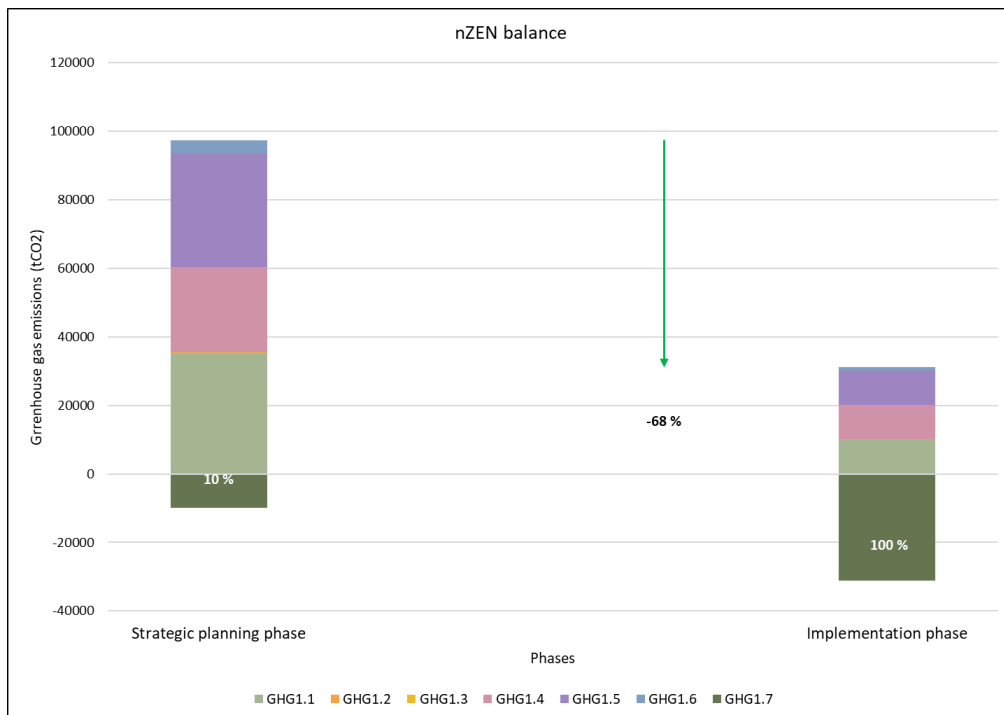


Figure 15. Example of visualization of nZEN balance in the ZEN KPI tool.

Spider diagram

The performance with respect to the other categories in the result worksheet are presented in a spider diagram which shows the ambition levels (as given in the Ambition levels worksheet) for each category in orange, see Figure 13. In addition, it shows the neighbourhood's actual performance in the implementation phase, in blue. The different tones of green used in the spider graph correspond to the colour codes given in Table 3.

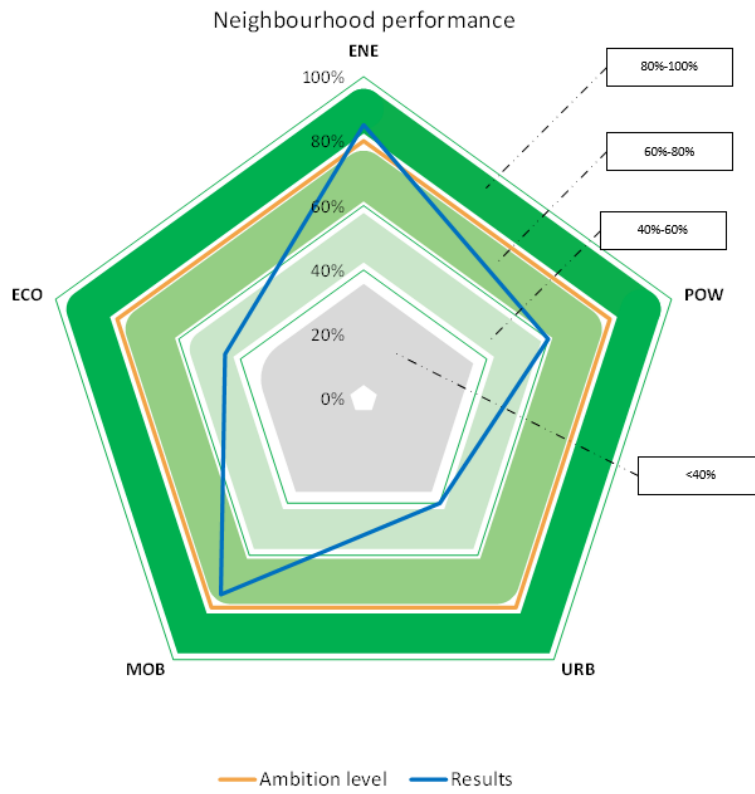


Figure 13. Spider diagram of results for the other categories.

References

- [1] Wiik MRK, Homaei S, Lien SK, et al. Zero Emission Neighbourhoods In Smart Cities. Definition, Assessment Criteria and Key Performance Indicators: Version 5.0. English. ZEN Report, Oslo, Norway: SINTEF Academic Press, 2024.
- [2] Wiik MRK, Homaei S, Lien SK, et al. The ZEN Definition. A Guideline for the ZEN Pilot Areas. Version 4.0. ZEN Report, Oslo, Norway: SINTEF Academic Press, 2024.
- [3] Rokseth L, Vergerio G, Bø LA, et al. Processveileder for ZEN. ZEN Report, Oslo, Norway: SINTEF Academic Press, 2024.

Appendix A

An overview of the data inputs required in the ZEN KPI tool can be found in Appendix A. (R: Reference, Z: ZEN, R-O: reference with optimised control, Z-nO: ZEN without optimised control).

Ambition level Worksheet			
Gross floor area of buildings (m ²)			
Total heated floor area (m ²)			
Number of users (#)			
Share of new buildings in neighbourhood (%)			
Share of existing building in neighbourhood (%)			
GHG reduction (%)			
GHG compensation (%)			
ENE (%)			
POW (%)			
URB (%)			
MOB (%)			
ECO (%)			
GHG worksheet			
GHG1.1	Level 1 (tCO _{2eq})		
	Level 2 (tCO _{2eq})		
	Level 3 (tCO _{2eq})		
GHG1.2	Level 1 (tCO _{2eq})		
	Level 2 (tCO _{2eq})		
	Level 3 (tCO _{2eq})		
GHG1.3	Level 1 (tCO _{2eq})		
	Level 2 (tCO _{2eq})		
	Level 3 (tCO _{2eq})		
GHG1.4	Level 4 (tCO _{2eq})		
GHG1.5	Level 4 (tCO _{2eq})		
GHG1.6	Level 1 (tCO _{2eq})		
	Level 2 (tCO _{2eq})		
	Level 3 (tCO _{2eq})		
GHG1.7	Level 1 (tCO _{2eq})		
	Level 2 (tCO _{2eq})		
	Level 3 (tCO _{2eq})		
ENE worksheet			
ENE 2.1	Energy demand (kWh/m ² /yr)	R	
		Z	
ENE2.2	Electricity (kWh/yr)	R	
		Z	
	District heating (kWh/yr)	R	
		Z	
	Bio heat (kWh/yr)	R	
		Z	
ENE2.3	Self-consumption (%)		
ENE2.4	Net load profile for electricity	R	Yes <input type="checkbox"/> No <input type="checkbox"/>
		Z	Yes <input type="checkbox"/> No <input type="checkbox"/>
	Net load profile for district heating	R	Yes <input type="checkbox"/> No <input type="checkbox"/>

		Z	Yes <input type="checkbox"/> No <input type="checkbox"/>
ENE2.5	Colour-coded carpet plot for electricity	R	Yes <input type="checkbox"/> No <input type="checkbox"/>
	Colour-coded carpet plot for district heating	Z	Yes <input type="checkbox"/> No <input type="checkbox"/>
POW worksheet			
POW3.1	Electricity peak load(kWh/h)	R	
		Z	
	District heating peak load (kWh/h)	R	
		Z	
POW3.2	Peak export (kWh/h)		
	Peak import (kWh/h)		
POW3.3	Electricity consumption during peak hours (kwh)	R	
		Z	
	District heating consumption during peak hours (kwh)	R	
		Z	
POW3.4.	Electricity	R	Yes <input type="checkbox"/> No <input type="checkbox"/>
		Z	Yes <input type="checkbox"/> No <input type="checkbox"/>
		Different seasons/weekdays R	Yes <input type="checkbox"/> No <input type="checkbox"/>
		Different seasons/weekdays Z	Yes <input type="checkbox"/> No <input type="checkbox"/>
		Different seasons/weekdays (R-O)	Yes <input type="checkbox"/> No <input type="checkbox"/>
		Different seasons/weekdays (Z-nO)	Yes <input type="checkbox"/> No <input type="checkbox"/>
	District heating	R	Yes <input type="checkbox"/> No <input type="checkbox"/>
		Z	Yes <input type="checkbox"/> No <input type="checkbox"/>
		Different seasons/weekdays R	Yes <input type="checkbox"/> No <input type="checkbox"/>
		Different seasons/weekdays Z	Yes <input type="checkbox"/> No <input type="checkbox"/>
		Different seasons/weekdays R-O	Yes <input type="checkbox"/> No <input type="checkbox"/>
		Different seasons/weekdays Z-nO	Yes <input type="checkbox"/> No <input type="checkbox"/>
POW3.5	Electricity (kWh/yr)	R-O	
		Z-nO	
	District heating (kWh/yr)	R-O	
		Z-nO	
POW3.6	Electricity (NOK/yr)	R	
		Z	
		R-O	
		Z-nO	
	District heating (NOK/yr)	R	
		Z	
		R-O	
		Z-nO	
POW3.7	Electricity during peak hours (kWh)	R-O	
		Z-nO	
	District heating during peak hours (kWh)	R-O	

		Z-nO	
POW3.8	Electricity peak load (kWh/h)	R-O	
		Z-nO	
	District heating peak load (kWh/h)	R-O	
		Z-nO	
URB worksheet			
URB4.1	Population density		
URB4.2	Block density (%)		
URB4.3	Land use mix (%)		
URB4.4	Access to diversity and amenities (#)		
URB4.5	Dwelling type (%)		
URB4.6	Multifunctional building roofs (%)		
URB4.7	Active frontages (%)		
URB4.8	Street connectivity	Poorly connected <input type="checkbox"/> 50% are connected <input type="checkbox"/> All are connected <input type="checkbox"/>	
URB4.9	Street intersection density (m)		
URB4.10	Walkable and bikeable streets (%)		
URB4.11	Share of green open public space (%)		
URB4.12	Share of green permeable area (%)		
URB4.13	Plan for preserving trees	Yes <input type="checkbox"/> No <input type="checkbox"/>	
MOB worksheet			
MOB5.1	Frequency (per hour)		
	Distance to bus stop (km)		
MOB5.2	Distance between two destinations (km)		
	Travel time public transport (min)		
	Travel time private motorized (min)		
	Travel time bicycle (min)		
MOB5.3	No of car parking spaces (#)	R	
		Z	
	Bicycle parking as a percentage of the parking norm (%)		
ECO worksheet			
ECO6.1	Shared costs NOK <input type="checkbox"/> NOK/m ² /yr <input type="checkbox"/>	R	
		Z	
	Building NOK <input type="checkbox"/> NOK/m ² /yr <input type="checkbox"/>	R	
		Z	
	Heat, ventilation, and sanitation. NOK <input type="checkbox"/> NOK/m ² /yr <input type="checkbox"/>	R	
		Z	

	Electric power NOK <input type="checkbox"/> NOK/m ² /yr <input type="checkbox"/>	R	
		Z	
	Telecommunications and automation NOK <input type="checkbox"/> NOK/m ² /yr <input type="checkbox"/>	R	
		Z	
	Other installations NOK <input type="checkbox"/> NOK/m ² /yr <input type="checkbox"/>	R	
		Z	
	Outdoors NOK <input type="checkbox"/> NOK/m ² /yr <input type="checkbox"/>	R	
		Z	
	General costs NOK <input type="checkbox"/> NOK/m ² /yr <input type="checkbox"/>	R	
		Z	
	Special costs NOK <input type="checkbox"/> NOK/m ² /yr <input type="checkbox"/>	R	
		Z	
Value added tax (VAT) NOK <input type="checkbox"/> NOK/m ² /yr <input type="checkbox"/>	R		
	Z		
Expected addition (incl. VAT) NOK <input type="checkbox"/> NOK/m ² /yr <input type="checkbox"/>	R		
	Z		
Uncertainty provision (incl. VAT) NOK <input type="checkbox"/> NOK/m ² /yr <input type="checkbox"/>	R		
	Z		
Price regulation (incl. VAT) NOK <input type="checkbox"/> NOK/m ² /yr <input type="checkbox"/>	R		
	Z		
ECO6.2	Operational costs NOK <input type="checkbox"/> NOK/m ² /yr <input type="checkbox"/>	R	
		Z	
ECO6.3	ECO6.3 Residual value NOK <input type="checkbox"/> NOK/m ² /yr <input type="checkbox"/>	R	
		Z	
ECO6.4	Measure for shared mobility	Yes <input type="checkbox"/> No <input type="checkbox"/>	
	Measure for common space	Yes <input type="checkbox"/> No <input type="checkbox"/>	
	Measures for collective services and shared equipment	Yes <input type="checkbox"/> No <input type="checkbox"/>	
ECO6.5	Wood and wood-based products originate from forests managed according to sustainable forest management principles as certified by FSC or PEF.	Yes <input type="checkbox"/> No <input type="checkbox"/>	
	Minimum 70% of concrete used shall be low carbon concrete A or better.	Yes <input type="checkbox"/> No <input type="checkbox"/>	
	Minimum 75% recycled steel/aluminium content	Yes <input type="checkbox"/> No <input type="checkbox"/>	
	No dangerous substances from the Substances of Very High Concern (SVHC) included on the EU's REACH Candidate list or on the Norwegian priority list.	Yes <input type="checkbox"/> No <input type="checkbox"/>	
	No synthetic plastic and rubber surfaces on playgrounds and outdoor areas e.g. artificial turf, mats, tiles, fibres, chips, and granules.	Yes <input type="checkbox"/> No <input type="checkbox"/>	

	Amount of waste and treatment of waste achieves minimum a green level from Figure 42 in ZEN definition guideline.	Yes <input type="checkbox"/> No <input type="checkbox"/>	
ECO6.6	Pre demolition analysis	Yes <input type="checkbox"/> No <input type="checkbox"/>	
	Potential reuse and recycling documenting	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	
ECO6.7	Zero Emission Neighbourhood handbook	Yes <input type="checkbox"/> No <input type="checkbox"/>	
	ZEN dashboard	Yes <input type="checkbox"/> No <input type="checkbox"/>	
ECO6.8	Cost of emission saved (NOK/tCO _{2e})	Measure 1: material measure	
		Measure 2: energy measure	
		Measure 3: mobility measure	
		Measure 4: area-efficiency measure	
		Measure 5: other measure	
		Measure 6: other measure	
		Measure 7: other measure	
		Measure 8: other measure	



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