SUPPORT DHC

District heating network separation to transition towards low-temperature systems

User Guide

October 2026

TITLE OF THE DELIVERABLE	
Deliverable number	
Responsible partner	
Due date of deliverable	
Actual submission date	
Version/document history	
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Work package number and title	

DISSEMINATION LEVEL (please select one)		
SEN	Sensitive, limited under the conditions of the Grant Agreement	☐
PU	Public, fully open	☐

PROJECT'S INFORMATION	
Grant Agreement No.	101119914
Project Full Title	Supporting a fast implementation of low-grade renewable energy and waste heat for district heating and cooling
Project Acronym	Support DHC
Start Date	01 October 2023
Duration	39 months
Project Coordinator	WIP Renewable Energies
Project Website	www.supportdhc.eu

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1 Purpose and quick start

This guide explains how to run the supplied MATLAB implementation. The tool selects candidate cells for a potentially separated DH subsystem supplied by a new low-temperature heat source. It is a spatial screening algorithm; it does not calculate heat-source operating temperatures, pipe hydraulics or network investment costs.

1.1 Quick start

The following steps provide a quick overview of how to prepare the inputs, run the MATLAB tool, and review the results. Further details are provided in the subsequent sections.

1. Prepare an Excel workbook named DH_Cell_Input_Data.xlsx with one row per DH cell and the six required column headers shown in Section 2.
2. Place the workbook in the MATLAB Current Folder together with DH_Network_Separation.m.
3. Open DH_Network_Separation.m and review or modify the parameters near the beginning of the script, as described in Section 4.
4. Run DH_Network_Separation.m in MATLAB. The script iteratively searches for a separated area and then generates the final outputs.
5. Review the two output Excel workbooks, the final separated design heat load printed in the Command Window, and the three figures.

1.2 Files and what they contain

The tool requires MATLAB with the Image Processing Toolbox and an Excel input workbook, as summarised in Table 1. The Excel file must be prepared or provided by the user.

Table 1. Files required to run the tool.

File	Role
DH_Network_Separation.m	Main MATLAB script, including the separation algorithm as a local function.
DH_Cell_Input_Data.xlsx	Required cell-level input workbook; must be provided or prepared by the user.

2 Prepare the Excel input data

The script reads cell-level data directly from an Excel workbook. Each row must represent one DH-area cell. The required input columns and their formats are listed in Table 2. Column names must match the spelling and capitalisation used in the MATLAB code.

Table 2. Required input data and formats.

Exact column name	Meaning and format
pointid	Unique numeric cell identifier; use nonmissing, preferably integer, IDs.
Latitude	Latitude of cell location/centre in decimal degrees.
Longitude	Longitude of cell location/centre in decimal degrees.
AnnualHeatDemand_MWh	Annual heat demand for the cell, in MWh/year.
CMI	Construction Modernity Index; numeric value between 0 and 1 (precalculated).
DesignHeatLoad_MW	Design/peak heat load for the cell in MW (precalculated).

The code assumes a 100 m × 100 m spatial grid by default (params.cellSpacing = 100). Geographic positions are approximately projected onto a local Cartesian grid and rounded to

that spacing. Input cell locations should therefore be consistent with the chosen spatial resolution.

3 Calculate the inputs not computed by MATLAB

Two fields must be available before running the separation script: the CMI and the design heat load. The main script reads these values; it does not derive them from raw building-floor-area data or from annual demand.

3.1 Construction Modernity Index (CMI)

The accompanying technical report defines CMI as a weighted index of floor-area shares across four construction periods. The corresponding relative age weights are presented in Table 3.

Table 3. Relative age positions assigned to construction periods for calculating CMI.

Building period	Relative age weight
Before 1975	0.00
1975–1990	0.33
1990–2000	0.66
2000–2014	1.00

For floor-area fractions S1, S2, S3 and S4 (summing to 1), CMI = 0(S1) + 0.33(S2) + 0.66(S3) + 1(S4). A higher value indicates more recent building stock according to this index.

3.2 Cell design heat load

The accompanying technical report presents both a detailed design heat load estimation method and a simplified approach used in the demonstration. In the simplified approach, DHW is assumed to account for 30% of the annual heat demand, and the total design heat load is approximated as ten times the average hourly DHW demand.

This calculation is performed when preparing the input data, not by the MATLAB script. More reliable design heat load estimates can be used if available. Further details are provided in Section 3.1 of the technical report.

4 Configure the MATLAB script

Before running the tool, review the parameters defined near the beginning of DH_Network_Separation.m. Table 4 presents the case-specific parameters, while Table 5 summarises the algorithm settings. The listed default values correspond to the supplied MATLAB code.

Table 4. Case-specific input parameters.

Parameter	Default	Explanation
params.inputFile	'DH_Cell_Input_Data.xlsx'	Input workbook filename or valid path.
params.sourceLat	44.6779838	New heat-source latitude (degrees); Reggio Emilia example.
params.sourceLon	10.6453515	New heat-source longitude (degrees); Reggio Emilia example.
params.sourceCapacity	50	New heat-source capacity in MW.
params.R	inf	Maximum search distance from source in m; inf allows full data extent.

Parameter	Default	Explanation
params.epsilon	0.20	Assumed maximum peak-load fraction from the backup/main DH network.

Table 5. Algorithm and spatial-processing parameters.

Parameter	Default	Explanation
params.cellSpacing	100	DH grid-cell spacing in m.
params.maxBridgeDistance	500	Maximum gap bridged between disconnected groups, in m.
params.absorbSmallRemainingIslands	true	Enable absorption of eligible small remaining islands.
params.maxIslandSizeFactor	0.2	Max island size as a fraction of selected real-cell count.
params.maxIslandDHLToAbsorb	inf	Maximum MW load of an absorbable island.
params.alphaValue	150	Alpha-shape boundary parameter, in m.

5 Run the tool in MATLAB

Once the input data and user-defined parameters have been prepared as described in the previous sections, run DH_Network_Separation.m.

During execution, the algorithm iteratively adjusts the region-growing target to identify a separated area with a design heat load within the specified acceptance range. This process runs automatically without requiring user interaction. Upon successful completion, the Command Window displays the final separated design heat load in MW.

6 Interpret the outputs

6.1 Exported files

Upon successful execution, the MATLAB script generates two Excel output files. Table 6 summarises their contents and how to interpret them.

Table 6. Output files generated by the MATLAB tool.

Output	How To Interpret It
Separated_real_cells.xlsx	Selected real DH cells only; provides the records to map or further assess for candidate separation. Artificial topology cells are excluded.
DH_cells_with_priority_index.xlsx	All original cell records plus PriorityIndex. A higher index indicates greater local ranking under the three criteria.

6.2 Three figures displayed by the script

The MATLAB script also generates three figures to visualise the selected DH area, the different cell categories, and the spatial distribution of the priority index, as described below.

- Separated district heating area: original DH cells in black and selected real cells in red.
- Separated district heating area and cell categories: distinguishes original, artificial bridge/hole-fill, selected and absorbed-island cells; marks the source location.
- Spatial distribution of the priority index: original DH cells coloured from low to high score; the heat source is marked.

7 Illustrative application: Reggio Emilia

The accompanying technical report demonstrates the application of the algorithm to the DH system of Reggio Emilia, Italy. The DH area was extracted from the Pan-European Thermal Atlas, while heat demand and building-age data were obtained from Citiwatts. The assumed heat-source characteristics and selected algorithm parameters are summarised in Table 7.

Table 7. Input parameters used for the Reggio Emilia demonstration.

Setting	Demonstration Value
sourceLat	44.6779838
sourceLon	10.6453515
sourceCapacity	50 MW
epsilon	0.20
cellSpacing	100 m
R	inf (whole study area)

8 Scope and limitations

The following limitations should be considered when interpreting the results and applying the tool to other DH systems.

- This is an early-stage area-selection method, not a pipe-routing, hydraulic or operational optimisation model.
- The algorithm uses grid adjacency and artificial bridge/hole cells; these do not demonstrate physical pipeline feasibility.
- Building age is represented by CMI as a proxy for low-temperature suitability; actual building-level temperature requirements must be evaluated separately.
- Island processing improves spatial coherence, but the remaining DH area is not guaranteed to remain a single connected region.
- The coordinate conversion uses a local approximation (111,000 m per degree of latitude), which is generally suitable for city-scale applications but may be less accurate for larger geographical areas.