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RTC Heat pump project – tools user guide

Version 1.1

15th March 2022

Contents

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1. Introduction

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About Renewable Thermal Collaborative (RTC)

The Renewable Thermal Collaborative (RTC) is the global coalition for companies, institutions, and governments committed to scaling up renewable heating and cooling at their facilities, dramatically cutting carbon emissions. RTC members recognize the growing demand and necessity for renewable heating and cooling and the urgent need to meet this demand in a manner that delivers sustainable, cost-competitive options at scale. The RTCs visions is to:

- Educate all parties about the urgent need to address renewable options for thermal energy
- Identify market barriers to renewable thermal technologies
- Enable the delivery of cost-competitive renewable thermal options
- Improve the marketplace and financing for renewable thermal technologies
- Develop a long-term vision for scaling up renewable thermal technologies in the United States and globally

About the RTC Heat Pump Project

The RTC Heat Pump Project ran from March to September 2022. It was a collaborative project between RTC, a group of RTC member companies and Verco, a leading energy software and consultancy company.

The objective of the project was to support the identification, first appraisal and subsequent implementation of heat pumps in industrial applications through provision of simple decision support tools.

Contact details

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Note: Enabling macros

Tools 1 and 2 both use macros. It may be necessary to enable ‘enable macros’ when open excel for the sheets to function.

This can usually be achieved by changing the macro settings in the Microsoft ‘Trust Centre’. (File > Options > Trust Cente)

Alternatively download the Tool files to local folder, right-click on the file name, select ‘Properties’ and check the "Unlock" checkbox at the end (Security option).

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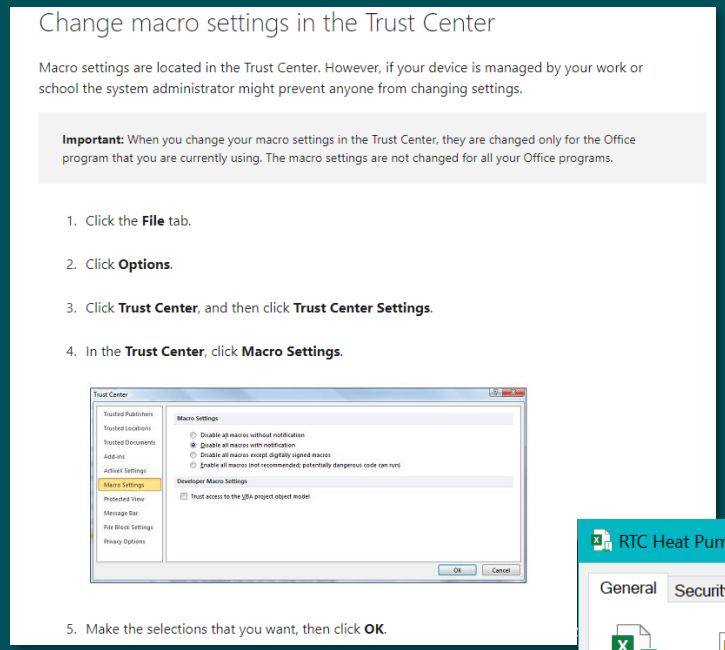
Microsoft support - enable macros



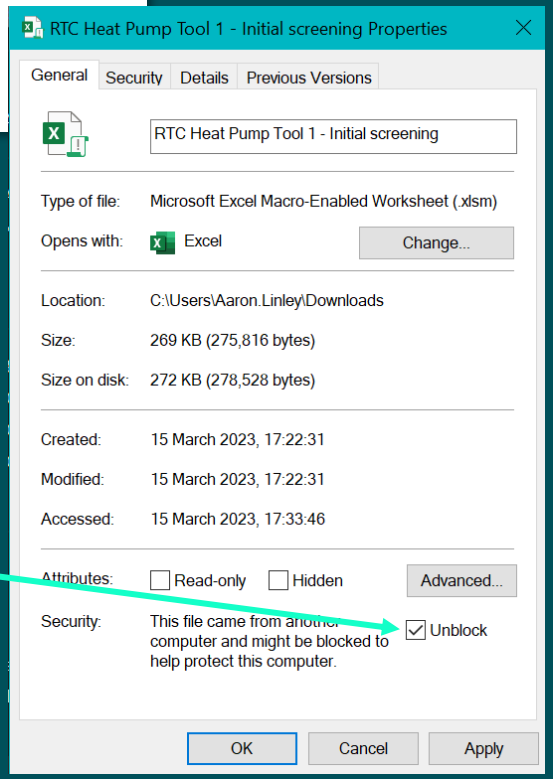
Change macro settings in the Trust Center

Macro settings are located in the Trust Center. However, if your device is managed by your work or school the system administrator might prevent anyone from changing settings.

Important: When you change your macro settings in the Trust Center, they are changed only for the Office program that you are currently using. The macro settings are not changed for all your Office programs.

1. Click the **File** tab.
2. Click **Options**.
3. Click **Trust Center**, and then click **Trust Center Settings**.
4. In the **Trust Center**, click **Macro Settings**.

5. Make the selections that you want, then click **OK**.

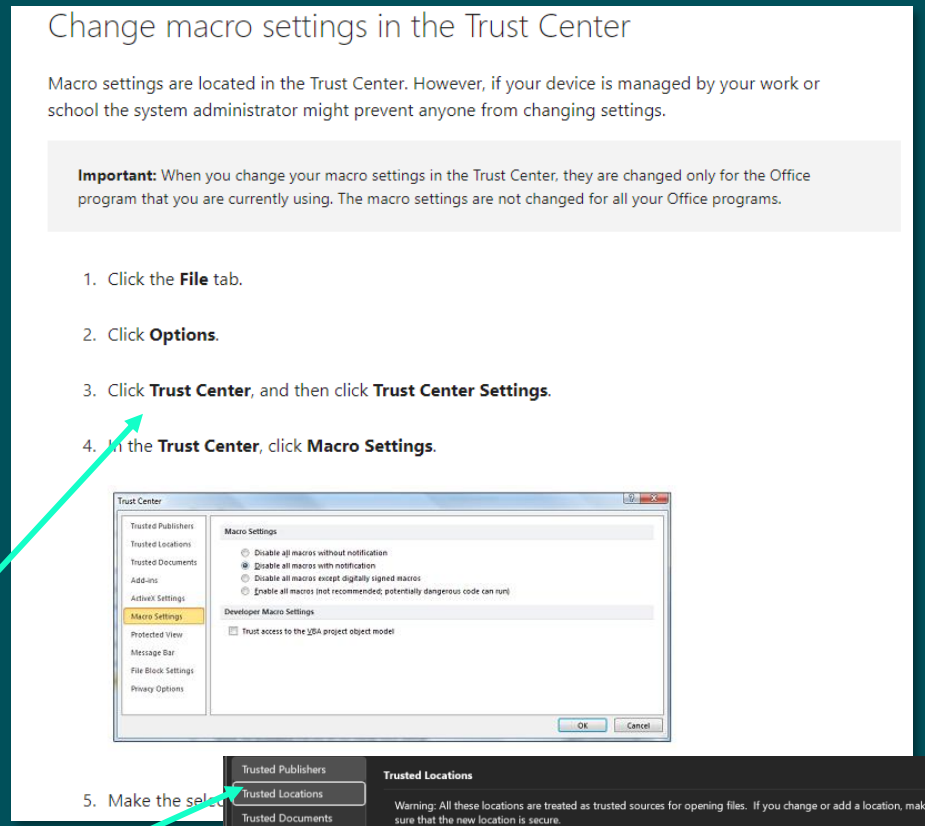


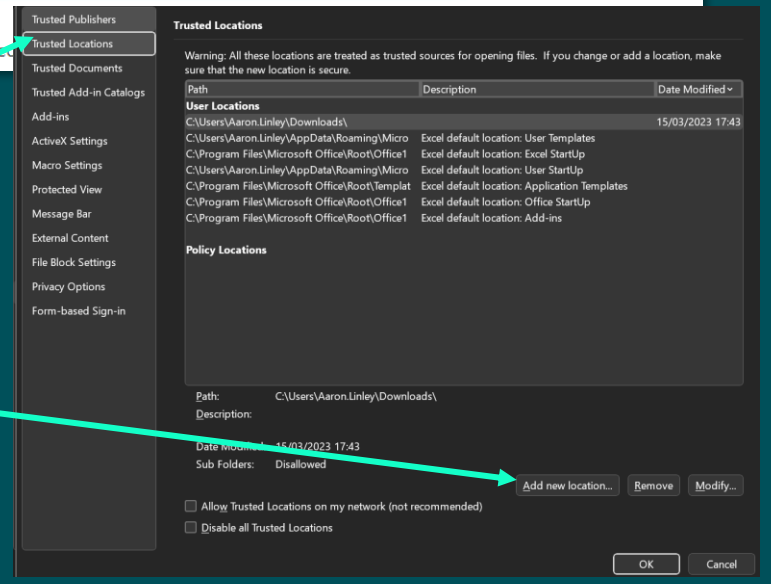
Failing that…

Refer to the following website: https://www.ablebits.com/office-addins-blog/enable-disable-macros-excel/#:~:text=Click%20the%20File%20tab%2C%20and%20then%20click%20Options%20at%20the,all%20macros%20and%20click%20OK.

Go to the ‘Trust Center Settings’ as per image, then ‘Trusted Locations’

Click ‘Add new location…’ and add the location where the file is placed





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1. Summary of tools

RTC Heat Pump project - 3 decision support tools

The RTC Heat Pump project has created **three** tools, designed to answer the common questions when considering the use of heat pumps:

1. Where might a heat pump be useful?
2. What technologies might be suitable?
3. Has a similar installation been done before?

Tool #1 Initial screening

4. Would it be commercially viable?
5. What can I do to improve the confidence in project viability before investing in detailed feasibility or design work?

Tool #2 High-level feasibility

6. Who can we work with and where?

Tool #3 Supplier database

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Tool summary

Tool 1: Initial screening

Purpose: identification of heat pump opportunity(s)

Main user inputs:
- Industry
- Heat application
- Waste heat source

Tool 2: High-level feasibility

Purpose: initial technical and commercial viability assessment.

Main user inputs:
- Technical e.g. temps, flows, mediums, efficiencies.
- Commercial e.g. energy tariffs, grid factors and unit costs.

Tool 3: Supplier database

Purpose: provide details of relevant suppliers

User inputs:
- Country and technology of interest

Outputs:

- Short list of potential applications
- Case study links

- Technical parameters
- Costs and benefits
- Tailored implementation check list

- List of relevant suppliers
- Weblinks and contact details

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Tool 1: Initial screening

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Tool 1 user guide – general tool description

The initial screening tool is designed to help identify heat pump options based on only high-level information about candidate sites. This allows the user to focus down on the sites and technology options most worthy of further investigation.

The tool contains two databases, one of technology applications and the other of case studies. This tool filters these databases according to the user inputs to return potential applications and associated case studies relevant to the chosen sector and input parameters.

The tool can be used to explore options for single sites, or multiple sites with the same thermal processes.

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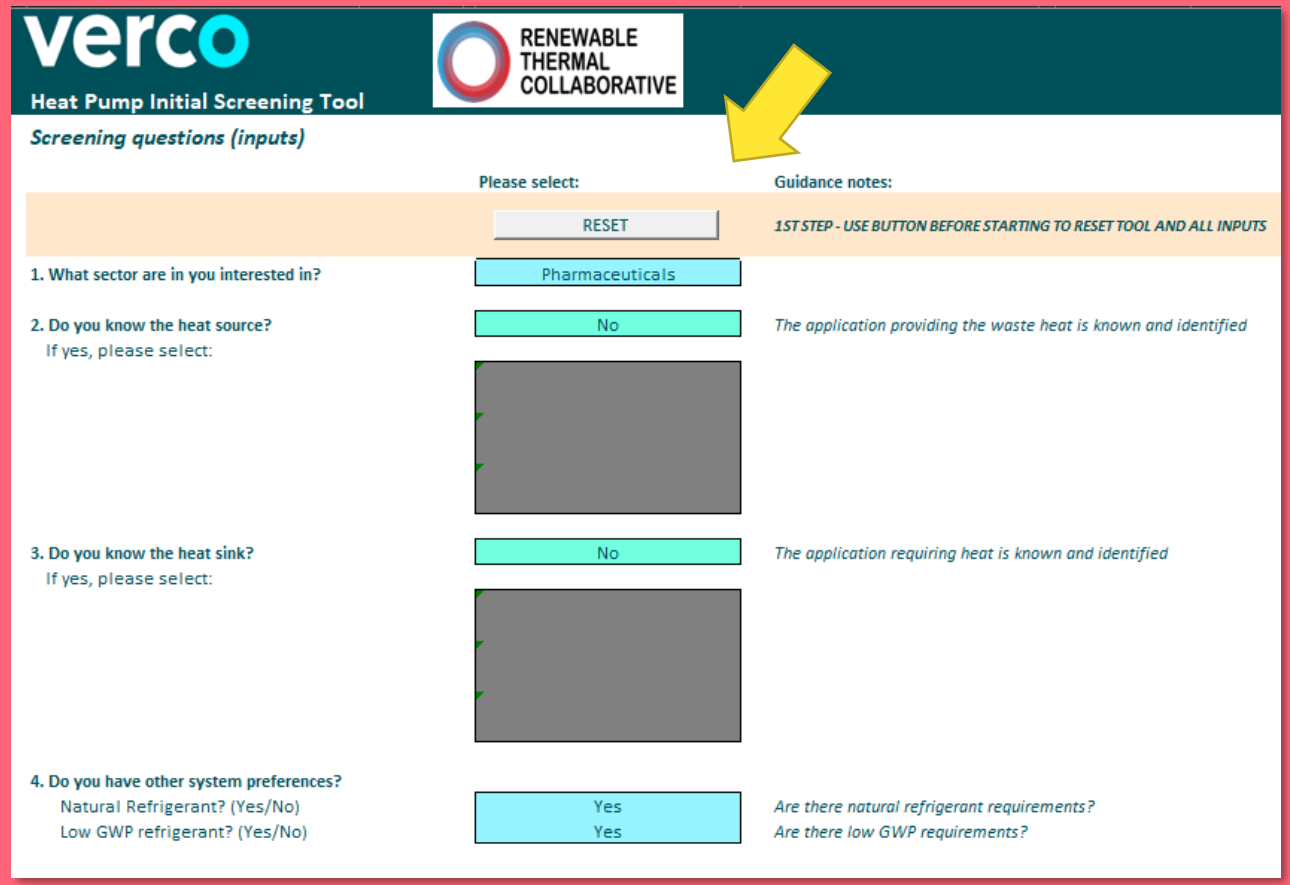
Tool 1 user guide - inputs

First of all, press the RESET button to clear previous inputs.

This also resets some cells that can be overwritten.

The tool may not work correctly if this is not done.



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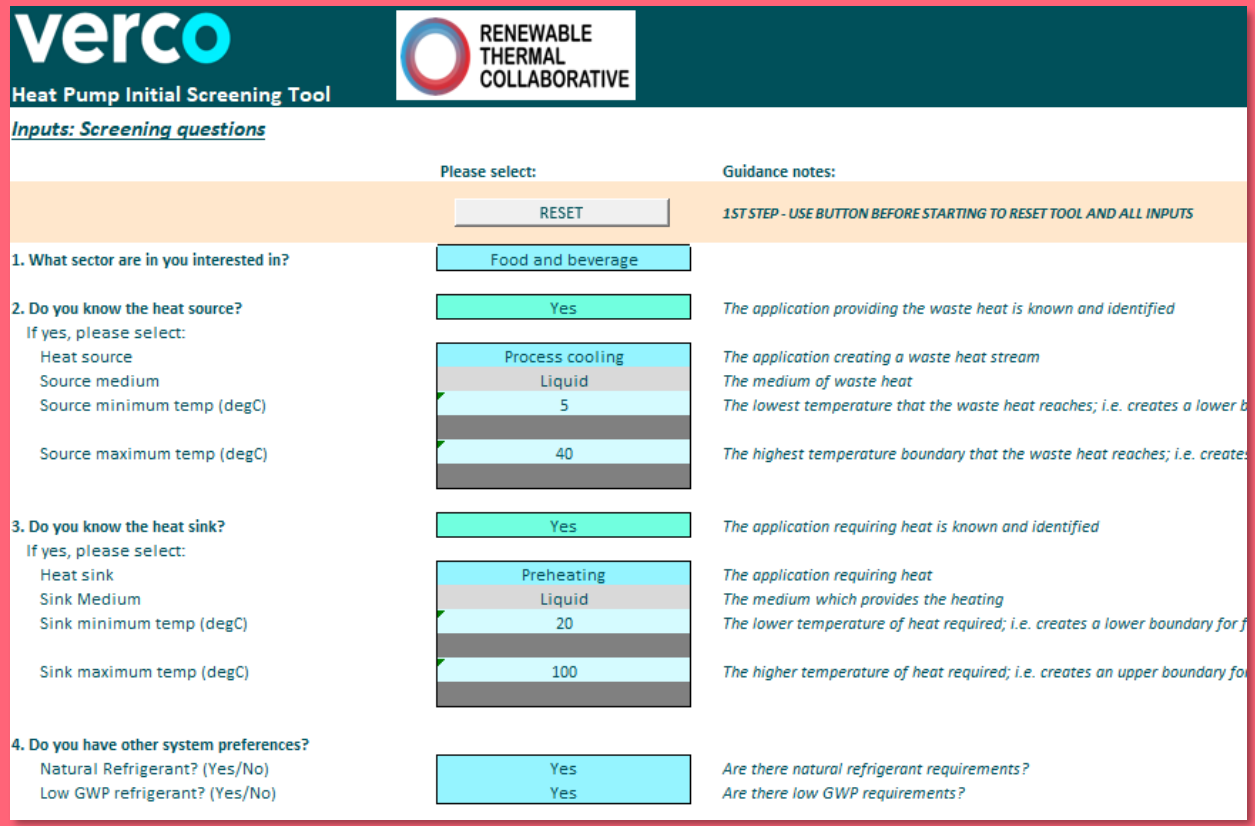
Tool 1 user guide - inputs (continued)

Answer questions 1 – 4.

If you can provide details of the heat source and sink, then the outputs will be more specific to your case.



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Heat Pump Initial Screening Tool

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Inputs: Screening questions

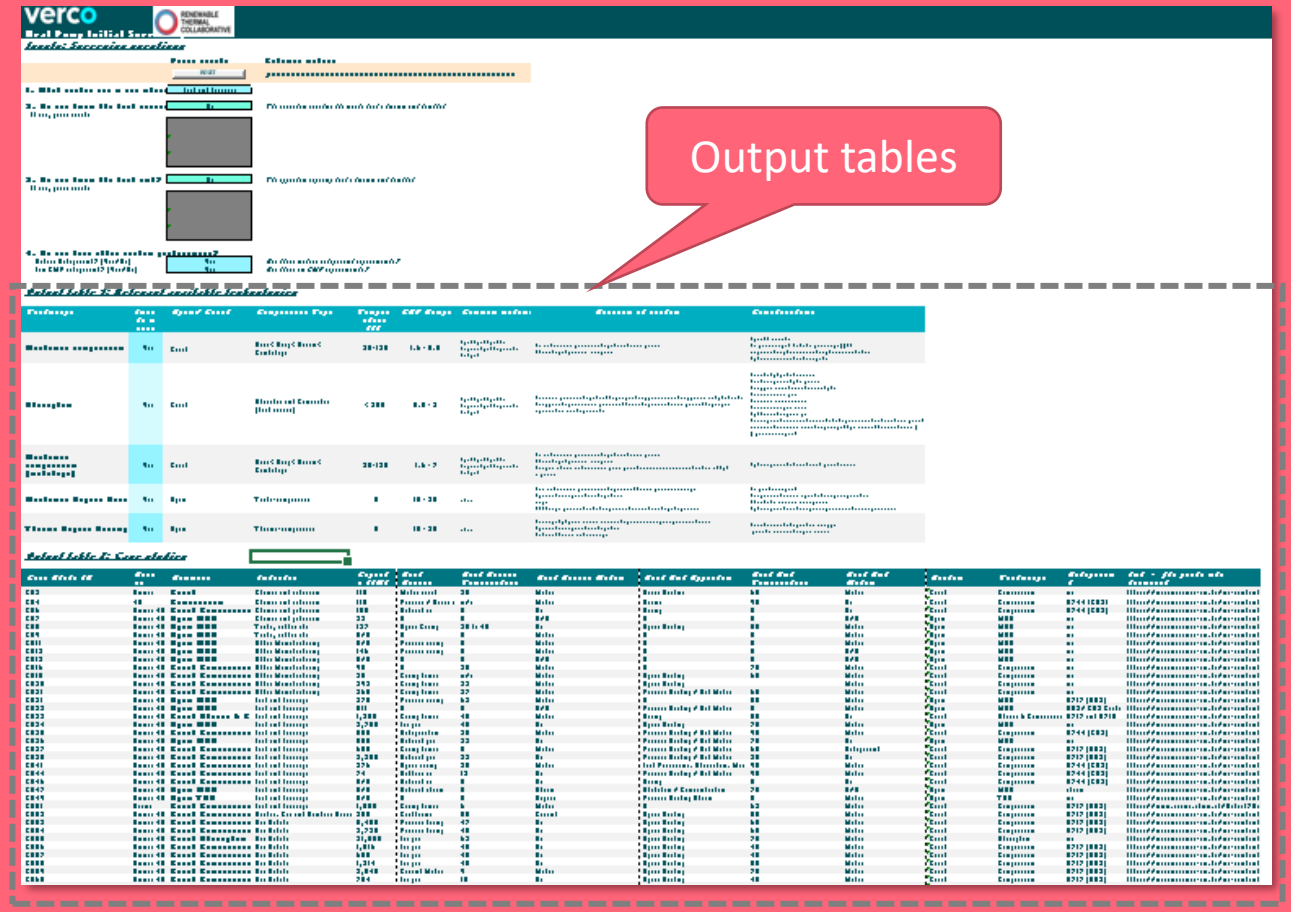
	Please select:	Guidance notes:
	RESET	*1ST STEP - USE BUTTON BEFORE STARTING TO RESET TOOL AND ALL INPUTS*
1. What sector are in you interested in?	Food and beverage	
2. Do you know the heat source?	Yes	*The application providing the waste heat is known and identified*
If yes, please select:		
Heat source	Process cooling	*The application creating a waste heat stream*
Source medium	Liquid	*The medium of waste heat*
Source minimum temp (degC)	5	*The lowest temperature that the waste heat reaches; i.e. creates a lower b*
Source maximum temp (degC)	40	*The highest temperature boundary that the waste heat reaches; i.e. create*
3. Do you know the heat sink?	Yes	*The application requiring heat is known and identified*
If yes, please select:		
Heat sink	Preheating	*The application requiring heat*
Sink Medium	Liquid	*The medium which provides the heating*
Sink minimum temp (degC)	20	*The lower temperature of heat required; i.e. creates a lower boundary for f*
Sink maximum temp (degC)	100	*The higher temperature of heat required; i.e. creates an upper boundary fo*
4. Do you have other system preferences?		
Natural Refrigerant? (Yes/No)	Yes	*Are there natural refrigerant requirements?*
Low GWP refrigerant? (Yes/No)	Yes	*Are there low GWP requirements?*

Tool 1 user guide - outputs

Outputs are shown in two tables underneath the input fields:

- Table 1: Relevant available technologies
- Table 2: Case studies

Note that case studies are not available for all possible sector and technology combinations. Table 2 may thus appear blank when less common technology options are selected.



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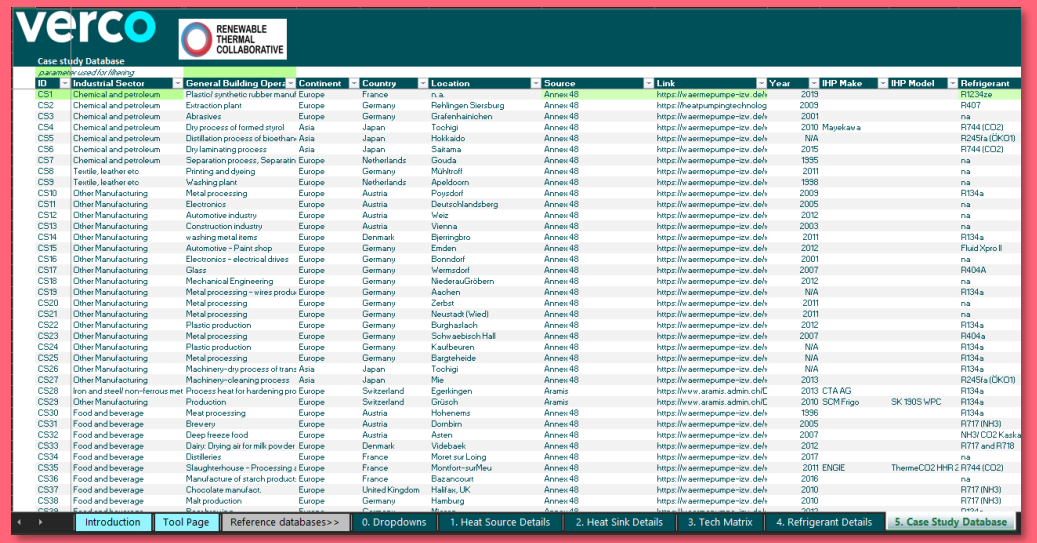
Tool 1 user guide - reference sheets

All reference tabs are shown to the righthand side of the workbook.

These may be of interest in their own right. For example, the complete database of 200+ case studies can be viewed in reference tab 5



Tool Navigation

Reference Tab	Description
Tool Page	*User interface. Contains Inputs & Outputs.*
0. Dropdowns	*Reference page used to populate the 'Tool Page' and create dropdown lists.*
1. Heat Source Details	*Database of industries and their relevant heat sources. Includes heat source medium and temperature range.*
2. Heat Sink Details	*Database of industries and their relevant heat sinks. Includes heat sink medium and temperature range.*
3. Tech Matrix	*Database of heat pump technologies and their characteristics.*
4. Refrigerant Details	*Database of refrigerants and their properties.*
5. Case Study Database	*Detailed database of over 200 case studies.*

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Tool 2: High-level feasibility

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Tool 2 user guide – general tool description

The high-level feasibility tool is designed to help with initial solution identification and feasibility at the preliminary stage of a heat pump project. The Tool helps to highlight the variables which effect the performance and output of heat pumps. It achieves this by modelling the operating conditions, distribution complexity, storage requirements / availability and financial variables.

The tool is designed to explore the feasibility of a single technology configuration and country location at a time.

It can used to consider the aggregate cost and benefits of multiple installations of the same type, but generally it is expected that the user will have a specific site in mind in order to input the required parameters and to obtain the most accurate results.

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Tool 2 user guide – tool structure

The tool comprises two input sheets, three outputs sheets and further sheets with databases and references.

Two user input sheets

Three output sheets

Look up lists and databases

Reference Tab	Description
Technical Inputs	*User interface - inputs only.*
Financial Inputs	*User interface - inputs only.*
Feasibility Outputs	*Model outputs - technical and financial parameters.*
Implementation check list	*Check list - to determine the most effective system.*
Flat file and output records	*Database of previous model runs.*
0. Dropdowns	*Reference page used to populate other pages and create dropdown lists.*
1. Heat Source Details	*Database of industries and their relevant heat sources. Includes heat source medium and temperature range.*
2. Heat Sink Details	*Database of industries and their relevant heat sinks. Includes heat sink medium and temperature range.*
3. Tech Matrix	*Database of heat pump technologies and their characteristics.*
4. Refrigerant Details	*Database of refrigerants and their properties.*
5. Heat Transfer	*Database of Specific Heat coefficients (Cp) of different mediums.*
6. Carbon Factors	*Database of carbon emissions factors for different countries and utilities.*
7. Currencies	*Database of currency exchange rates as of 09/06/2022.*
8. CAPEX	*Database of capital expenditure of various projects.*
9. Checklists	*Master Table highlighting the implementation considerations.*

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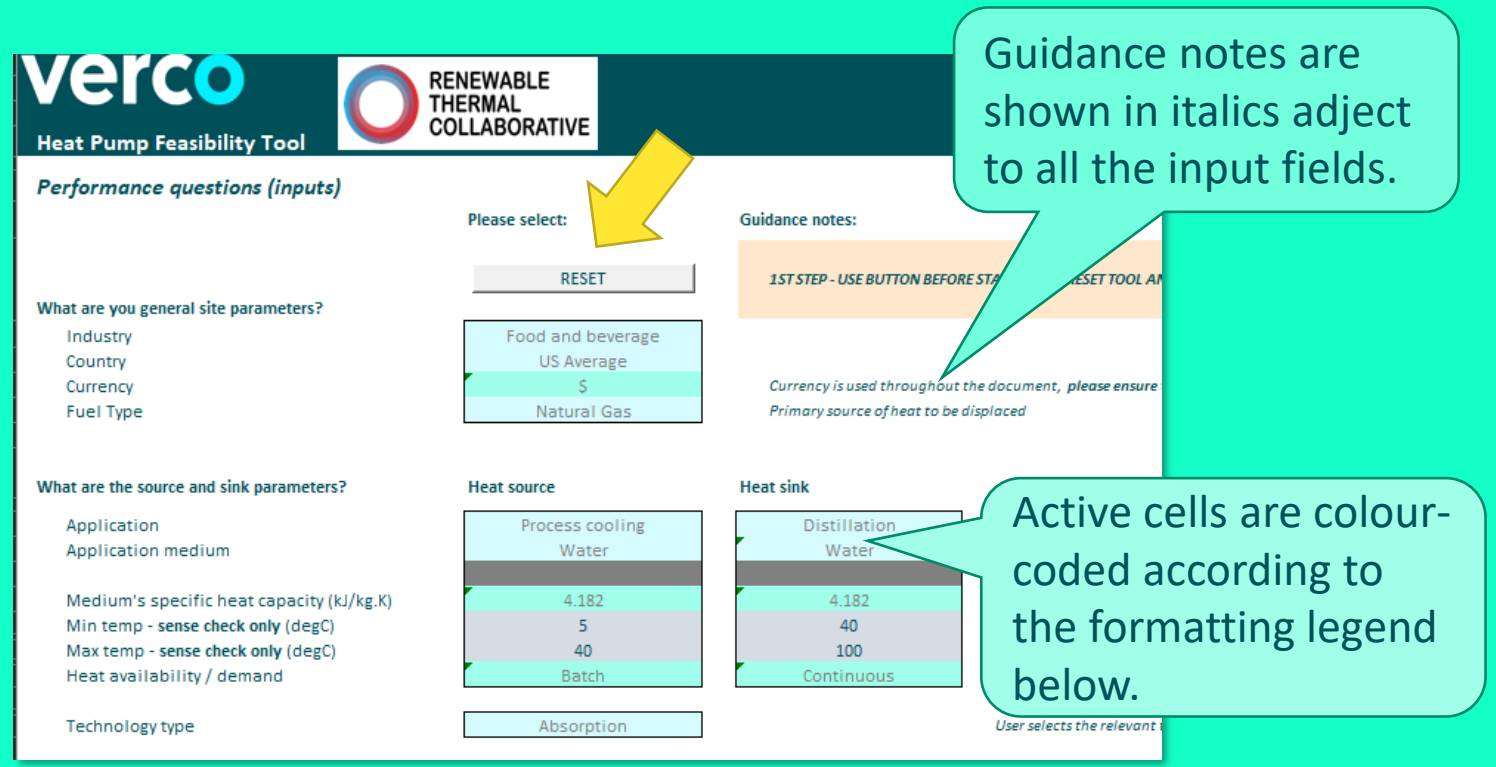
Tool 2 user guide - inputs

When starting, press the RESET button to clear previous inputs.

This also resets some cells that can be overwritten.

The tool may not work correctly if this is not done.

The input cells should be self-explanatory.



Primary input - required
Primary input with pre-populated formula for guidance; ***can be overwritten***
Calculation - read only
Output
Key output

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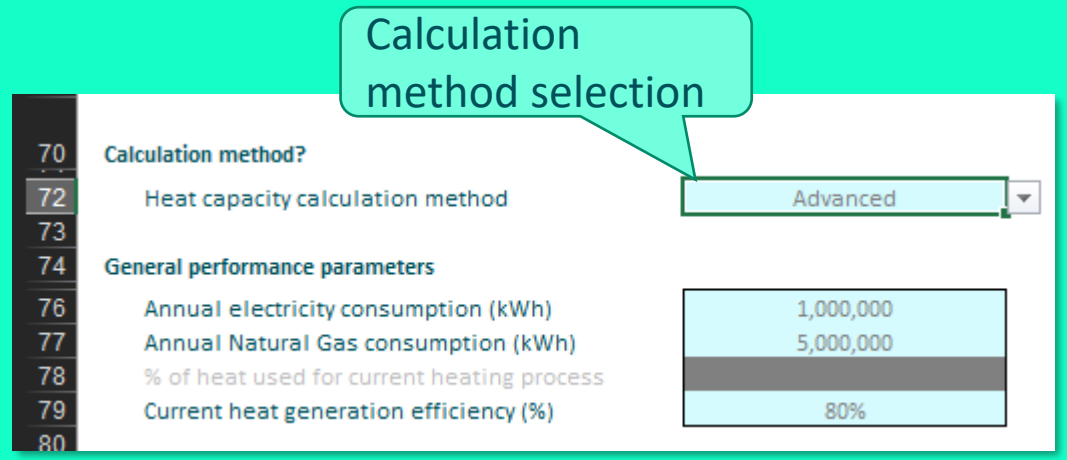
Tool 2 user guide – calculation options

Row 72 of the Technical Input sheet allows the user the choice of **Basic** or **Advanced** calculation options.

If average sink flow rate and sink return temperature are known /can be estimated, then the Advanced method is recommended for more accurate results.

If information is lacking, then the Basic calculation option runs the model with more assumptions and fewer user inputs.



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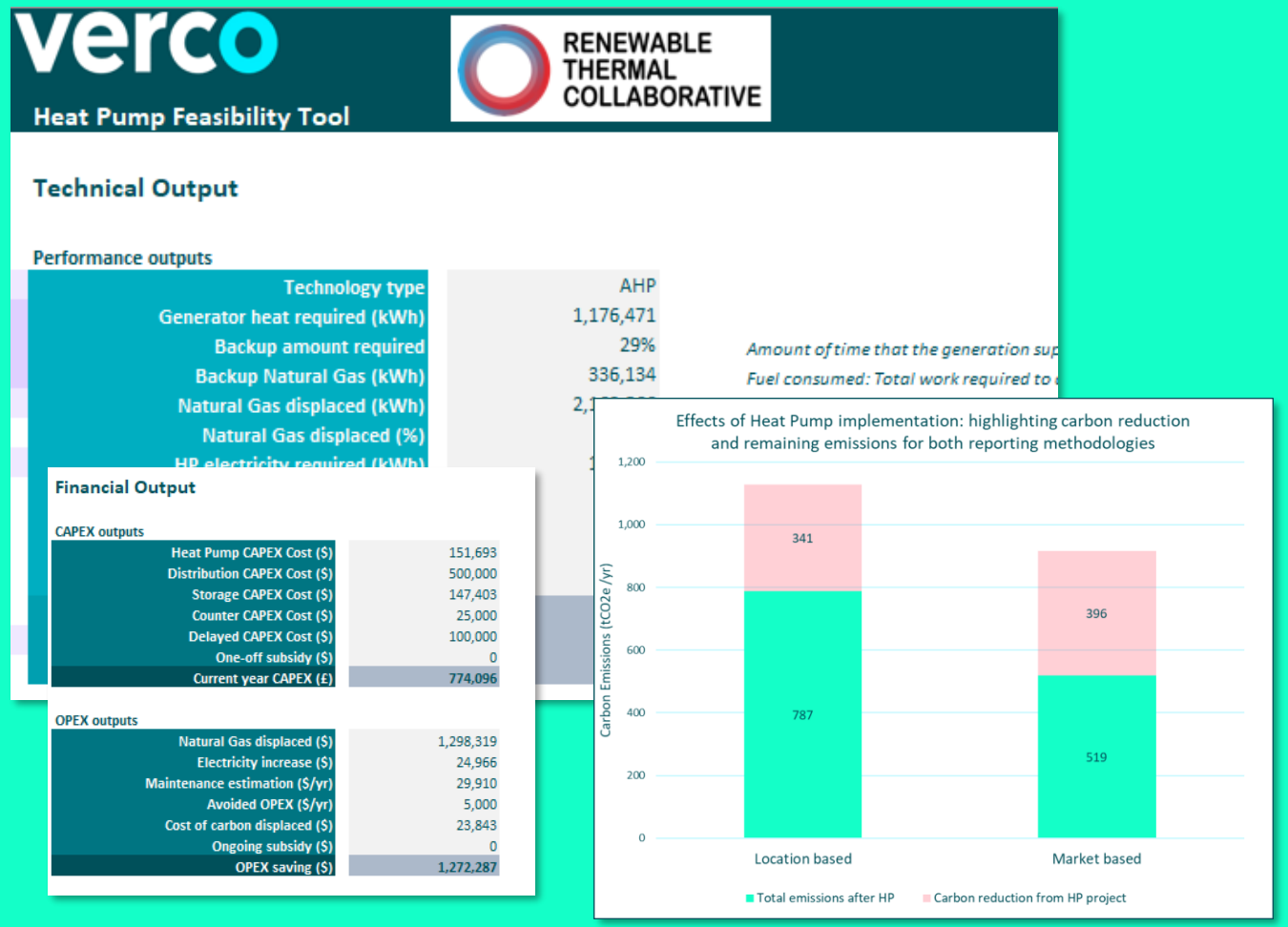
Tool 2 user guide – quantitative outputs

The quantitative outputs are all shown on the ‘Feasibility outputs’ sheet, with further guidance notes where relevant.

Technical and financial outputs are shown on the same sheet.



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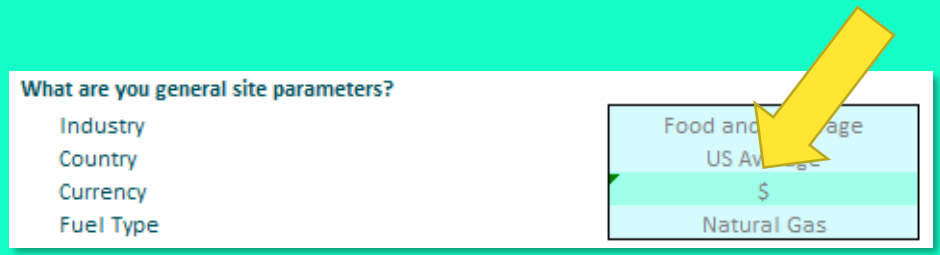
Tool 2 user guide – project cash flows

The currency for the financial analysis is set in the ‘general site parameters’ section of the 'Technical Inputs' tab.

Project cashflows up to year 10 are shown in a table near the bottom of ‘Feasibility outputs’ tab. The cash flows are undiscounted.



Project cashflows - undiscounted and without inflation

		Current	1	2	3
Opex	$	0	-50,353	-50,353	-50,35
Natural Gas displaced	$		*-203,292*	*-203,292*	*-203,29*
Electricity increase	$		*134,408*	*134,408*	*134,40*
Maintenance	$		*36,298*	*36,298*	*36,29*
Avoided OPEX	$		*-5,000*	*-5,000*	*-5,00*
Cost of carbon displaced	$		*-12,767*	*-12,767*	*-12,76*
Capex	$	838,953	0	0	
Heat Pump	$	*250,484*	*0*	*0*	
Distribution	$	*500,969*	*0*	*0*	
Storage	$	*112,500*	*0*	*0*	
Counter	$	*-25,000*	*0*	*0*	
Delayed	$	*0*	*0*	*0*	
Subsidy	$	0	0	0	
One-off subsidy	$	*0*	*0*	*0*	
Ongoing subsidy	$		*0*	*0*	
Net Savings	$	838,953	-50,353	-50,353	-50,35
Cumulative Impact	$	-838,953	-788,601	-738,248	-687,89

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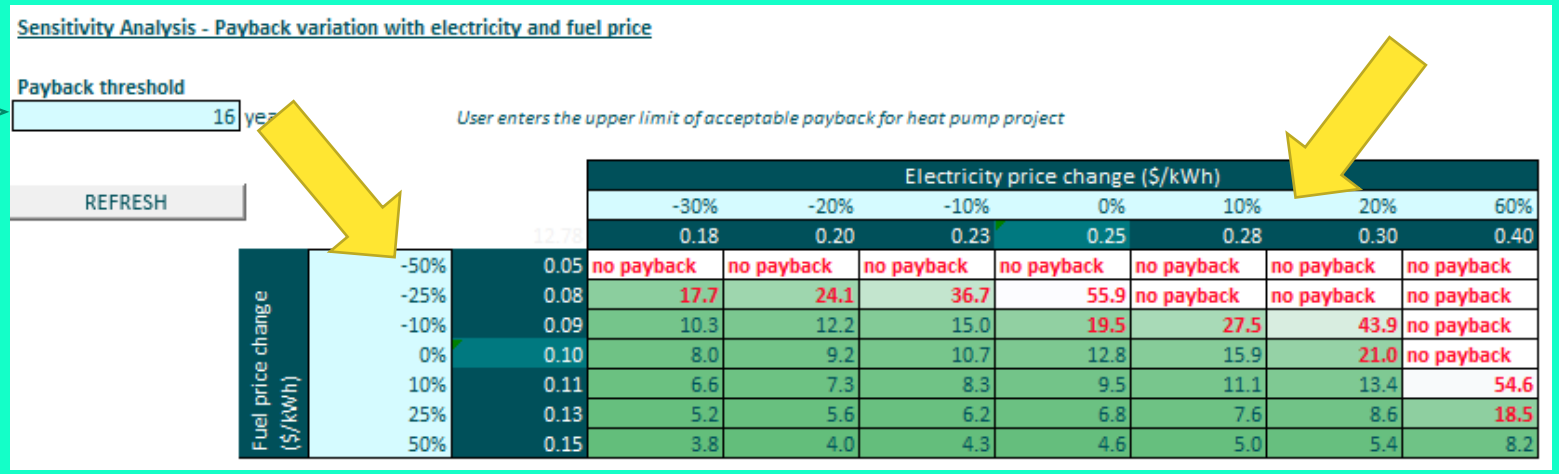
Tool 2 user guide – sensitivity table

At the bottom of 'Feasibility Outputs' tab there is a sensitivity analysis table showing how simple payback period varies due to changes in fuel and electricity prices.

Users enter percentage variations (relative to the previously-entered electricity and fuel prices) clicks the REFRESH button to populate the table with the respective payback periods.

This cell controls the formatting of the table. Payback periods under the threshold are shown in black



Sensitivity Analysis - Payback variation with electricity and fuel price

Payback threshold

16 ye

User enters the upper limit of acceptable payback for heat pump project

REFRESH

Fuel price change ($/kWh)			Electricity price change ($/kWh)						
			-30%	-20%	-10%	0%	10%	20%	60%
			0.18	0.20	0.23	0.25	0.28	0.30	0.40
	-50%	0.05	no payback	no payback	no payback	no payback	no payback	no payback	no payback
	-25%	0.08	17.7	24.1	36.7	55.9	no payback	no payback	no payback
	-10%	0.09	10.3	12.2	15.0	19.5	27.5	43.9	no payback
	0%	0.10	8.0	9.2	10.7	12.8	15.9	21.0	no payback
	10%	0.11	6.6	7.3	8.3	9.5	11.1	13.4	54.6
	25%	0.13	5.2	5.6	6.2	6.8	7.6	8.6	18.5
	50%	0.15	3.8	4.0	4.3	4.6	5.0	5.4	8.2

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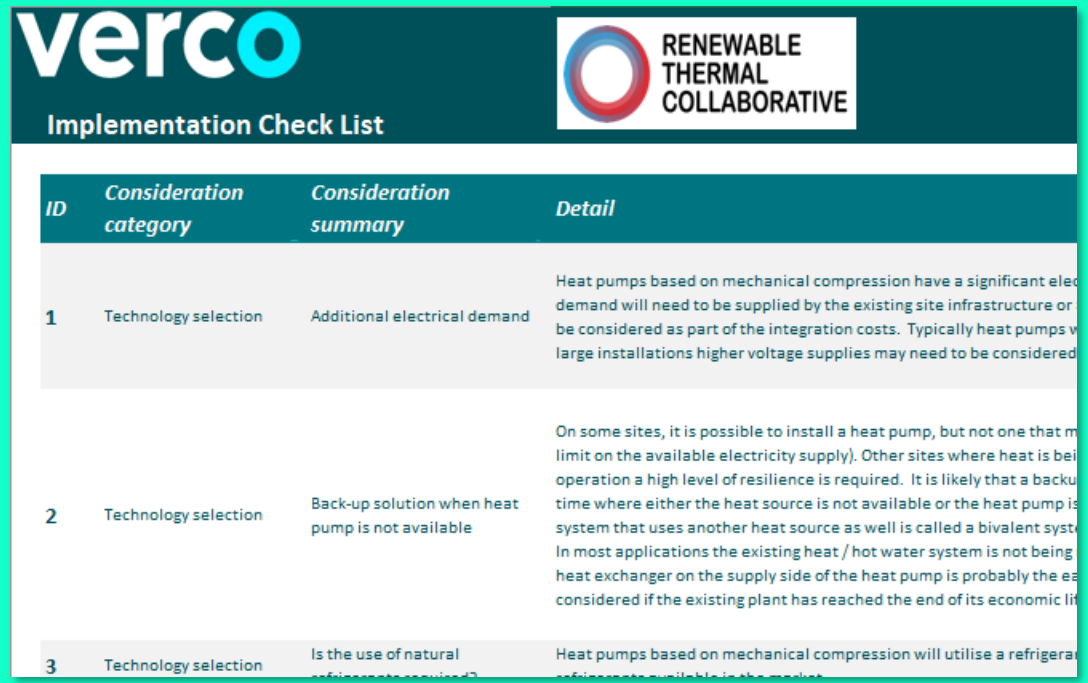
Tool 2 user guide – implementation check list

The ‘implementation check list’ sheet provides practical guidance to refine the initial feasibility and to progress the project concept towards detailed feasibility work.

The objective is to identify and consider all the key issues which may present barriers at the earliest stage possible, before significant time or resources have been spent.

The recommendations are tailored to the application in question, drawing from the full check list database contained in reference sheet 9. 'Checklists'.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Implementation Check List

ID	Consideration category	Consideration summary	Detail
1	Technology selection	Additional electrical demand	Heat pumps based on mechanical compression have a significant elec demand will need to be supplied by the existing site infrastructure or be considered as part of the integration costs. Typically heat pumps w large installations higher voltage supplies may need to be considered
2	Technology selection	Back-up solution when heat pump is not available	On some sites, it is possible to install a heat pump, but not one that m limit on the available electricity supply). Other sites where heat is bei operation a high level of resilience is required. It is likely that a backu time where either the heat source is not available or the heat pump is system that uses another heat source as well is called a bivalent syst In most applications the existing heat / hot water system is not being heat exchanger on the supply side of the heat pump is probably the ea considered if the existing plant has reached the end of its economic li
3	Technology selection	Is the use of natural	Heat pumps based on mechanical compression will utilise a refrigera

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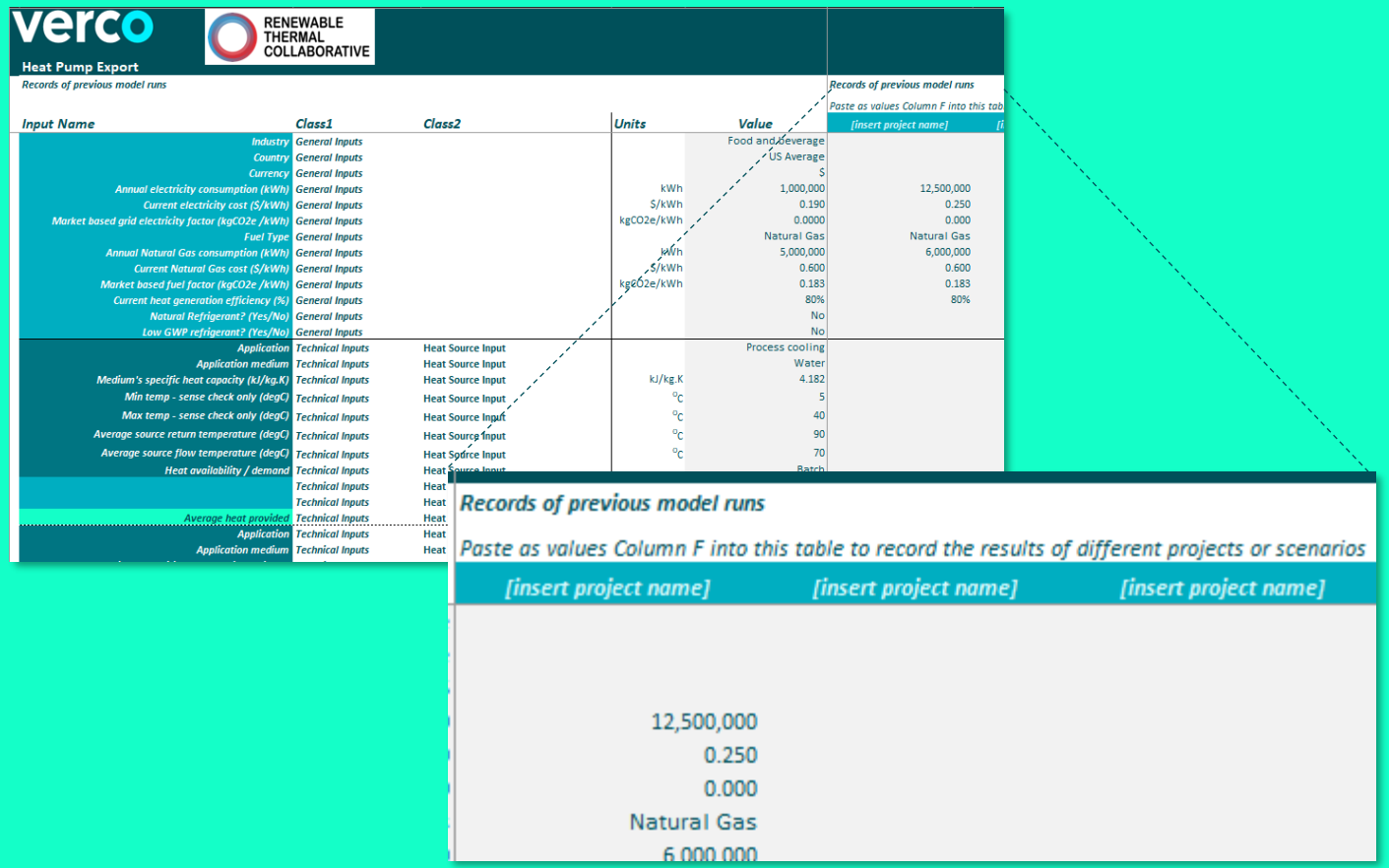
Tool 2 user guide – Flat file and output records

The ‘Flat file and output records’ sheet summarises all the input and output fields in one place for easy export.

There are unlocked columns (column G and to the right) for the user to paste the results of previous model runs alongside the ‘live’ model outputs for comparison.



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Tool 3: Supplier database

Tool 3 user guide - general tool description

Tool 3 is designed to help identify suitable manufacturers and suppliers that can deliver services in the following areas:

1) Equipment manufacturing

2) Design and engineering

3) Supply, installation, and commissioning

4) Ongoing operation and maintenance support

This tool filters by the country the project is based in and the technology of interest, providing contact details and website links for the most appropriate manufacturers and providers.

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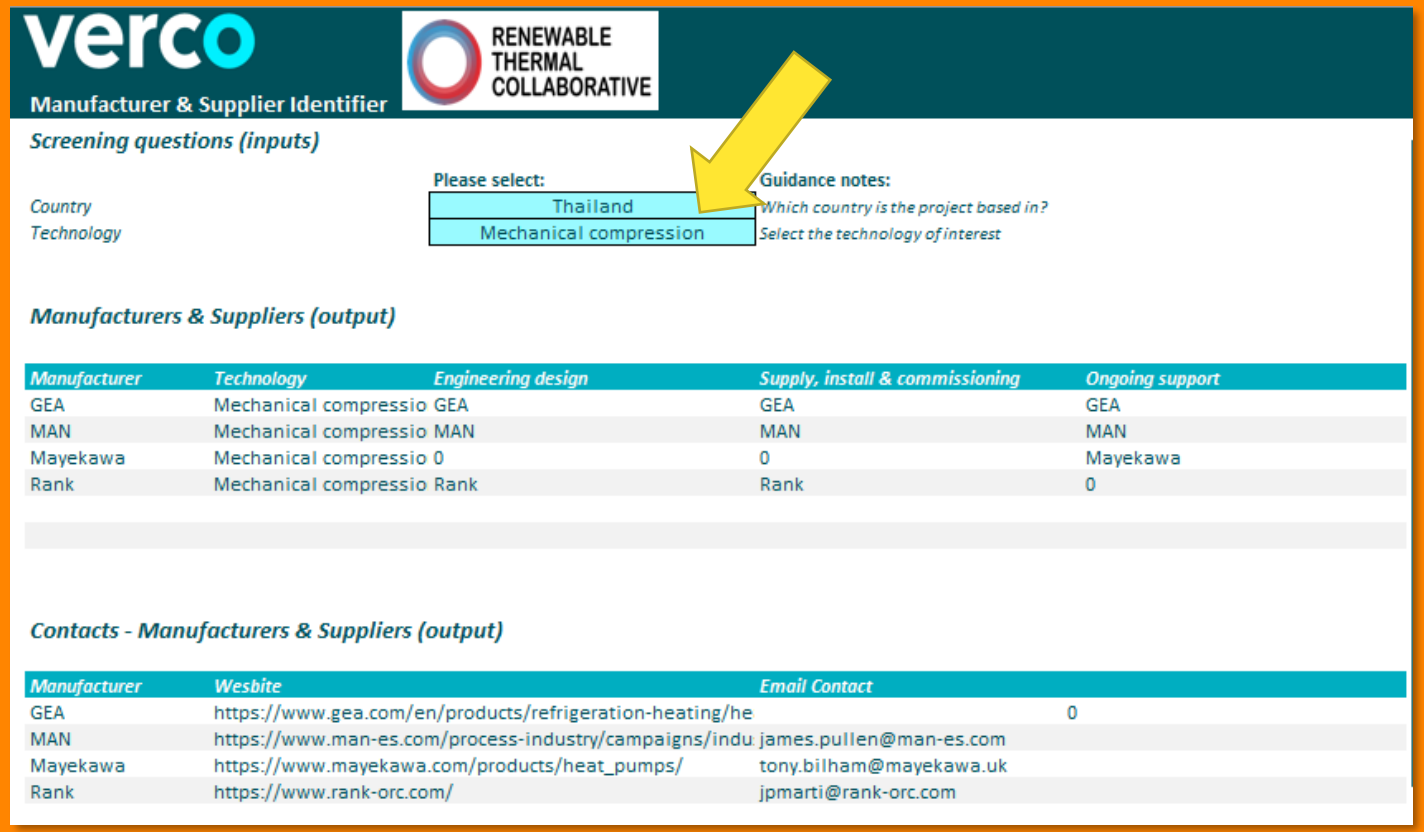
Tool 3 user guide - inputs

This tool requires two inputs in order to find appropriate manufacturers and suppliers:

1) The country the project is based in e.g. Thailand

2) The technology of interest e.g., mechanical compression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Manufacturer & Supplier Identifier

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Screening questions (inputs)

	Please select:	Guidance notes:
Country	Thailand	*Which country is the project based in?*
Technology	Mechanical compression	*Select the technology of interest*

Manufacturers & Suppliers (output)

Manufacturer	*Technology*	*Engineering design*	*Supply, install & commissioning*	*Ongoing support*
GEA	Mechanical compressio	GEA	GEA	GEA
MAN	Mechanical compressio	MAN	MAN	MAN
Mayekawa	Mechanical compressio	0	0	Mayekawa
Rank	Mechanical compressio	Rank	Rank	0

Contacts - Manufacturers & Suppliers (output)

Manufacturer	*Wesbite*	*Email Contact*	
GEA	https://www.gea.com/en/products/refrigeration-heating/he		0
MAN	https://www.man-es.com/process-industry/campaigns/indu	james.pullen@man-es.com	
Mayekawa	https://www.mayekawa.com/products/heat_pumps/	tony.bilham@mayekawa.uk	
Rank	https://www.rank-orc.com/	jpmarti@rank-orc.com	

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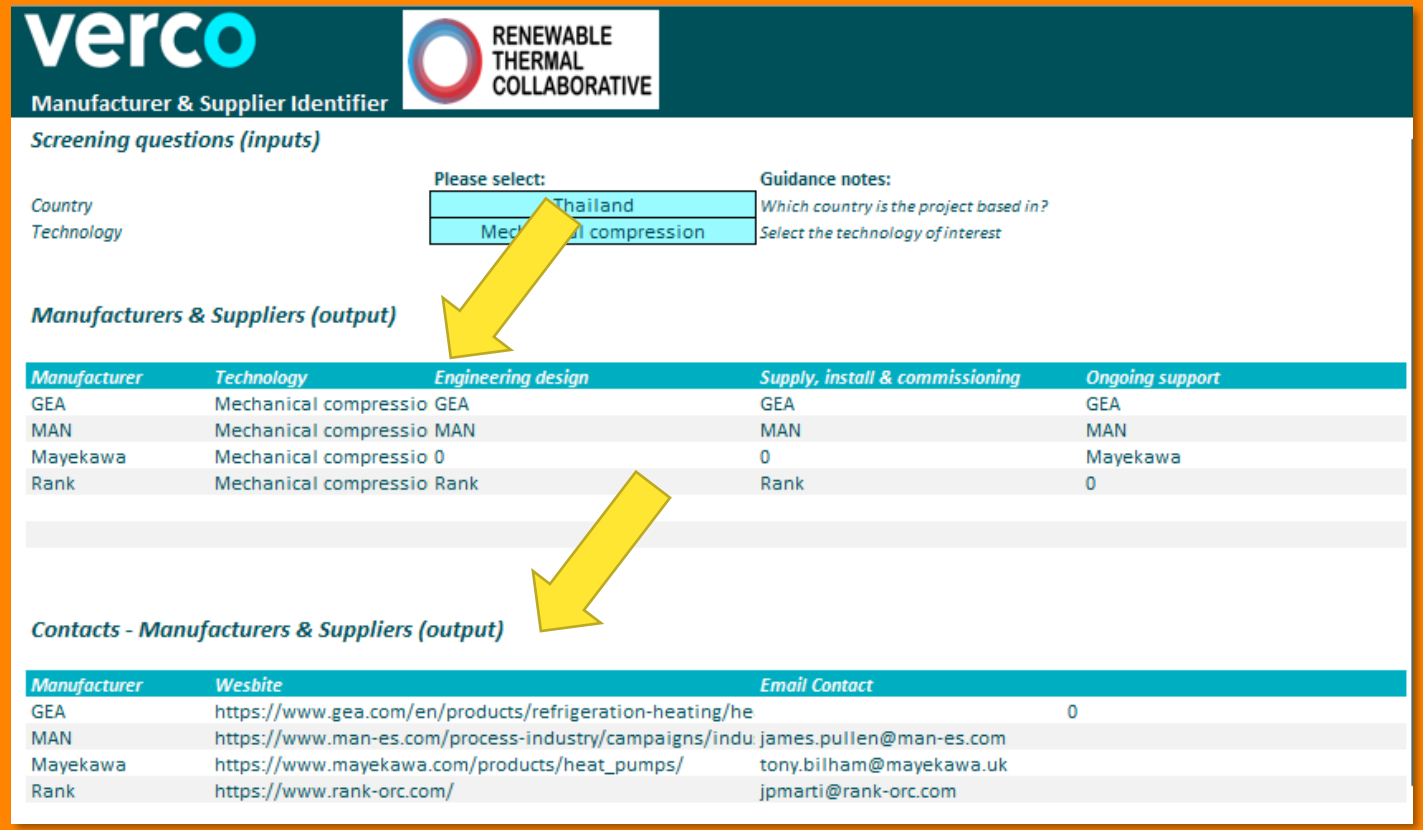
Tool 3 user guide - outputs

Using the inputs provided by the user the tool calculates the following outputs:

1) Table of suitable manufacturers & suppliers and their areas of operation, e.g. engineering design, ongoing support

2) Email contacts and website links to the manufacturers and suppliers identified



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Manufacturer & Supplier Identifier

RENEWABLE THERMAL COLLABORATIVE

Screening questions (inputs)

	Please select:	Guidance notes:
Country	Thailand	*Which country is the project based in?*
Technology	Mec l compression	*Select the technology of interest*

Manufacturers & Suppliers (output)

Manufacturer	*Technology*	*Engineering design*	*Supply, install & commissioning*	*Ongoing support*
GEA	Mechanical compressio	GEA	GEA	GEA
MAN	Mechanical compressio	MAN	MAN	MAN
Mayekawa	Mechanical compressio	0	0	Mayekawa
Rank	Mechanical compressio	Rank	Rank	0

Contacts - Manufacturers & Suppliers (output)

Manufacturer	*Wesbite*	*Email Contact*	
GEA	https://www.gea.com/en/products/refrigeration-heating/he		0
MAN	https://www.man-es.com/process-industry/campaigns/indu	james.pullen@man-es.com	
Mayekawa	https://www.mayekawa.com/products/heat_pumps/	tony.bilham@mayekawa.uk	
Rank	https://www.rank-orc.com/	jpmarti@rank-orc.com	

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