Final product document

The potential customer base of our app is huge, including engineers, students, construction workers, etc. No matter what purpose they use this app, they must go through the same operation process to get the information they want. The following is the introduction to the detailed process of our APP.

Step 1: Upon opening the app, users can choose between dark or light background colour and green and brown button colour. We also provide a function to select their preferred language(English, French, Chinese, or Spanish). They must agree to the terms and conditions before proceeding.

Step 2: On the second page, users are introduced to two construction methods: IGSHPA and ASHRAE. Within the IGSHPA method, three sub-methods (horizontal, vertical, and horizontal trench) are available for selection. Users can click on the "i" symbol for more detailed information about each method.

Step 3: After selecting the desired method, users proceed to the next page, where they input various parameters needed for pipeline construction. The "i" symbol explains each parameter, and users can select different units to ease conversion.

Below shows our sample data which is needed to be filled in to get the final result(all the sample data is the recommended value for the building recommendation)

Common parameters will be marked in black
IGSHPAHB unique parameters will be marked in green
IGSHPAHT unique parameters will be marked in yellow
ASHRAE unique parameters will be marked in blue

Heat Pump Specification

Heat pump specifications include heating and cooling capacity, energy efficiency ratings, refrigerant type, noise level, airflow, controls and features, installation requirements, and warranty.

Parameter	Detail info	Default value
COP(D)	Designed Coefficient of Performance.	4
EER(D)	Energy Efficiency Ratio at design cooling condition.	14.5
HC(D)	Total Heating Capacity of the Heat Pump at design conditions.	20 kW, 68242.84 BTU/h or 5.687 TR

TC(D)	Total Cooling Capacity of the Heat Pump at design conditions.	20 kW, 68242.84 BTU/h or 5.687 TR
Cp	Ground Heat Exchanger (GHE) fluid (water) thermal heat capacity.	4000 J/kg K or 955.384 BTU/lb ℉
T(inHP)	Heat Pump Entering Water Temperature.	4.4 ℃ or 39.92 ℉
m(fls)	Mass Flow Rate of Fluid per kilowatt of peak hourly ground load.	0.074 kg/s kW

Heat Pump Design Conditions

Heat pump design conditions refer to the specific parameters and criteria used to determine the performance and efficiency of a heat pump system.

Parameter	Detail info	Default value
EWT(min)	Minimum Entering Water Temperature at heating design conditions.	4 ℃ or 39.2 ℉ for Melbourne
LWT(min)	Minimum Leaving Water Temperature at heating design conditions.	1 ℃ or 33.8 ℉ for Melbourne
EWT(max)	Maximum Entering Water Temperature at heating design conditions.	30 ℃ or 86 ℉ for Melbourne
LWT(min)	Maximum Leaving Water Temperature at heating design conditions.	34 ℃ or 93.2 ℉ for Melbourne
RT(CLG)	Actual Equipment Run Time in cooling mode per month.	476 h
RT(HTG)	Actual Equipment Run Time in heating mode per month.	476 h

Ground Properties

Ground properties refer to the physical characteristics and composition of the Earth's surface, including soil type, moisture content, thermal conductivity, and bearing capacity.

Parameter	Detail info	Default value

k(G)	Ground Thermal Conductivity.	1.73 W/(m·℃) or 1 BTU/(h ft ℉ for Melbourne"
T(G)	Deep – Earth Temperature.	18 ℃ or 64.4 ℉ for Melbourne"
D(G,O)	Diameter of the ground surrounding the borehole affected by heat transfer.	4.572 m or 15 ft
T(M)	Mean Earth Temperature in top 10 feet of soil.	24 ℃ or 75.2 ℉ for Melbourne
A(S)	Annual Swing of earth surface temperature above and below TM.	-0.1 ℃ or 31.82 ℉ for Melbourne
α	Soil Thermal Diffusivity.	0.06 m²/day or 0.646 ft²/day for Melbourne
k	Ground Thermal Conductivity.	1.73 W/m K or 1 BTU/h ft ℉ for Melbourne
Tg	Undisturbed Ground Temperature.	12.41 ℃ or 54.338 ℉ for Melbourne
q(y)	Yearly Average Ground Load.	-1.762 kW, -6012.194 BTU/h or -0.501 TR
q(m)	Monthly Ground Load.	-100 kW, -341214.2 BTU/h or -28.435 TR
q(h)	Hourly Average Ground Load.	-392.25 kW, -1338412.699 BTU/h or -111.534 TR

Borehole Parameters

Borehole parameters refer to the key characteristics and measurements associated with a borehole, such as depth, diameter, geology, water table level, and drilling method.

Parameter	Detail info	Default value
D(B)	Diameter of Borehole.	0.128 m or 5.039 in
D(P,O)	Outer Pipe Diameter.	0.027 m or 1.063 in

D(P,I)	Inner Pipe Diameter.	0.022 m or 0.866 in
k(Grout)	Grout Thermal Conductivity.	0.692 W/(m·℃) or 0.399 BTU/h ft ℉"
k(P)	Pipe Thermal Conductivity.	0.346 W/(m·℃) or 0.120 BTU/h ft ℉
d	Average Pipe Depth.	3.1 m or 10.170 ft
B	Distance between boreholes.	6.1 m or 20.013 ft
NB	Number of Borehole GHEs.	120
A	Borefield Geometrical Aspect Ratio.	1.2
r(bore)	Radius of Borehole.	0.054 m 2.126 in
Lu	Centre-to-centre distance between pipes of U loop.	0.0471 m or 1.854 in
r(p,in)	Inner Radius of U loop.	0.0137 m or 0.539 in
r(p,ext)	Outer Radius of U loop.	0.0167 m or 0.657 in
k(pipe)	Pipe Thermal Conductivity.	0.346 W/m K or 0.120 BTU/h ft ℉
H(conv)	Internal Convection Coefficient.	1000 W/m² K or 176.11 BTU/h ft ℉

Trench Pipe Parameters

Trench pipe parameters include dimensions, material, installation depth, and load-bearing capacity.

Parameter	Detail info	Default value
D(P,O)	Outer Pipe Diameter.	0.027 m or 1.063 in
D(P,I)	Inner Pipe Diameter.	0.022 m or 0.866 in
k(P)	Pipe Thermal Conductivity.	0.346 W/(m·℃) or 0.120 BTU/h ft ℉
d	Average Pipe Depth.	3.1 m or 10.170 ft

S(M)	Trench Spacing Multiplier.	1.2
P(M)	Pipe Diameter Multiplier.	1

Step 4: Users can customise the input length of a single pipe or the total number of pipes, ensuring the final recommended setting aligns with their expectations. Once all parameters are entered, users click the calculation button to proceed.

Borehole Configuration (optional)

Borehole configuration refers to the layout and arrangement of boreholes for geothermal or ground source heat pump systems.

Parameter	Detail info	Default value
Borehole Number	Number of boreholes.	
Borehole Length	Max length of a single borehole.	

Trench Configuration (optional)

Trench configuration refers to the arrangement or layout of trenches used for heat pump installations.

Parameter	Detail info	Default value
Number of Trenches	Number of Trenches	
Pipes Per Trench	Number of Pipes in each Trench.	

Step 5: After entering the final result display page showcases the user's entered parameters for confirmation. our app provides build recommendations and corresponding images to help users visualise the ideal build setup. Users can also save the results by entering an email address to receive all information records. Moreover, If users seek more detailed pipeline construction settings, they can enter their personal information (name, phone number, address) to request further advice from 4ee.）