



***DEAP Heat Pump Methodology Proposed changes***

***For Public Consultation: Q2 2019***

V1.1

---

## Contents

<b>1</b>	<b><i>Introduction</i></b> .....	<b>3</b>
<b>2</b>	<b><i>Changes based on revised EN15316-4-2:2017</i></b> .....	<b>5</b>
<b>3</b>	<b><i>A/W, B/W and W/W electric heat pumps</i></b> .....	<b>6</b>
<b>4</b>	<b><i>Exhaust Air (EAHP)</i></b> .....	<b>7</b>
4.1	<b><i>Accounting for renewable energy contribution in EAHP</i></b> .....	<b>7</b>
<b>5</b>	<b><i>Direct Exchange (DX) electric heat pumps</i></b> .....	<b>9</b>
<b>6</b>	<b><i>“To-air” electric heat pumps</i></b> .....	<b>10</b>
<b>7</b>	<b><i>Double-duct heat pumps and heat recovery systems incorporating heat pump functionality</i></b> .....	<b>11</b>
<b>8</b>	<b><i>A/W, B/W, W/W Gas fired (GAHP) heat pumps</i></b> .....	<b>12</b>
<b>9</b>	<b><i>Accounting for the heat pump degradation coefficient, Cdh</i></b> .....	<b>13</b>
<b>10</b>	<b><i>Other refinements in the heat pump calculation</i></b> .....	<b>15</b>
10.1	<b><i>Refinement to “standard rating conditions”</i></b> .....	<b>15</b>
10.2	<b><i>Avoiding negative COPs in interpolation formula</i></b> .....	<b>15</b>
<b>11</b>	<b><i>Revised approach to backup (bivalent) heating systems</i></b> .....	<b>17</b>
<b>12</b>	<b><i>Variations of group / individual systems and multiple heat pumps</i></b> .....	<b>18</b>

## 1 Introduction

This document outlines the changes proposed by SEAI's EPBD/NZEB programmes to the methodology and calculations for heat pumps entered in DEAP assessments for BERs and Part L compliance checking in dwellings. These changes are proposed to the existing methodology and associated calculation algorithms published since early 2016 on the SEAI website<sup>1</sup>. The text in this document is not to be considered as guidance for BER assessments or Part L compliance checking until the resulting revised heat pump methodology is published by SEAI after the public consultation period.

Prior to implementation of the proposed changes, SEAI are seeking feedback via a public consultation specifically on the content of this document. This document is accompanied by a feedback template which must be used for any responses to the consultation. Feedback on items beyond the scope of this document (i.e. not related to the proposed changes to the heat pump methodology herein) will not be considered during this consultation. As always, where respondents are not in agreement with proposed changes, SEAI welcome constructive alternative proposed approaches. These alternatives should be based on relevant European standards where possible and will be considered by SEAI where possible, particularly where they are feasible to implement in the methodologies and for use by BER Assessors. Some changes may be retained for consideration for future updates to the methodology if not feasible within the short term. Other changes may not be considered appropriate and therefore might not be implemented in the methodology.

**Submissions must be returned in the template format accompanying this document (MS Excel format or equivalent), and emailed to the BER Helpdesk ([info@ber.seai.ie](mailto:info@ber.seai.ie)) no later than 5pm on Friday 17<sup>th</sup> of May 2019.**

This document focusses on enhanced technical improvements to the DEAP heat pump calculation methodology and expansion thereof to account for a wider range of heat pump types and does not focus on the following changes to the heat pump methodology:

- While SEAI are in the process of developing Version 4 of DEAP, and will be integrating the MS Excel heat pump calculator into DEAP, this is not referenced in any depth in this document. The calculation algorithms and results will be the same regardless of whether they are published in DEAP 4 or MS Excel.
- SEAI intend to facilitate listing of heat pump Ecodesign efficiency data for use in the heat pump calculation in an online database such as HARP to increase ease of use of the heat pump methodology and increase accurate data entry for BER assessments. This integration of Ecodesign data into an online SEAI database is not referenced further in this document.

The technical changes proposed in this document are based on the following core issues:

- Implement changes to account for the following:
  - Revised standard EN15316-4-2 updated from 2008 to 2017<sup>2</sup> version
  - Direct-exchange (DX) heat pumps
  - Gas fired heat pumps (GAHP)
  - Low temperature heat pumps for space heating only
  - Exhaust air heat pumps (EAHP)
  - Double-duct heat pumps and heat recovery systems incorporating heat pump functionality
  - New approach to bivalent systems and clarification for buildings heated by more than one heat pump
  - Accounting for the "degradation coefficient" in oversized heat pumps
  - Other calculation refinements

NB the heat pump calculation will continue to operate on the premise that test data is always based on source and sink temperatures detailed at test points in the relevant EN standards. These standards and associated test points are referenced throughout this document.

The heat pump calculation methodology will enable the user to select options as follows. Many of these choices are already available in the 2016 SEAI DEAP heat pump Excel tool.:

- Select heat pump type from one of the following options. These are electric heat pumps unless otherwise indicated:
  - A/W (Electric or GAHP)
  - B/W (Electric or GAHP)
  - W/W (Electric or GAHP)

<sup>1</sup> <https://www.seai.ie/energy-in-business/ber-assessor-support/deap/#comp00005970b18b0000006cc77a27>

<sup>2</sup> Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-2: Space heating generation systems, heat pump systems

- 
- A/A
  - B/A
  - W/A
  - EAHP
  - Double duct air conditioner / heat recovery systems incorporating heat pump functionality
  - Direct exchange (DX)
- Heating type: space heating, water heating or both.
  - “Low temperature heat pump” (applies to DX, EAHP and “to water” units). These units are for space heating only.

This document details the relevant standards and test point temperatures for all heat pump types to be catered for in the revised heat pump calculation methodology.

#### **Approach to Renewable Energy Ratio (RER) for heat pumps**

The RER for heat pumps will be calculated as specified in the wider DEAP methodology in line with EN ISO 52000 -2017 as detailed in the recent public consultation<sup>3</sup> for updates to DEAP, Part L and TGD L. Derivation of the RER is therefore not detailed further in this document other than for EAHPs.<sup>4</sup>

#### **Approach to heat pumps in Non-domestic Energy Assessment Procedure (NEAP)**

SEAI have recently updated the NEAP assessment methodology to cater for updates in the Simplified Building Energy Model (SBEM) as well as introduction of NZEB Part L for non-domestic buildings. In the longer term, SEAI will be adapting a heat pump calculation methodology like that used for DEAP for the purposes of NEAP assessments. Until then, BER Assessors must follow the approach detailed in the latest published NEAP Survey Guide and iSBEM User Guide.

#### **Ecodesign requirement**

The regulations implementing the Ecodesign directive (e.g. regulations 813/2013 and 206/2012) specify the dates from which space and water heaters are required to meet the Ecodesign requirements in those regulations. Heat pumps should only be specified as providing space heating and/or water heating in DEAP assessments if they meet Ecodesign requirements detailed in the relevant regulations and were placed on the market on or after the applicable dates in those regulations.

---

<sup>3</sup> <https://www.housing.gov.ie/housing/building-standards/tgd-part-f-ventilation/public-consultation-review-part-l-f-building>

<sup>4</sup> A heat pump is not considered to provide any renewable contribution for the purposes of Part L RER calculation when it sources heat from a circuit “pre-heated” by another heat source rather than from ambient air/water/ground. If the “pre-heat” is provided by a heat pump, then that pre-heating heat pump is considered to provide a renewable contribution as it sources heat from ambient air/water/ground. This guidance applies in cases both where the pre-heat circuit is part of a group or individual heating scheme. Section 12 in this document details a range of different system types.

## 2 Changes based on revised EN15316-4-2:2017

The standard underpinning the calculation methodology in the 2016 DEAP heat pump calculator was:

***I.S. EN 15316-4-2:2008 - Heating Systems in Buildings - Method for Calculation of System Energy Requirements and System Efficiencies Part 4-2: Space Heating Generation Systems, Heat Pump Systems***

This has been superseded by:

***I.S. EN 15316-4-2:2017: Energy Performance of Buildings - Method for Calculation of System Energy Requirements and System Efficiencies Part 4-2: Space Heating Generation Systems, Heat Pump Systems, Module M3-8-2, M8-8-2***

The existing heat pump calculation methodology was reviewed against the new standard as IS EN15316-4-2 is heavily relied upon in the space heating calculation in the heat pump calculation. Changes arising from the update to IS EN 15316-4-2 are primarily aesthetic rather than technical/algorithmic. In other words, the calculations in the heat pump calculator largely do not change due to the latest version of this standard. Where references to formulae and content in EN15316-4-2 have changed, these will be updated in the SEAI heat pump calculator.

**The only calculation change arising from the updated standard is as follows:**

The current published heat pump Excel calculator (2016) details the calculations for space heating on the “Heating Calc” tab. The standard reference for the COP Correction Factors detailed in Rows 52 and 53 as per the following screenshot was Equation (11) in EN15316-4-2:2008 and is now located in Equation (D.8) in EN15316-4-2:2017, accompanied by fluid temperature differences in Table D.1:

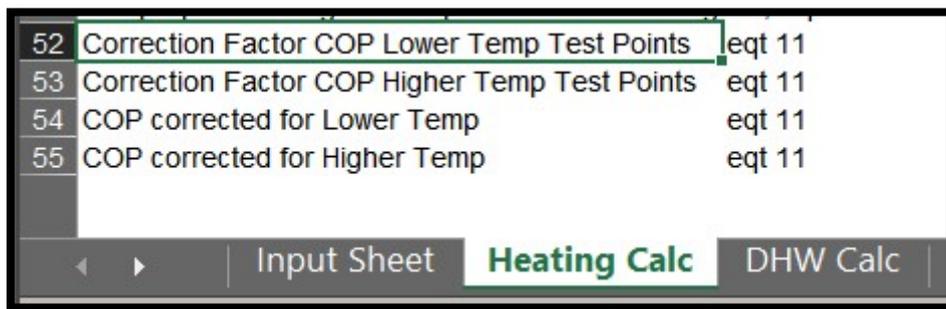


Figure 1: COP Correction Factor in heat pump calculator

The constant values for  $\Delta T_{sk}$  and  $\Delta T_{sc}$ <sup>5</sup> (annotated as  $\vartheta_{HP;gen;cond;int}(t)$  and  $\vartheta_{HP;gen;evap;int}(t)$  in the 2017 version of the EN 15316-4-2 standard) have increased from 4K to 5K. This change will be implemented in the above COP Correction Factors in the DEAP heat pump calculation.

<sup>5</sup> Respectively, these are:

- The average temperature difference between heat transfer medium and refrigerant in condenser in degrees Kelvin.
- The average temperature difference between heat transfer medium and refrigerant in evaporator in degrees Kelvin.

### 3 A/W, B/W and W/W electric heat pumps

The heat pump calculator already caters for this type of heat pump. Figure 2 summarises the applicable standards and test points noting that:

1. The standard EN14825 was updated in 2016. The test point temperatures and part load settings therein have **not** changed from that in the DEAP heat pump methodology published in 2016, but the EN14825 table number references have changed with the revision of EN14825. The new table references will be shown in the revised heat pump calculation (e.g. A/W space heating test points are now in tables 8-11 of EN14825:2016).
2. The terminology for different grades of “temperature application” has been revised so that Ecodesign and EN14825 use the same terminology as follows. The revised terminology will be used in the SEAI heat pump calculator:
  - a. **35°C** sink temperature is still called the “**low** temperature” application
  - b. **45°C** sink temperature was called the “medium temperature” application but is now the “**intermediate** temperature” application
  - c. **55°C** sink temperature was called the “high temperature application” but is now the “**medium** temperature” application
  - d. **65°C** sink temperature was called the “very high temperature” application but is now the “**high** temperature” application
3. Introduction of a “Low temperature” heat pump for A/W, B/W and W/W. These will only require “low temperature” 35°C test results. Low temperature heat pumps do not provide hot water.
4. If not a “low temperature heat pump”, the “medium temperature” 55°C test point is mandatory, as is the case in the current published heat pump calculator.
5. Test results for hot water generally must be from EN16147 tests, although there will be limited circumstances in group heating schemes where this is not mandatory. These limited circumstances are detailed in Section 12 of this document.

Heat pump type	Electric/ GAHP?	Space heating? Water heating?	Test standard	Source temps degC	Sink temperatures (fixed) deg C @ part loads: 88%; 54%; 35%; 15%; 100%				Sink temperatures (variable) deg C @ part loads: 88%; 54%; 35%; 15%; 100%				How to treat low temperature version of this heat pump	Approach where ecodesign n/a
					Low temp application	Intermediate temp	Medium temp	High temp	Low temp application	Intermediate temp	Medium temp	High temp		
A/W	Electric	Space	EN14825:2016 Table 8, 9, 10, 11	-7; 2; 7; 12; TOL	35	45	55	65	34; 30; 27; 24; 35	43; 37; 33; 28; 45	52; 42; 36; 30; 55	61; 49; 41; 32; 65	"Low temp application" only temp required for low temp heat pumps. Medium temp mandatory otherwise No DHW mode for low temp option	Unchanged. DEAP Appendix G/HARP and Table 4c. EN14511/255-2/255-3
		Water	EN16147	7	Reference hot water temperature in EN16147 test									
B/W	Electric	Space	EN14825:2016 Table 12, 13, 14, 15	0	All sink test points identical to A/W electric heat pumps								"Low temp application" only temp required for low temp heat pumps. Medium temp mandatory otherwise No DHW mode for low temp option	Unchanged. DEAP Appendix G/HARP and Table 4c. EN14511/255-2/255-3
		Water	EN16147	0										
W/W	Electric	Space	EN14825:2016 Table 12, 13, 14, 15	10	All sink test points identical to A/W electric heat pumps								"Low temp application" only temp required for low temp heat pumps. Medium temp mandatory otherwise No DHW mode for low temp option	Unchanged. DEAP Appendix G/HARP and Table 4c. EN14511/255-2/255-3
		Water	EN16147	10										

Figure 2: Test temperatures and standards for A/W, B/W, W/W heat pumps

## 4 Exhaust Air (EAHP)

The EAHP is catered for in the existing SEAI heat pump calculator. Figure 3 summarises the applicable standards and test points noting that:

1. The standard EN14825 was updated in 2016 and details the source temperature for space heating as 20°C as reflected in the table below. This will be accounted for in the SEAI heat pump calculation methodology.
2. The low temperature heat pump option will be catered for in the heat pump calculator for EAHP's
3. The EAHP ventilation rate (in m<sup>3</sup>/hr) will be recorded in the DEAP Ventilation tab. This figure will be used toward calculating the share of renewable energy as outlined below. In addition, the ventilation rate will be used by DEAP to calculate the impact of ventilation rate on the mechanical ventilation system energy. This will help ensure that systems are not oversized

Heat pump type	Electric/ GAHP?	Space heating? Water heating?	Test standard	Source temps degC	Sink temperatures (fixed) deg C @ part loads: 88%; 54%; 35%; 15%; 100%				Sink temperatures (variable) deg C @ part loads: 88%; 54%; 35%; 15%; 100%				How to treat low temperature version of this heat pump	Approach where ecodesign n/a
					Low temp application	Intermediate temp	Medium temp	High temp	Low temp application	Intermediate temp	Medium temp	High temp		
EAHP (A/W data applies for RER calculations)	Electric	Space	EN14825:2016 Table 8, 9, 10, 11	20	35	45	55	65	34; 30; 27; 24; 35	43; 37; 33; 28; 45	52; 42; 36; 30; 55	61; 49; 41; 32; 65	"Low temp application" only temp required for low temp heat pumps. Medium temp mandatory otherwise	Unchanged. DEAP Appendix G/HARP and Table 4c. EN14511/255-2/255-3
		Water	EN16147	20	Reference hot water temperature in EN16147 test								No DHW mode for low temp option	

Figure 3: Test temperatures and standards for Exhaust Air Heat Pumps

### 4.1 Accounting for renewable energy contribution in EAHP

Renewable contribution must align to the relevant directive as follows: **Renewables directive 2018/2001**

- (1) 'energy from renewable sources' or 'renewable energy' means energy from renewable non-fossil sources, namely wind, solar (solar thermal and solar photovoltaic) and geothermal energy, ambient energy, tide, wave and other ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas, and biogas;
- (2) '**ambient energy**' means **naturally occurring thermal energy and energy accumulated in the environment with constrained boundaries, which can be stored in the ambient air, excluding in exhaust air**, or in surface or sewage water;

This means that energy recovered from the dwelling via heat recovery (either in a conventional ventilation system with heat recovery or a heat pump incorporating heat recovery) is not renewable. Therefore, for an exhaust air heat pump, the energy extracted from ambient (external) environment must be distinguished from the heat recovered from the dwelling. The "share of renewable energy" will be calculated by the SEAI heat pump calculator for EAHP's to align to the above directive requirements, so DEAP can determine what the renewable contribution from the EAHP as a share of the heat pump's refrigeration capacity. The approach detailed below means that only the test points in Figure 3 above will be required for the heat pump calculator to derive the EAHP renewable contribution rather than having to rely on additional test points not normally required for EAHPs.

The calculation and resulting examples are shown as follows:

- Ventilation capacity is calculated based on the difference between indoor air (20°C for EAHP) and outdoor air (varies depending on which of the 5 heat pump test points is being evaluated). For water heating, the same approach is taken, although the only relevant external temperature is as per the relevant test conditions of 7°C.
- It will be subtracted from the refrigeration capacity to determine the actual renewable contribution from the EAHP. The result is then divided by the refrigeration capacity to determine the “share of renewables” from the EAHP
  - For any given temperature “bin”, the refrigeration capacity is the capacity\*(1-1/COP)
  - Ventilation Capacity =  $Q_{vent} = \text{MassFlowRate}(h_{20} - h_{T_{outdoor}})$ 
    - Where  $\text{MassFlowRate (kg/S)} = (\text{m}^3/\text{hr FlowRate}) * 1.2 / 3600$
    - Temperature difference of internal and external air temperatures  
Indoor Temperature = 20°C and Outdoor air temperature is taken at test condition (TOL, -7, 2, 7, 12).
    - Share of renewable at each test point =  

$$\frac{[\text{Declared capacity} * (1 - 1/\text{COPd}) - (\text{flow rate} * 1.2 / 3600) * (20 - (\text{outdoor air temp}))]}{[\text{Declared capacity} * (1 - 1/\text{COPd})]}$$

Share of renewables: examples:

Type of heating application	Capacity at each bin (kW)	COP at each bin	Total energy extracted from air by heat pump (kW) (refrigeration capacity)	Flow rate (m3/hr)	Indoor temp (degC)	Outdoor bin temp (degC)	Enthalpy difference between indoor and outdoor air	Air density (kg/m3)	Ventilation loss (kW)	Share of renewables (%)
Space heating (binA)	3.39	2.38	1.97	150	20	-7	27	1.2	1.35	31.32%
Space heating (binB)	2.08	3.4	1.47	150	20	2	18	1.2	0.90	38.70%
Space heating (binC)	1.35	4.45	1.05	150	20	7	13	1.2	0.65	37.90%
Space heating (binD)	1.43	4.36	1.10	150	20	12	8	1.2	0.40	63.70%
Space heating(binE)	3.05	2.38	1.77	150	20	-10	30	1.2	1.50	15.18%
Spaceheating (binD) (unit with lower flow rate)	2.22	2.25	1.23	50	20	12	8	1.2	0.13	89.19%
Water heating (7degC source only)	4	2.1	2.10	150	20	12	8	1.2	0.40	80.91%

## 5 Direct Exchange (DX) electric heat pumps

1. The heat pump calculator will now cater for DX heat pumps: Figure 4 summarises the applicable standards and test points, noting that:
  - a. The heat pump calculator will show a 4°C source temperature for water heating, as per EN16147
  - b. The calculator will also show a 4°C source temperature for space heating as per prEN14825:2018. prEN14825:2018 is similar to the 2016 version but explicitly caters for DX heat pumps
2. The low temperature heat pump option will be catered for in the heat pump calculation methodology for DX units.

Heat pump type	Electric/ GAHP?	Space heating? Water heating?	Test standard	Source temps degC	Sink temperatures (fixed) deg C @ part loads: 88%; 54%; 35%; 15%; 100%				Sink temperatures (variable) deg C @ part loads: 88%; 54%; 35%; 15%; 100%				How to treat low temperature version of this heat pump	Approach where ecodesign n/a
					Low temp application	Intermediate temp	Medium temp	High temp	Low temp application	Intermediate temp	Medium temp	High temp		
Direct exchange (DX)	Electric	Space	EN14825:2016 Table 12, 13, 14, 15 (0 degrees source) or prEN14825:2018 Table 12, 13, 14, 15 (4 degrees source)	4	All sink test points identical to A/W electric heat pumps								"Low temp application" only temp required for low temp heat pumps. Medium temp mandatory otherwise	Unchanged. DEAP Appendix G/HARP and Table 4c. EN14511/255-2/255-3/ EN15879-1
		Water	EN16147	4									No DHW mode for low temp option	

Figure 4: Test temperatures and standards for DX heat pumps

## 6 “To-air” electric heat pumps

The heat pump calculation already caters for A/A, B/A and W/A heat pumps. The following table summarises the applicable standards and test points noting that:

1. There is no additional “low temperature” option as the sink temperature is unchanged at 20°C.
2. While typically there would be no hot water provision in these units, selection of hot water provision is not prohibited for these units in the heat pump methodology (e.g. in case an A/A unit is installed for space heating alongside an A/W unit for water heating).
3. The standard EN14825 was updated in 2016. The test points therein have **not** changed, but the table references have changed. The new table references will be shown in the revised heat pump calculation methodology (e.g. Table 6 is now for A/A).

Heat pump type	Electric / GAHP?	Space heating? Water	Test standard	Source temps degC	Sink temperatures (fixed) deg C @ part loads: 88%; 54%; 35%; 15%; 100%				Sink temperatures (variable) deg C @ part loads: 88%; 54%; 35%; 15%; 100%				How to treat low temperature version of this heat pump	Approach where ecodesign n/a
					Low temp application	Intermediate temp	Medium temp	High temp	Low temp application	Intermediate temp	Medium temp	High temp		
A/A	Electric	Space	EN14825:2016 Table 6	-7; 2; 7; 12; TOL	20								No additional "low temp" option. Water heating as per A/W	Unchanged. DEAP Appendix G/HARP and Table 4c. EN14511/255-2
B/A	Electric	Space	EN14825:2016 Table 7	0	20								No additional "low temp" option. Water heating as per B/W	Unchanged. DEAP Appendix G/HARP and Table 4c. EN14511/255-2
W/A	Electric	Space	EN14825:2016 Table 7	10	20								No additional "low temp" option. Water heating as per W/W	Unchanged. DEAP Appendix G/HARP and Table 4c. EN14511/255-2

Figure 5: Test temperatures and standards for to-air electric heat pumps

### Approach to “WTOL” for “to-air” heat pumps:

In the current published heat pump tool, the design flow temperature is compared to “WTOL” (heating water operating limit temperature). However, term WTOL is not applicable for “to air” heat pumps according to regulation 206/2012. Therefore, the heat pump calculator will no longer seek the WTOL entry for “to air” heat pumps.

## 7 Double-duct heat pumps and heat recovery systems incorporating heat pump functionality

Double duct air conditioners and heat recovery systems (referred to hereafter as “double duct air conditioners” for the remainder of this section) will be accounted for in the heat pump calculation methodology update. Unlike other electric heat pumps, EN14825 is not applicable to these units. EN14511-2:2018 is used to test these units and 5 test points will be required for entry in the heat pump calculation methodology as outlined in the Figure 6. This aligns with the 5 temperature “bins” already in the DEAP heat pump methodology for all other heat pump types.

As the EN14511-2 data required for these units is not displayed on the Ecodesign technical documentation, the data MUST be sourced on test certs from a suitably accredited body.

If not all 5 test points are available for this heat pump type, then there will be a means to use pessimistic values in place of the missing test points. As always, SEAI encourage use of non-defaults to the relevant standards rather than relying on defaults. As an example, if the -15°C and 12°C source temperature test points are missing, BER assessors will be required to take the following approach:

- COP at A-15 and A12 assumed to be the lowest of the three available COPs (A-7, A2, A7)
- Capacity at A-15 and A12 assumed to be the lowest of the three available capacities (A-7, A2, A7)

Heat pump type	Electric / GAHP?	Space heating? Water	Test standard	Source temps degC	Sink temperatures (fixed) deg C @ part loads: 88%; 54%; 35%; 15%; 100%				Sink temperatures (variable) deg C @ part loads: 88%; 54%; 35%; 15%; 100%				How to treat low temperature version of this heat pump
					Low temp application	Intermediate temp	Medium temp	High temp	Low temp application	Intermediate temp	Medium temp	High temp	
Double duct air conditioner	Electric	Space	Covered by 14511:2018 table 3 only. Not by 14825	-15; -7; 2; 7; 12	20								No additional "low temp" option.
		Water	EN16147	7	Reference hot water temperature in EN16147 test								

Figure 6: Test temperatures and standards double duct air conditioners

The following guidance from the current published DEAP heat pump guidance document will continue to be applied for this type of heat pump:

*“These are broken down into their individual ventilation and heat pump components and entered in DEAP within the rules of the DEAP methodology for each component. Enter the heat pump component as a heat pump following the guidance in this document. Enter the heat recovery ventilation system using data for MVHR’s defaulted from DEAP under the “ventilation tab” or using non-defaults from the Product Characteristic Database in the UK if available.”*

In addition, care must be taken not to double count the benefit from heat recovery and to ensure that fan power is correctly accounted for in the heat pump efficiencies entered in the heat pump calculation methodology / DEAP ventilation tab.

The system ventilation rate (in m<sup>3</sup>/hr) will be recorded in the DEAP Ventilation tab. This figure will be used toward calculating the impact of ventilation rate on the mechanical ventilation system energy (i.e. fan energy use). This will help ensure that systems are not oversized

## 8 A/W, B/W, W/W Gas fired (GAHP) heat pumps

These heat pumps will be a new addition to the SEAI heat pump calculation, using data from the following standards rather than EN14825 and EN16147, and are entered in the heat pump calculation in the same manner as the corresponding electric heat pump types:

1. Water heating performance must be demonstrated using EN13203-6:2018<sup>6</sup>. The results from this standard are in the same format as those for EN16147 and are also available in Ecodesign technical documentation for the GAHP as per Ecodesign implementation regulations 813/2013 and 814/2013.
2. Space heating performance must be demonstrated using EN12309-6:2014<sup>7</sup>. The results from this standard are in the same format as those for EN14825 and are also available in Ecodesign technical documentation for the GAHP as per Ecodesign implementation regulation 813/2013.

Heat pump type	Electric / GAHP?	Space heating? Water	Test standard	Source temps degC	Sink temperatures (fixed) deg C @ part loads: 88%; 54%; 35%; 15%; 100%				Sink temperatures (variable) deg C @ part loads: 88%; 54%; 35%; 15%; 100%				How to treat low temperature version of this heat pump	Approach where ecodesign n/a
					Low temp application	Intermediate temp	Medium temp	High temp	Low temp application	Intermediate temp	Medium temp	High temp		
A/W	GAHP	Space	EN12309-6:2014 Table 5, 8, 11, 14	-7; 2; 7; 12; TOL	35	45	55	65	34; 30; 27; 24; 35	43; 37; 33; 28; 45	52; 42; 36; 30; 55	61; 49; 41; 32; 65	"Low temp application" only temp required for low temp heat pumps. Medium temp mandatory otherwise No DHW mode for low temp option	n/a
		Water	EN 13203-6	7	Reference hot water temperature in 13203-6 test									
B/W	GAHP	Space	EN12309-6:2014 Table 17, 20, 23, 26	0	All sink test points identical to A/W GAHP								"Low temp application" only temp required for low temp heat pumps. Medium temp mandatory otherwise No DHW mode for low temp option	n/a
		Water	EN 13203-6	0										
W/W	GAHP	Space	EN12309-6:2014 Table 17, 20, 23, 26	10	All sink test points identical to A/W GAHP								"Low temp application" only temp required for low temp heat pumps. Medium temp mandatory otherwise No DHW mode for low temp option	n/a
		Water	EN 13203-6	10										

Figure 7: Test temperatures and standards for to-air electric heat pump

### Mass flow rate for GAHPs in DEAP heat pump methodology

Cell "C44" of the current published heat pump calculator, (Heating Calc tab), details the mass flow rate according to EN15316-4-2 (equation 10 in the 2008 version, and now equation D.7 in the 2018 version). The heat pump calculator currently sets a "temperature spread at the condenser" of 5K as required in EN14825. The value for GAHPs differs and is based on EN12309-3 Table 5 (air source) or Table 6 (brine or water source) as follows, with "Tout" being the higher sink temperature of 35, 45, 55 or 65° C. This results in a ΔTmax of 7, 10.33, 13.66, or 17K respectively, depending on the sink temperature in the temperature application being assessed.

$$\Delta T_{\max} = 7 + \left( \frac{T_{\text{out}} - 35}{30} \right) \cdot 10$$

<sup>6</sup> Gas-fired domestic appliances producing hot water - Part 6: Assessment of energy consumption of adsorption and absorption heat pumps

<sup>7</sup> Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70kW - Part6: Calculation of seasonal performances

## 9 Accounting for the heat pump degradation coefficient, Cdh

Ecodesign regulation 813/2013 (and 206/2012) reference the “degradation coefficient” (Cdh). This is to be accounted for in the DEAP heat pump calculation update to discourage oversizing of heat pumps. Ecodesign regulations define Cdh as follows:

- 813/2013 (relevant for “to-water” heat pumps)

‘degradation coefficient’ (Cdh) means the measure of efficiency loss due to cycling of heat pump space heaters or heat pump combination heaters; if Cdh is not determined by measurement then the default degradation coefficient is Cdh = 0,9;

- 206/2012 (relevant for “to-air” units)

‘degradation coefficient’ is the measure of efficiency loss due to cycling (compressor switching on/off in active mode) established for cooling (Cdc), heating (Cdh) or chosen as default value 0,25;

The heat pump calculator will have four new entries for Cdh, one for each of the four Ecodesign-based temperature applications: 35°C, 45°C, 55°C, 65°C, with values taken directly from published Ecodesign data. Where the values aren’t entered, the heat pump calculator will default them to 0.9 or 0.25 as per the excerpts above, dependant on the heat pump type. Other entries (i.e. COP and capacity) will be sourced at each of the 5 “bin” test points, as per the current published heat pump tool. The approach to Cdh outlined below is like the UK MCS<sup>8</sup>, although the DEAP heat pump calculator will require only one Cdh value per temperature application, rather than the five Cdh values required in the MCS tool.

Cdh will be applied to ecodesign-sourced COPs as follows in the heat pump calculator, based on EN14825:2016.

- For **air-to-air, brine-to-air and water-to-air** units, at each of the 5 “bins” A-E in the heat pump calculator:

$$COP_{bin} = COP_d \times (1 - Cdh \times (1 - CR))$$

- COP<sub>bin</sub> = COP for the bin, after adjustment based on Cdh and CR
- COP<sub>d</sub> = COP corresponding to the declared capacity for each bin, prior to Cdh adjustment
- Cdh = degradation coefficient for this temperature application.
- CR = capacity ratio = (part load ratio at each bin) \* (dwelling design load) / (declared capacity at each bin). CR has a maximum of 1 and is used to identify if the heat pump is running below capacity.
- As an example, if calculating the COP for bin A:
  - COP<sub>d</sub> = 3.0
  - Cdh = 0.25
  - Part load ratio as per EN14825 bin A = 88.5%
  - Dwelling design load = 5kW
  - Declared capacity = 6kW
  - CR = .885\*5/6 = 0.7375
  - COP<sub>bin</sub> = 3 x {1 – 0.25 x (1 – .7375)} = 2.80
  - A lower Cdh or a capacity ratio closer to 1.0 yields a COP<sub>bin</sub> closer to COP<sub>d</sub>
- For **air-to-water, brine-to-water and water-to-water and DX<sup>9</sup>** units, at each of the 5 “bins” A-E in the heat pump calculator, the same definitions apply as above, but the equation and Cdh default differs:

$$COP_{bin} = COP_d \times CR / \{Cdh \times CR + (1 - Cdh)\}$$

- As an example, if calculating the COP for bin A:
  - COP<sub>d</sub> = 3.0
  - Cdh = 0.9
  - Part load ratio = 88.5%
  - Dwelling design load = 5kW
  - Declared capacity = 6kW
  - CR = 0.7375
  - COP<sub>bin</sub> = 3 x .7375 / {.9 x .7375 + (1 - .9)} = 2.90
  - A higher Cdh or a capacity ratio closer to 1.0 yields a COP<sub>bin</sub> closer to COP<sub>d</sub>

<sup>8</sup> [https://www.microgenerationcertification.org/wp-content/uploads/2018/02/MCS\\_026\\_SCOP\\_SSHEE\\_Model\\_V1\\_0\\_FINAL\\_t.xlsx](https://www.microgenerationcertification.org/wp-content/uploads/2018/02/MCS_026_SCOP_SSHEE_Model_V1_0_FINAL_t.xlsx)

<sup>9</sup> While DX aren’t catered for in EN14825:2016, they are to be facilitated in the heat pump calculator based on the approach proposed in FprEN14825:2018. Cdh will be applied to DX units on this basis.

Additional notes on degradation coefficient changes:

- While Cdh is referenced in the relevant Ecodesign regulation for GAHPs (813/2013), the EN standards (EN12309-6/3/4) do not detail how the Cdh and capacity ratio are applied to determine the impact of oversizing these units. SEAI will apply the same approach as is detailed above for electric “to-water” units for GAHPs given the requirement to apply a Cdh value as per regulation 813/2013.
- Cdh does not apply to Double duct units / heat recovery with in built heat pump. These units are not covered by EN14825. Also, directive regulation 206:2012 section on information requirement for double duct units, does not reference a degradation coefficient. The applicable test standard, EN14511-2, does not reference the degradation coefficient or capacity ratio.

The heat pump calculator will flag a warning in cases where the Capacity Ratio is less than 1, and therefore may be oversized for the load being assessed.

## 10 Other refinements in the heat pump calculation

### 10.1 Refinement to “standard rating conditions”

The current published heat pump calculator identifies capacity at “Standard Rating Conditions” in cell C43 of the HeatingCalc tab in the workbook:

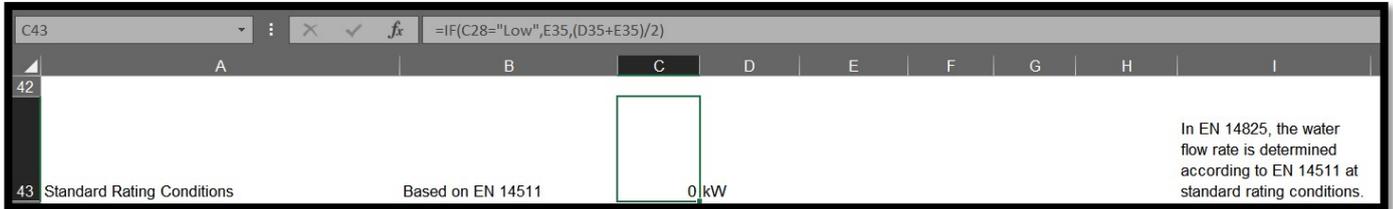


Figure 8: Standard rating condition capacity in heat pump calculator

The heating capacity at standard rating conditions (Cell C43) is drawn from row 35 of the same tab from cell E35 or the average of (D35+E35)/2. As cells D35 and E35 don’t represent standard rating conditions, the calculation will be changed to draw cell C43 from the standard rating condition (7°C source) in cell F35 instead.

### 10.2 Avoiding negative COPs in interpolation formula

The HeatingCalc tab of the heat pump calculator interpolates the COP on Row 56 of the Excel workbook for variable speed units as follows:

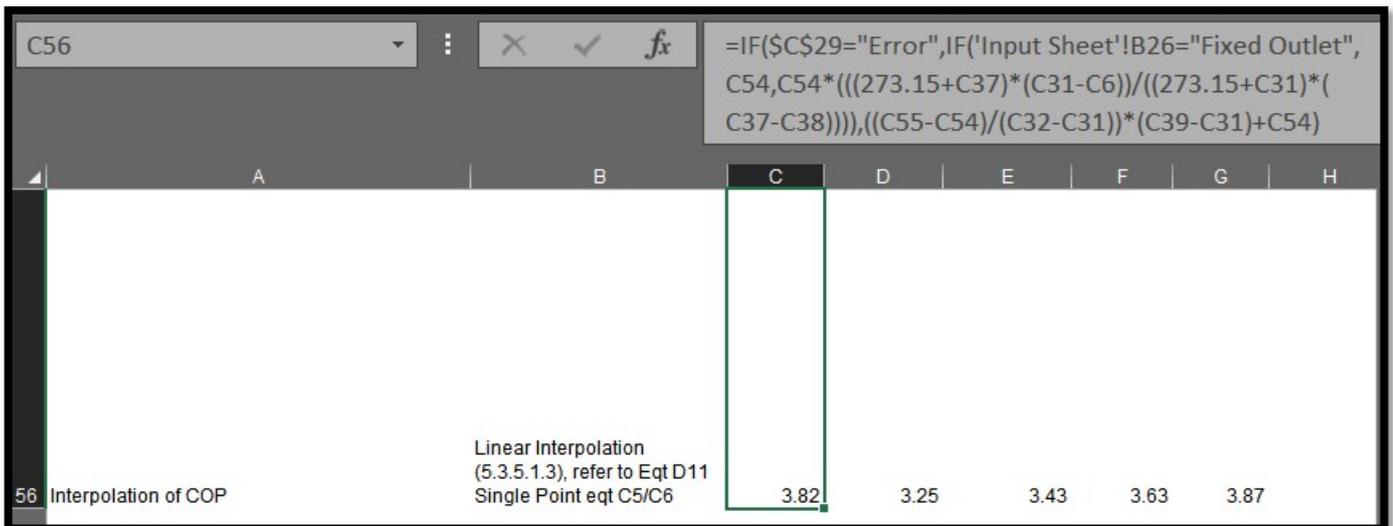


Figure 9: COP interpolation in heat pump calculator

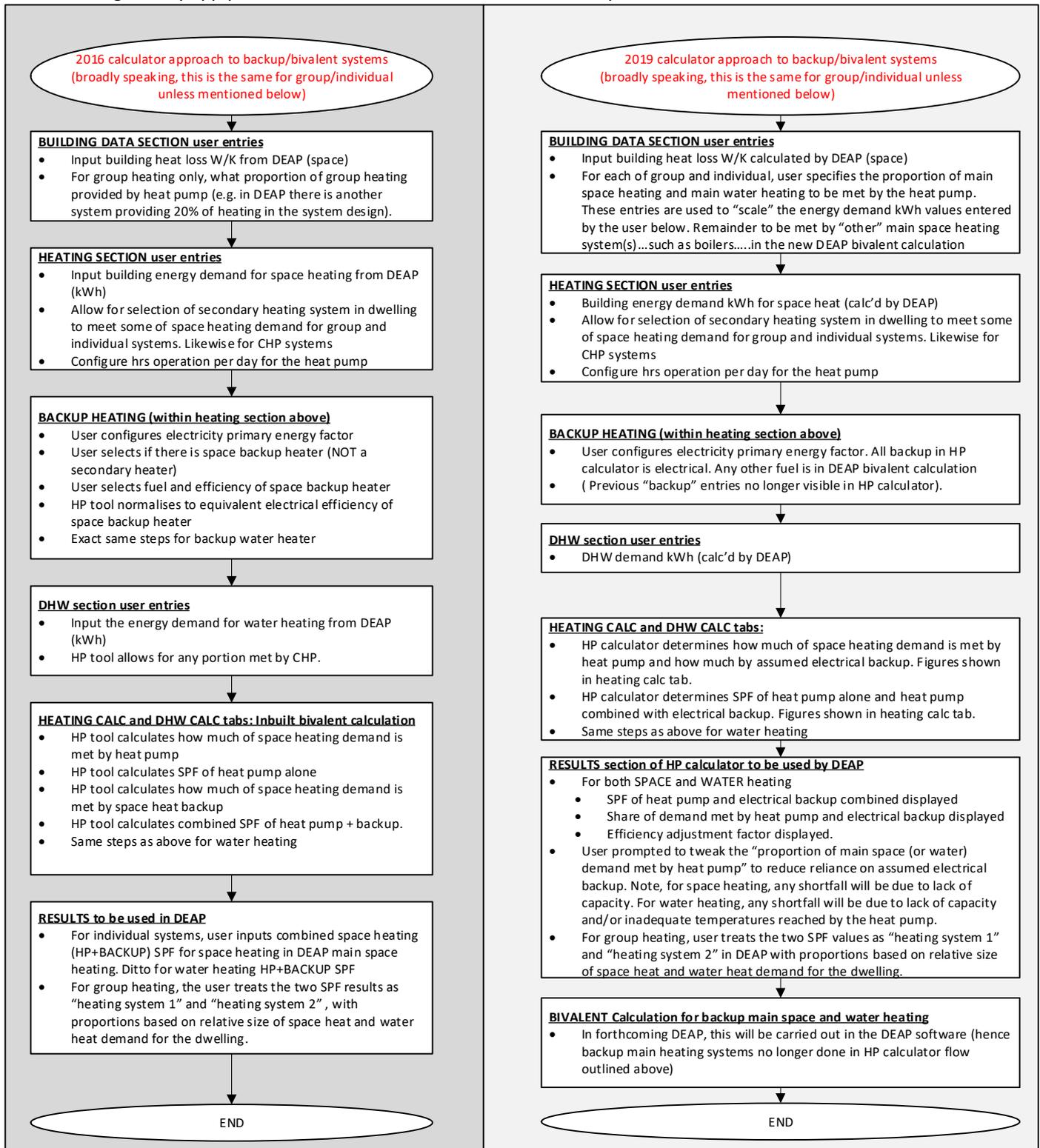
In some rare cases, the COP arising from this interpolation is incorrectly derived as  $\leq 0$ , giving a corresponding negative value for electricity consumed by the heat pump (this would, in turn cause the calculation to erroneously assume that the heat pump is generating electricity).

It is necessary to ensure that this does not happen in the heat pump calculation: **the HP calculation will set the interpolated COP to 0.5 or the to the interpolation result above (whichever is greater) to ensure that there are no negative values.** The 0.5 figure is considered a pessimistic value, reflective of the fact that the actual interpolated COP was very low (low enough to be  $\leq 0.5$  in truth).



## 11 Revised approach to backup (bivalent) heating systems

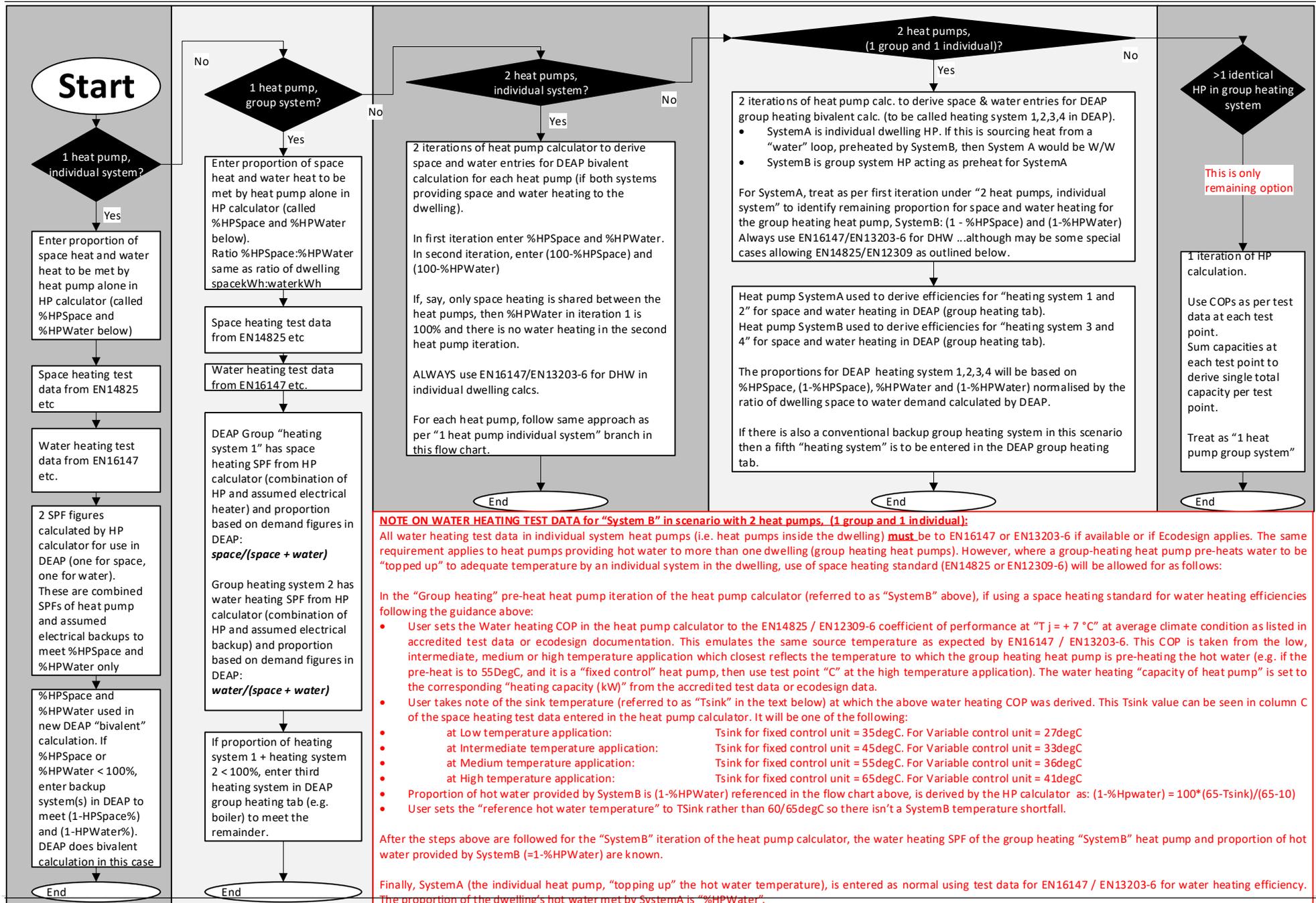
The following flow chart shows the approach to bivalent/backup systems in the current heat pump methodology (2016) and the approach to be taken in 2019. The changes are aligned to the forthcoming capabilities in DEAP to handle more than one main space heating system and more than one main water heating system. See Section 12 of this document also. All references to DEAP here generally apply to NEAP also, since SBEM allows for bivalent systems.



## **12 Variations of group / individual systems and multiple heat pumps**

The various types of systems detailed in the following flow chart give an overview of systems known to exist or to be arising in the marketplace. The heat pump methodology guidance documents will illustrate the approach to these various systems along the following lines. See overleaf for details.

Note: This document focusses on group schemes, district heating schemes are not dealt with in this document. Guidance in relation to District Heating Schemes will be issued separately.



**NOTE ON WATER HEATING TEST DATA for "System B" in scenario with 2 heat pumps. (1 group and 1 individual):**  
 All water heating test data in individual system heat pumps (i.e. heat pumps inside the dwelling) **must** be to EN16147 or EN13203-6 if available or if Ecodesign applies. The same requirement applies to heat pumps providing hot water to more than one dwelling (group heating heat pumps). However, where a group-heating heat pump pre-heats water to be "topped up" to adequate temperature by an individual system in the dwelling, use of space heating standard (EN14825 or EN12309-6) will be allowed for as follows:

In the "Group heating" pre-heat heat pump iteration of the heat pump calculator (referred to as "SystemB" above), if using a space heating standard for water heating efficiencies following the guidance above:

- User sets the Water heating COP in the heat pump calculator to the EN14825 / EN12309-6 coefficient of performance at "T<sub>j</sub> = + 7 °C" at average climate condition as listed in accredited test data or ecodesign documentation. This emulates the same source temperature as expected by EN16147 / EN13203-6. This COP is taken from the low, intermediate, medium or high temperature application which closest reflects the temperature to which the group heating heat pump is pre-heating the hot water (e.g. if the pre-heat is to 55DegC, and it is a "fixed control" heat pump, then use test point "C" at the high temperature application). The water heating "capacity of heat pump" is set to the corresponding "heating capacity (kW)" from the accredited test data or ecodesign data.
- User takes note of the sink temperature (referred to as "Tsink" in the text below) at which the above water heating COP was derived. This Tsink value can be seen in column C of the space heating test data entered in the heat pump calculator. It will be one of the following:
  - at Low temperature application: Tsink for fixed control unit = 35degC. For Variable control unit = 27degC
  - at Intermediate temperature application: Tsink for fixed control unit = 45degC. For Variable control unit = 33degC
  - at Medium temperature application: Tsink for fixed control unit = 55degC. For Variable control unit = 36degC
  - at High temperature application: Tsink for fixed control unit = 65degC. For Variable control unit = 41degC
- Proportion of hot water provided by SystemB is (1-%HPWater) referenced in the flow chart above, is derived by the HP calculator as: (1-%HPwater) = 100\*(65-Tsink)/(65-10)
- User sets the "reference hot water temperature" to Tsink rather than 60/65degC so there isn't a SystemB temperature shortfall.

After the steps above are followed for the "SystemB" iteration of the heat pump calculator, the water heating SPF of the group heating "SystemB" heat pump and proportion of hot water provided by SystemB (=1-%HPWater) are known.

Finally, SystemA (the individual heat pump, "topping up" the hot water temperature), is entered as normal using test data for EN16147 / EN13203-6 for water heating efficiency. The proportion of the dwelling's hot water met by SystemA is "%HPWater".