SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Introduction to DEAP
for Professionals

DWELLING ENERGY ASSESSMENT PROCEDURE (DEAP)

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Introduction

The Dwelling Energy Assessment Procedure (DEAP) is the official Irish methodology for calculating the energy performance and associated carbon dioxide emissions for the provision of space heating, ventilation, water heating and lighting in dwellings. DEAP consists of a software tool and an associated guidance manual and is a key component of the Irish Building Energy Rating (BER) scheme. DEAP is also the compliance tool specified in Part L of the Irish Building Regulations. The software and manual are freely available on www.seai.ie/deap.

DEAP is published by the Sustainable Energy Authority of Ireland (SEAI). Our mission is to play a leading role in transforming Ireland into a society based on sustainable energy structures, technologies and practices.

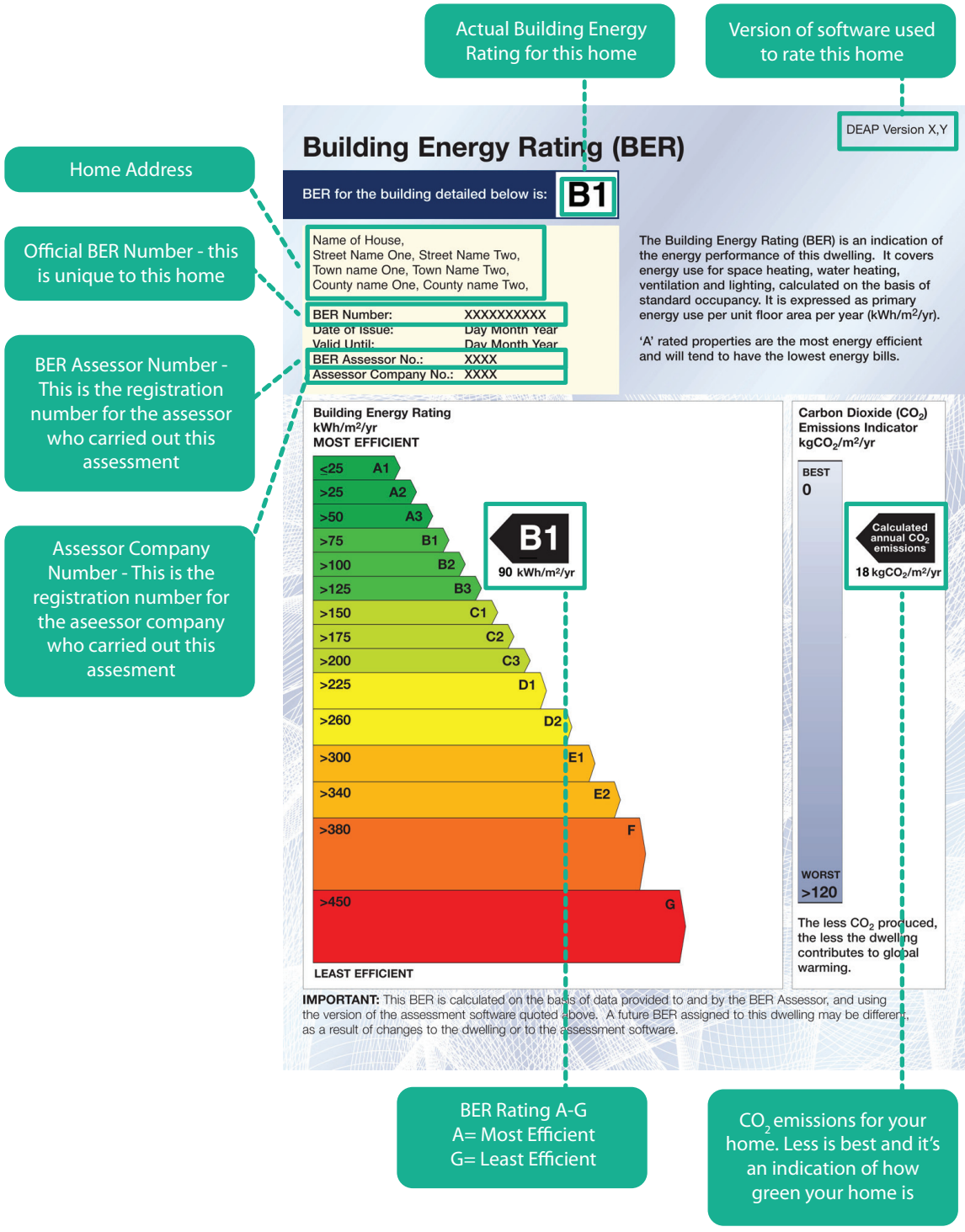
This document provides an introduction to the principles of DEAP for anyone involved in building research or the design, construction or retrofit of dwellings. It is also useful for anyone wishing to understand the technical basis for BER certificates.

DEAP Functionality:

The key functions of DEAP are as follows:

1. DEAP models expected energy consumption and associated CO_2 emissions for the dwelling under standardised operating conditions.
2. DEAP enables publication of a BER certificate as shown in Figure 1. The BER cert shows a rating scale based on the dwelling's energy consumption per unit area. The published BER certificate is accompanied by an advisory report outlining relevant improvements for the dwelling.
3. All BER certificates are stored on SEAI's National Administration System (NAS). Summary information from published BER certificates is accessible from www.seai.ie/ber using the dwelling's BER number or MPRN number. The MPRN for the home is printed on the electricity bill.
4. Aggregated data for all BERs can be downloaded from the SEAI National BER Research Tool Tool on www.seai.ie/ber

Figure 1: The BER Certificate



5 › DEAP allows prospective buyers or tenants to objectively compare the energy performance of different dwellings on a like for like basis. DEAP is an asset (calculated) energy rating rather than an operational (measured consumption) rating. The key differences between calculated energy consumption and measured energy consumption are as follows:

Figure 2: Calculated vs. Measured Energy Consumption

Calculated Energy Consumption

Key features:

- Calculate energy usage based on the dwelling NOT the occupants – like MPG rating for cars the actual driving style, terrain and conditions not accounted for
- Consistent assumptions made for all dwellings such as:·
  - Same level of lighting required in all dwellings
  - Number of occupants and hot water demand based on floor area
  - Fixed length heating season and fixed heating periods per day
  - Dwelling heated to fixed temperatures
  - Climate

Some pros:

- Allows all dwellings to be compared on like for like basis
- The prospective buyer or tenant is not dependant on current occupier behaviour
- Ideal for dwellings being sold or rented
- Ideal for evaluating the building for regulatory purposes

Some cons:

- If the occupant is frugal or wasteful in their energy usage, their energy bills could be much smaller or larger than the asset rating would indicate
- Requires detailed survey of dwelling fabric and heating system

Measured Energy Consumption

Key features:

- Measures actual energy usage
- Can be based on bills and/or monitored data
- No need to identify building components
- Standardised assumptions not relevant

Some pros:

- Reflects actual energy usage
- Does not require detailed survey of dwelling fabric and heating system

Some cons:

- Difficult for prospective buyer or tenant to compare on like for like basis
- Highly dependent on behaviour of occupants
- Not suitable for demonstrating compliance with regulatory requirements as home must be occupied to enable measurement of energy consumption

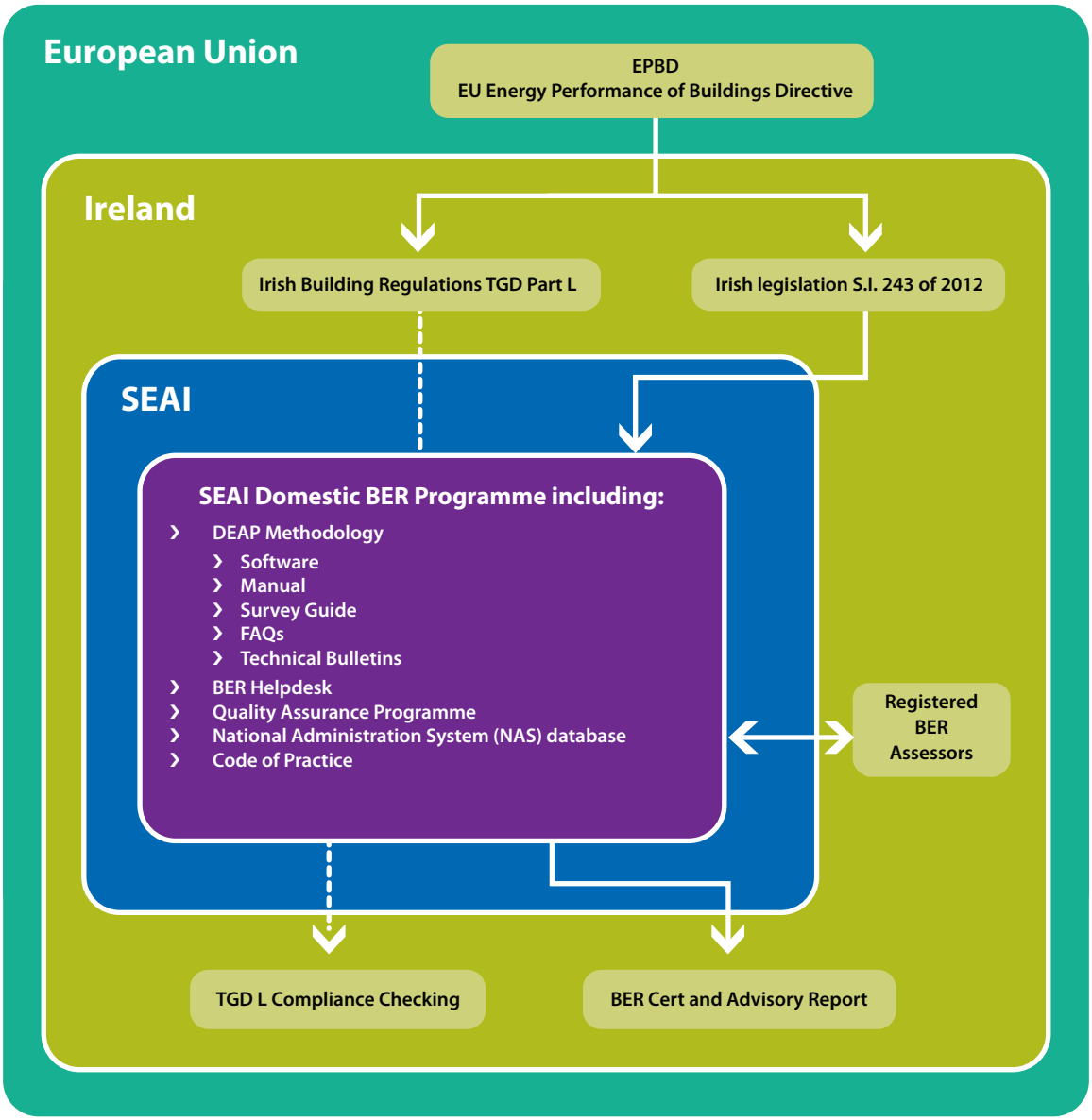
6 › DEAP performs compliance checking calculations for Part L of the Building Regulations and generates a conformance report summarising the relevant information for the purposes of building control. The calculation checks that the primary energy consumption associated with the operation of the dwelling and the related CO_2 emissions do not exceed the Maximum Permitted Energy Performance Coefficient (MPEPC) and the Maximum Permitted Carbon Performance Coefficient (MPCPC) when compared to a reference dwelling defined in the Building Regulations Part L Technical Guidance Document (TGD L). In addition to checking compliance with the above target values DEAP also performs the following checks as specified in TGD L:

- level of installed renewable energy per unit area;
- heat losses through the building fabric;

7 › DEAP enables the dwelling designer to identify likely areas of high energy usage in the dwelling. The designer can determine the relative impacts of various design changes using DEAP.

Legislative Background

Figure 3: Legislation and the BER Programme

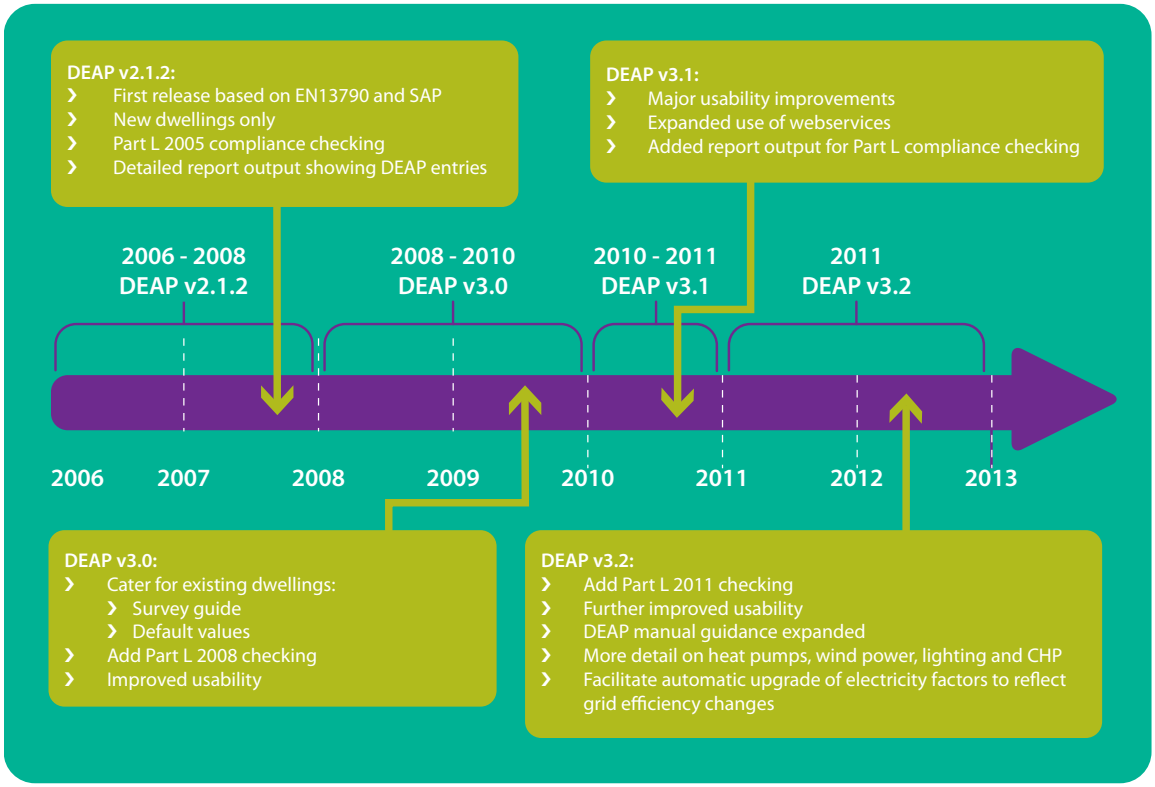


The Energy Performance of Buildings Directive (EPBD Recast Directive 2010/31/EU) Article 3 requires that each member state adopts a methodology for the calculation of building energy usage. Article 12 of EPBD Recast requires that energy performance certificates are made available by building owners when the building is constructed, sold or rented. S.I. 243 of 2012 transposes EPBD Recast into Irish Legislation, specifically referencing the requirement for a calculation methodology and software from the Issuing Authority (SEAI). This is illustrated in Figure 3.

The original EPBD (2002) was first transposed into Irish legislation through S.I.666 of 2006 and introduced the mandatory requirement for BERs in Ireland. DEAP was first developed to meet this requirement and has evolved through a number of revisions since then.

DEAP Development

Figure 4: The evolution of DEAP



DEAP was first introduced in 2006, and, as shown in Figure 4, it has been regularly updated and refined to meet the needs of regulation, users, consumers and industry. DEAP is the national tool for BER calculation and Building Regulations Part L compliance checking. It is compliant with the methodology framework as detailed in Annex I of the EU Energy Performance of Buildings Directive (EPBD). The DEAP methodology is primarily based on the following:

- IS EN 13790: Energy performance of buildings -- Calculation of energy use for space heating and cooling.
- Other relevant European and international standards as detailed in the DEAP manual.
- The Standard Assessment Procedure (SAP) for energy rating of dwellings in the UK.

The original DEAP methodology was based on research work by University College Dublin's Energy Research Group, National Energy Services (UK) and Rickaby Thomson Associates (UK). Ongoing development, maintenance and support is carried out by SEAI as required. Major revisions to DEAP follow a process of design, public consultation, development and software testing. The DEAP software and manual are freely available on the SEAI website and are supplemented by guidance publications and SEAI's BER Helpdesk.

The SEAI website provides a register of BER assessors. These assessors are trained in the use of DEAP to produce BER certificates as required by the legislation. Many construction professionals such as Architects and Engineers have also attended DEAP training, enabling them to check compliance with Part L of the Building Regulations during dwelling design.

As DEAP evolves, it will continue to maintain alignment with forthcoming Irish policies and Building Regulations, particularly Irish transposition of EPBD Recast, associated IS and EN standards and Part L of the Building Regulations.

DEAP and the EPBD Requirements

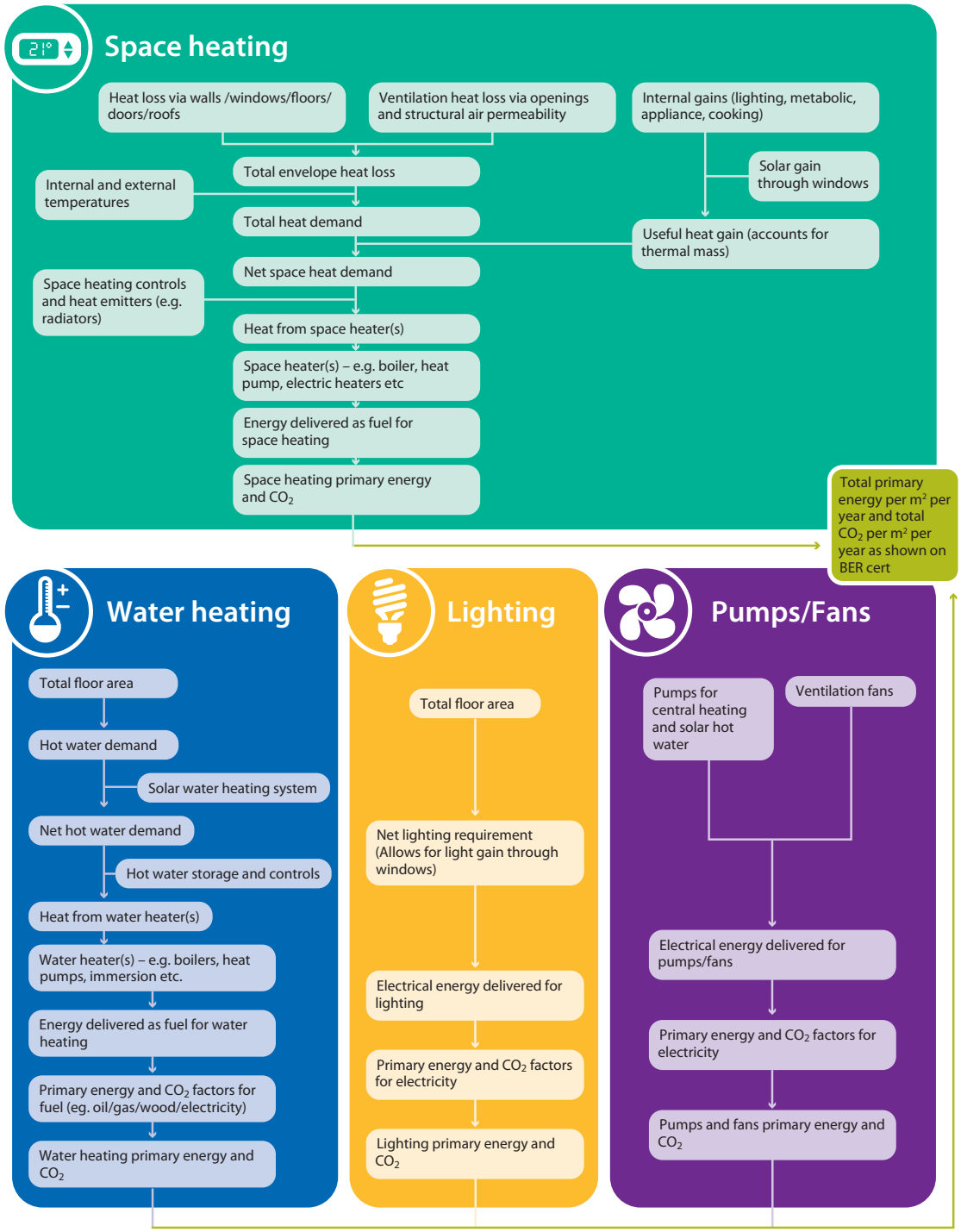
The Energy Performance of Buildings Directive (Recast – Annex I) requires that a number of building categories are catered for via a national methodology. DEAP is the methodology for "single family houses of different types" and also assesses individual apartments.

EPBD Annex I Requirement	Summary of implementation in DEAP
"The methodology of calculation of energy performances of buildings shall include at least the following aspects:"	
(a) thermal characteristics of the building	DEAP calculates ventilation/air leakage and external fabric heat loss along with the impacts of thermal mass and thermal bridging at junctions. Passive internal and solar gains are also calculated.
(b) heating installation and hot water supply, including their insulation characteristics	DEAP evaluates the heating system type and controls along with insulation on hot water storage and pipe work.
(c) air-conditioning installation	DEAP accounts for heating from air conditioning systems, but does not yet account for the cooling from these systems. To date, cooling calculations have not been deemed necessary for dwellings in the Irish climate. This is partially due to low market penetration of these systems and also the low cooling energy demand expected in Irish dwellings.
(d) ventilation	DEAP accounts for ventilation losses (natural and mechanical) and electrical fan power required for mechanical ventilation systems. Structural air tightness is also accounted for.
(e) built-in lighting installation (mainly the non-residential sector)	DEAP calculates the dwelling lighting demand and associated electricity requirement. Reduced lighting energy requirement is calculated based on installed low energy lighting.
(f) position and orientation of buildings, including outdoor climate	DEAP accounts for orientation of openings and solar collectors and calculates resulting solar gain. It also considers typical Irish monthly temperatures, and shelter impact on ventilation losses.
(g) passive solar systems and solar protection	DEAP accounts for passive solar heat and light gains. The level of overshading on openings and solar collectors is evaluated.
(h) indoor climatic conditions, including the designed indoor climate	DEAP assumes that an adequate level of ventilation and air temperature are maintained in the dwelling. Standard temperature levels are assumed during heating periods: 21°C in living areas and 18°C in the remainder of the dwelling.
(h) internal loads	DEAP calculates the heat load based on the above climatic conditions. It also calculates the dwelling hot water demand based on the assumed number of occupants (which is in turn based on floor area).
"The positive influence of the following aspects shall, where relevant in the calculation, be taken into account:"	
(a) local solar exposure conditions, active solar systems and other heating and electricity systems based on energy from renewable sources	DEAP accounts for a multitude of conventional and renewable heat sources (active solar, passive solar, boiler, heat pump, wood, electric etc). PV and onsite wind turbines are also accounted for.
(b) electricity produced by cogeneration	DEAP accounts for CHP systems in group (district) and individual heating systems
(c) district or block heating and cooling systems	DEAP accounts for thermal energy supplied by group heating systems allowing for various types of systems and distribution networks. DEAP does not yet calculate cooling requirement.
(d) natural lighting	DEAP accounts for natural lighting depending on the window size, type, shading and orientation. This can reduce the dwelling heat and lighting demand.

Technical Outline of the DEAP Software

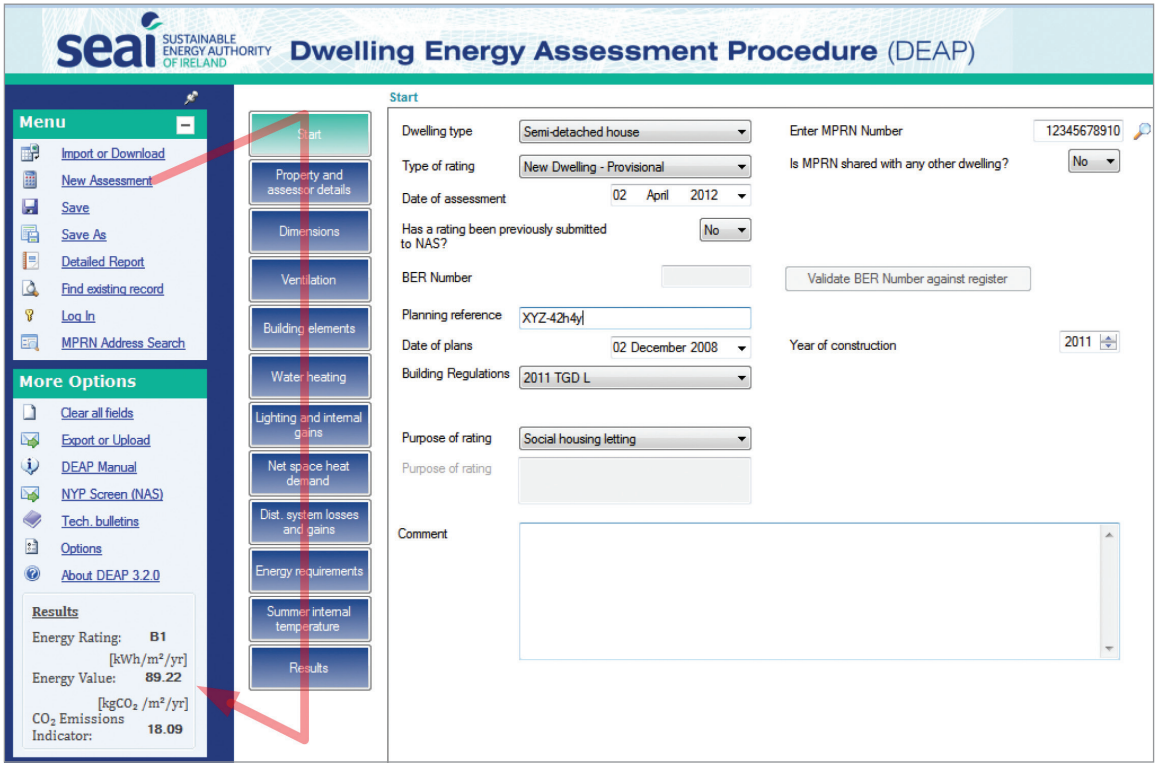
Figure 5 shows the key considerations in the DEAP calculation to derive the total primary energy and CO_2 results. The diagram summarises the calculation process to derive the total energy usage for space heating, water heating, lighting, pumps and fans.

Figure 5: DEAP Calculation Summary



The DEAP software brings the user through a number of windows or tabs to calculate the BER result. The red arrow in Figure 6 follows through the list of tabs from "Start" to "Results", with the Energy Rating shown on the left hand side of the screen. Most of the DEAP entries must be completed, although some of the optional entries provide useful ancillary information relating the dwelling. There are strict conventions and guidelines relating to each field set out in the DEAP Manual and survey guide to avoid incorrect entry of data. The DEAP guidance documents, available on www.seai.ie/DEAP, provide full detail on all of the DEAP entries and tabs. The BER technical bulletins provide further detail and worked examples on various sections of DEAP, and users may obtain guidance from the BER helpdesk where further assistance is needed.

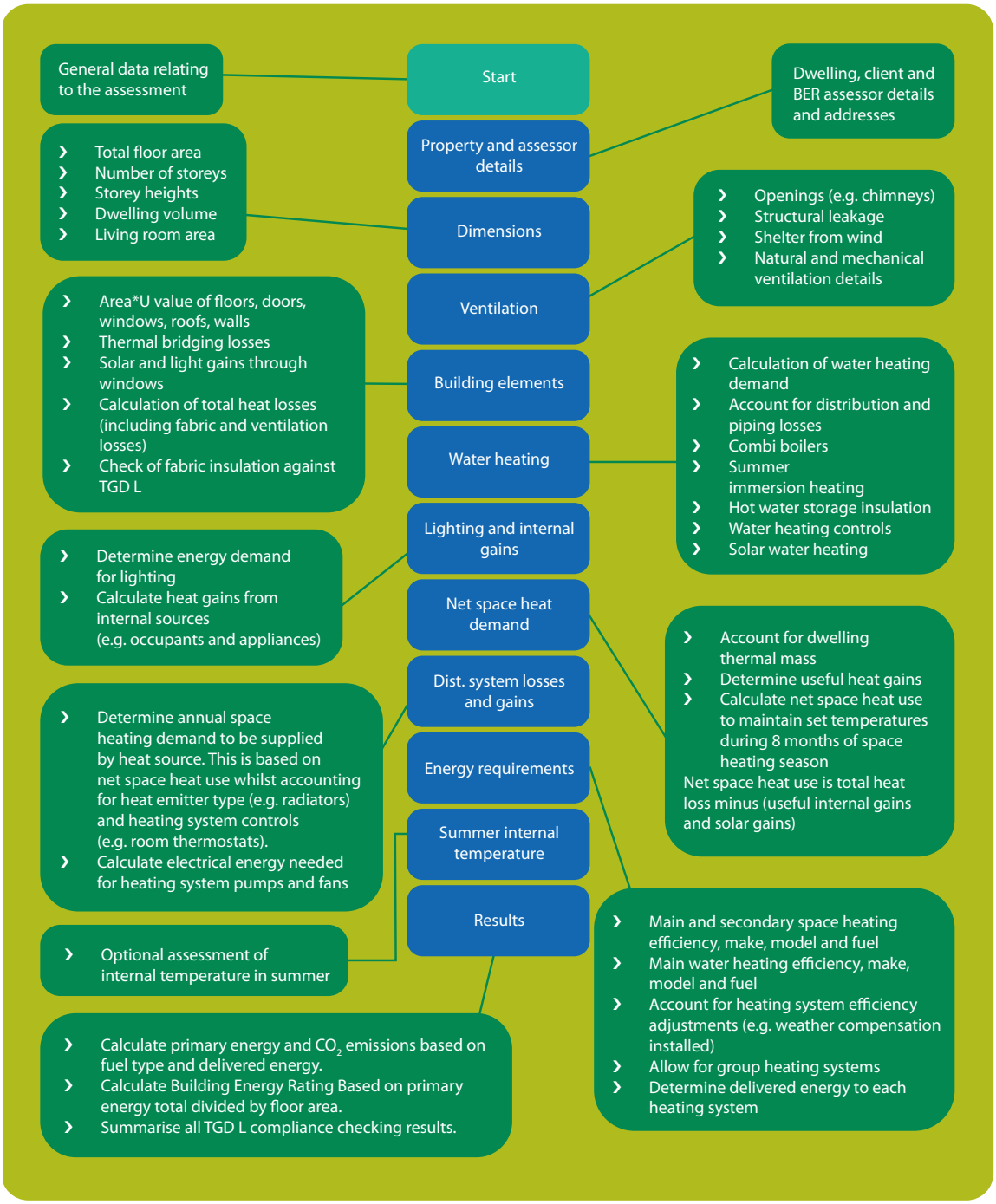
Figure 6: DEAP software screenshot



The DEAP Manual provides a significant level of detail on the data entries in the software. The tables in the DEAP Manual provide conservative defaults and assumed values for the various DEAP fields in the absence of actual data. The DEAP Survey Guide and Survey Form are used by BER assessors when carrying out a BER survey. The Survey Guide provides useful guidance on how to complete a survey correctly and details how evidence supporting each DEAP field is obtained on site or from the dwelling owner.

The DEAP calculation is also available in Microsoft Excel format at the website above for those who wish to gain further insight into the calculation equations. The Excel version of DEAP cannot be used to publish a BER on the SEAI National Administration System (NAS) or to generate BER certs.

Figure 7: DEAP tab outline



The DEAP tabs are summarised in Figure 7. The table below provides further detail on the key data to be entered in DEAP. The table also shows the main outputs from each tab and identifies some of the parameters most likely to have a large bearing on the BER result. When designing a dwelling, or considering potential improvements to an existing dwelling, consider all areas of the BER for potential improvements. Entries on most of the DEAP screens can impact the BER, allowing flexibility in choosing the most effective upgrade.

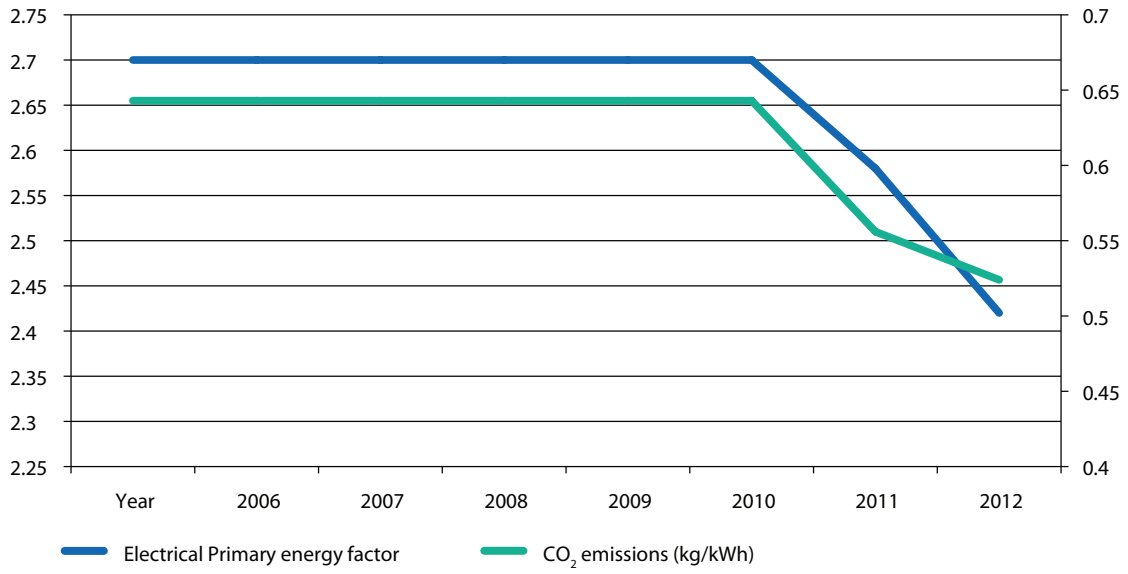
Tab	Main user entry actions	Visible calculated outcome and other comments
Start	Administrative details of the dwelling and BER assessment including electricity Meter Point Reference Number (MPRN), new/existing dwelling, TGD L version, construction date and dwelling type.	As entered
Property and assessor details	Details of property, client and Assessor	As entered
Dimensions	Area and height of each storey, area of living room, number of storeys.	› Total floor area, dwelling volume and living area fraction. › Total energy usage is divided by the dwelling floor area to determine the Building Energy Rating. › All dimensions in DEAP are internal – this is a standard convention in UK and other EU member states. Irish Building Regulations Part L work to internal dimensions.
Ventilation	Openings (e.g. chimneys), structural leakage and mechanical ventilation systems.	› Ventilation heat loss (components and total), electricity for fans, heat gain from fans. Air permeability compliance check with Building Regulations 2008 and 2011 TGD L requirements. › Number of openings (such as chimneys, permanently open wall/window vents) is likely to have a significant bearing on the BER. If using mechanical ventilation, it is best to use test data from SAP Appendix Q rather than default data.
Building elements: › Floors › Walls › Roofs › Doors	Heat loss building element dimensions and U-values. Default U-values may be used for existing dwellings.	› Total Area*U-value for each element type. U-value is the rate of heat loss per m^2 surface area per degree. E.g. a U-value of 1, with a temperature inside of 21 and outside of 11 on a $1m^2$ wall area has a rate of heat loss of 10W. › Best to use actual calculated U-values instead of defaults, but supporting evidence must be acquired from survey or dwelling specifications (such as insulation type, thickness, area, certified test data). Certified data from Agrement certs or accredited data gives insulation thermal conductivity. The DEAP Manual details the applicable European U-value calculation standards (such as EN6946 for walls and roofs). › Adding insulation to a poorly insulated building element will have a significant bearing on the BER.
Building elements: Windows	Window and glazed door dimensions, orientations, U-values and shading characteristics. Defaults may be used for new or existing dwellings.	› Glazed area, heat loss, effective area for solar gain, glazing ratio for daylight gain, summer heat gain. › Window orientation is important. Actual U-values and solar transmittance should be used where available from certified data (to relevant European standards such as EN10077-1;2).

Tab	Main user entry actions	Visible calculated outcome and other comments
Building elements: Heat loss results	Thermal bridging factor	› Tab calculates fabric heat loss, total heat loss coefficient and heat loss parameter for the dwelling. Compliance check with Building Regulations fabric insulation requirements (for Building Regulations 2005 - 2011 TGD L as appropriate for the dwelling) is also carried out. › Obtain more beneficial thermal bridging factor from certified calculations or use of Acceptable Construction Details for new dwellings as published by DECLG. › Dimensions are internal as per TGD L. Thermal bridging heat losses are added to the fabric plane elements heat losses. › A supporting spreadsheet to calculate actual Thermal Bridging heat loss as per TGD L 2011 is available on www.seai.ie
Water heating	Water heating system characteristics, including supplementary electric water heating in summer and solar water heating	› Tab calculates the hot water heating demand, solar hot water output, solar hot water pump consumption, primary circuit loss, internal heat gains from hot water, distribution losses. › Hot water storage insulation and improved hot water storage controls (time and thermostatic) are commonly used to improve the BER.
Lighting and internal gains	Proportion of fixed lighting outlets which are low energy	› Annual energy use for lighting, internal seasonal heat gains from lighting and other internal heat gains. › Installation of low energy light bulbs (CFLs, LEDs and fluorescent tubes) is a cost effective way to improve the BER.
Net space heat demand	Thermal mass category	› Mean internal temperature, annual 'useful' space heat demand from monthly calculations allowing for intermittency, solar gains and internal heat gain utilisation.
Distribution system losses and gains	Heating system control category, responsiveness category, heat emission characteristics, pumps and fans	› Annual space heat demand allowing for control, responsiveness, heat emission and equipment heat gain characteristics. › Electrical power consumed by pumps (e.g. central heating pumps) calculated. › Use of thermostats, zoning, TRVs and programmers along with other control improvements can have a significant bearing on the BER. Central heating pumps with high efficiency labels will also decrease energy consumption in DEAP.

Tab	Main user entry actions	Visible calculated outcome and other comments
Energy requirements: Individual heating system	Individual heating systems: Space and water heating appliance efficiency and fuel characteristics. Combined heat and power plant characteristics. Secondary heating (e.g. fireplace) is also considered.	› Annual delivered fuel consumption for space and water heating, CO_2 emissions. › Improved heat source efficiency is critical to obtaining a better BER. Data is preferably taken from www.seai.ie/HARP. The Home-heating Appliance Register of Performance (HARP) lists efficiencies based on accredited test data to the standards and calculation methods specified in DEAP. › Replacing an open fire with a stove and flue will reduce ventilation losses and improve the secondary heating system efficiency. Heating system efficiencies are based on Gross Calorific Values and generally are a seasonal value as calculated in the DEAP Appendices. The test data are derived from European standards (e.g. EN14511 for heat pumps).
Energy requirements: Group heating	Community/ group heating schemes: Space and water heating appliance efficiency and fuel characteristics. Combined heat and power plant characteristics.	› Annual fuel consumption for space and water heating, CO_2 emissions. › Heating system efficiency, controls and pipework should all be considered to reduce energy consumption for all dwellings heated by the group system.
Summer internal temperature	Effective air change rate of dwelling	› Optional tab › Calculates threshold internal temperature and provides approximate indication of overheating risk

Results	None	› Annual delivered energy
		› Annual primary energy and CO_2 emissions. DEAP derives these values by multiplying the delivered energy for each fuel by the associated primary energy and CO_2 factors for those fuels.
		› The BER grade ranging between A1 and G.
		› Building Regulations Compliance checking for new dwellings:
		  › Energy and CO_2 emissions compared to TGD L reference dwelling.
		  › Renewables conformance requirements checking as per TGD L
		  › Fabric insulation levels as per TGD L
		  › Air tightness checking against TGD L performance levels

Figure 8: DEAP Electricity Factors since 2006



The primary energy and CO_2 factors for electricity are shown in Figure 8. The electricity factors are higher than other fuels as there are inherent inefficiencies involved in electricity generation and transmission. However, this figure is updated annually as the electricity generation fuel mix changes. In earlier versions of DEAP, the primary energy factor for electricity meant that for every unit of electricity delivered to the dwelling, 2.7 units of primary energy were assumed by DEAP. This value is now much lower at 2.42. DEAP allows for automatic update of the electricity factors - the update is carried out annually by SEAI.

Graphical Energy Representation

DEAP has a number of features to ensure ease of use. For example, it provides graphical representation of the data on the results tab (shown in Figure 9) and the net space heat demand tab to help users quickly identify where most energy savings can be made. The sample graph below clearly shows that the space heating demand should be addressed if this BER grade is to be improved. This indicates that one or both of the building fabric and heating system should be examined more closely for inefficiencies.

Figure 9: DEAP results tab graph

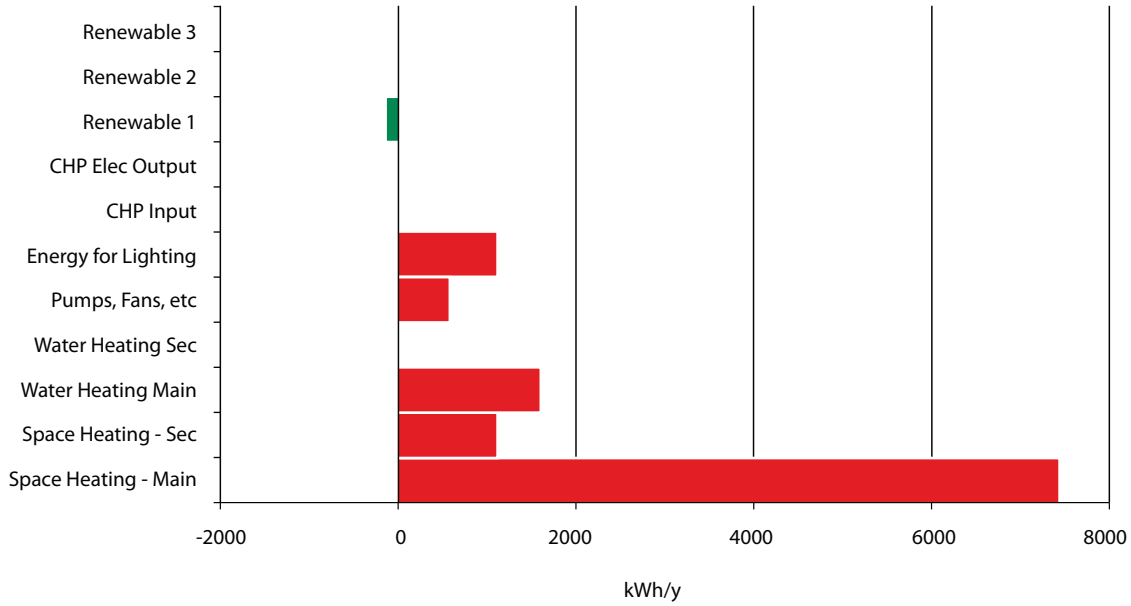
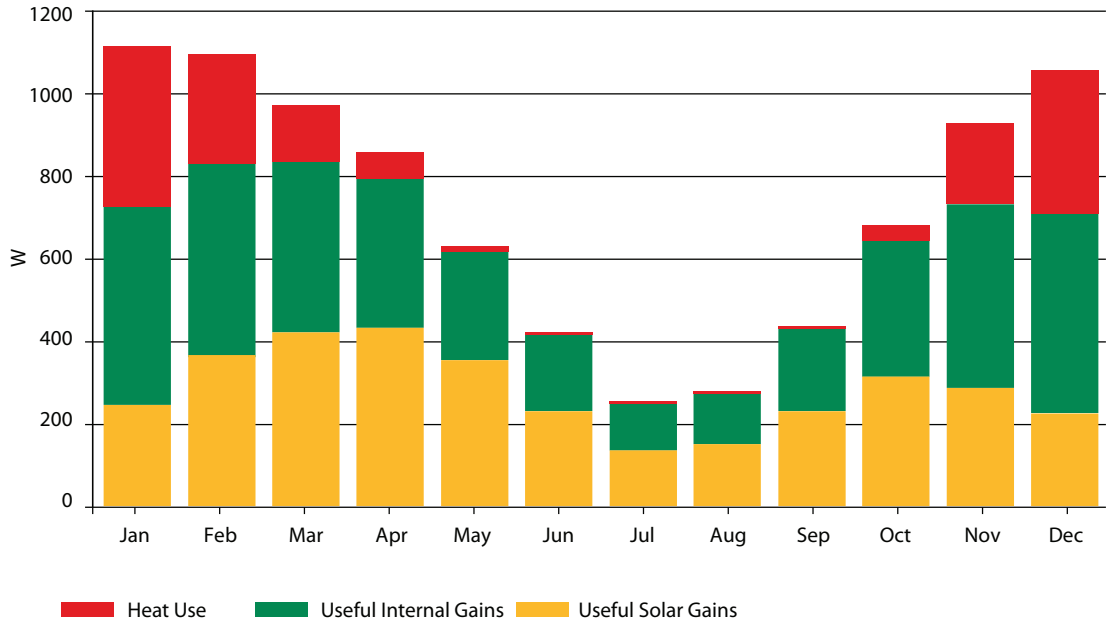


Figure 10 shows the graphical information provided in DEAP's net space heat demand tab. In this case, the dwelling is well insulated and is capitalising on solar heat gains to reduce the space heat loss. As it is well insulated, the heat use is minimal in Spring and Autumn. While DEAP is not a building design tool, this graph does indicate that space heat demand will be very low, particularly in Spring and Autumn. As always, Building Regulations should be followed when designing the building (e.g. ensure there is adequate ventilation). The building designed should also ensure best practice is followed to avoid unwanted overheating in summer.

Figure 10: Net space heat demand



References:

- DEAP Methodology guidance and software: www.seai.ie/DEAP
- BER Helpdesk: http://www.seai.ie/Your_Building/BER/BER_Contact_Info/
- HARP database: www.seai.ie/HARP
- National BER database: https://ndber.seai.ie/pass/ber/search.aspx
- National BER Research Tool: http://www.seai.ie/Your_Building/BER/National_BER_Research_Tool/
- DEAP FAQ (including thermal bridging calculation tool): www.seai.ie/berfaq
- Legislation from Department of Environment, Community and Local Government (DECLG): www.environ.ie :
  - Building Regulations (Part L Amendment) Regulations 2011 (S.I. No. 259 of 2011)
  - Technical Guidance Document to Part L 2011 and Acceptable Construction Details
  - Statutory Instrument 243 of 2012
  - Statutory Instrument 666 of 2006
- EPBD Recast Directive 2010/31/EU:

  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF
- SAP Appendix Q Database: www.sap-appendixq.org.uk

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