Data Article

Residential stock data and dataset on energy efficiency characteristics of residential building fabrics in Ireland

Tomás Mac Uidhir a, *, Fionn Rogan a, Matthew Collins b, John Curtis b, Brian Ó Gallachóir a, c

a Energy Policy and Modelling Group, MaREI Centre, Environmental Research Institute, University College Cork, Lee Road, Cork, Ireland
b Economic and Social Research Institute, Sir John Rogerson’s Quay, Dublin, Ireland
c School of Engineering, University College Cork, Co. Cork, Ireland

ABSTRACT

These data support the research article “Improving energy savings from a residential retrofit policy: a new model to inform better retrofit decisions” — (Mac Uidhir et al., 2019) [1]. This article presents 3 data sources which are utilised in conjunction with a detailed energy system model of the residential sector to explore policy pathways for residential retrofitting. Data is collected from the Central Statistics Office (CSO) and the Sustainable Energy Authority of Ireland (SEAI). The first SEAI dataset is compiled for Ireland in compliance with the EU Energy Performance of Buildings Directive (EPBD) [2]. Data is collected using the Dwelling Energy Assessment Procedure (DEAP) [3]. DEAP is used to produce energy performance certificates known as Building Energy Ratings (BER). A BER indicates a building’s energy performance across a 15-point energy efficiency scale, rated alphabetically from A1 to G, in units of kWh/m² year. A BER is required for new buildings and the rent or sale of existing dwellings — therefore the database has consistently grown in size since its inception in 2006. The BER database contains 735,906 records of individual dwellings. The database includes detailed building fabric information across a range of different building types, year of construction, Main/Secondary space/water heating fuels, heating system efficiency, ventilation method and structure type (Insulated concrete form, Masonry,
Timber or Steel Frame). The second SEAI dataset (PWBER) contains aggregated pre and post BER information for a sample of 112,007 dwellings retrofitted during the period 2010–2015; this database contains mean energy efficiency improvement (kWh/m² year) for a range of retrofit combinations as they apply to nine distinct building archetypes. The third CSO dataset is compiled from census data, representing the frequency of building types by year of construction.

© 2020 The Author(s). Published by Elsevier Inc. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

Specifications Table

| Subject | Engineering (General) |
|---------|-----------------------|
| Specific subject area | Residential dwelling energy performance characteristics and stock for Ireland. |
| Type of data | Microsoft SQL Database, Excel Spreadsheet with supplementary tables |
| How data were acquired | • BER database information was acquired from the Sustainable Energy Authority of Ireland (SEAI). Provided as unfiltered database of all BER records. Microsoft SQL used to process/query this database. • PWBER data acquired from SEAI. • National building census data gathered from Central statistics office (CSO). |
| Data format | Filtered model input data, SQL format Raw Model Input data |
| Parameters for data collection | All data on construction characteristics impacting energy performance of residential dwellings in Ireland. |
| Description of data collection | Data made available by the Sustainable Energy Authority of Ireland. Stored in SQL database and filtered using data collection parameters specified in section 2.1.4. CSO National Stock acquired from the Central Statistics Office (CSO) |
| Data source location | CSO/PWBER data related to Ireland, BER data provided provide at postal code level for Dublin and City/County level for all other counties. |
| Data accessibility | Data is provided with this article in the following formats: • BER Database is provided with the article in the form of SQL database attachment. • PWBER Data provided as supplementary Excel file • CSO data is provided within this article |

Value of the Data

- This data provides transparency to model input parameters used in the evaluation of energy efficiency measures for residential dwellings in Ireland. The data provides a detailed source of building fabric information in a queryable format.
- Energy analysts can benefit from the detailed building fabric information, serving to aid in replication of residential energy efficiency analyses. Policymakers can also benefit from detailed analyses underpinning evidence-based policy support.
- This data can be used to gain insights into the link between energy performance of specific building fabrics and the associated net improvement to building energy efficiency.

1. Data

The supplementary SQL database attachment provided with this article contains detailed building fabric performance characteristics for 735,906 dwelling records. Informational data is provided for each record in the form of a description of the dwelling type (Apartment, Basement Dwelling, Detached
house, End of terrace house, Ground-floor apartment, House, Maisonette, Mid-floor apartment, Mid-terrace house, Semi-detached house, Top-floor apartment), year of construction, dwelling location (postal code for Dublin and City/County description for all other counties), date/purpose of the BER assessment (Grant Support, New Dwelling, Private Letting, Sale, Social Housing Letting, Unknown, Other). Building fabric data is provided in the form of U-Values (W/m² K) and surface area (m²) for each dwelling’s walls, roof, floors, windows and doors. The number of building stories, ground floor area (m²), heating system efficiency and the main/secondary space/water heating fuels are also provided for each record. This data is gathered for Ireland in compliance with the EU EPBD [2] using DEAP [3].

The datasets within this article provide CSO census [4] and BER data on the number of dwellings by type, year of construction and BER grade category (Table 2). This data is presented in Table 1 and Table 2.

Data specifying the total number of dwelling types, by year of construction, is presented in Table 1. This data was collected as part of the national census completed in 2016. The energy performance of building types is not included in this data.

Data specifying the total number of building archetypes, by year of construction and energy performance grouping is presented in Table 2. This dataset is collected as part of Building Energy Rating (BER) programme operated by SEAI. A BER is compulsory for all new dwellings, dwellings being sold/rented, dwellings in receipt of an SEAI energy efficiency grant.

The BER database, included as supplementary material, represents a range of 140 individual building characteristics as they apply to 735,906 dwellings. The average U-Value (W/m² K) for walls, roof and windows, for each of the nine dwelling archetypes and year of construction bracket, is shown in Tables 3-5 respectively. A complete list of building characteristics is included and further described in Table 7.

The PWBER dataset included as supplementary material represents the average energy efficiency improvement (kWh/m² year), for a range of 50 retrofit combinations, as they apply to nine distinct

Table 1
CSO Census data, number dwellings by type and year of construction.

| House Type | <1919 | 1919 to 1945 | 1946 to 1960 | 1961 to 1970 | 1971 to 1980 | 1981 to 1990 | 1991 to 2000 | 2000 to 2005 | >2006 | Not stated |
|------------|-------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------|-----------|
| Detached house | 74125 | 46847 | 42427 | 42221 | 97698 | 86491 | 111455 | 175223 | 18050 | 20596 |
| Semi-detached house | 15478 | 25149 | 39121 | 43364 | 71056 | 49522 | 80437 | 115869 | 5900 | 26052 |
| Terraced house | 36956 | 31594 | 38410 | 24570 | 36997 | 23557 | 19161 | 51682 | 3127 | 19315 |
| Flat or apartment in a purpose-built block | 3159 | 2434 | 3415 | 4039 | 5873 | 9310 | 27108 | 84521 | 5717 | 26520 |
| Apartment in converted house/commercial building | 9575 | 2653 | 1745 | 1186 | 1176 | 1039 | 1530 | 2247 | 365 | 7267 |
| Bed-sit | 972 | 306 | 229 | 195 | 152 | 136 | 142 | 42 | 940 |
| Not stated | 935 | 685 | 760 | 666 | 1121 | 989 | 978 | 2069 | 235 | 13432 |

Table 2
BER data: Number of dwelling archetypes by type, year of construction and BER group.

| Building Archetype | <1919 | 1919 to 1945 | 1946 to 1960 | 1961 to 1970 | 1971 to 1980 | 1981 to 1990 | 1991 to 2000 | 2000 to 2005 | >2006 |
|--------------------|-------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------|
| Apartment AB | 132 | 296 | 185 | 422 | 249 | 180 | 964 | 6407 | 22054 |
| Apartment CD | 1769 | 1065 | 1044 | 1450 | 2442 | 4091 | 17611 | 31561 | 19926 |
| Apartment EFG | 7216 | 2371 | 1615 | 1500 | 1963 | 3187 | 8587 | 6397 | 2212 |
| Terrace AB | 644 | 893 | 1198 | 904 | 1757 | 1759 | 2796 | 4909 | 31761 |
| Terrace CD | 6401 | 9590 | 12820 | 12818 | 30992 | 30395 | 45837 | 50996 | 22915 |
| Terrace EFG | 13929 | 13619 | 15040 | 8137 | 13195 | 7499 | 7831 | 3727 | 1088 |
| Detached AB | 393 | 355 | 404 | 400 | 944 | 1195 | 3173 | 4929 | 15399 |
| Detached CD | 3777 | 3118 | 3598 | 4883 | 16510 | 18647 | 31420 | 26730 | 9761 |
| Detached EFG | 11400 | 8329 | 6755 | 5432 | 9209 | 4881 | 3163 | 1149 | 573 |
| All Types | 45661 | 39636 | 42659 | 35946 | 77261 | 71834 | 121382 | 136805 | 125689 |
building archetypes. These archetypes include energy performance groupings (AB, CD, EFG) applied to apartment, detached and terraced dwellings. Fig. 1 illustrates the average annual energy savings (kWh/m² year) associated with nine distinct retrofit combinations from the PWBER dataset.

2. Experimental design, materials, and methods

This section outlines the steps required to acquire, process and analyse the data referenced in this article.

2.1. Census data on housing in Ireland

The CSO provide direct access to 2016 census results for building type by year of construction through an online portal [4]. CSO survey definitions for building type differ from other sources and are
therefore aggregated into three building types (Detached, Terraced, Apartment), as shown below in Table 6.

2.2. BER database

This process describes the acquisition and filtering procedures to produce the included BER input database. Tables 2–5 are derived directly from the filtered BER database.

2.1.1 The Sustainable Energy Authority of Ireland host a public national depository of all BER records, available for download in excel format [5]. This format is not suitable for analysis and required further processing to produce queryable database in SQL format.

2.1.2 This Raw Data is imported into a blank Microsoft SQL database table using SQL Server Integration Services (SSIS). SSIS is used for complex data transformation and managing/filtering data [6]. This process allows all 735,906 records to be queried individually. A series of scripts are then utilised to manage and filter the database, adding unique record ID’s for each record in the database and removing unwanted outliers. Each script is provided with this article and its function described here.

Table 6
CSO dwelling type definitions - census 2016.

| Dwelling Type (CSO)                                      | Dwelling Type Aggregated |
|----------------------------------------------------------|--------------------------|
| Detached House                                           | Detached                 |
| Semi-Detached House                                      | Terraced                 |
| Terraced House                                           | Apartment                |
| Flat or Apartment in purpose-built block                 | N/A                      |
| Flat or Apartment in converted house or commercial building | N/A                      |
| Bed-Sit                                                  | N/A                      |
| Not Stated                                               | N/A                      |

![Fig. 1. PWBER Data: Average annual energy efficiency improvement by retrofit combination and dwelling archetype.](image)
**Table 7**
Data input variables name and description.

| SQL input variable name | SQL input variable description |
|-------------------------|--------------------------------|
| Record ID               | Unique BER record identifier  |
| CountyName              | BER record geographical location (county) |
| DwellingTypeDescr       | Description of dwelling type e.g. Detached, Apartment |
| Year_of_Construction    | Building year of construction |
| TypeofRating            | Nature of BER record, Final, Existing or Provisional |
| EnergyRating            | Letter grade for energy performance e.g. A1, A2, A3, B1, B2, B3, C1, C2, C3, D1, D2, E1, E2, F, G |
| BerRating               | Numerical energy performance rating (kWh/m²·year) |
| GroundFloorArea(sq m)   | Ground Floor Area (m²) |
| UValueWall              | Wall U-Value (W/m²K) |
| UValueRoof              | Roof U-Value (W/m²K) |
| UValueFloor             | Floor U-Value (W/m²K) |
| UValueWindow            | Window U-Value (W/m²K) |
| UvalueDoor              | Door U-Value (W/m²K) |
| WallArea                | Wall Area (m²) |
| RoofArea                | Roof Area (m²) |
| FloorArea               | Floor Area (m²) |
| WindowArea              | Window Area (m²) |
| DoorArea                | Door Area (m²) |
| NoStoreys               | Number Storeys per dwelling |
| CO2Rating               | BER CO2 intensity rating (kgCO2/m²·yr) |
| MainSpaceHeatingFuel    | Predominant fuel used for Main Space Heating |
| MainWaterHeatingFuel    | Predominant fuel used for Main Water Heating |
| HSMainSystemEfficiency  | Main Heating System Efficiency (%) |
| HSEffAdjFactor          | Heating system energy efficiency adjustment factor |
| HSSupplHeatFraction     | Supplementary Heating system fraction of heating requirement |
| HSSupplSystemEff        | Supplementary heating system efficiency (%) |
| WHMainSystemEff        | Main Water heating System Efficiency (%) |
| WHEffAdjFactor          | Water Heating Efficiency Adjustment Factor |
| SupplSHFuel             | Supplementary Space Heating fuel |
| SupplWHFuel             | Supplementary Water Heating Fuel |
| NoOfChimneys            | Number of Chimney stacks in dwelling |
| NoOfOpenFlues           | Number of Open Flues in dwelling |
| NoOfFansAndVents        | Number of fans and vents in dwelling |
| NoOfFluelessGasFires    | Number of Gas Fires not including Flues |
| DraftLobby              | Is a draft lobby present on entrance (yes/no) |
| VentilationMethod       | Dwelling ventilation method e.g. Natural Ventilation |
| StructureType           | Masonry, Timber or Steel frame |
| SuspendedWoodenFloor    | Is there a suspended wooden floor in dwelling (yes/no) |
| PercentageDraughtStripped | Percentage of floor draught stripped (%) |
| NoOfSheltered           | Number of sheltered walls |
| PermeabilityTest        | Was a permeability test performed (yes/no) |
| PermeabilityTestResult  | Permeability test result (m²/hour) |
| TempAdjustment          | Applied space heating temperature adjustment - dependent on space heating control category (°C) |
| HeatSystemControlCat    | Heating system control category ID |
| HeatSystemResponseCat   | Heating system response category ID |
| NoCentralHeatingPumps   | Number of central heating pumps |
| UndergroundHeating      | Does dwelling utilise underfloor heating (yes/no) |
| GroundFloorUValue       | Ground floor U-Value (W/m²K) |
| DistributionLosses      | Hot water heating distribution losses - dependent on hot water storage insulation (kWh/year) |
| StorageLosses           | Hot water storage losses |
| SolarHotWaterHeating    | Is solar water heating used in dwelling (yes/no) |
| ElecImmersioninSummer   | Supplementary electric immersion used in summer months (yes/no) |
| CombiBoiler             | Is Combi boiler used in dwelling (yes/no) |
| WaterStorageVolume      | Hot water storage volume (L) |
| InsulationType          | Hot water storage insulation type e.g. Loose Jacket |
| InsulationThickness     | Hot water storage insulation thickness (mm) |
| PrimaryCircuitLoss      | Hot water primary circuit losses (kWh/year) |
| GroundFloorArea         | Total ground floor area (m²) |
2.1.3 Using SQL Server Management studio (SSMS) [7]. A unique ID is associated with each record in the BER database. Executing SQL Script 1 creates a new database table which includes a record ID column and inserts all other records accordingly. This record ID is used to track deleted records upon removal of outliers. The ID is helpful with respect to error handling and understanding the reason an individual record might be removed.

2.1.4 Outliers are removed from the database, removing any records which satisfy the following criteria; Results are provisional, Main floor area $\leq 30$ m$^2$, Ground floor area $>1000$ m$^2$, Apartments/Terraced Dwellings with floor area $>500$ m$^2$, Heating System Efficiency $<19\%$, Heating System Adjustment Factor $<0.7$, Main Water Heating system efficiency $>450\%$, Main Water Heating system efficiency $<19\%$, Water Heating Efficiency Adjustment Factor $<0.7$, Living Area Percentage $>90$, Living Area Percentage $<5$, Supplementary Heat Fraction $\in \{0,0.1,0.15,0.2\}$, Declared Loss Factor $>20$, Thermal Bridging Factor $<0$, Thermal Bridging Factor $>0.15$, Dwelling Type Description $\in \{$House, Basement Dwelling, Maisonette$\}$ — resulting in removal of 46,661 records.

Executing SQL Script 2 removes record outliers from the database, tracking the total number of records removed from the database for each criterion stated.

2.1.5 Executing SQL Script 3 creates the final table and inserts all relevant values from the processed database. This table forms the input data for use within the energy system model defined as the SQL Archetype Dwelling Energy Model (ArDEM-SQL) [1]. Table 7 shows the complete list of input variables in this final table. The complete database backup is included as supplementary SQL backup (Backup.bak).

### Acknowledgments

The authors acknowledge the funding and support provided by the Environmental Protection Agency (EPA - 1016-CCPR-MS.24) and the SFI MaREI Centre for Climate, Energy and Marine (MaREI - 12/RC/2303).

### Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

| SQL input variable name | SQL input variable description |
|-------------------------|-------------------------------|
| GroundFloorHeight       | Total ground floor height (m) |
| FirstFloorArea          | Total first floor area (m$^2$) |
| FirstFloorHeight        | Total first floor height (m)  |
| SecondFloorArea         | Total second floor area (m$^2$) |
| SecondFloorHeight       | Total second floor height (m)  |
| ThirdFloorArea          | Total third floor area (m$^2$) |
| ThirdFloorHeight        | Total third floor height (m)   |
| ThermalBridgingFactor   | Transmission heat loss due to thermal bridging (W/m$^2$.K) |
| ThermalMassCategory     | Index of heat capacity required, rated ow, medium-low, medium, medium-high or high |
| PredominantRoofTypeArea | Total area of main roof (m$^2$) |
| PredominantRoofType     | Total main roof construction type |
| LowEnergyLightingPercent| Percentage of energy efficiency lighting installed (%) |
| LivingAreaPercent       | Percentage of building used for living space (%) |
| RoomInRoofArea          | Is attic converted to living space (yes/no) |
| MainFloorArea           | Total dwelling floor area (m$^2$) |
| PurposeOfRating         | Reason for BER assessment e.g. Sale, Retrofitting |
| DateOfAssessment        | Date of BER assessment |

Table 7 (continued)
Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dib.2020.105247.

References

[1] T. Mac Uidhir, F. Rogan, M. Collins, J. Curtis, B. Ó Gallachóir, Improving Energy Savings from a Residential Retrofit Policy: a New Model to Inform Better Retrofit Decisions, 2019.
[2] EU Parliament and the Council of the EU, Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the Energy Performance of Buildings EPBD(recast). https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF, 2010. (Accessed 8 October 2019).
[3] SEAI, Dwelling Energy Assessment Procedure (DEAP). https://seai.ie/publications/DEAP_Manual.pdf, 2008. (Accessed 9 December 2018).
[4] CSO, Census of Population 2016 - Profile 1 Housing in Ireland. https://www.cso.ie/en/releasesandpublications/ep/p-cp1hii/cp1hii/hse/, 2016. (Accessed 9 December 2018).
[5] SEAI, National BER Research Tool. https://ndber.seai.ie/BERResearchTool/ber/search.aspx, 2019. (Accessed 7 July 2018).
[6] Microsoft, SQL Server Integration Services - SQL 2014. https://docs.microsoft.com/en-us/sql/integration-services/sql-server-integration-services?view=sql-server-2014, 2017. (Accessed 1 October 2019).
[7] Microsoft, SQL Server Management Studio - SQL 2014. https://docs.microsoft.com/en-us/sql/ssms/sql-server-management-studio-ssms?view=sql-server-2014, 2017. (Accessed 1 October 2019).