



FUTUREquipped

Construction Sector

Energy Efficient Housing

UNIT

3

Funded by:



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Promoting further and higher education

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in collaboration by:

CONSTRUCTION
SCOTLAND
INNOVATION
CENTRE



DIGITAL
HEALTH & CARE
INSTITUTE

Learning outcome

Energy efficiency and sustainability are key aspects of SMART Homes. The unit introduces the principles of constructing energy efficient houses.



Sustainability & SMART Homes

Introduction

Airtightness of buildings refers to the degree with which air infiltrates or exfiltrates the building “envelope” – the walls, roof, floor, windows, doors, roof lights etc. – when the ventilation system is not used. This contributes to the level of energy loss from the building.

The Scottish Building Regulations (1st Oct 2010, section 6) now specify that any new dwellings are built “airtight”. The main benefits from reducing air leakage from buildings include lower energy use, increased owner and user comfort and lower operating and running costs of the building. Airtightness is achieved by installing an airtight membrane located within the internal structure. This comprises of the membrane (building paper/vapour barrier, OSB etc.) tapes, sealants and grommets at penetrations. Space heating is the biggest source of energy consumption in a domestic house. To reduce heat loss, the building fabric must be of high insulation quality. Around 50% of the heat can be lost due to poorly sealed and insulated properties.

Energy efficiency and sustainability are key aspects of SMART Homes that can also incorporate smart technologies to support the individuals living in these houses.

The most energy efficient, currently voluntary building standard is a German design for “passive house”, which can reduce energy costs by up to 80-90%.



This video explains the passive house concept in 90 seconds:

<https://www.youtube.com/watch?v=CasrjYhZB1M>

With energy efficient or ‘air tight’ buildings, Mechanical Ventilation with Heat Recovery (MVHR) should be incorporated to provide a healthy, continuous, fresh supply of pre-heated air to the dwelling.

In addition, the property should have a south facing glazed area with adequate shading to enable ‘Passive Solar Gain.’ This uses solar energy to heat the property and retain the heat within the building fabric through various absorbent building materials

With the combination of these techniques, a consistent, economical, healthy warm home is achieved without the need for any additional heating sources.

Watch this video on constructing a “passive house” – the film touches upon the main points of airtightness and ventilation: https://www.youtube.com/watch?v=Hz6qomFM_dw

Read more on ventilation on Scottish Government Building Regulations section 3.14: <https://www.gov.scot/publications/building-standards-2017-domestic/3-environment/314-ventilation/>

Key drivers for energy efficient housing, now and in the future

- Sustainability and environmental concerns
- Legislation to cut carbon emissions, e.g. Climate Change (Scotland) Act 2009.
- Building regulations (Scotland, 2004; UK2002)
- Economy: utility prices are driving some elderly people into fuel poverty
- Strive for more energy efficient housing: 95% of the current UK housing stock falls below recommended Energy Performance Certificate (EPC) levels. Annually around half of the utility costs are used to provide space heating.

Advantages of energy efficient (see passive house) design, incorporating MVHR, air tightness, well-insulated building fabric and solar gain:

- Low-carbon build;
 - Low energy use;
 - Highly efficient;
 - Consistent air quality and temperature;
 - Healthy living environment;
 - Elimination of bad odour and condensation;
 - Fresh air and extraction aiding allergies and asthmatics;
 - Noiseless extraction;
 - Humidity control;
 - Alternatively-designed systems can also be used for air cooling.
-

Who are the key players in the emergence of energy efficient construction methods?

- Building regulations for sustainable and energy efficient buildings and construction methods (Scottish and the UK governments; local authorities);
- Housing associations and construction companies;
- Construction Scotland Innovation Centre;
- Businesses and industries providing new technologies for construction.



Scottish Innovation Centre most closely linked to energy efficient housing:



Construction Scotland Innovation Centre (CSIC) – Construction industry-led Innovation Centre for Scotland’s construction industry. Since opening in October 2014, CSIC has been linking together businesses, university and college experts and public sector providers to deliver transformational change in construction along with the provision of appropriate innovation support in areas where industry demand is currently not being met. CSIC has an innovation factory that has specialist equipment which can be utilised for product development; CSIC also provide business support and networking opportunities for emerging market players.

What are the key challenges and opportunities for the development / adoption / progress of energy efficient housing?

Opportunities:

- Educate designers, architects, engineers to ensure good design at inception.
- Educate customers about the benefits of energy efficient building techniques.
- Ensure construction operatives understand the benefits of energy efficient building materials and process and why it is important to adhere to these.
- Ensure the availability and use of highest quality building materials for energy efficient buildings.
- Encourage clients to adopt procurement practices which are aligned to life-cycle rather than initial build costs.

Challenges:

- Difficulty in retrofitting existing housing stock;
- Lack of awareness of the benefits of “passive house” building techniques.
- Future modifications must be cognisant of Passivehaus standards and ensure that membranes are not breached in the process of work being carried out.



Please, read a

Case study

on building an energy efficient house:

Sustainable, self-built house at Huntshaw, Earlston

This property was designed to achieve an air tightness of maximum $1\text{ m}^3/\text{hr}/\text{m}^2$ air loss at a pressure of 50 Pa. This is near to the passive house ("Passivhaus" in German) standard of 0.6 m^3 . The current Scottish Building Regulations dictate that an air tightness of at least $7\text{ m}^3/\text{hr}/\text{m}^2$ at 50 Pascals of air pressure must be obtained in all new domestic properties.

Although passive house certification wasn't in the design brief, this property would incorporate all the design features included in a passive design:

- Large South facing glazed elevation
- Solar shading
- Thermal absorbing wall and floor construction
- Air tightness
- MVHR
- Triple glazing

Border College News explains: "Unlike regular builds, the 'foundation' for the new house is 100mm of reinforced concrete sitting within a 300mm deep raft of high-density polystyrene. He set about designing this low energy, sustainable house with his architect, Keith Renton, a passive house specialist, applying the principles of fabric first, air tight, ventilate right to the design and build.

The fabric of the house boasts many interesting and unique features. The house uses passive solar design, whereby the shape and positioning of the house maximises the use of the sun. Box guttering shades the sun from the windows during the summer to avoid overheating, but allows the sun onto the windows during the winter producing natural heating. The south-facing aspect of the house aids this process, and the aim is to maximise human comfort with a consistent ambient temperature of 20°C all year round without the added requirement of significant heating input".

Read more about the project at: <http://www.borderscollege.ac.uk/news-and-events/doctor-grows-his-own-breathable-self-cleaning-house/>

FUTUREquipped

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STUDY ROOM

LIVING ROOM

DINING ROOM

DEPOSIT

LAUNDRY ROOM

KITCHEN

HOUSEKEEPING ROOM

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Assessment 1

Multiple Choice Assessment (10 questions)

1. What does MVHR stand for?

- a. Modern Ventilation with Heat Recovery.
- b. Mechanical Ventilation with Heat Recovery.
- c. Mechanical Ventilation with House Recovery.
- d. Mechanical Ventilation with Heat Resource.

2. What is the first consideration in building an air tight design?

- a. Energy use.
- b. Building fabric, e.g. insulation.
- c. Ventilation.
- d. South facing property location.

3. What is the biggest user of energy in a domestic dwelling?

- a. Cooking.
- b. Lighting.
- c. Hot water.
- d. Heating.

4. To take advantage of "Solar Gain", which orientation should the glazed aspect of house be facing?

- a. North.
- b. West.
- c. East.
- d. South.

5. By how much can a passive house design reduce energy costs?

- a. 50-60%.
- b. 60-70%.
- c. 70-80%.
- d. 80-90%.

6. How much heat is lost on average through controlled ventilation?

- a. 20%.
 - b. 95%.
 - c. 50%.
 - d. 10%.
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- 7. Scottish Building Regulations state that new domestic dwellings must have an airtightness of...**
- 10m³/hr/m² at 50 pascals.
 - 5m³/hr/m² at 50 pascals.
 - 1m³/hr/m² at 50 pascals.
 - 7m³/hr/m² at 50 pascals.
- 8. What are the main benefits from reducing air leakage from buildings?**
- Lower energy use.
 - Increased comfort for the dweller.
 - Lower operating and running costs.
 - All of above.
- 9. What instrument can be used to discover heat loss in buildings?**
- Piano.
 - Laser level.
 - Infrared Camera.
 - Binoculars.
- 10. What % of the current UK housing stock falls below recommended Energy Performance Certificate (EPC) levels?**
- 95%.
 - 50%.
 - 75%.
 - 25%.

Answers on page 10

Assessment 2

Scenario / Project based Assessment

Write a short assignment (200-300 words) about the advantages of applying energy efficient design to a domestic dwelling, and consider how that would contribute to making the house "smart"?



Assessment 1 Answers

1. b - Mechanical Ventilation with Heat Recovery
2. d - South facing property location
3. d - Heating
4. d - south
5. d - 80-90%
6. c - 50%
7. d - 7m³/hr/m² at 50 pascals
8. d - all of above
9. c - Infrared Camera
10. a - 95%

These materials were produced by college lecturers as part of the FUTUREquipped project in 2018. The project was funded by the Scottish Funding Council and designed and delivered in collaboration by the Digital Health and Care Institute and the Construction Scotland Innovation Centre.

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