# Assessing the suitability of two hypothetical buildings for heat pumps

**This exercise examines the key factors you need to consider to find out if a heat pump is a suitable option for a particular building.**

**Time needed**

To complete this exercise you will need 60 minutes

- Stage 1) Grouping and explaining (5 minutes)
- Stage 2) Carrying out the exercise (25 minutes)
- Stage 3) Feedback (15 minutes)
- Stage 4) Discussion (15 minutes)

**Films that accompany this exercise**

As many people as possible in the group should have watched the following:

- 'Introduction to heat pumps' (disc 1)
- 'Setting up a heat pump project' (disc 1)

**Number of people or groups**

If there are lots of people, split into groups of two to six people (even numbers of groups may work best).

**Materials needed**

- A3 handouts with Case studies 1 and 2 and their respective discussion points for each group plus the handout 'Heat Pumps – key points'
- A calculator for each group
- Flipchart/whiteboard for recording feedback session with whole group

**Running the exercise**

*Stage 1) Grouping and explaining (5 mins)*

Explain to the whole group that they are going to initially work in smaller groups to discuss the suitability of heat pumps for two fictional community buildings and then discuss any opportunities for actual buildings within their community.

Divide into two or more groups and give each group one of the case studies.

*Stage 2: Carrying out the exercise (25 mins)*

Ask everyone to take 5 mins to read through the Heat Pump overview handout and then the case studies. Working in their individual groups, get people to run through the discussion points and debate their responses. Each group should appoint someone to note down the key points on the sheet provided, ready to feedback to the whole group later.

*Stage 3: Feedback from groups (15 mins)*

Gather everyone back into one group and briefly run through the case studies, asking for feedback on each discussion point. Record any queries or questions that people still have and offer them up to the group to see if anyone has an answer.

*Stage 4: Discussion of local opportunities (15 mins)*

Use this session to invite suggestions for actual buildings within the community which may be suitable for heat pumps. Points that could be covered include:

- How well is the **heat demand profile** of the building understood? (See the separate exercise: 'Estimating the heat demand of a community building')
- What are the opportunities for improving the thermal efficiency of the building?
- Could underfloor heating be installed or larger, lower temperature radiators?
- What space is available for digging trenches to lay slinky coils, or where could you put boreholes? Would boreholes be too expensive?
- What type of electrical supply does the building have (see handout)?
- Are there opportunities for renewable electricity generation e.g. solar PV, which could help power the heat pump and reduce $CO_2$ emissions further?
- What would be the impact of the forthcoming Renewable Heat Incentive (RHI) on running costs?

The group is unlikely to have answers to all the above, so record the comments for the building being discussed and flag areas for further investigation. Finish the session by deciding on a course of follow up action to continue assessing the building, and ask for volunteers to be part of a small group that will follow up the issues raised and report back.

# **Case study 1** Henford Village Hall

**Details**

Henford Village Hall is a highly regarded asset for the community in and around the Henford area. The Hall is owned by the Village Hall Charity and is used by a variety of users most weekdays and occasionally at weekends, including toddler, pre-school, ballet, sports and drama groups, as well as occasional users for parties, meetings, wedding receptions, training events, etc.

The original building was built in 1939 and has since experienced several alterations, resulting in a range of building standards throughout as implemented according to Building Regulations prevailing at the time. The older parts of the building are therefore poorly insulated and are not particularly energy efficient.

This includes the roof of the main hall, which consists of a vaulted pitched ceiling, and which has no insulation. By contrast, a new small hall was added in 2009 and has high levels of insulation. Future plans include an extension to the main hall and kitchen area.

The Village Hall grounds consist of a car park for 30 vehicles, a play park, multi use games area and a large green, all of which is owned by the Village Hall Charity.

The current heating system was installed in 1980 and consists of a 50kW gas boiler (to meet the peak heating load) and radiator system, with point-of-use electric water heaters for hot water taps in the toilets and kitchen.

The Henford Village Hall Committee now think it's time to renew the building's heating system and would like to look at options for renewable energy, including heat pumps. They are committed to improving the building's insulation as a first step, which would be expected to reduce the peak heating load by 20%.

**Points for discussion**

**1)** Would a ground or air source heat pump be technically feasible for Henford Village Hall? If not, what would be needed to make it so?

**2)** In the case of a ground source heat pump, what would be the most suitable option for the ground loop? How much space would be needed? (Hint – see last bullet point on heat pump handout)

**3)** What do you think the key issues would be in assessing the economic viability of a heat pump for this building?

**4)** What do you think would be the pros and cons of an air source heat pump compared to a ground source heat pump?

# Case study 1 Batsford Community Centre

**Details**

The New Batsford Community Centre was constructed in 2007 to replace the existing community building, which was becoming very dated and structurally unsound. Having been carefully designed to blend into the woodland setting of Batsford Gardens, the intention was to create a 'hub' for organisations and activities, and which is used most of the day and evening, including weekends.

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Activities within the building range from training sessions, indoor markets, lunch clubs, performances of both drama and music, community resource centre, playgroups, local clubs and societies and some indoor physical activities such as yoga. The building has a café, small kitchen, toilet and shower facilities. The building is mostly surrounded by fairly dense wooded areas, with one side opening on to a large council-run open car park.

The site does not currently have a mains gas supply and hence a 25 kW oil-fired boiler was specified to meet the peak heat load for the building, which works in conjunction with an underfloor heating system and hot water tank for hot water outlets. However, the management are concerned with the rising costs of oil and wish to consider a replacement heating system which is cheaper to run and results in lower $CO_2$ emissions.

**Points for discussion**

**1)** Would a ground or air source heat pump be technically feasible for Batsford Community Centre? If not, what would be needed to make it so?

**2)** In the case of a ground source heat pump, what would be the most suitable option for the ground loop? How much space would be needed? (Hint – see last bullet point on heat pump handout)

**3)** What do you think the key issues would be in assessing the economic viability of a heat pump for this building?

**4)** What do you think would be the pros and cons of an air source heat pump compared to a ground source heat pump?

# Heat-pump handout

- Heat pump systems capture solar heat energy which is stored in the ground (ground source heat pumps), bodies of water (water source heat pumps) or air (air source heat pumps). They can be used for space heating, water heating, heat recovery and cooling in a range of buildings.

- Although all the heat delivered by heat pumps comes from renewable energy (stored solar energy), a supply of electricity is required to power the heat pump system, which may or may not come from renewable sources. Some larger heat pumps are driven by fairly large electrical motors which often work best with a '3-phase' electricity supply rather than the 'single phase' supply that is supplied to most homes. When considering a heat pump, any requirements for upgrading a building's electricity supply should be discussed at an early stage with the heat pump supplier.

- The Coefficient of Performance (CoP) is the key parameter to indicate the efficiency of a system. For each unit of electricity used, a well-designed system will typically extract at least three units of renewable heat energy (i.e. a CoP of 3), making the system more cost effective and carbon efficient than some other types of heating systems.

- As the required delivery temperature of the heating system increases, the efficiency decreases, and so heat pumps therefore work best with low temperature heating systems (typically 35-40°C), such as underfloor heating or by using specially designed large radiators. As these systems are designed to work more or less constantly (keeping the building at a stable internal temperature rather than the on/off cycle of conventional heating systems), they are much more suited to new or well-insulated buildings.

- Heat pumps can be designed to supply 100% of space heating, but usually only provide a proportion of domestic hot water (if at all) as higher temperatures are required. In this case electric immersion heating is normally used as a top-up.

- Ground source heat pumps extract heat from the ground, which remains at a constant temperature all year round, whereas air source units extract heat from the outside air. In practice, this means that air source units work less efficiently during the winter, especially as the majority of heating is required during this period, and tend to have lower annual average CoPs than ground source units.

- The heat-load profile of a building should be well understood before detailed design of a heat pump is undertaken. This involves knowing the total amount of heat or fuel used throughout the year, and how this is spread over the course of a day, week or month. To avoid unnecessary capital costs, the heat pump should not be oversized for the building.

- For ground source heat pumps, a 'ground loop' is used to collect the heat from the ground. This takes the form of either a coiled 'slinky' pipe laid in trenches or vertical pipes within boreholes. The borehole option is more expensive. For trenched 'slinky' ground loops, 10m of trench length is typically needed per kW of heat required with a minimum of 4m between trenches; for borehole systems, one borehole (100m deep) should deliver between 3 and 5 kW of heat. Borehole spacing should be 5m minimum.

- The installed cost of a ground source heat pump will range from around £800-£1,400 per kW. Systems with trenched ground loops will be at the lower end of this range, and those with boreholes at the higher end. Borehole costs vary considerably depending on the geology and ground conditions at the site.

**'Slinky' ground loop (far left), ground source heat pump unit (middle) and air source heat pump unit (below).**

Credits: (Slinky in trench) Schoonover Plumbing & Heating | (Compressor and heat exchanger) Rob Baxter / flickr.com