Electric heat pumps – using energy storage to become a demand side management tool

Rationale:
- 23% of UK energy demand and associated CO₂ emissions are as a result of domestic space heating and hot water supply
- Even with major improvements in building performance and behavioural change there will still be a major need for heat energy to provide comfort and sanitary hot water.
- Use of electrically driven heat pumps to:
  - Reduce carbon emissions through increased efficiency and use of renewably derived electricity
  - Provide a management tool for non-dispatchable renewable energy (e.g. wind) through efficient heat pump operation coupled to a compact thermal store

Why a Heat Pump and Demand Side Management?
An electric heat pump uses high grade energy to extract heat from the environment (the outside air, the ground, a river etc.) and to upgrade it to a temperature that can be used for heating and hot water. The Coefficient of Performance of a heat pump, equivalent to the efficiency of a boiler, is the useful heat output / high grade input and is always greater than one. A condensing boiler might have a maximum efficiency of 0.9 (90%).

Demand Side Management: using energy storage to match energy supply to energy demand
- Heat Pump Performance - Ensuring maximum Coefficient of Performance is compatible with Energy Storage
- Energy Storage - Phase change or Chemical materials to minimise storage size

Previous Research at Ulster
- Advanced Heat Pumps developed under EPSRC “Calebre”
- Economised vapour injection and rotary compressor & expander units under development and test

Current research (i-STUTE)
- Demand Side Management Test Stand integrated to rear of Terrace Street
- Terrace Street
- 1900’s solid wall houses
- Phase 1 – Integration of optimised heat pump and energy storage

Challenges
- Optimised heat pump uses weather compensation
- Air source heat pump heating time may be too slow to benefit from 30 minute pricing intervals
- What temperature should heat be stored at?
- Heat Pump requires a feed forward prediction to supply heat at required temperature later in the day

Solutions
- Multiple tanks, blends of PCMs etc are possibilities