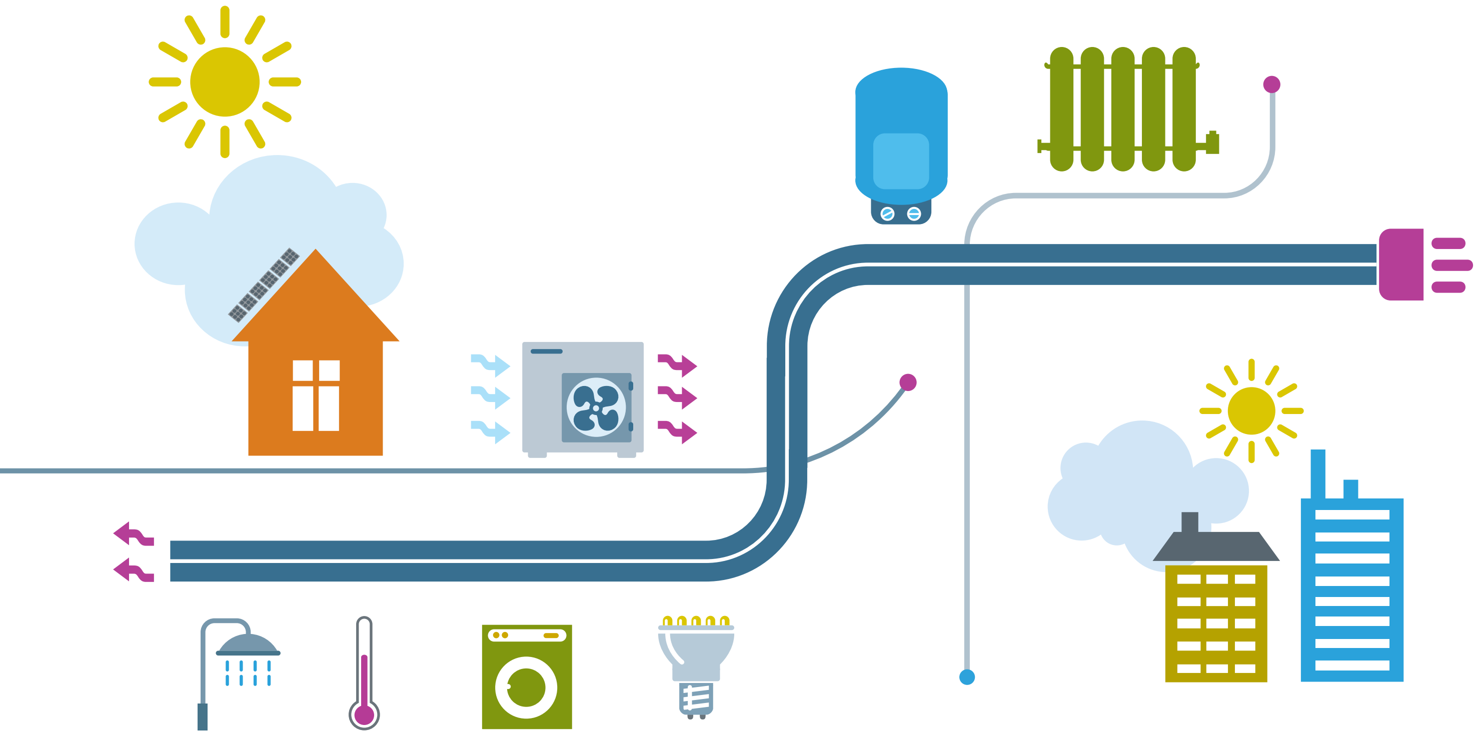
TECHNICAL BULLETIN

SUMMARY OF
BEAMA AIR SOURCE HEAT PUMP TRV SALFORD ENERGY HOUSE TEST



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The trade association for energy infrastructure & systems

SUMMARY

This technical bulletin is a summary of the report titled 'BEAMA Air Source Heat Pump TRV Salford Energy House Test'. Commissioned by a number of BEAMA Heating Controls manufacturers, the Energy House Labs testing project was designed to assess the impact of analogue and smart TRVs (Thermostatic Radiator Valves) on ASHP (Air Source Heat Pump) performance and to inform future modelling of TRVs deployed alongside ASHP systems. This report was produced with the University of Salford based on the following:

- Tests were conducted to measure how trimming room temperatures using TRVs influences internal conditions, ASHP efficiency, and space heating energy consumption.
- The tests found that trimming internal temperatures with both traditional and smart TRVs reduced ASHP space heating energy consumption and did not significantly impact its coefficient of performance (COP).
- Reductions in energy consumption were proportional to reductions in space heating demand (internal to external temperature difference) achieved using TRVs. The trimming scenarios tested resulted in space heating energy savings of between 6-8%.
- The findings suggest that TRVs can be used to provide occupants with greater internal temperature control and reduce ASHP space heating energy use, as is customary with gas central heating systems.
  - Although, those with ASHP systems wishing to limit internal temperatures should initially reduce the flow temperature and programme setbacks, with TRVs used as a secondary measure.
- Using TRVs requires adequate volume within a system and flow rates to be maintained. Therefore, a volumiser and automatic bypass valve should be installed alongside an ASHP.

Salford Energy House heat pump installation

FINDINGS

- Trimming internal temperatures with TRVs reduced ASHP space heating energy consumption by 6-8% and had no impact on the efficiency of the ASHP.
- Traditional TRVs exhibit analogue behaviour and smart TRVs exhibit digital behaviour. The variation in flow rates caused by smart TRVs on/off behaviour did not impact ASHP efficiency.
- TRV use was also found to result in a reduction in the air temperatures of adjoining zones.
    - Maintaining a zone below its design temperature means that radiators in adjoining zones must increase their output to compensate for the additional heat transfer within a dwelling.
- TRV use increased the flow rate through other radiators on the system which could result in additional power output elsewhere in the dwelling, which may reduce the impact of increased heat transfer between zones.
    - In this case, manually increasing the flow rate through radiators in the zone most directly impacted by trimming elsewhere in the dwelling, could provide more effective and targeted mitigation.
- Trimming internal temperatures with traditional TRVs had a similar impact on system behaviour as trimming with lock shield valves.
    - **Note:** traditional TRVs are not a substitute for accurately sizing and balancing a system, however, may provide occupants with a simple method to mitigate the impact of oversized radiators or those with too high a flow rate.
- TRVs should be used as a secondary measure to reduce internal temperatures. For efficient ASHP operation, the initial course of action should be to reduce the flow temperature until the worst performing room reaches a comfortable temperature. TRVs should then be used to trim temperatures in other rooms.
- Findings are dependent on occupancy behaviours, heating circuits and ASHPs. More aggressive trimming scenarios should be assessed:
    - Including use of very low TRV settings on some radiators to simulate unused rooms.
    - Exploring mitigation measures to compensate for increased heat transfer within dwellings.
    - Radiators that are subject to trimming comprised a relatively low proportion of the total flow rate through the system.
    - Trimming of radiators with a high proportion of flow rate requires further examination.
    - Further investigation is also required to understand how TRV trimming impacts ASHPs with differing characteristics regarding minimum flow rates.

SETBACK TEMPERATURE PATTERN

- Programming the heat pump with a setback setpoint between heating periods also reduced the internal temperature outside of the setback periods.

- The ASHP flow temperature is only sufficient to maintain the setpoint rather than increase the setpoint, showing that some room compensation is required for setback heating patterns in situations where the weather compensation curve closely aligns with fabric thermal performance.

- Although the setback significantly reduced energy use, the reduction in heating period temperatures means that it is not robust to compare energy use with tests in which setpoints were achieved during heating periods, as occupants would experience notably lower temperatures. The setback heating test with no trimming does, however, provide a baseline to assess TRV use with a setback heating pattern.

Salford Energy House

SETBACK TEST FINDINGS

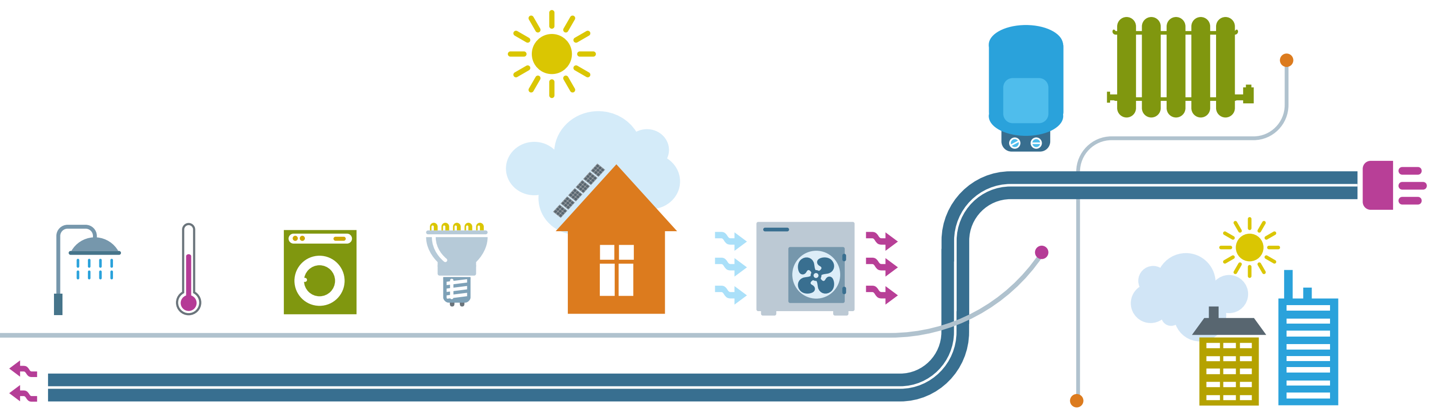
- Traditional TRVs provided similar conditions in non-trimmed rooms as the baseline test. Flow rate measurements suggest that the TRVs were trimming the internal temperature of the bathroom and kitchen during setback periods.
- During heating periods, the flow temperature increased, which resulted in the TRVs further restricting flow, which in turn increased the flow rate through non-trimmed radiators.
- Trimming did not impact the COP and significantly reduced space heating energy use.
- Using smart TRVs on all radiators to provide a setback between heating periods significantly increased heat pump cycling.
- A whole house setback period should be programmed using the heat pump controller, rather than smart TRVs on all radiators.
    - It is worth considering that occupants in this scenario may have gained some comfort benefits without increasing ASHP energy use. Had smart TRVs been used for purely trimming purposes alongside programming the ASHP to provide setback, then cycling would have been reduced.
- The behaviour during setback periods demonstrates the importance of ensuring weather compensation curves are not set too high, as this could result in unnecessary TRV intervention, which in extreme cases may reduce flow rates below minimum levels and increase cycling, which could impact ASHP efficiency.

IMPACT OF VOLUMISER & DIURNAL EXTERNAL TEMPERATURE

- The use of the volumiser without trimming has no significant impact on system behaviour with either a constant or diurnal external temperature pattern.
- Changing from a constant to a diurnal external temperature pattern had no measurable impact on COP or energy use.
- Any reduced stability present can be attributed to a combination of weather compensation control, modifying the flow temperature and thermal inertia of the building fabric.

CONCLUSION

This report has established that **TRVs can reduce ASHP space heating energy consumption by 6-8% without reducing appliance and system efficiency** and can reduce the air temperature of adjoining zones. TRVs have the potential to provide greater internal temperature control to occupants and reduce ASHP space heating energy use. It is important for a volumiser and automatic bypass to be installed alongside the ASHP to ensure the adequate volume in the system is achieved. TRVs should be used as a secondary measure to reduce internal temperatures.



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