New technologies are constantly shaping our futures, injecting new life where stagnation has occurred. Within an increasingly conscientious and progressively-minded world, a passive adherence to the ‘traditional’ or ‘usual’ is no longer sufficient, and ‘efficient enough’ is no longer adequate.

ProHeat Systems was established as a specialist supplier of indirect heating technology focused on developing more robust and efficient preheat solutions for gas distribution networks (GDNs). Heat is required to avoid freezing outlet pipework at points of pressure reduction, and represents a significant source of carbon emissions for gas networks.

Through a multi-party collaboration between UK GDNs, academia and ProHeat’s industrial partners, a promising new technology has been demonstrated that has the potential to realign the old with the new, and inefficiency with efficiency.

**LANDSCAPE**

Historically, GDNs have faced three main obstacles to progress. Firstly, a network of tried and tested legacy equipment which, though having reliably formed the foundations of modern GDNs over 40 years, is now at the end of its life and requires replacement. Secondly, over-reliance on traditional business-as-usual technology has bred a cultural resistance to change. And thirdly, for many sources of supply, GDNs have come to rely on a limited number of suppliers, or even a single supplier, which has led to a lack of experimentation and innovation, and at times produced an apathetic attitude towards the exploration of alternatives.

**WHAT’S CHANGING**

Until such incentives as the Network Innovation Allowance (NIA) and the Network Innovation Competition (NIC), change occurred incrementally and, for the most part, adhered to the above limitations. For two decades, boiler houses have provided improved preheat efficiency over traditional water bath heaters, but they aren’t without their own caveats — namely, added complexity leading to maintenance difficulties and a significant reduction in asset life.

ProHeat Systems managed to find a desirable middle ground; offering the improved efficiency of boiler houses, but doing so with a simple and reliable design. However, such a feat wouldn’t have been possible without wider industry change, spurred by an increasingly environmentally and financially conscious landscape. Innovation is now seen as a necessary precursor to providing security of supply and value for money as Great Britain moves towards a low carbon future.

**STORY SO FAR**

But first, some backstory. The ProHeat mission began in 2012 to fill a perceived market gap for an improved preheat technology. Whereas many companies begin with a product mandate, ProHeat’s starting point was a need articulated by GDNs to reduce whole-life cost and to improve environmental performance of preheat assets. During conceptual design, the project began with a blank slate to explore a number of preheat solutions, and was able to measure suitability using the goals defined by the GDNs. A key feature of ProHeat’s strategy was to limit technical risks by combining concepts that were proven and which had previous applications on an industrial scale.

An engineering team was assembled that included the University of Swansea’s Advanced Sustainable Manufacturing Technologies group (ASTUTE). With ASTUTE’s help, a performance simulation tool was developed which in turn provided the theoretical underpinnings of the initial design. This allowed the project to progress from concept to a 120-kilowatt demonstration plant in just over 18 months.

ProHeat then set out to establish a supply chain, providing the remaining experience required to successfully deliver the project. Managing Director of ProHeat Systems Stefan Romocki said: “We drew on the experience of the entire development team to think of all the improvements we could build into the
conceptual design, to optimise fabrication, installation and the long-term performance of the preheater."

**HOW IT WORKS – THE IMMERSION TUBE PREHEATER**

The design concept is based on a combination of two proven technologies: a high efficiency immersion burner and a more effective means of moving energy using a thermosiphon. The immersion burner was developed by ENGIE’s research and development team for industrial fluid heating, and has since built a reputation for reliability with customers such as Coca-Cola and Airbus, whose operations depend on efficiency and continuity of service. ProHeat’s main feature, however, is the use of a dual-phase thermosiphon to create steam and deliver efficient, reliable heating. The benefits of using steam for energy transfer include its high energy carrying capacity, uniform heat transfer and ease of control. With steam, up to 20 times less overall fluid is required, making systems more compact, responsive and easy to control. Problems associated with the loss of preheat due to pump failures are resolved as steam provides a natural source of maintenance-free circulation. Energy is moved by convection as steam rises to the natural gas heat exchanger, while gravity returns liquid water to be re-energised in the boiler. These improvements provide the foundation for a flexible preheat solution, able to adapt easily to rapidly changing gas flows. Benefits are further enhanced by operating under a partial vacuum, limiting opportunities for corrosion, and reducing environmental losses with steam temperatures as low as 39°C. Stefan said: “A key benefit of the design is the ability to respond quickly to changing heat requirements, offering true on-demand heat with a degree of control that was previously unachievable.”

ProHeat’s immersion tube technology has been designed to be simple, in so far as is possible, providing both efficiency and reliability with low maintenance requirements. Preheat systems can be built at cost, competitive with conventional technology while using more robust materials, leading to a longer service life. The company’s commitment to performance was recognised by the UK’s Energy Innovation Centre (EIC) when it received the Best Gas Network Improvement Award (2016). And, in 2014, the new immersion tube preheat concept received the prestigious Built Environment Award from the Institution of Engineering and Technology (IET), with the panel commenting: "The development programme was undertaken with excellent market collaboration and, as a result, the final outcome was fit-for-purpose and had immediate market applicability."

**BENCHMARKING RESULTS**

In fall of 2015, with support from the new NIA, SGN conducted a head-to-head efficiency comparison between the immersion tube technology and an existing water bath heater. Over a six-day test period, the immersion tube preheater demonstrated an average thermal efficiency of 85 per cent as compared to 57 per cent for the existing water bath heater. Significantly, the results were achieved while operating at 20 per cent of design capacity, wherein the immersion tube preheater outperformed the water bath heater in fuel economy, efficiency, response time and associated reduction in carbon emissions. SGN’s report on the benchmarking trial was published via the Energy Networks Association’s Smarter Networks Portal. With performance accountability becoming a focal point within the industry, Northern Gas Networks (NGN) has invested significant resources to launch the Low Carbon Gas Preheat (LCGP) project. Co-funded under Ofgem’s annual Network Innovation Competition (NIC), the £6.8 million study will be the first of its kind to use real-time monitoring for a comparison of preheat technology performance across a range of NGN sites. Results are intended to provide a sound basis for future investment. At present, there are five immersion tube installations operating across Great Britain, with an additional eight installations scheduled to be commissioned over the 2016/17 period.

**AN EFFICIENT FUTURE**

ProHeat’s immersion tube preheater technology has been made possible by Ofgem’s new innovation incentives, which seek to connect GDNs with the technology required to make significant improvements to efficiency and reliability. In an industry traditionally known for its slow progress, SMEs like ProHeat are aligning GDN and regulatory objectives with new supply chains and technical partnerships to squash any hereditary slowness in favour of transformative change. Over the RII0-GD1 and GD2 regulatory period, more than £100 million will be invested in upgrading ageing preheat infrastructure, including over 300 water bath heaters approaching the end of their service lives. When comparing the resulting emissions to existing bath heaters, a 500kW immersion tube preheater is anticipated to save over 3,000 metric tonnes of CO₂ equivalent over a 40-year period. If all remaining water bath heaters were to be replaced with immersion tube preheaters, the resulting reductions in carbon emissions would be equivalent to having installed 250 wind turbines. Moreover, as compared to conventional preheat solutions, a durable design with low maintenance requirements is anticipated to provide whole-life cost savings of over 25 per cent, ensuring value for investment as Great Britain migrates to a low carbon economy.

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