Pipe dreams

Pipes. Hardly a topic to set the pulse racing perhaps. Yet the millions of miles of pipework that lie out of sight and largely out of mind are, in reality, the unseen heroes of civilised society. They are the arteries and veins through which clean water, gas and sewage flow, and which shield power and telecommunications cables. Without this unseen plumbing, argues ***Mark Everard****, society would simply cease to function.*

What goes through the pipes has a lot to do with the metabolism of society, and therefore its sustainability. However, let's for a moment reflect upon the unsung heroes themselves. Even discounting what goes through them, pipes have their own sustainability story to tell.

The sustainability challenges

Society is faced by a range of sustainability challenges. Some of these issues were plainly visible through the lens of sustainable development many years ago, but are only now manifesting as current 'issues' for business (the Climate Change Levy, for example).

Many of these sustainability challenges revolve around what flows through the pipework under our streets and indeed with the pipework itself. Let's explore some of these sustainability challenges.

Social value per unit of material. For much of our industrial past, we have undervalued the resources that support our day-to-day lives and we are increasingly faced by the inevitable 'downstream' waste issues of profligate resource usage in the developed world – the need to do 'more with less'. So, a material with a design life of 50 years and an anticipated performance closer to a century has obvious sustainability advantages over material that has a theoretical life of perhaps 20 years. Resistance to the forces of corrosion, vibration and ground movement has real sustainability and economic benefits where they enhance product durability and longevity. Furthermore, if that material is then recyclable, the social value per unit of material offers efficiencies of real sustainability and economic value.

Safe water and sanitation. Water and sanitation are amongst the key challenges within the Millennium Development Goals set by the United Nations in 2000. Therefore, access to the infrastructure to deliver these services, and the affordability of that infrastructure, is central to the delivery of acknowledged sustainability challenges. Pipework again takes centre stage (albeit that it is buried beneath that stage).

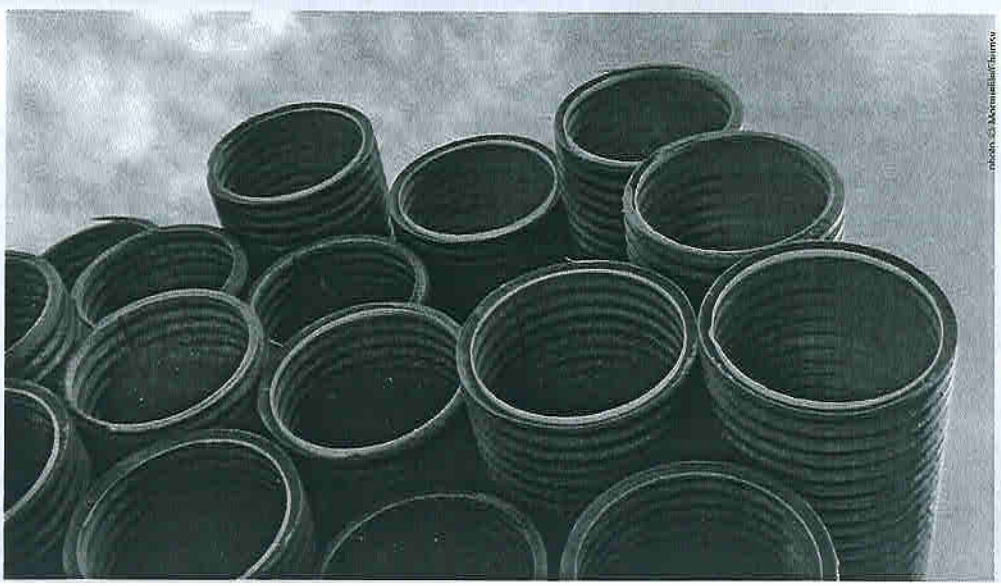
Affordability. Having technical capacity to do something is all well and good, but affordability is key to achievability. Materials from which both technically efficient and cost effective pipes can be made, therefore, may have a role in providing services, not just to the developed world but also in delivering upon commitments to improve the life of those in developing countries.

Stewardship of resources. We can no longer afford to waste precious commodities such as water and gas. The water itself is a limited resource, and the loss of treated water further represents wastage of the substantial amounts of chemicals and energy expended in the purification process and pumping through the system.

Disruption of society. The acceptability of digging up our streets and pavements on a frequent basis is declining. Furthermore, miles of traffic queues, each car or truck with its engine idling behind red lights during installation, repair or replacement works, contributes very significantly to the greenhouse emissions of the nation. Add to this the reduction of waste during digging and of aggregate use in refilling trenches. Pipes that can be installed with minimal disruption have much to offer in terms of the wider sustainability picture and cost.

Cutting out waste. In years gone by, it may have been acceptable to lay new pipework on top of redundant old infrastructure in the ground. However, this practice is now coming under scrutiny. It does, in effect, represent an unlicensed waste stream, and potentially contaminated waste disposal given the work that we ask our pipes to do. We therefore need to make sure that we plan for redundant pipework to be removed from the ground. After all, pipe recovery is already the norm in the Netherlands, due to a high water table, ground movement and congestion under the streets. But how can we achieve this without just adding to existing waste mountains? Pipes that can be recycled could therefore represent a step forward in terms of the overall sustainability of our infrastructure and the management of waste costs.

Value recovery from end-of-life resources. Increasingly, owing to efficiencies required of them, utility companies are looking to recover the value of assets at end-of-life. This includes buildings, vehicles, office equipment, and pretty much everything else... potentially



including pipes if only a value recovery mechanism (which may include averting disposal costs) could be identified.

Creating a virtuous circle

What a list of sustainability challenges to grapple with! And what a split of responsibilities between different types of businesses, public-sector bodies, and others to sort out! However, a bigger picture does emerge, within which, if all the key players collaborated, could maybe just deliver a virtuous circle of sustainability wherein everyone benefits.

This might appear an outlandish claim from where we stand today. However, let's look at the staging posts within the circle one-by-one, each related to the sequence of sustainability challenges already explored above.

The benefits of durability and recyclability. Where ductile iron pipes can be economically recovered for re-smelting into new products, they certainly fulfil sustainability criteria for durability and recyclability. They may also already be made from recycled metal. However, it is all too common for ageing iron pipe to break down substantially in the ground, and what remains at end-of-life is difficult to recover and consequently of dubious value to recycle. Lead pipe scores poorly on any sustainability assessment not merely because it is a softer metal more prone to deformation, but also due to its toxicity and the consequent ban on its use. Likewise, health implications mean that asbestos and asbestos cement pipes are no longer permitted. Furthermore, if left in the ground at end-of-life, these pipes would contribute to the contaminated land of the future. Clay and concrete pipes, though recommended by some pressure groups for water supply, are not viable for this purpose owing to the difficulty of pressure-sealing them. Furthermore, they too are prone to degradation.

By comparison, and notwithstanding their manufacture today from petrochemicals, plastic pipes offer certain advantages. Their design life exceeds that of other materials, and they are also flexible and durable in the face of vibration, and resistant to chemicals and intrusion by roots. Furthermore, once the molecular matter of certain plastics has served this extended life cycle, it is possible to recycle it efficiently without significant loss of technical quality to extend its useful value to society by many more years. In theory, PVC and polyethylene pipes may last a century, perhaps more, before needing replacement, then they may be recovered for remanufacture through several cycles without losing significant technical quality; a high social value per unit of material indeed. Though today derived from petroleum (but potentially derived from crops in the future), the molecules comprising these plastics can deliver significant social value over several extended product life cycles.

> "the real weakness is with our current economic system, which excludes so many of the environmental and social costs"

Safe, efficient and affordable conveyance. Crucial services such as the delivery of clean water, gas, energy and communication systems and removal of sewage is essential to support the goals of both developed and developing society. Add to the durability of plastic piping the fact that it is light and cost efficient to produce, and its potential to deliver these vital services is significant. Furthermore, as a technically-efficient material, the capacity of plastic piping to deliver without wasting the resource it is conveying further enhances the sustainability argument in its favour.

Non-disruptive installation. Unlike traditional rigid materials, flexible plastic pipework can assist the process of trenchless pipe-laying, allowing society to function at closer to normality during renovation or installation activities. Whether installed de novo or as an inner plastic liner to existing, failing metal or ceramic pipes, or fed into a trenchless dig tunnel, 'no dig' technology applied to both the laying and extraction of pipework can reduce the sustainability footprint in reinstatement costs and the use of aggregates.

Recovery of end-of-life resources and their associated economic value. Notwithstanding the long lifetime of service that we can expect from it, we need to plan ahead in expectation of needing to remove spent infrastructure. Flexible pipework facilitates this process. For good sustainability as well as economic reasons, we don't just want to add to waste mountains. Therefore, the inherent recyclability of plastic pipes potentially offers us sustainability benefits. However, the 'Holy Grail' for those arguing in favour of a cyclic, resource recovery economy has always been to ensure an economic return from the recovery of end-of-life materials, closing the loop, which converts the concept of 'waste' to one of 'resource recovery'.

Trends in the industry

Many of these sustainability-related pressures have already begun to influence the market. During the 1960s, the predominant materials used for water service pipes were lead or copper. Polyethylene, and to a lesser extent PVC, had only just begun to enjoy a small market share. Today, polymer pipes account for the majority of water service pipes, of which most are polyethylene. For gas in the UK, only polyethylene and ductile iron are used.

This market share has been achieved not merely on the basis of cost alone, but also technical performance. All plastics used for water service pipe manufacture are tested for compliance with a 50-year simulation of test pressure/stress at elevated temperatures. Some PVC applications conform to 80-year tests, and the effective service life may be longer still. However, 100 years is a most conservative and probably the most commercially sane warranty issued by the more adventurous of manufacturers. This represents a significant span of delivery of social value for a given molecular content, as well as averting the expense, disruption, demand for landfill and aggregates, traffic obstructions and other issues associated with replacement of shorter-life assets.

Today, many water and other utility companies see leaving pipes in the ground as entirely acceptable and certainly the lowest-cost option. However, for reasons of underground clutter, a growing perception of an unlicensed contaminated waste

stream, and other arguments associated with resource recovery addressed above, we cannot assume that this will remain acceptable forever. Current recycling infrastructure in the UK can create real obstacles to the efficient reuse of pipe material at end-of-life.

Then, of course, we have the issue of appropriate markets for recycled polymer. The point at which the polymer product enters the waste stream determines the options available for this. For example, waste arising during the manufacturing process is already recycled with high efficiency into new product, and there is little need to intervene in this process which is driven largely by market forces bearing upon resource efficiency and waste costs. Waste arising from the construction phase when pipes are installed include off-cuts, short lengths and faded stock left too long over-ground without cover. Applications in sewerage pipes, furniture, building products, sidings, ducting or new window frames offer a mature market with an existing strong demand.

Most end-of-life underground pipework in the UK is disposed of by being left in the ground, local burying or entry into mixed waste streams. From the sustainability angle, market forces hardly help this process today. We therefore need to invest in elements of resource recovery infrastructure as a 'toe-hold' into the resource efficient habits required in future.

Closing the loop

The missing link, to date, has been the lack of an economic and efficient recovery system and the subsequent regeneration of primary materials. However, in recent years, some important pilot work has been done to bridge that gap. This is now being rolled out as a commercially viable network of infrastructure.

In 2005, the PVC industry instigated the Recovinyl programme – a process initiated by the European PVC industry to make value recovery from spent PVC products a reality (see Stepping Stones, 'the environmentalist' October 2006).

Recovinyl works through a diverse consortium of partners. By subsidising those who collect and send PVC waste to accredited waste recovery companies and recyclers, the recycling of PVC products is encouraged on an industrial scale. Recovinyl also subsidises recycling plant and recycling technology, both in terms of mechanical recycling (extrusion of new PVC compounds from cleaned end-of-life materials) and feedstock recycling (remanufacture of PVC or other materials once the used plastic is broken down into its chemical constituents). Therefore, Recovinyl circumvents the issues of concern raised by traditional disposal of spent products, including both the wastage of valuable resources and their embodied energy as well as the potential for formation of harmful waste by-products.

The Recovinyl scheme is booming in the UK. In April 2005, when instigated here, there were just two recyclers and no registered collectors (these are generally local authorities or recyclers). By March 2006, there were 18 recyclers and 85 collectors and we can expect a dramatic increase in PVC recovery rates.

Missing links

Recovinyl currently relies on subsidy to make the all-important 'take-back' part of the cycle work. Some might see this as a weakness. However, the real weakness is with our current economic system, which excludes from market price so many of the environmental and social costs associated with resource extraction, the supply chain, waste disposal and liabilities for the future.

Recovinyl addresses them directly by creating an incentive to make stepwise progress towards the kind of cyclic re-manufacturing model which is both inevitable in a more resource-constrained and heavily-populated future.

Add to this the implications of rising oil prices for the cost of raw materials and risks associated with security of supply of fossil precursors. The economic as well as sustainable development rationales for PVC and polymer recovery is already compelling.

Completing the circle

So, the pieces of the chess set are all but assembled. All we need now is a willing consortium of common interests ready to commit to play the game. But where would we find this? Again, let us return to the sexy topic of pipes.

For society at large, the sustainability benefits of efficient and effective pipework are clear. For a manufacturer of materials that is committed to sustainable development, it is now able to recover spent product rather than to depend forever upon virgin resources and somewhere for its eventual end-users to throw away the inevitable waste. For a manufacturer of pipes and other products for which the polymer content of end-of-life pipes can be reused, there are market differentiation, ethical and even now some direct economic benefits to plastic recovery. For a utility operator with a commitment to sustainability, and also an ever-vigilant eye upon the looming pressures likely to impinge upon a heavily-regulated industry, the facility to source recycled material with a long service life and the potential for asset recovery beyond end-of-life must be attractive.

In short, there exists a clear opportunity for benefit to all players within the loop, as well as the wider society that the products serve. We stand on the threshold of realising in commercial practice the elusive and attractive concept of closed-manufacturing. The only thing, it seems, that might hold us back are entrenched habits in some notoriously conservative industry and regulatory sectors.

A piping hot opportunity

So there we have it. We have the opportunity to enhance the sustainability of pipe infrastructure to a very significant degree, simultaneously delivering material benefits to the participating businesses and serving their sustainability aspirations.

All we need now are for some key players to decide to work together to seize the piping hot opportunity that lies waiting on the table. It would be a crime if this inherently sustainable opportunity were not seized.

Dr Mark Everard
Visiting Research Fellow
University of the West of England
This is an edited version. The full article may be obtained from the editor.