APPLYING A CARBON LENS IN EVALUATING STRATEGIC WATER RESOURCE OPTIONS

What do we mean by 'best value' in relation to strategic resource options for public water supply? How do we ensure that 'best value' results in sustainable outcomes for communities and the environment, in ways that contribute to the net zero carbon commitment, whilst delivering the required resilience? We discuss some of the findings from the early stages of developing solutions for strategic resource options, the sources of uncertainty and how we might attribute carbon and wider 'costs' and 'benefits'.

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'Best value' is the goal for strategic resource options

Eighteen strategic resource options (SROs) are currently being evaluated to alleviate potential future water deficits in England as shown in Figure 1. Solutions are to be developed by the water companies to be 'construction-ready' for 2025-2030.

The schemes are set in the context of growth, climate change and abstraction reform at a time when many water companies have committed to net zero carbon emissions by 2030. These large infrastructure projects offer opportunities for innovation and wider sustainability benefits. If designed appropriately, they can also create social value through the provision of new amenities, enhance biodiversity (contribute to biodiversity net gain targets), and support carbon sequestration.

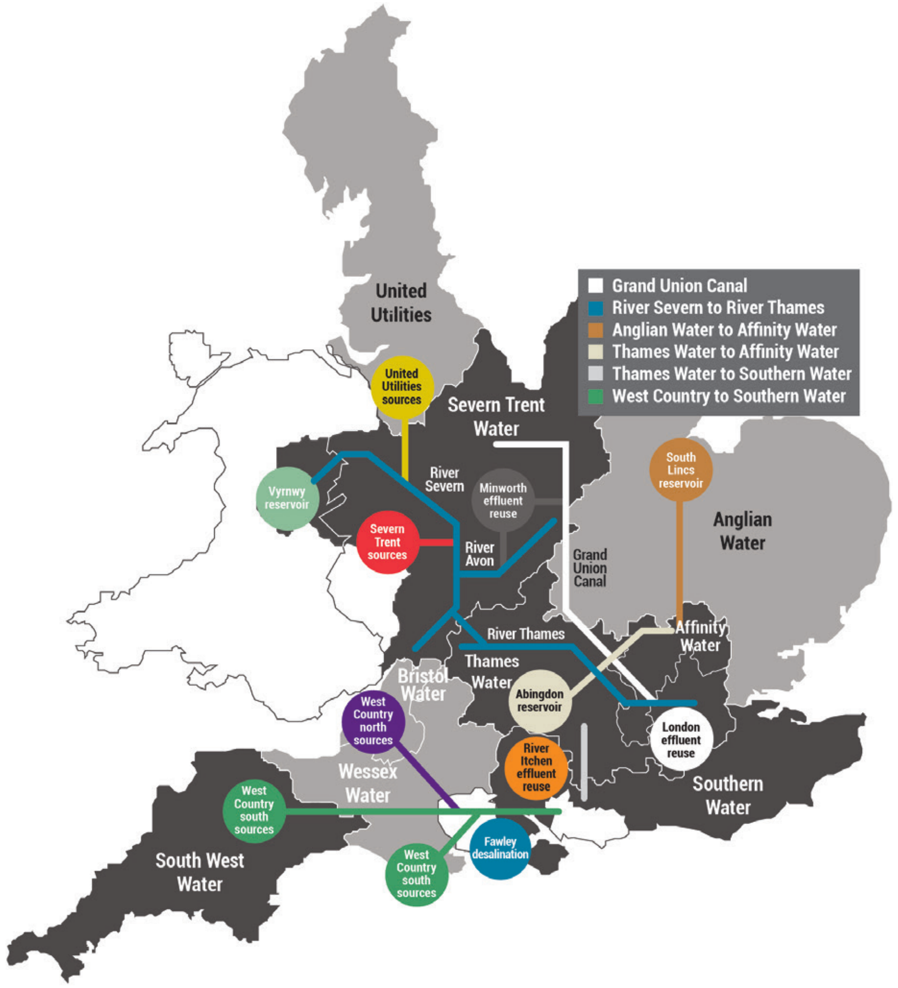
SROs will be evaluated on 'best value', a term that can be interpreted in different ways. For example, does best value include paying extra now to deliver outcomes in the future such as net zero carbon emissions, biodiversity net gain, or improved social value? If so, how much extra should be invested now to achieve these benefits?

Water Resources South East (WRSE) is currently consulting on its best value objectives and how these would be evaluated; using different weightings between objectives to establish the trade-offs. In this process, carbon is to be included as the cost of offsetting and inter-generational equity considered using relevant HM Treasury discount rates in calculating net present value. This assumes that these benefits and costs can be adequately monetised and can reflect the variations in local and regional importance, value or temporal effects associated with non-financial cost and benefits.

Beyond the obvious benefits of providing resilience to areas with projected future supply deficits, there are also opportunities to create local employment, improve the local environment and leave a lasting, sustainable legacy. These benefits must outweigh the costs, including capital and operational carbon emissions, biodiversity loss, as well as direct capital and operational expenditure. The costs of mitigating residual impacts would need to be attributed to the schemes for a full assessment with recognition of where these occur geographically together with any trade-offs, such as may exist between terrestrial and aquatic biodiversity. This is crucial, as the 'costs' or disbenefits of abstracting and pumping water across the landscape for example, may occur primarily in one region or water company area, whilst the 'benefits' could be received elsewhere.

A natural capital approach, incorporating carbon assessment is a useful mechanism, particularly in the light of the net zero and wider environmental commitments. The carbon reduction hierarchy – 'build nothing, build less, build smarter and build efficiently' – as set out in PAS2080 (a strong framework for carbon management in infrastructure) and the recently published Water UK route map (which provides pathways for carbon reduction, renewables and dealing with residuals) are also helpful signposts to delivering the most carbon-efficient solutions.

Figure 1: Strategic resource options transferring water to the South East (source: Pr19 Final Determinations appendix: Strategic regional water resource solutions appendix)



Minimising whole life carbon

As illustrated in Figure 2 overleaf, building new works to augment or improve water supply typically may result in increased carbon emissions over time (assuming no carbon mitigation measures) from the baseline position, resulting both from the resources used (materials and energy) in construction and the greater use of power and chemicals needed during future operation.

In fact, the large infrastructure works being considered in the current programme of SROs studies (e.g., transmission pipelines) could have very significant carbon impacts. Thus, it is vital the best combination of alternatives to traditional supply-side solutions – including local storage, additional wastewater reuse and even, in extreme droughts, drawing on currently protected water sources – continue to be properly explored (with evaluations of carbon impacts), along with demand management, before decisions are made.

Given the climate emergency, understanding the 'whole life carbon' emissions of schemes and taking decisive action to ensure these are kept as low as possible has never been more important.

Experience has demonstrated that early decisions have the largest impacts on the overall carbon outcome of a scheme; the diminishing returns of carbon reduction as schemes progress is highlighted in PAS2080. Accordingly, opportunities to deliver more sustainable, possibly nature-based alternatives must be explored now together with action to aggressively minimise the carbon of traditional 'grey' infrastructure solutions. In short, sustainability measures must be intrinsic and not be treated as mitigations to be 'added on' later.

Whole life carbon assessments for these schemes are needed to inform the decision-making process, taking account of the capital carbon, replacement, maintenance, and operational carbon associated with chemicals and power used during the life of the scheme.

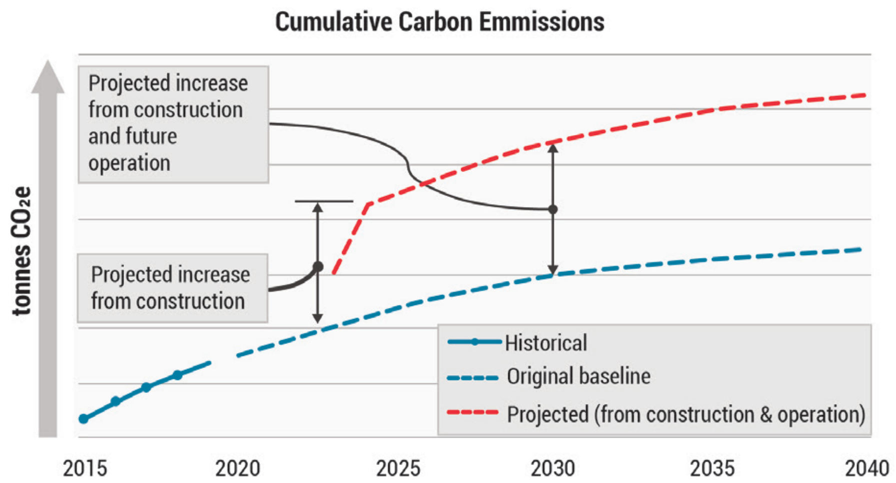
Minimising carbon through design could include optimising the scale, getting the right balance between local storage and regional transfer capacity, optimising the transfer to minimise pumping and find the shortest feasible route, selecting low carbon materials, lean design of ancillary works (such as access roads) and employing low carbon construction methods.

To inform this optimisation of transfers, wherever new route SROs are proposed, Stantec uses a routing tool to help derive high-level alternative schemes. Evaluation criteria and weighting are applied to help find the alternatives with a combination of the shortest route, least elevation differences, carbon impacts, biodiversity impacts and minimising stretches passing through sensitive areas such as ancient woodlands or sites of archaeological interest.

The boundaries of the assessments and assumptions underpinning these evaluations need to be made on the same basis as the comparison of other costs and benefits, for example, assumptions regarding the level of detail in relation to transport of materials, labour, construction energy use, and source data sets.

This is important to ensure 'like-for-like' comparisons are made. It is also important to revisit initial assessments at later stages to monitor whether the benefits

Figure 2: Understanding the whole life carbon impacts of a project over time



(and costs) estimated in the early stages are actually being delivered or need to be revisited to bring them back on track.

Some SROs may have a built-in operational carbon (and cost) risk. For some SROs, there will be a need for 'sweetening' flows to be maintained throughout the life of the scheme to ensure the water quality. This is because the assets used for clean water transfers cannot be initiated only in the event of a drought.

Opportunities to further reduce carbon 'costs' and provide benefits

Once solutions are decided, we must still go further to drive down whole life carbon. Options to minimise embodied carbon include making the right choice of materials. For example, for the design of a (non-SRO) multi-kilometre long pipeline transfer scheme, various pipeline materials are being considered to identify the lowest carbon option.

The capital carbon impact of these long-pipelines can vary significantly depending on the pipe material selected (such as concrete-lined ductile iron or epoxy-lined steel), diameter (the impact increases rapidly as the diameter increases – some of these pipelines are projected to be 800-900 mm in diameter), manufacturing process, transport from the point of manufacture and method of on-site installation. Where polyethylene pipe materials are selected, evidence from construction of the Glencorse water supply scheme for Edinburgh shows that manufacturing lengths of pipeline on

How much carbon would these options add?

According to Discover Water, in 2019-20, the carbon intensity of supplying drinking water to customers varied significantly across England and Wales from 100 up to 300 kg of carbon dioxide equivalent (CO2e) per megalitre (Ml). This is as a result of grid power used for pumping and treatment.

Let's say that providing treated water emits on average 200 kgCO2e/Ml. The SROs are intended to increase supply by 1500Ml/day (mainly during droughts). Constructing and operating the 17 SROs (assuming 1000km of new transmission mains, in addition to reservoirs, water treatment works and desalination plants) for this could generate in the region of 3 million tonnes CO2e over the next 60 years (about the same as the annual electricity use from 3.6 million homes today).

This equates to approximately 10 times the current emissions per megalitre from water supply although values of up to 200 times the current emissions have been estimated on some of the SRO options considered.

site can be lower carbon (and cost) than overseas manufacture and transport to the UK.

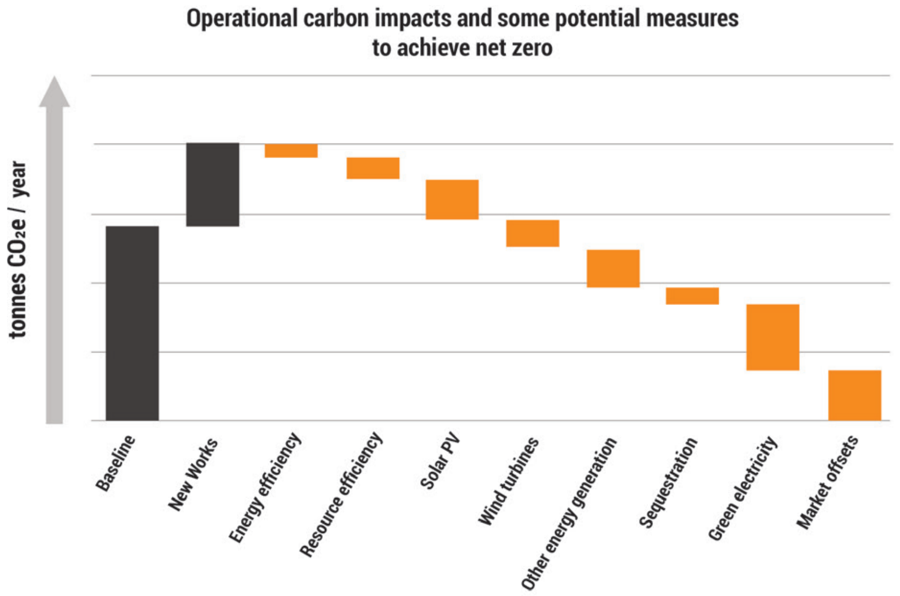
Consideration should also be given to transporting pipe bedding materials along the shortest possible distances and, wherever possible, to using local materials and re-using excavated materials. For example, in replacing lead pipes in Thames Valley, valuable carbon was saved, and noise and traffic impacts on the local community reduced, because excavated material was managed locally (graded, a binder added in the process and the material used as backfill). Given the large diameters of the pipelines for SROs, there is likely to be a significant volume of spoil. This could be put to beneficial use, for example, as raw materials for landscaping new amenities such as skate or cycle parks near communities adversely impacted during construction of the schemes.

Once effort has been made to reduce whole life carbon through efficient design and use of resources, attention can be given to which additional carbon mitigation measures – such as renewable energy generation, sequestration and, as a last resort, market offsets – may be applied individually or in combination to achieve net zero, as illustrated in Figure 3.

For example, could we routinely install solar PV along pipeline routes, on pump station roofs and at impounding reservoirs or water treatment works? At discrete facilities such as pump stations, the opportunity to use battery storage in combination with renewable energy generation may be viable. Wind turbines could potentially be built on additional or third-party land in cases where it is difficult to locate within the boundaries of proposed schemes. Of course, the practicalities of obtaining planning permission, accommodating local community preferences and proximity to the grid need to be addressed at individual locations.

Carbon sequestration, such as planting trees in a way that enhances natural habitats, is a further mitigation option but needs careful consideration. The cost

Figure 3: Operational carbon impacts and potential measures to achieve net zero



of tree-planting can readily be determined for the financial evaluation but assessing the benefit of the carbon sequestered is more complex. Rather than assuming a single value of carbon sequestered by planting trees (which varies according to species, rate of growth, whether planted individually or as part of a forest, and how the forest is managed), their impact on the overall carbon profile of the total system needs to be determined.

The carbon performance of the system (comprising asset construction, future operation, as well as tree or forest growth) depends on the net rate of carbon emitted and absorbed over time. Such measures should also contribute to enhancing habitats and biodiversity. When coupled with additional land use or purchase, these measures could be implemented at or beyond the boundaries of transmission pipelines and other works.

Concluding remarks

To truly represent 'best value', solutions to improve strategic resilience will be those where the future water demands are met in ways that are affordable, achieve net zero (or at least minimal) whole life carbon emissions, whilst also enhancing aspects of social and natural capital.

To achieve true 'net zero', schemes should incorporate best value combinations of options for carbon reduction (determined from applying the carbon reduction hierarchy from the outset and throughout scheme development), renewable energy generation and carbon sequestration accompanied by a rigorous sustainability appraisal. This will help ensure each project minimises all relevant costs, carbon impacts and maximises the wider benefits arising from the scheme, including those that are less easy to quantify or monetise through a conventional cost benefit analysis.