

515: Inter-seasonal Co-generation as a Carbon-neutral solution for heritage-led regeneration

Greg Keeffe

*Bioclimatic Architecture Labs, Manchester School of Architecture Manchester UK
g.keeffe@mmu.ac.uk*

Abstract: Inter-seasonal Co-generation as a Carbon-neutral solution for heritage-led regeneration

Rated by Prince Charles as the most intact Victorian mill town in Britain, Nelson UK is dying: pickled in aspic by English Heritage, it is losing population at an alarming rate, and those remaining are ageing and racially entrenched. How can radical change be integrated with heritage interests as strong as these? This paper describes an ambitious attempt to create a 21st century carbon-neutral future within a very regulated aesthetic.

Nelson, as a Victorian boom-town, has no public space, and the housing is mainly terraces without gardens. The brief was to make difference without changing the historic character of the area. The competition-winning scheme for the Whitefield ward by CityLab and Maccreeanor-Lavington starts with the insertion of a much-needed public space; this has several functions: It links the town with the canal; provides a pedestrian link to school and creates an edge to the town centre. However, beneath it, lie large water tanks that act as an inter-seasonal store.

To regenerate the city as a sustainable entity, it is necessary to reduce dramatically its carbon footprint. The heritage-led constraints limit opportunities to reconfigure anything, so the design-team focussed on the co-generation of heat and power, using bio-diesel produced from waste cooking oil. The main issue with co-generation, is how to equalise the demands between the need for more heat in winter and the constant demand for electricity. The solution, is to use waste heat in summer to heat a large thermal store, which can then be used in winter – thus regulating the demand between seasons, and optimising the efficiency of the plant. With the CHP plant adjacent and the inter-seasonal store beneath and its urban design functions, the public space can be seen as a total sustainable solution to a complex political, social and ecological condition.

Keywords: Heritage, urban design, interseasonal

1. Introduction

The North West of England, a post-industrial landscape of failing Victorian mill-towns, has some of the worse-performing boroughs in the country. These Victorian boom-towns have fallen on hard times, since its cotton production economy collapsed during the 1970 and 80s. The weaving towns of East Lancashire were hardest hit and Whitefield, Nelson is typical of many neighbourhoods in the region. It developed rapidly between 1870 and 1890 on the back of cotton production, based around jacquard weaving. The neighbourhood developed with virtually no public space or even private gardens: the houses are ubiquitous, small, terraced and built of local materials; they are laid out on a grid iron of streets with a brutal but consistent aesthetic (developed by community steeped in Methodism) that contrasts with the expansive views of unspoilt countryside that surrounds the town. Although originally built by mill-owners to rent, or by workers co-operatives to own, most (80%) of the properties are now owner occupied¹.

The collapse of its industrial base has meant that Nelson is shrinking: people do not want to live

here; it is remote, isolated and entrenched, 65% of the population are of non-British origin. Since 1960 it has lost one third of its population and only some 22,000 remain. Whilst much of Britain has enjoyed an incredible housing boom, with prices doubling every 7 years throughout the past 30 years, in many parts of Nelson and the surrounding towns of East Lancashire, house prices have hardly changed. This lack of equity has meant that very little modernisation has taken place and over 25% of the houses are considered unfit for habitation.

In order to deal with this failure of the housing market the UK Government published *The Sustainable Communities Plan* in 2003² this provided the Government framework for a reinvestment in nine areas of the country to try to deal with not only the symptoms of market failure, but the contributory factors in its creation. The main lever for the framework is the Housing Market Renewal Initiative (HMRI): a package of investment measures implemented in order to create a buoyant local housing market.

In order to facilitate this investment, a series of 'Pathfinders' were created, one for each Housing

Action Area. Elevate East Lancashire is the pathfinder for Nelson: their aim is to re-invigorate the housing market by creating sustainable communities with a diverse housing stock. This aim already has problems as it suggests that housing alone can create a sustainable solution, to dying towns. Sustainability is ecological – and within this ecology are environmental, social, and economic factors. All must be considered in order to produce ecological sustainability. There is a belief that a ‘housing ladder’ (a complete market from poor first-time buyers’ homes to affluent large family houses) needs to be developed to make a housing market where profit through selling and moving replaces the lost local economy through globalisation.

With this as a development ethos, the Housing Market Renewal Initiative aimed to compulsory purchase and demolish any areas of housing where the market had ‘failed’ and insert in their place new affordable and diverse housing. This brutal ‘pruning’ of towns has not been without controversy and nearly all the HMRI pathfinder schemes throughout the country have been contested by local residents and professionals alike, and many interest-groups have taken issue with the moves and motives. Whitefield, Nelson is no exception: bodies such as English Heritage, the Society for the Protection of Ancient Buildings and the Prince’s Foundation as well as residents groups, all opposed initial moves to demolish the whole neighbourhood.

2. Heritage in the UK

In the UK, ‘Heritage’ is considered to have cache. In 2006 The Commission for Architecture and the Built Environment (CABE) published survey data that showed people considered places to be more favourable if they had ‘history’ or ‘heritage’³, but what makes heritage is open to question.



Figure 1: Whitefield, Nelson- a heritage streetscape?

Castles and so forth are obvious heritage – but what about ubiquitous Victorian Housing? – is

everything old of value and if so how do we regenerate anywhere? The UK government’s statutory advisor is English Heritage; they are the arbiters of taste in this contested area: they schedule and list places of historical importance. Once listed or scheduled, only certain modifications can be performed on the building and these are placed under extreme scrutiny. Although they might see themselves as otherwise they are the agents of conservatism in the built environment in the UK. Currently, mapping is underway of the heritage of the whole UK landscape, generally on an older-is-better footing. English Heritage listing is often used as a weapon of choice by groups opposed to major change in an area to fight development, as once in place it prevents almost any change.

In Whitefield, the residents group, faced with wholesale demolition of their neighbourhood, contacted Prince Charles, modern architecture’s most severe critic, promoter of new urbanism and the saviour of the conservative forces of British architecture. Prince Charles took a personal interest in Whitefield through his Princes Foundation for the Built Environment. The Foundation is an educational charity with one stated aim ‘to improve the quality of peoples’ lives by teaching and practising timeless and ecological ways of planning, designing and building.’ The Foundation is in effect a troubleshooting protagonist for ‘new urbanism’ able to use its financial situation to create ‘visions’ for communities, for them to use as a lever to put pressure on democratically elected bodies, who on the whole do not want to upset the Heir to the throne.

The Prince’s interest was consummated in an ‘Enquiry by Design’ where a crack team of the Foundation worked with residents and English Heritage to create a new vision for the neighbourhood that did not completely destroy it: it was, in fact, a heritage-led regeneration⁴. However, this ‘vision’ was not as unique as one might imagine, as it seems to bare more than a passing resemblance to other schemes by the Foundation, such as Poundbury. It seems that the dogma of new urbanism cannot create any more real place-based architecture, than the apparently flawed dogma it tries to replace.

The scheme did, however, still demolish 58 houses. In the meantime, spurred on by the Prince’s interest, English Heritage, against the wishes of Pendle Council, gave the neighbourhood ‘Conservation Area’ status. This meant that the neighbourhood could now neither be demolished nor radically altered.

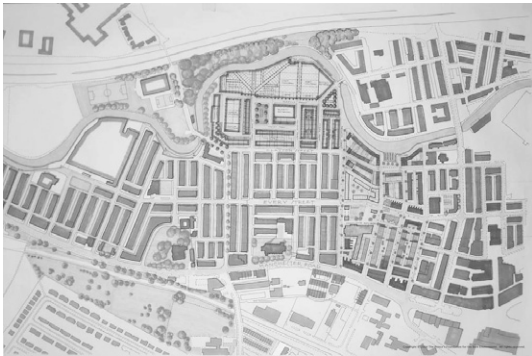


Fig 2. More of the same: the EbD masterplan by the Princes Foundation.

Pendle Council and Elevate were now on the horns of a dilemma: how could radical change be introduced in such a severely regulated context? Surely to produce a sustainable neighbourhood from this weak starting point it would need wholesale remodelling? It was decided that an international architectural competition would be the best way to solicit ideas for a way forward from this impasse.

3. Whitefield International Ideas Competition

The winning competition entry by MacCreanor Lavington Architects, Rotterdam, and CityLab MSA was entitled 'Future Heritage'. The overriding idea being that any new insertions into the urban realm would be such that they would, at a later date, be suitable for listing by English Heritage. The design team started with a strategic approach to regenerating the area, developed from a critical reading of the place and the systematic processes that have configured it to date, rather than a narrow minded position of conservation.

The urban strategy started from the a position of minimal removal of extant built form, this would maximise the heritage value of the whole fabric. Clearance was then viewed as a precision tool to release latent site potential. It was clear that the site benefited from a clear urban pattern but suffered from the de-contextualisation of elements within that pattern. Analysis of the precise nature of this de-contextualisation allowed it to be addressed through two key approaches: firstly the reinterpretation and amplification of existing conditions and patterns, and secondly the introduction of new complimentary programmes and patterns to modify interrelationships between site elements.

3.1 Strategic and Tactical Responses

The overarching strategic objective of the proposed scheme was to redefine the contextual juxtaposition of the elements of Nelson as a town and Whitefield as a neighbourhood. This 'nested' model consolidated Whitefield as an important locality within the town, and through the readdressing of this

relationship, the profile of Nelson could be raised within the region. The de-contextualisation of Whitefield is due to its current post-industrial situation, where its original *raison d'être* has been superseded and its current connections no longer appropriate. The new context and connections must be based on current and future needs, rather than past ones. The strategy is reflexive, allowing an additive process of regeneration to take place, once a few key urban moves have been implemented. This makes the neighbourhood an ecology rather than an artefact; a living organism, rather than something in stasis, allowing it to adapt to future external changes in circumstance.

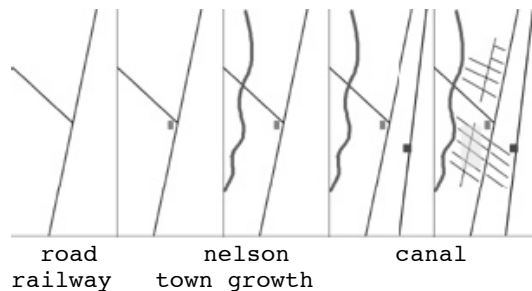


Fig 3. The growth of Nelson

The town is almost all industrial, having been developed purely in the late Nineteenth Century, with the arrival of the Burnley to Leeds railway. In fact the town was named after the Station, which in turn was named after a coaching inn on the junction of two roads. Whitefield, itself, is bounded to the North by the Leeds-Liverpool canal and to the South by Manchester Road. Its relationship with these two thoroughfares could not be more different however: Manchester Road is embraced through a series of Landmark buildings, and the canal, being made redundant by the arrival of the railway, is largely ignored. Both however are definite urban edges.

The major move creates a new public space that links these two thoroughfares this then continues in the form of a bridge over the canal to link Whitefield directly with its own school and the park beyond. The public space affords several benefits: firstly it creates a focus to the neighbourhood, which was lacking in the original configuration; secondly, it creates an edge, which allows the town centre to extend into the neighbourhood; thirdly it offers a pedestrian route through the neighbourhood, particularly to the school; it offers improved visual connection with the unspoilt countryside that surrounds the town and finally it is heritage friendly- demolishing only 16 houses.

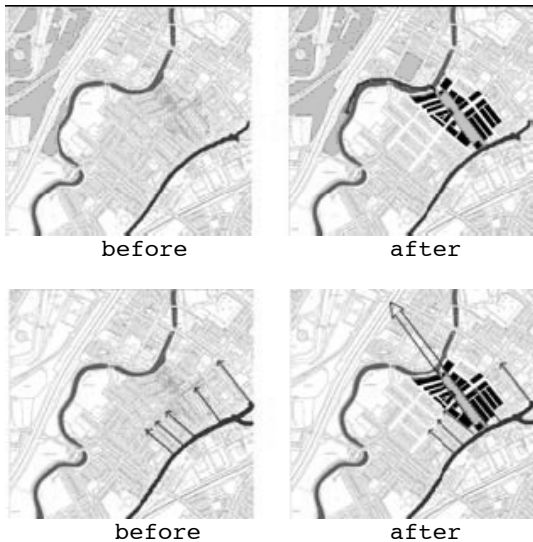


Fig 4. Urban Moves: the competition entry

The demolition of the houses created a space large enough to allow a new landmark building to be inserted at one end on a prominent position on the main arterial road in the town, which helps to brand the neighbourhood. A shared surface in the centre of the strip permitted the reconnection of the interior spine of the neighbourhood, namely Every Street. This street was once a bustling local retail centre, later amputated by over-zealous traffic engineers. Its reconnection at the shared surface offered the chance for leisure focused retail to be re-established.



Fig 5. The CityLab - MacCreanor Lavington Masterplan

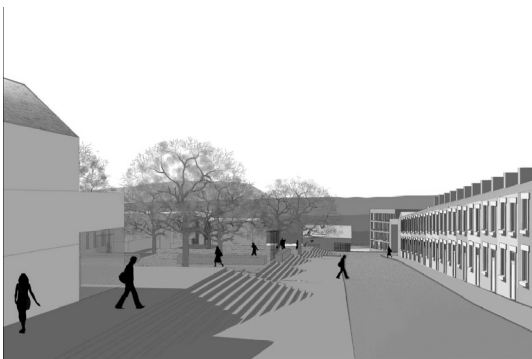


Fig 6. The public space

3.2 Sustainability Issues.

With the urban design issues solved, and the public space and bridge helping to re-invent the pedestrian-focused neighbourhood, first first level of sustainability was established – that of networks. The houses created a different set of problems, is it possible to create sustainability where the Heritage interests prevent any aesthetic change? This first issue was overcome with the idea of the ‘Heritage Envelope’.

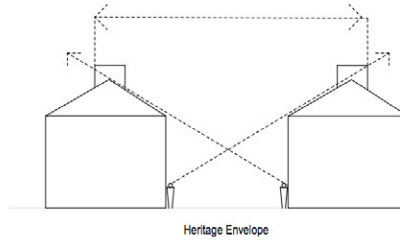


Fig 7. The Heritage Envelope.

This envelope is a visual one, and includes everything visible from the street; anything not visible could be altered. The Heritage envelope was constructed to allow wholesale redevelopment of the rear of the properties without any aesthetic change on the streetscape.

This approach was agreed by the heritage bodies, and in conjunction with a heritage-led streetscape strategy, which recycled hidden materials under modern road and pavement surfaces, meant a new old streetscape could be reinvented. The redeveloped houses, rather than affording just 1 or 2 bedrooms maximum, could now be extended to 4 or 5 bedroom properties, if required.

Although this strategy allowed the redevelopment of the houses in part, it did not create many options for creating carbon-neutrality, as the orientation of the houses (generally East or West facing) could not be changed – there was little option for passive or active solar design. Super-insulation was not possible either due to the extreme confines in the size of the terraced houses; with a frontage of just 4m dry-lining with high performance insulation would have made the interiors too small. Photovoltaic roofs or wind-turbines were also not possible as the heritage lobby was too strong. The solution would have to come from the way heat and power were produced: the houses would at best be 20% better than UK Building Regulations.

3.3 Co-generation

Biofuels are nearly carbon neutral, particularly if sourced locally. Work by the Burnley Schools project have utilised wood-chip with considerable success in the area with combined Heat and Power (CHP) applications. Schools are a particularly good vehicle for CHP, because they

have very little demand for either electricity or heat in the summer months. This means that there is not a great waste of heat whilst producing electricity, when heat is not needed. Thus the plant can be switched off when most inefficient.

In additions there are two other problems in using wood as a fuel: firstly that of demand: its increase in popularity has meant that local high-quality sources were not available, and secondly that its use means that a second reserve oil-fired plant has to be installed in addition in case of supply failure. These issues were overcome by specifying a bio-diesel powered plant.

The bio-diesel in question is made locally from recycled cooking fat, in fact the supplier is less than 10km from the site, so fuel miles are low. The biodiesel can be used in a standard diesel CHP unit and the changeover from bio-diesel to mineral diesel if necessary due to availability takes less than 30 minutes. This is important because it means that backup power plant is not required; this saves a great deal of capital cost.

Combined heat and power is a simple local cogeneration strategy: a diesel engine powers an electrical generator – the electricity produced supplies the locality – any shortfall being met by the national supplier: the waste heat produced by the diesel engine is then used for space heating: these are produced in approximately 30/70 ratio. In a perfect situation where the amount of electricity supplied was just enough to meet demand and the heat created by this production was exactly the amount needed for space heating, a near 100% efficiency could theoretically be obtained. However in practice, the demand profile (as it is known) is generally not well matched and the fluctuation of demand can create other problems: so it is usual to only use CHP to provide a non-fluctuating proportion of the typical electricity demand, and the rest being provided by national supplier. This allows heating demand to be mainly provided by the waste heat – any shortfall is generally provided by backup boilers.

There are problems with housing-based community co-generation – the first is summer performance – in summer there is no need for heating – yet electricity use is still quite high so all heat is wasted at this time. This can be quite a substantial amount. Secondly, demand fluctuation is difficult to deal with: does the system try to match heat needed or electricity needed? Both strategies have problems – extra electricity is an uneconomic option as the national providers offers a low price for it – often below cost, and extra heat production is just thrown away as a waste product.

The novel solution employed here was to use an inter-seasonal store. This is a huge tank of water, which acts a sink for all waste heat produced in the system. This helps in three ways: firstly it equalizes demand so fluctuations

in heat demand can now be met by surplus from the store. Secondly there is no waste heat – any surplus production can be dumped in the store, and thirdly good summer fuel efficiency can be met by storing all waste heat from the summer production of electricity.

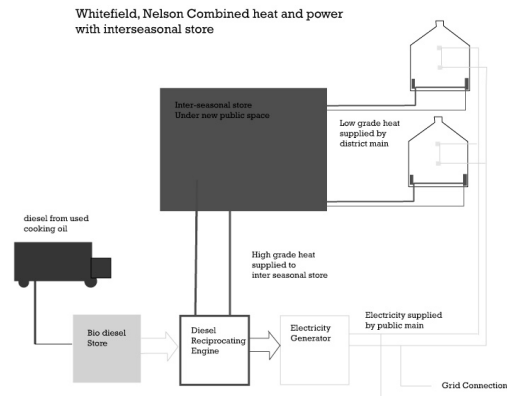


Table 8: Schematic of carbon neutral chp system.

The CHP would power the dwellings – and its heat would go directly into the seasonal store. The store would then heat each dwelling by a district heating system. This system, if the store were correctly sized, would offer close to ideal efficiencies of the system. The store (or several in this case) is placed beneath the new public space in Whitefield, with the energy centre – a new landmark building in close proximity. Thus the public space becomes a synergistic insertion into Whitefield, offering social and environmental sustainability, with a single urban move.

3.4 System sizing

The system is sized firstly by meeting the electricity demand for the neighbourhood, which is, for the 250 homes to be redeveloped, approximately 750,000kWh per annum (approx 3000 kWh pa per house), in addition to this load, its is intended to over-produce by around 10% and export this to the grid. The profit made will pay for the upkeep of the new public space. With a 30/70 split of power to heat, this gives 1,930,000kWh of low-grade hot water to heating.

This heat output is slightly above that required by the new development over the year for space heating and domestic hot water, which is also approximately equal to 1,930,000 kWh per annum (Nelson, Lancs, degree days per annum 2400, base temp 15.5degC, design temp -1 degC; typical house design heatloss 4.5kWh, domestic hot water 12% of duty). The size of the inter-seasonal store is interesting, as there are no precedents in the UK. Initial calculations indicate that the tank will need to store approximately 40% of the total heat output of the system. This will be stored at a maximum temperature of 80 degC and deplete to 30 degC. This capacity is split into six separate chambers to maximise the efficiency of heat transfer to and from the main.

The tanks will be large, with a total capacity of 13,300 Tonnes of water. Each tank will be 36m x 25m x 2.5m deep. Fortunately, the new public space is large enough to accommodate these. They will be of steel construction with at least 200mm of closed cell polyurethane insulation. Insulation is not a crucial issue, as the tanks are submerged and steady-state conditions will be quickly reached. These are initial design calculations, and are subject to review.

Integration of the district heating main into the heritage streetscape is through a common trench underneath the pavement. This is easy to achieve because all services in the neighbourhood are to be replaced due to most being obsolete. Each house will have an individual heat meter housed with the electricity meter at its intake point.

4. Conclusion

Britain currently needs over three times its landmass to support its population: radical change is needed in order for the UK to meet its Earthshare⁵. This is an enormous problem and one that will need radical urban change. However, instead of embracing these difficult issues, the UK is in a Heritage enhanced trance-happily gazing backward because the future is too uncertain to face. This paper shows however that through appropriate sustainable thinking, Heritage can be embraced and made sustainable.

This is place-based sustainability, which is intrinsic rather than an add-on to a design idea, and by embodying the carbon-footprint of the town in its social infrastructure, a synergy is created which makes place unique, meaningful and productive, and not a pastiche of other famously successful places.

5. Acknowledgements

The author acknowledges the hard work of Tom Jefferies, Melanie Latham, Kevin Logan, Gerard MacCreanor, Neil Swanson and Frank Mills in the production of this paper

6. References

1. Houghton Kathleen R et al, *Elevate East Lancashire*, pp58, HMRI Prospectus HMSO 2004
2. *Sustainable Communities Plan*
3. Woolley, H et al, *The Value Of Public Space-How High Quality Parks And Public Spaces Create Economic, Social And Environmental Value*, pp 33, CABE-Space, London. 2005.

4. The Princes Foundation for the Built Environment, Whitefield, Nelson Enquiry by Design, pp 3-7. London 2004.

5. Dodds, Oswald et al, *City Limits*. London 2002.