Sustainable Supply Chains That Support Local Economic Development

The Prince's Foundation
FOR THE BUILT ENVIRONMENT

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This paper explores how low-energy design for residential buildings can be used to stimulate regional manufacturing and local construction markets. Taking a single construction product, the insulating aerated clay block employed at the Prince's Foundation/BRE 'Natural House', the paper calculates the financial benefits of promoting better onsite construction practice over remote, factory-based offsite manufacturing solutions.

Whilst it is unlikely that all materials demanded by low-energy residential construction techniques can be of local or regional origin, this paper estimates the effects of a balanced procurement solution in which local labour and skills are allowed to play a significant role, distributing the benefits of a low-carbon economy directly to areas of housing growth. Finally, this paper argues that there is significant danger in producing 'single issue' solutions to complex, inter-linked problems such as climate change and local economic decline, and that taking a holistic, integrated approach to the construction of new homes and communities will have a larger positive impact far beyond the walls of the homes being built.

Introduction

The UK Government has committed to reducing CO_2 emissions to 34% of 1990 levels by the year 2020.[1] The built environment will play a major role in this effort. Housing currently accounts for nearly 30% of all CO_2 emissions in the UK, and the Government estimates that about 15% of necessary cuts in emissions will have to come from housing and the built environment.[2] The policy mandate for more efficient homes is clear, and the demand for more efficient housing is also strong.

1 *Department of Energy and Climate Change (2009)* The UK Low Carbon Transition Plan, *accessed online at: http://www.decc.gov.uk/en/content/cms/publications/lc_trans_plan/lc_trans_plan.aspx*

2 *Ibid.*

Building technologies and construction systems will play an essential role in reducing household energy needs. The UK Code for Sustainable Homes mandates that by 2016, all new homes must be built to Code 6 certification, defined as homes with zero carbon impact.[3] This ambitious challenge requires a step change in how British homes are built, with significant consequences for both the building trades and the industries that they support.

BRE Natural House

The industry has, to date, proposed two general approaches to meeting this challenge; either through novel, high tech and often expensive prototypical systems, or through the gradual improvement of existing simple, flexible, and locally adaptable

3 *Department of Communities and Local Government (2008)* Code for Sustainable Homes*, accessed online at: http://www.communities.gov.uk/planningandbuilding/buildingregulations/legislation/codesustainable/*

Above: Aerated clay 'Ziegel' block produced by Thermoplan
Right: Block is laid into thin-bed mortar on site

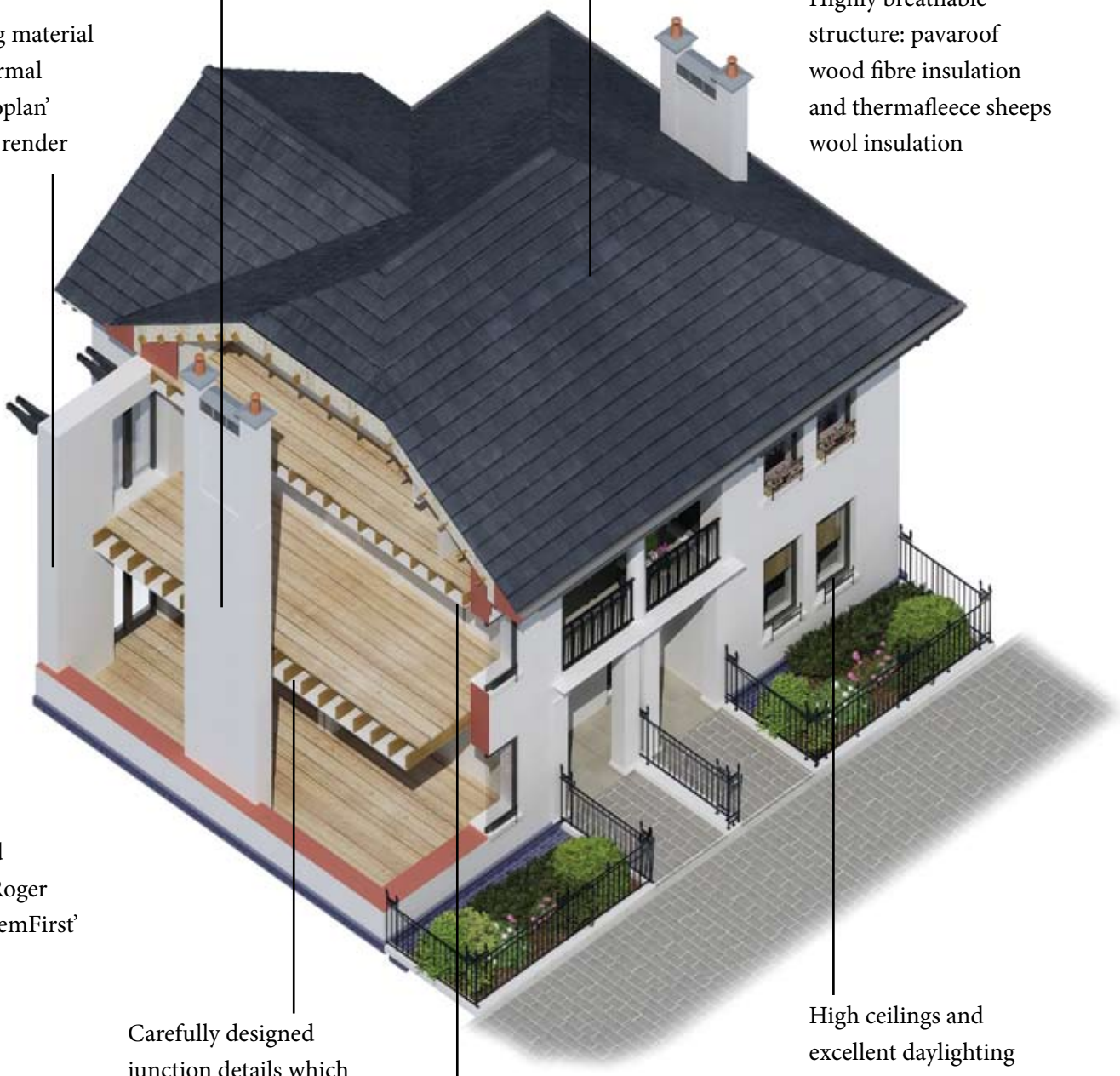
construction methods. While both will likely be able to meet high energy performance specifications, The Prince's Foundation believes that the use of natural building systems which are inexpensive, easy to learn, and flexible to deploy offer a range of benefits above and beyond their energy efficiency — benefits which recommend them over more complex, offsite, and technologically dependent, solutions.

To test this belief, The Prince's Foundation, in partnership with Natural Building Technologies, Kingerlee Homes and other project partners, have put the principles of adaptable and flexible construction choices in action through the construction of 'The Natural House,' a prototype dwelling on the BRE Innovation Park. This building will demonstrate how the establishment of coherent thermal shell can be fundamental to environmental performance in the long term. Impermeable and inorganic insulation techniques — particularly plastic membranes — have been eschewed in favour of vapour-open construction employing natural materials such as clay block and lime render. The principal structural material in the Natural House is the aerated clay block, which offers a series of benefits: easily understood and rapid onsite construction methods, low cost, demonstrable track record, and highly effective thermal properties with good site tolerances.

The Natural House has also been designed to face contemporary market conditions, being suited to current cost, market and construction approaches. It is particularly relevant to the nature of the UK construction skills market, where delivery can be in the hands of small-scale contractors and a strong reliance on site-based practice. The emergence of technologies that are predominantly factory based, whilst ostensibly offering speed of construction on site, do not adequately address the heavy reliance on site-based construction in the UK and will not meet the residential sector's expectations in the short term. The use of the aerated clay block, by contrast, offers a chance for incremental change as the road to higher environmental performance, with immediate results achievable at scale.

The purpose of this study is to explore the question of onsite benefits derived from the use of regionally sourced materials and building systems. It does so by quantifying the social and economic impacts of a single example; that of the aerated clay block. Sold in the UK as the ThermoPlan System, these blocks are similar to many aerated block products used throughout Europe. These simple blocks are composed of extruded clay, which when coursed in thin-bed mortar form structural, insulating, and highly efficient load

Rendering of 'The Natural House' designed by The Prince's Foundation for the Built Environment


Sandtoft clay roof tiles
Humdity-controlled passive stack ventilation for each room
Highly breathable structure: pavaroof wood fibre insulation and thermafleece sheeps wool insulation
Robust walling material with good thermal mass: 'Thermoplan' block; Baumit render
Concrete piled foundations: Roger Bullivant 'SystemFirst'
Carefully designed junction details which minimise thermal bridging
Non-toxic building materials: Masonite I-beams, wooden floors and plastered masonry walls
High ceilings and excellent daylighting through large windows with Katzbeck triple glazing

bearing walls. These walls have a very low U-value, are composed of non-toxic and sustainable materials, and are cheap to produce and easy to assemble. The block is also structurally self-supporting up to five storeys.

Currently, these blocks are produced in Germany and imported for use in the UK at high CO_2 and transport costs. Tests have shown that high-quality blocks could be regionally produced in the UK by UK brick plants, and then assembled onsite with relatively little training or technology.[4] These blocks, offering good U-values when employed with compatible renders and plasters, represent a good case study for exploring the impacts of using regionally produced, locally assembled technologies in the supply chain.

The Prince's Foundation for the Built Environment is regularly involved in the master planning of urban extensions and housing developments throughout the UK. The goal of these developments is to produce beautiful, sustainable communities that create long-term social, economic and ecological value. Could the choice of building materials and supply chains help achieve these ends? The main purpose of this study is to quantify the impact that the localisation of certain elements of building supply chain would have on local communities. A secondary purpose is to explore whether the use of localised supply chains can help to achieve larger social goals beyond simple energy efficiency.

Methodology

This study used stakeholder interviews, desktop research and simple financial modelling to explore the economic and social effects of regionally produced, locally assembled clay blocks for use in specific forthcoming large scale build projects.

Three Prince's Foundation for the Built Environment projects in South Wales were used as case studies for this effort. The first, a large urban development, Coed Darcy, will provide an estimated 4,000 homes close to a relatively deprived community. The final scheme will represent a mix of tenure choices as well as commercial uses alongside residential homes. The second is an expansion and redevelopment of Swansea University, intended to provide approximately 2,000 mixed tenure homes and residential units to staff, students and local residents. The third is the redevelopment of a central site in Neath, which will provided approximately

4 Interview, NBT Technologies, supplier and contractor specialising in ThermoPlan block construction.

350 residential units in a waterfront mixed-use development. The combined volume of these projects will produce an estimated 6,350 homes within a relatively local economic catchment area, all of which could potentially be constructed using aerated clay blocks similar to the ThermoPlan system. They therefore represent a good sample to be used as test cases for this study.

Four different approaches were taken to estimate the impacts of using clay blocks for these projects. The first approach calculated local impacts from a single house, assuming adequate supply of blocks. The second used similar data to estimate local impacts of building all 6,350 houses, including the local and regional impacts derived from production and transport. The third approach estimated the impacts of a fully operational clay block industry, consisting of two fully functioning plants producing output for approximately 12,000 homes per year. The fourth and final approach

I LOCAL ECONOMIC IMPACT ASSESSMENT METHODOLOGY

Materials Demand estimation +	**Labour demand estimation** +	**Transport demand estimation**
Number of blocks per home	Blocks per labour day	Tonnes per trip
Tonnes of blocks per home (average interior/exterior)	Average regional day wage	Cost per trip
	Number of workers per house	CO_2 per trip
		Trips per home

×

Size of development
Total: 6,350 homes
Annual build-out: 300 homes

×

Local economic multiplier
1.79

Local economic impact
Annual wage impact, Amortised capital impact, Number of jobs supported

scaled this estimate for the entire nation, providing high, medium and low estimates of impact as if all new residential buildings were built using this technique.

The first approach used information derived from the BRE House to estimate the average amount of labour and materials required to build a single house. The BRE House is currently under construction and uses a similar block construction method as that explored in this study.[5] Data for this house and from its suppliers was supplemented and fact-checked through a series of interviews with regional house builders, construction specialists, and brick

5 Additional information on The Prince's Foundation for the Built Environment's BRE House can be found online at: http://www.princes-foundation.org/index.php?id=732

II REGIONAL IMPACT ASSESSMENT METHODOLOGY

Plant conversion & production costs	+	**Labour requirements**	+	**Transport impacts**
Capital outlay for plant conversion		Workers per shift, per factory		Tonnes per trip
Outlay for new plant construction		Average regional day wage		Cost per trip
				CO_2 per trip
				Trips per home built

×

Annual production volume
100,000 tonnes per plant
Two competing plants

×

Local economic multiplier
1.79

Local economic impact
Annual wage impact, Amortised capital impact, Number of jobs supported

manufacturers. Figure I presents a summary of how impacts were calculated for this scenario, focusing exclusively on the local economic impacts.

After ensuring that all parameters used in the study were properly understood and calibrated, the costs and impacts were then scaled up to approximate both the local and regional impacts generated from a series of large housing developments such as those considered in this study. Figure II presents a summary of how impacts were calculated at the regional level for approximately 6,350 homes.

The third approach estimated national impacts and reflects the economies of scale necessary to support a successful clay block industry. Interviews revealed that in order to be economically competitive it would be necessary for a block production plant to

III INDUSTRY-WIDE IMPACT ASSESSMENT METHODOLOGY

Regional economic impacts +
Capital and labour costs annually for running two competing plants

National assembly demand
Local economical impact × the total volume of homes necessary to support two plants running at full capacity

National transport impacts to carry materials for house construction

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National economic impact
Annual wage impact, Amortised capital impact, Number of jobs supported

produce between 100,000 and 150,000 tonnes of block per year; far more than any single development would absorb. Interviewees suggested that major house builders would also be less willing to accept a single supplier for a new building system, suggesting that at least two factories would be required to create a robust marketplace. The third approach therefore estimated impacts from a national production standpoint, running financial models as if there was adequate national demand for two factories to run at full capacity. This approach allowed for the larger effects of a sustainable block industry to be calculated, providing an alternative perspective to the localised impacts of the first approach. Figure III presents a summary of how impacts were calculated for this scenario, focusing on the national impacts of production, transport and assembly.

Finally, a fourth and final approach scaled these estimates up for the entire UK new build housing industry, estimating economic impacts for use of the block if all residential new builds were built using this approach.

In all cases, capital, labour, and transport costs were estimated and checked with key stakeholders. The total amount of material, in tonnes, was estimated for an average house based on consultation with industry experts and the material used at the PFBE BRE House. The requisite construction time, wages and labour input was derived from this figure. In the case of production and start up costs, all scenarios considered plant locations in the Midlands, due to the existence of appropriate natural clays, existing production infrastructure and geographic centrality. The costs of plant conversion and new plant construction were then estimated

Forthcoming 'eco hamlet' at Coed Darcy. Image by Ben Pentreath, Working Group

using industry statistics for this region, as were operating costs over time. Labour needs for both plants were estimated based on their respective levels automation, and the capital impact of construction or conversion were estimated based on standard capital depreciation rates. Transport costs were also estimated at current haulage rates, per tonne, adjusted for inflation over a 20-year period. A small percentage of total transport cost was assigned to the development site locally, taking into account impacts associated with petrol, local retail and other services, whilst the rest was assigned to the region where the materials were produced.

Economic impacts on the larger community were then estimated using Type II local economic multipliers derived from multiple sources, including input-output tables for the Welsh Assembly for Welsh construction trades, regional averages from the former Department for Energy, Trade and the Regions (DETR), English Partnerships, and other academic and private sources.[6]

Findings: Direct & indirect economic impacts

Figure IV presents preliminary findings for the local and regional economic impacts of using clay blocks as the main building system in three Welsh case study projects. The case study projects in Swansea will be able to provide approximately 6,350 new homes to existing communities over the next 20 years, with an estimated build-out rate of around 300 homes per year. One of the main benefits of the utilisation of an easily learned, rapidly assembled technology, such as the structural clay block, is that it enables a local workforce to be employed. This ensures that a greater proportion

6 *Sources: Bryan, J., Jones, C., Munday, M. and Roberts, A. (2004), Welsh Input-Output tables for 2000, Cardiff University Press; Department for Energy, Trade and the Regions (2000), 'New Deal for Communities and the Single Regeneration Budget Project Appraisal and Approval'; English Partnerships (2004), 'Additionality Guide: A Standard Approach to Assessing the Additional Impact of Projects, Method Statement, Second Edition' September 2004, accessed online at: http://www.englishpartnerships.co.uk/docdownload.aspx?doc=Additionality%20Guide_0.pdf&pid=E6B323D899F74AE381E392234B7AF5FD; GHK International (2007), 'Assessment of the Local Economic, Employment and Training Impacts of Heritage Lottery Fund Funded Projects: Final Report', accessed online at: http://legacy.hlf.org.uk/HLF/Docs/.../Volume1_MainReport.pdf*

of economic value is captured in the local economy, which would not be the case if specialised, high-tech, pre-manufactured systems and imported labour were utilised. Most of the economic benefits described below result from this value capture.

Assuming a build-out rate of 300 homes per year, this development would support a crew of approximately 8 dedicated labourers working 260 days per year. Assuming a regional wage of approximately £28,000 per year, and a local economic multiplier for the Welsh construction industry of 1.79, the total economic impact in the Swansea region would be approximately £1.1 million pounds per year. This would then be augmented by an estimated £30,000 of transport impacts per year, for an estimated total impact of approximately £1.125 million per annum over a 20-year period.

Accounting for the impact of production and sales at the regional level, this figure would be supplemented by an additional £3.1 million impact for the larger region, factoring in wages, sales and transport of materials from the manufacture and transport of the necessary materials (£2,890,000 in production and £270,000 in transport). Taken together, it can be estimated that the regional production and assembly of sustainable clay blocks as part of an integrated, localised supply chain would support just over 150 full time jobs for the lifetime of the development process, i.e., over 20 years.

A second scenario was calculated which assumed full plant output for two competing plants and a national absorption rate of approximately 12,000 homes per year. Figure v presents preliminary impacts for the national scale, assuming a full production scenario for two brick manufacturing plants. Such a scenario

IV LOCAL & REGIONAL IMPACTS

Impact	Value	Jobs
Assembly (local share)	£1,100,000	
Transport (local share)	£ 30,000	
Transport (regional share)	£ 270,000	
Production	£2,900,000	
Total Financial Impact	**£4,300,000**	
Total Jobs Supported		**153**

assumes an estimated 100,000 tonnes of production per plant, per year; a figure which equates to approximately 12,000 homes nationally per annum. Using the same rates and wages as Scenario 1, it is estimated that this level of production would create approximately £74 million of value per year, comprised primarily of wages for assembly (£50 million), transport (£21 million) and production (£3 million). Production impacts in this scenario would be confined to the region of the manufacturing plants (Midlands), whereas transport and assembly would be distributed throughout the nation relative to housing construction levels. It is estimated that this level of production and assembly would support approximately 2,500 new jobs nationwide.[7]

7 Source: Office of National Statistics, "Employees in the Construction Industry, 2008", accessed online at http://www.statistics.gov.uk/STATBASE/tsdataset.asp?vlnk=341

V INDUSTRY IMPACTS, ASSUMING FULL PLANT PRODUCTION (~12,000 HOMES PER YEAR)

Impact	Value (£million)	Jobs
Assembly (distributed locally throughout the country)	50.2	
Transport (distributed nationally)	21.0	
Production	2.9	
Total Financial Impact	**74.0**	
Total Jobs Supported		**2,500**

VI NATIONAL IMPACTS FOR DIFFERENT BUILD OUT SCENARIOS

Build out scenario	Number of new home starts	Financial impact	Jobs supported
High	230,000	£2.6 billion	90,000
Medium	160,000	£1.8 billion	60,000
Low	80,000	£900 million	30,000

A fourth and final scenario estimated the economic impacts of full national build out using similar block technologies. This calculation used the basic impact per house, then multiplied this up by high, medium and low annual residential new builds for the entire country. A conservative estimate of 80,000 new builds in 2010 would produce an estimated £900 million in impact, supporting nearly 30,000 jobs and livelihoods when counting the local economic multiplier. A mid-range estimate of 160,000 new builds, closer to what was built on average in the years before the economic crisis, would produce approximately £1.8 billion of economic, supporting nearly 60,000 jobs. Finally, an optimistic scenario of 240,000 new build homes would produce an estimated £2.6 billion of economic impact and nearly 90,000 jobs worth of work, nationwide.

Findings: Non-economic impacts

In addition to the fiscal and employment benefits produced by the use of local labour and regional production, a variety of non-economic impacts would be expected to accrue as well. These include professional skills development, a heightened sense of personal dignity and respect resulting from long-term professional employment, enhanced social well-being, improved social capital, healthier buildings, a more resilient building supply chain, reduced CO_2 emissions, and increased longevity of the building stock. Each is explored in more detail below.

Professional Benefits

On a professional level, the use of relatively simple and generic building techniques lowers the bar of professional entry to the trades. It is estimated that a completely untrained crew could be trained to work with a clay block system in under two days.[8] After laying the first course of blocks, which is the most detail-oriented and time consuming step in the process, laying successive courses can proceed rapidly and with few complications. This speeds up the build process by an estimated factor of 3, resulting in faster assembly without the need for specialised technicians assembling factory produced components.[9]

8 Interview, NBT Technologies

9 Ibid

The use of simplified building systems would therefore enable a new generation of workmen to enter the profession, by lowering the bar of entry through an easily acquired skills set. The ease of assembly would allow for the creation of multi-skilled crews and long-term skill development, whereby less time and specialisation was demanded to build the structural system and more time can be spent on the development of a broader building skill-set. This would ensure that local workers will benefit from the construction of new homes in their community, having the double-benefit of providing an avenue of entry into a new profession with ample opportunity for skills development over time.

Social benefits

The second area of benefit derives from the first. A variety of studies have documented the psychological effects of long-term unemployment; including increased anxiety, helplessness, depression, and stress.[11] A Rutgers University study from the United States, one of the largest and most comprehensive of its kind, reports that many jobless individuals experience sleeping problems and strained relationships, avoid social situations, and have diminished hopes of finding employment over the long term.[12] Extensive studies in the UK have found that underemployed individuals often experience lower levels of psychological well-being, self-esteem, and employment commitment, which get more severe over time.[13] These psychological impacts often affect other areas of life, including health and well-being, increased alcoholism and domestic violence, increased suicide rates, decreased overall life expectancy, and strained marital and family relationships.[14]

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11 Feather, J. (1990) The Psychological Impact of Unemployment, New York, NY, US: Springer-Verlag Publishing.

12 Van Horn, C. and Zukin, C. (2009) 'The Anguish of Unemployment', Heldrich Center for Workforce Development, Rutgers University, Rutgers, NY.

13 Winefield, et al. (1993) Growing Up with Unemployment: A Longitudinal Study of its Psychological Impacts*, London: Routledge Publishing.*

14 Lewis, G. and Sloggett, A. (1998) 'Suicide, deprivation, and unemployment: record linkage study', BMJ*. 1998 Nov 7;317(7168):1283–6.*

The use of simple building systems would allow for the development of entry-level skills in the building trades, thereby providing long-term employment and ongoing opportunities for professional development. The provision of long-term employment in an underemployed area such as South Wales would therefore have significant psychological, social and other well-being impact. These studies suggest that such impacts would include enhanced self-respect, augmented confidence and personal satisfaction, increased job and life satisfaction, and long-term social and community capital formation.[15]

Carbon benefits

A final set of non-financial impacts relate to the production, transport and use of the material itself. Currently, clay blocks are produced in Germany and imported to the UK, with an estimated emissions impact of nearly 11.5 tonnes of CO_2 per home. Producing these blocks regionally would emit almost 3 times less CO_2 than importing them from abroad (2.8 times less), with significant cost savings as well. This would help the government meet its overall goal of carbon reduction, as well as saving money in the process.

The overall trip length from the production plant to the development site would also be significantly shortened (assuming plant location in the East Midlands) and all materials involved in the production of the block materials could be sourced regionally. This shortens the supply chain, reduces the number of intermediary brokers and dealers, and enhances the resilience of the supply chain to various shocks and disruptions. Doing so would help build community resilience to changes such as fuel price increases, currency fluctuations, international political or trade conflicts, and transport disruption.

Finally, the clay material itself is entirely natural, non-toxic and sustainable, producing buildings that last longer, are easier to maintain, are healthier to live in with vapour-open wall construction, and cost less than more specialised offsite building solutions.

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15 Aked, J., Marks, N., Cordon, C., Thompson, S. (2008) 'Five Ways to Well-being: The evidence', Report presented to the Government's Foresight project on Mental Capital and Wellbeing, the new economics foundation accessed online at: http://www.neweconomics.org/sites/neweconomics.org/files/Five_Ways_to_Well-being_Evidence_1.pdf

Discussion

There are a combination of direct and indirect impacts resulting from the use of simplified, regionally sourced, locally assembled building systems. Although this study only explored a single element of the building supply chain — structural clay blocks — these findings suggest that certain general lessons could be taken from this example. These lessons include tailoring construction techniques to local skill; designing building components which provide a range of secondary and tertiary benefits; and taking advantage of the positive impacts of simplified, generalisable approaches to complex, high-tech, specialised ones. This is particularly relevant to the step change being demanded of the residential construction industry to achieve low-energy building.

There are significant advantages to the use of building systems that can take advantage of local skills. Although there are several ways to meet the mandate of more energy-efficient homes, the majority of solutions being proposed are narrow in their application and ignorant of their larger social context. High-tech, specialised, mass-produced, and pre-fabricated building systems require specialised teams of factory workers to produce and assemble them, far from the location of the build. Site assembly necessitates importing specialised workers from elsewhere in the country or abroad, meaning wages and benefits are siphoned out of the community and into other sources.

Given that the same energy reduction goals can be achieved through the use of simplified, generic and regionally produced materials such as clay blocks, it is clear that a larger, systemic benefit can be achieved through the use of low-skill, low barrier-to-entry systems that are regionally produced and locally assembled. This will accomplish the sustainability goals of the development whilst simultaneously adding additional value to the community in which it is built. This is a non-trivial impact when considered over the 20-year build-out cycle for a large housing development.

The range of genuinely sustainable products (that is, both low-impact in their supply and of high thermal performance) that would deliver similar economic benefits is large and the recognition of their benefit is increasing. Each of the following materials would merit further impact studies; sheepswool insulation, hempcrete, sustainably sourced narrow-diameter timber, wood fibre insulation, local slate and building stone, as well as a range of recycled products and by-products (such as Welsh slate waste). The combination of such products in new build will offer stimulus to localised construction practice and hence local economies. The encouragement of their use, in design codes and planning regulation, would furthermore promote

their take-up by the building industry and increasingly competitive pricing.

Expanding the sphere of enquiry, the opportunity for local economic multipliers should be considered by developers and building professionals in the selection of renewable technologies, with a balance to be struck between economies of scale and local area returns. Employed at appropriate scale, air and ground source heat pumps, wind and water based renewables, photovoltaics and solar hot water panels may boost regional and local economies who are able to embrace their manufacture and life cycle operation.

Beyond new build construction, a natural approach to materials sourcing means many of the products identified are equally suitable to retrofit in buildings of traditional construction. This dual compatibility of such materials should be a key consideration of contractors, specifiers and customers in both new build and retrofit markets when choosing between artificial products and vapour open, naturally sourced ones compatible with the 21% of homes built in the UK before 1919.

Conclusion & policy recommendations

This study found that the regional production and local assembly of sustainable clay blocks would produce significant, long-term benefits for the community in which they were deployed. These benefits include over £1.1 million of local economic impacts per year, 40 locally supported jobs, £4.28 million and 153 jobs at regional impact, and up to £2.6 billion and 90,000 jobs nationally in an optimistic full build-out scenario.

All of these benefits suggest that UK housing and planning policy should emphasise the use of locally assembled, ecologically produced sustainable materials. This would provide jobs and employment, meet the demands of energy efficient homes for the future, and produce a range of secondary and tertiary benefits.

There is significant danger in producing "single issue" solutions to complex, inter-linked problems such as climate change and local economic decline. This paper has argued that taking a holistic, integrated approach to the construction of new housing developments, considering both the process and the product of their creation, can have bigger picture impacts that go far beyond the walls of the homes being built. It is therefore recommended that policies supporting the production of regional materials, regional and local supply chains, and explicitly local assembly systems be produced, for the benefit of both local communities and the nation as a whole.

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