Project title: 304 DELIVERING HOMES AS POWER STATIONS

Project Sponsors (Lead partner): Local Authorities

Summary:

Energy efficiency and demand side management is needed to reduce energy costs and provide affordable warmth for housing. This programme will target both new build projects and the retrofit of existing buildings. SBCR will make available a Local Authority led regional land-bank for new build. It will promote energy retrofits, initially through the public sector housing stock, and after proving the process and financial measures it will target rollout to private sector landlords and owner-occupiers. Energy retrofits will be linked to other housing improvement programmes in order to optimise efficiency of delivery. A major aim will be to reduce fuel poverty and its impact on health. There will also be a focus on broadband Internet connections and smart metering. This proposal has been discussed with the four Local Authorities and has received their full support. The Local Authorities will be supported by Swansea University (Specific) in delivering the project.

The SBCD will kick start a construction programme of £517,050,000 for an investment of £15 million (3% of the total programme value) generating an estimated 4,512 new jobs.

Programme strand: Internet of Energy

Swansea Bay City Region – City Deal – Business Case

Project title:	***304 DELIVERING HOMES AS POWER STATIONS***					
Project Sponsors (Lead partner)	*Local Authorities*					
Summary:	Energy efficiency and demand side management is needed to reduce energy costs and provide affordable warmth for housing. The programme will target both new build projects and the retrofit of existing buildings. SBCR will make available a Local Authority led regional land-bank for new build. It promotes energy retrofits, initially through public sector housing stock, and after proving the process and financial aspects will target rollout to private sector landlords and owner occupiers. It will link energy retrofits to other housing improvement programmes. A major aim will be to reduce fuel poverty and its impact on health. There will also be a focus on broadband internet connections and smart metering. The SBCD will kick start a construction programme of £517,050,000 for an investment of £15 million (3% of the total programme value) generating an estimated 4,512 new jobs in the construction industry and its supply chains.					
Programme strand:	*Internet of Energy (Efficiency)*					
*Financial summary**	*2017/18*	*2018/19*	*2019/20*	*2020/21*	*2021/22*	***TOTAL***
Total costs (£)	*32,400,000*	*66,150,000*	100,400,000	137,500,000	180,600,000	517,050,000
City Deal input (£)	*2,900,000*	*4,400,000*	*4,400,000*	*3,000,000*	*300,000*	15,000,000
Private Sector (£)	*23,075,000*	*47,675,000*	*73,050,000*	*102,600,000*	*136,500,000*	382,900,000
Other public (£)*	*6,425,000*	*14,075,000*	*22,950,000*	*31,900,000*	*43,800,000*	119,150,000
Prepared by:	*Name: Gareth Nutt, Phil Jones* *Tel: 44 02920 874078* *Email: jonesp@cardiff.ac.uk*					

* Includes an estimated 40% new houses developed by public sector.

SBCR City Deal Business Case

1) Project title. DELIVERING HOMES AS POWERSTATIONS

2) Executive summary

Energy efficiency and demand side management is needed to reduce energy costs and provide affordable warmth for householders. The programme will target both new build housing projects and the retrofit of existing housing. SBCR will make available a Local Authority led regional land bank for new build. It will promote energy retrofits, initially through the public sector housing stock, and after proving the process and financial measure it will target the rollout to private sector landlords and owner-occupiers. Energy retrofits will be linked to other housing improvement programmes in the Region, for example, ARBED. A major aim will be to reduce fuel poverty and its impact on health. There will also be a focus on broadband Internet connections and smart metering, and the potential for links to a local authority led ESCO (Energy Supply Company).

The current shortage of new housing in SBCR will be met with a programme of new housing which will be designed to be energy efficient with integrated renewable energy. A programme of existing housing retrofit will improve their energy efficiency. The proposed programme will therefore:

- Help fill the Region's new housing gap between demand and current rate of build.
- Provide lower cost energy bills to households and reduce energy demand from grid supply.
- Reduce fuel poverty and provide householders with more spending power.
- Improve health and well being through affordable warmth and better quality indoor environment.
- Expand broadband usage and links with user-led energy demand management (smart meters).
- Create jobs and industry (rising to an estimated 4,512 new jobs over a five year period).
- Add value to the Regions housing stock.

The Centre for Excellence in Next Generation Services (CENGS) (101) will provide the will provide a data analytics capability to support the projects smart and healthy elements.

3) Project description

There are 3 aspects to the programme.

(A) New Houses: There is a need for new housing across the Region. It has been estimated that 8,700 new houses a year are needed in Wales, of which, 63% would be in the private sector (5,500 a year), and 37% in the social sector (3,300 a year). In the SBCR some 2674 new houses are needed a year, however the current completion rate is 1471. So current completions are only 55% of housing needs target. It is proposed to build up to 1200 houses to 'energy positive' standards to help bridge the gap between the current and target new build rate. There is an interest in the rollout of energy positive houses, shown in the figure below (developed WEFO LCRI project). The design is based around reducing energy demand, renewable supply and energy storage. This can be applied to groups of housing, and eventually to other building types. This activity can contribute to affordable new build programmes, creating supply chain industries and construction related jobs. It is proposed for LA's to provide a combined land bank from their existing portfolio, in proportion to their housing needs to accommodate up to 1200 'energy positive' houses per year, with the potential to create an estimated 2,880 jobs. The programme would begin with a target of around 200 houses in the first year rising to 1200 after five years. The programme would look for support from Welsh Building Regulations, and buy-in from public and private sector house builders. The housing would target public and private sector developments, leading with public sector (LA's and RSL's), whilst engaging with the private sector.

New Build 'Energy Positive' House (ERDF funded)

SPECIFIC is a National Innovation Centre developing the concept of buildings as power stations, and has WEFO funding to engage with industry in the application of new technology, and developing supply chains and demonstration projects. SPECIFIC at Baglan can act as a supply chain hub for BAPS (Buildings as Power Stations) supply chains. The activities of SPECIFIC are embedded within private sector-led agenda to create new opportunities for an emergent industry embracing a range of sectors. This include 50+ industry partners from small SMEs through to large corporate partners interested in developing solutions in Wales for global export. It will link to work at Tata's Sustainable Building Envelop Centre (SBEC) on innovation in steel products for the construction industry at Shotton, to provide innovative components such as transpired solar (air collectors (TSC's) and integrated steel based solar PV roofs. Recent work at SBEC includes demonstrating TSC's for heating a range of building types across Wales (ERDF funded) and the development of glazed-in solar air collectors involving collaboration between Tata and NSG glass (funded by A4B). This work on new applications of steel in the construction industry continues through the new SPECIFIC2 ERDF project based at SPECIFIC Baglan (partners including Swansea University and Cardiff University), and potentially links to the proposed SBCR Steel Innovation Centre.

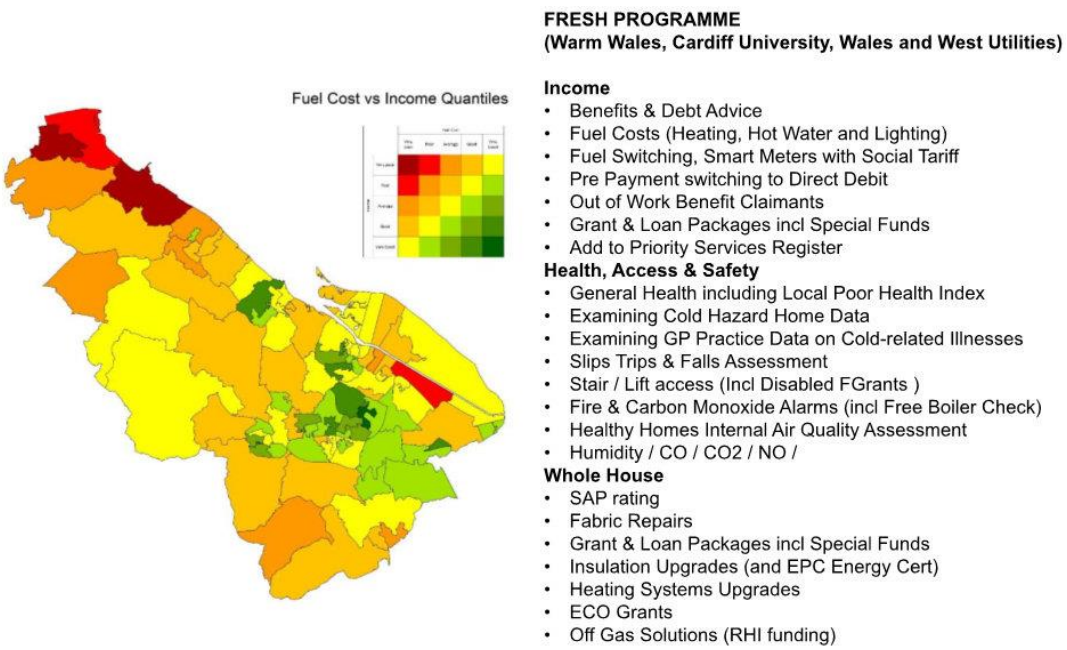
The project will seek to engage with volume house-builders, who are already looking at the move to near zero carbon houses in line with European Directives (which will likely continue after BREXIT). A recent meeting attended by volume house builders, RSL's, Local Government and Welsh Government, discussed the move towards zero carbon performance and the need to work together on appropriate solutions.

(B) Housing Retrofit: There are 323,274 housing units in SBCR, of which 28,000 are managed by LA's, and 23,000 by RSL's. 87,954 are below the energy target of SAP65, of which 15,000 are in the public sector (analysis by Warm Wales Ltd (Margam). In SBCR some 33,000 of households are in fuel poverty, where they need to spend more than 20% on energy. In many cases, households cannot afford to heat their houses to appropriate standards, and this incurs considerable health problems. 80% of the fuel poor are in the private sector. In SBCR, the public sector has around 2,500 fuel poor households. These should be a priority for retrofit as they are more accessible and potentially easier to fund through projects with LA's and RSL's. Once retrofit models (technical and financial) are proven, the scheme can be focussed more on private landlord and owner-occupied properties. There is already experience of large scale housing retrofit in Wales through ARBED, Warm Wales (Community Interest Company based in Margam) and the WEFO LCRI Retrofit project (see figure below). Large-scale whole-house retrofit programmes can

significantly reduce energy needs and provide affordable warmth, which contributes to healthy living. However, there is a need to carry out whole house deep retrofits in a professional way with quality checks. In the past large scale retrofit projects have been compromised in relation to quality by lack of quality control. Retrofit programmes can also include health and IT Broadband measures. Once proven, the retrofit 'model' can then be offered to the private sector. The programme would build up to a target 3,600 per year after 5 years. (estimated by Warm Wales Ltd). The current average cost of 'whole house' retrofit is £25,000 (based on the LCRI Retrofit costs). The target would be to reduce this to below £20,000 through scaling. At £20,000 per house, at year 5, the total spend would be £72 million per year, which equates to around 1500 jobs.

Demonstration LCRI Housing Retrofits (ERDF funded)

(C) Smart Healthy Homes: The project will also focus on smart technologies in relation to energy demand management (i.e. grid import and export in relation to energy demand, building integrated renewable energy and energy storage) for both new and retrofit housing. Discussions with the international software company SAP have resulted in them seeking to engage with the project in rolling out smart technology for both new build and retrofit. The proposed Centre for Excellence in Next Generation Services (CENGS) (101) will provide the will provide a data analytics capability to support the projects smart healthy elements. Warm Wales, and Wales and West Utilities have worked on smart healthy homes, which in future could link to the Internet of Health theme. The figure below summarises their FRESH Programme (initially developed for Flint and Cardiff LAs), which links area analysis of fuel cost and household income, which is then used to trigger house visits which address income, health, access and safety, and whole house retrofit opportunities. Survey work relating to health and housing in Carmarthenshire is demonstrating health improvements resulting from housing quality upgrades. This innovative approach to energy, household income and health can be rolled out across SBCR.



FRESH Programme (WWU funded)

Comparative advantage of Homes as Power Stations

Other projects have had limited success with increased scale, both for new build and retrofit programmes. For new build there has been uncertainty and lack of awareness of what is possible, e.g., the SOLCER house. For retrofit funding has been unsteady and somewhat disjointed, resulting in short term programmes and lack of skills development, and potentially poor quality outcomes. Both situations have been a barrier to setting up robust supply chains and achieving confidence in performance.

The homes as power stations programme would scale-up in a manageable way that gives industry a longer term perspective to set up local supply chains. It will oversee performance, create a better understanding and develop skills. This can then be used to show the way to other regions and the UK as a whole.

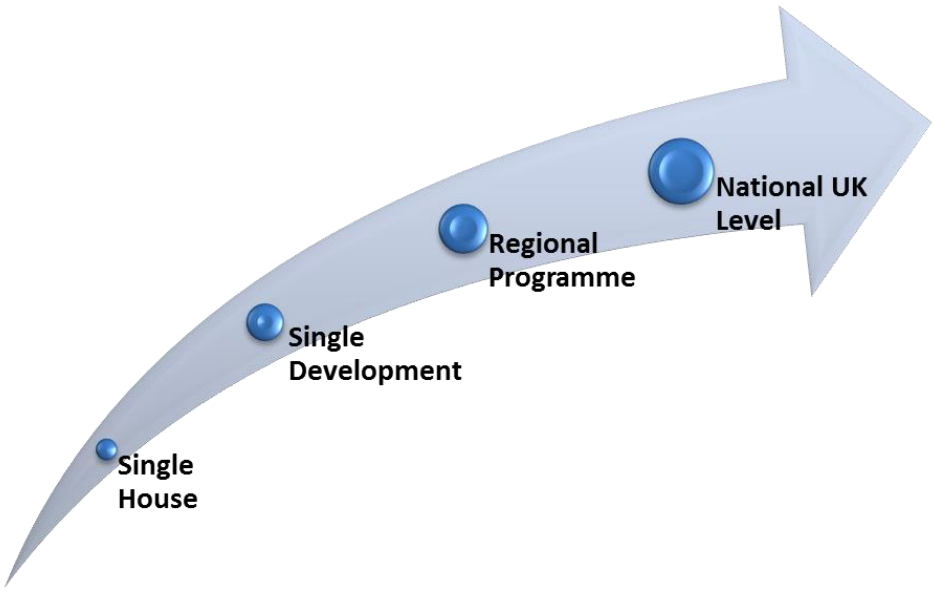
3) Project aim and SMART objectives

- *Delivering Innovative Smart Low Carbon Homes* will initiate a programme of new build and retrofitting existing houses aimed at providing energy efficient healthy homes, particularly targeting vulnerable groups, such as the fuel poor. The focus on housing will extend to health monitoring and broadband services. It will coordinate a local authority land bank for new houses, and initially LA and RSL housing stocks to develop large scale retrofits. It will develop supply chains and training within the region to support this activity.
- At the end of a five year period it will build up to a target of 1200 new houses per year, helping to fill the gap between the current rate of new build and the rate required to meet housing demand. Over this 5-year period it will also develop a steady-state programme of at least 3,600 retrofits a year. It will create jobs and supply chain industries, rising to an estimated 4,512 new jobs over a 5-year period.
- The programme will include a monitoring and quality activity, which will collect data to provide measurable outputs in relation to job creation and added value to the region in the form of house values, health improvements.

- The programme will manage expectations through increasing the number of new build and retrofits in line with developing supply chains and training, therefore maximising the local impact of economic activity and delivering multiple benefits to communities in the form of energy cost savings, improved health and economic growth (see details below in section 14).
- The activities will kick start a construction programme of £517,050,000 for an investment of £15 million (3% of the total programme value) by the SBCR City Deal.
- The project will be relevant not only to the Internet of Energy theme but also to the Internet of Health and Internet of Economic Acceleration.
- The time scale of the programme will develop numbers of new build and retrofit houses, starting with existing resources in the Region, and growing numbers over a 5-year period through expansion of the construction industry in the region.

The City Region has adopted a stepped approach model for delivering homes as power stations at scale and magnitude. To ensure that a qualitative programme is achieved and delivered at volume the following platforms have been identified to ensure that a progressive and structure advancement is taken towards a national level roll out.

- Single House (Solcer)
- Single Development (15 Homes)
- Regional Programme across the four Local Authorities
- National Level



During the five year regional SBCR housing programme the following mechanisms and components will be developed and established that will ensure that a structured and well co-ordinated scaled up approach is set in place that will enable a smooth transition and progression between the various platforms to a national level at volume:

- Creation of a specialist programme management vehicle
- Establishment of professional and informed workforce for programme delivery across relevant disciplines
- Formulation of effective partnership arrangements
- Quality assured design and construction processes adhering to and enhancing approved procedures
- Proven and established cost model

- Creation of a robust supply chain
- Established training programme
- Reporting and review protocols

The aforementioned elements will ensure longevity and the delivery of carbon neutral/houses as power stations for years to come on a regional scale contributing to future carbon and renewable generation targets.

The co-ordination and scalability of the delivery of homes as power stations will achieve far greater economic value than an ad-hoc approach. To summarise the City Deal will evolve from a single house to individual development regional approach to national UK level.

SBCR have already established a pilot programme through Neath Port Talbot in partnership with POBL and SPECIFIC ahead of the SBCR Low Carbon Housing Programme. The methodologies and the multi-discipline project management of buildings, energy storage, and occupance has already been established. A forward plan is also being prepared for the monitoring of outcomes, including health, occupier experience, supply chain capability and financial benefits.

> The homes as power stations programme would scale-up in a manageable way that gives industry a longer-term perspective to set up local supply chains. It will oversee performance, create a better understanding and develop skills. This can then be used to show the way to other regions and the UK as a whole.

4) Applying organisation including contact details and details of partners involved.

The programme will be led by a consortium of the four local authorities.

5) Strategic Fit.

The programme will provide a vital contribution to make to the wellbeing of future generations in Wales. It will drive actions to deliver against the goals set out in our new and historic ***Wellbeing of Future Generations (Wales) Act***, tackling poverty and the global threat of climate change, building resilience for our communities, boosting green growth in the economy and addressing the health inequalities caused by poor energy efficiency.

Besides addressing the energy “trilemma” of affordability, security of energy supply and the need for decarbonisation, the strategy is designed to play a major role in driving economic growth – supporting the growth of green jobs and skills throughout Wales and increasing the competitiveness of our businesses.

To protect the long-term well-being of our citizens, we need to take action now to improve the energy efficiency of our homes, our businesses and our public sector. The energy system in Wales is on the threshold of considerable change with new energy, technology and low carbon transition opportunities. Ensuring that our buildings are energy efficient will be the bedrock of this transition.

The programme fits with societal needs for efficient and healthy housing with lower energy costs, and government targets for maintaining security of energy supply and reducing carbon dioxide emissions. In particular it:

- Builds on and will gain support from existing activities in the region, eg SPECIFIC's Buildings as Power Stations programme, large scale housing energy retrofits by Warm Wales Ltd.
- Links to Welsh Government policy and initiatives such as ARBED and NEST.
- Fits with the government's low carbon agenda.
- Meets the demand for more new houses.
- Reduces energy costs especially for fuel poor.
- Has links with the SBCR Health and Internet themes.
- Aligns with Future Generation policy and environment and energy policy.

The recent ***A Smarter Energy Future for Wales March 2016*** report recommends to urgently revise Building Regulations to ensure that all new houses are built to 'near zero' energy standards. Research by LCRI has shown that the cost of building an efficient, energy-positive house is similar to the existing cost of market and social housing. Retrofitting energy efficiency measures into existing housing stock has a crucial part to play, and Welsh Government schemes such as Nest and Arbed will be key to improvements.

The endeavor of the project proposal is to prove and implement homes as power stations and deliver at scale at a regional level, this is the challenge and the reason why the project is needed. There have been previous attempts and efforts that have met with limited success due to the nature of funding and the lack of a professional and coordinated approach.

6) Evidence of need / demand for the project

Market failure has led to (i) a low supply of new housing on the market which has leading energy demand management features (ii) low levels of take up on retrofitting in the private sector (iii) in terms of the public sector, the nature of housing improvements tends to be procurement led rather than individual household-centric, with little attention taken to the consumption patterns and demands of an individual household. (iv) few skills and only limited awareness of the role active energy management can have.

Specific evidence includes:

- House builders have been reluctant to integrate leading edge technology into housing developments on the grounds of costs and expected returns on investment.
- The provision of new housing is not achieving targets. In the SBCR some 2674 new houses are needed compared to the current completion rate of 1471.
- There are 323,274 housing units in SBCR, of which 28,000 are managed by LA's and 23,000 by RSL's. 87,954 are below SAP65, of which 15,000 are in the public sector.
- In SBCR 33,000 households are in fuel poverty many of which will not be adequately heating their houses, which has major impacts on health; In SBCR the public sector has around 2,500 fuel poor.
- Failure of the government 'green deal' to provide a financial model for retrofitting. Previous attempts to retrofit energy technologies (via for example the Green Deal) has failed because of (i) the poorly received financial package available to assist householders invest in energy saving technologies (ii) the energy products on offer focusing on replacing existing energy saving equipment such as boilers and windows rather than new approaches to energy management and consumption.
- Welsh households pay more for gas and electricity than the UK average, with average annual costs £725 for gas and £618 for electricity compared with UK averages of £715 and £584. Many fuel poor households are on prepaid meters, which further increases energy costs.
- The City Deal addresses these market failures and will:
- Show how energy efficient designed housing can be constructed in volume at a similar/same cost as a comparable house.
- Based on discussions with the Principality Building Society has explored providing increased mortgage lending for house buyers, based on lower energy costs releasing greater spending power for households.

- Demonstrate the positive economics of retrofit in public sector housing
- Stimulate skill needs and demand for skills in new, value added construction activities
- Lead to the integration of good and practice in future housing scheme design and implementation as well as encourage new, household focused, models of retrofit and energy saving.
- Professionalise the housing retrofit industry with training and quality assurance processes.
- Link with a Regional ESCO to stabilise and reduce energy costs.

The key fundamental difference of delivering homes as power stations proposal is that what has happened before is not sufficient to make the changes needed both in terms of new build and retrofit housing schemes, to provide affordable, energy efficient, healthy housing and the significant step and cultural change to carbon neutral homes. Previous efforts have lacked the co-ordination, scale and ambition to enable effective delivery.

Additional information on market failure

For new build, the costs can be similar to standard house costs. The volume house builders will have to change/modify house types which they need encouragement to do. As end-users realise what is possible in terms of energy positive performance, the demand will increase.

Retrofit will cost more (although there will be concerted to reduce and drive down costs) and the multiple benefit argument will be used to include benefits of improved quality of life and health, affordable warmth, increased asset value, local job creation, as well as energy savings and CO_2 emission reduction (which are more related to government targets than user benefits).

7) Added Value

The added value of the programme will include:

- Construction (new build) impacts will lead to increased economic activity and GVA through this sector.
- Retrofit programmes will also lead to direct job generation and increased housing value.
- Lower fuel bills will lead to an increase in household wealth and expenditure.
- The estimated energy savings on 10,800 houses will be around £5.36 million per year from year 5. This will increase by around £2.4 million a year from year 5.
- Reduced fuel poverty will lead to (i) increased household expenditure elsewhere (ii) reduced 'poverty trap' making employment and training more desirable option for workless households.
- Every £1 invested in reducing fuel poverty has a £0.42 value to NHS. If we assume 30% of retrofits are in Fuel poverty then the NHS value from a £72 million per year programme is £24 million per year [1].
- It has been estimated that the social value of £1 investment in energy retrofits yields a return of £4 [1].
- The increase in value of the new build for the initial 5 year programme is estimated at £350 million (based on build costs).
- The increased value in the retrofit housing from applied measures will be £214 million.
- 4,512 jobs will be created as direct jobs and indirect jobs in the supply chain. It is important to develop local supply chains in the Region.

([1] Towards the delivery of a national residential energy efficiency programme Appendix Issue, 8 July

2016, ARUPS.)

Reason why this proposal is not a devolved housing matter

The key justification for the programme not being a devolved matter are UK level carbon emission reduction targets and the requirement for a synchronised approach for achieving zero/low carbon housing that will be essential for Central Government to deliver the require reductions in carbon emissions.

A centralised and co-ordinated programme will achieve significant in-roads to decarbonisation of the homes in an efficient timescale, ensuring qualitative standards are achieved.

Another reason for a centralised governmental approach is to ensure that key fundamental issues are addressed in the delivery of large-scale zero/low carbon (homes as power stations) new build and retrofit homes.

With the abject failure of the green deal programme, it is vitally important that a tested and proven model and programme is implemented from a central datum across the principality to a UK level.

Centralised governmental approach will address the uncertainties by disseminating clear and easy to understand demonstration and delivery of smart low zero carbon housing programme to householders and all industry parties in a timely manner.

With the renewed vigour of zero carbon housing within Parliament, the SBCR programme will act as a pathfinder initiative.

8) Details of the activities/ outputs / results in the short, medium and long term

The programme outline and estimate of economic value and jobs is presented below. The SBCR investment in this programme is considered in the Financial section.

Years	1	2	3	4	5
New Build Number Houses	200	400	600	900	1200
Cost of build (120 TO 100K/house)	£24M	£46M	£66M	£94.5M	£120M
Jobs (2.4 jobs/house[1])	480	960	1,440	2,160	2,880
Retrofit Number Houses	250	750	1,500	2,000	3000
Total costs (£24k down to £20K (over 5 years) per house)	£6M	£17.25M	£33M	£42M	£60M
Jobs (22 / £1M costs)[2]	132	379.5	726	924	1,320

[1] *The industry estimates every new home built creates 1.5 direct house building jobs plus 0.9 jobs in the supply chain, or 2.4 direct and supply-chain jobs in total.*

[2] *The Energy Efficiency Industrial Forum (2012) states that on average, investing €1 million energy efficiency for buildings would create 19 new local and non-transferable jobs in the construction sector.*

The programme addresses both new build and retrofit schemes and the application of a whole house approach to both. The technologies for new build and retrofit overlap (e.g. energy savings, renewables and energy storage). The innovation will be in the development and integration of technologies, and in particular the connectivity across technologies and digitization and smart control, and the links with smart grids and future ESCo's. There will also be innovation in the associated design, planning and construction processes and performance quality checks. All this would have national (and potentially international) impact.

The purpose and requirements of each proposal type is outlined below:

Retrofit
At least 80% of the homes that will exist in 2050 have already been built, therefore the homes as power stations retrofit scheme will have a significant role to play in ensuring the climate change targets are met also assisting to alleviate fuel poverty and additional health benefits.

New build
Housing targets within the UK are to build one million new homes by 2020 and two and a half million homes over the next ten years. Using the Building as Power stations approach, a generation capacity reduction of 3GW can be achieved; equivalent to approximately to one new nuclear station or a substantial coal fired station.

The strategy is to establish an early impact through deploying the approach on a proportion of the planned 1,000 low carbon building programme. Retrofit can be more easily tackled once consumer confidence, supply chain capability and lower cost technology has been establish, this is considered the quickest route to overall impact.

The following retrofit and new build building projects have been programmed over the five year period of the SBCR proposal. Retrofit will account for 3,000 (71%) with new build accounting for 1,200 (29%).

Years	1	2	3	4	5
New Build Number Houses	**200**	**400**	**600**	**900**	**1,200**
Retrofit Number Houses	**250**	**750**	**1,500**	**2,000**	**3,000**

The key fundamental difference of delivering homes as power stations proposal is that what has happened before is not sufficient to make the changes needed both in terms of new build and retrofit housing schemes, to provide affordable, energy

efficient, healthy housing and the significant step and cultural change to carbon neutral homes. Previous efforts have lacked the co-ordination, scale and ambition to enable effective delivery.

Other projects have had limited success with increased scale, both for new build and retrofit programmes. For new build there has been uncertainty and lack of awareness of what is possible, e.g., the SOLCER house. For retrofit funding has been unsteady and somewhat disjointed, resulting in short term programmes and lack of skills development, and potentially poor quality outcomes. Both situations have been a barrier to setting up robust supply chains and achieving confidence in performance.

The key wider economic benefits flow from:

- Housing construction :
  - Details of construction costs per house (presently estimated at £120,000) per house.
  - Reduced timescales for construction and sale of houses (and generation of data).
  - Proportion of capital construction costs (CAPEX) which will be captured via local supply chains.
- The impact on domestic consumer patterns and fuel poverty (health improvement) on targeted households.
- The SBCD will kick start a construction programme of £517,050,000 for an investment of £15,000,000 (3% of the total programme value) generating an estimated 5,184 new jobs.

Details on how the private rented sector and owner-occupier properties will benefit from this programme.

To summarise the private rented sector and owner-occupier properties will benefit from the programme by increased asset value, lower energy costs, improved health and well-being. Many private sector landlords are committed to improving quality of life for their tenants. More expansive details how the private rented sector and owner-occupier properties will benefit from the programme are outlined below.

<u>Private rented sector</u>

The benefits to private landlords will be the attractiveness to prospective tenants of an energy efficient, carbon neutral cost effective household. Additionally the applicable generation technologies will be a potential source of income generation where incentives exist. They will also address poor quality housing via the retrofit programme.

Key benefit to tenants will be the cost effectiveness of the electricity and heating costs of the carbon neutral house as power stations helping to alleviate fuel poverty within a sector where fuel poverty is prevalent. Additionally tenants will be protected from energy price increases as a consequence of the volatility of energy markets.

Existing owner-occupier properties

The retrofit element of the programme will assist private householders to improve the energy efficiency and renewable generation of their homes. Existing owner occupier properties will benefit from the following aspects:

- Reduced household energy costs
- Achieve affordable warmth
- Creation of healthier homes
- Improved household energy and carbon performance
- Increased in householders disposable income
- Discounted mortgage rates for zero carbon homes
- Potential positive income flow
- Alleviation of fuel poverty
- Adoption of sustainable cost effective lifestyle
- Improved quality of internal living and environment and comfort conditions
- Increased asset value of the property
- Protection for private householders from energy price increases as a consequence of the volatility of energy markets
- Provision of more self-sufficient electricity and heating systems increasing the security of both electricity and heat provision
- The programme will ensure that installed low/zero carbon and renewable systems will be installed to high qualitative standards

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- Creation of healthier homes
- Improved household energy and carbon performance
- Increased in householders disposable income
- Discounted mortgage rates for zero carbon homes
- Potential positive income flow
- Alleviation of fuel poverty
- Adoption of sustainable cost effective lifestyle
- Improved quality of internal living and environment and comfort conditions
- Increased asset value of the property
- Protection for private householders from energy price increases as a consequence of the volatility of energy markets
- Provision of more self-sufficient electricity and heating systems increasing the security of both electricity and heat provision
- The programme will ensure that installed low/zero carbon and renewable systems will be installed to high qualitative standards

Wider economic benefits:

To summarise the wider economic benefits of the delivery of homes as power station can be categorised into the following sectors:

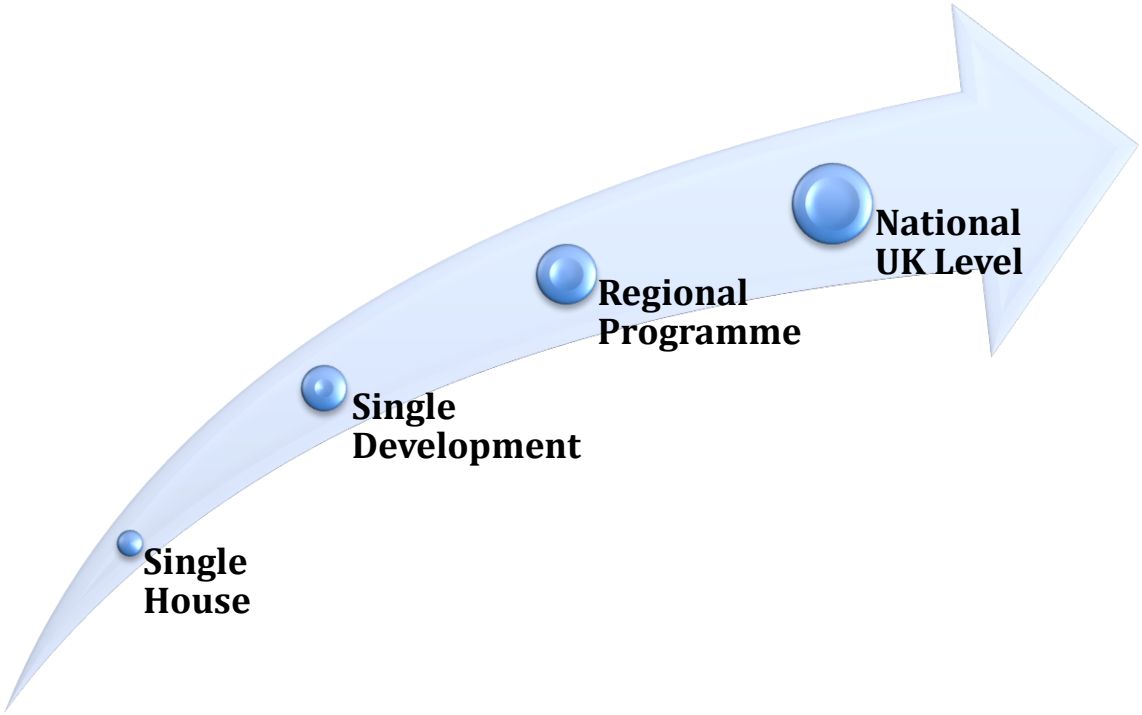
- Householders
- Smart/Intelligent
- Construction
- Supply Industry
- Local Authorities
- Housing Providers
- Health Care Sector
- Central & Regional Government

Sector	Benefit
Householders	a) Reduced household energy costs b) It has been estimated that the social value of £1 investment in energy retrofits yields a return of £4 c) Reduced fuel poverty will lead to (i) increased household expenditure elsewhere (ii) reduced 'poverty trap' making employment and training more desirable option for workless households

	d) Provide protection against future energy market price increases
Smart/Intelligent	a) Enable householders to implement smart systems in conjunction with the low/zero carbon systems to achieve full optimisation and make use of smart energy tariffs b) Provide capability for identifying energy cost wastage
Construction	c) Construction (new build) impacts will lead to increased economic activity and GVA through this sector d) Retrofit programmes will also lead to direct job generation and increased housing value
Supply Industry	a) Increased productivity and job security b) Address skills shortage c) 5,184 jobs will be created as direct jobs and indirect jobs in the supply chain
Training	a) Increase in the uptake of university research support (FLEXIS & SPECIFIC) b) Training provision for relevant discipline/trades at local colleges
Housing Providers	a) Increased sales and rentals b) Tenants can afford to rent c) Helps to achieve and satisfies quality housing criteria d) Long term investment
Health Care Sector	a) Improve the health of occupants helping to reduce number of householders requiring care and the consequential financial impact b) Every £1 invested in reducing fuel poverty has a £0.42 value to NHS. If we assume 30% of retrofits are in Fuel poverty then the NHS value from a £72 million per year programme is £24 million per year
Central & Regional Government	a) Reduced carbon emissions b) Lower environmental impact c) Assist in the delivery of carbon reduction targets e) Helps achieve security of supply on a regional level f) Reduces the demand on electricity and gas national grid systems

The co-ordination and scalability of the delivery of homes as power stations will achieve far greater economic value then an ad-hoc approach. The City Deal will evolve from a single

house to individual development regional approach to national UK level.



The GVA figures from Swansea University will provide further quantitative analysis on the wider economic benefits of the project proposal.

- **Wider economic benefits**

Localised benefits will be replicated at scale through the advancement at each platform. Wider benefits of the programme will be the delivery of UK level carbon emission reduction targets and the requirement for a synchronised approach for achieving zero/low carbon housing that will be essential for Central Government to achieve the required reductions in carbon emissions.

A centralised and co-ordinated programme will achieve significant in-roads to decarbonisation of the homes in an efficient timescale, ensuring qualitative standards are achieved. Another reason for a centralised governmental backed approach is to ensure that key fundamental issues are addressed in the delivery of large-scale zero/low carbon (homes as power stations) new build and retrofit homes.

It is vitally important that a tested and proven model and programme is implemented from a central datum across the principality to a UK level. Centralised governmental endorsed approach will address the uncertainties by disseminating clear and easy to understand demonstration and delivery of smart low zero carbon housing programme to householders and all industry parties in a timely manner.

Find below analysis on the main energy and cost beneficial impacts of the SBCR Homes as Power Stations programme at the following levels:

- Regional (SBCR)
- Principality/National
- UK Level

Scale	Housing Stock	Energy Savings		Cost Savings		Jobs	
		MWh		£Million		x1000	
		Existing	New	Existing	New	Retrofit	New Build
SBCR	323,274	33,480.0	11,160.0	33.5	0.9	1.6	2.9
WALES	1,405,959	145,608.7	48,536.2	145.6	4.0	6.9	12.5
UK	28,249,959	2,925,718.2	975,239.4	2925.7	79.7	138.4	251.7

- **Dissemination of project knowledge and insights with the rest of Wales and the UK**

There will be a dedicated knowledge and information sharing plan which will be built into the mobilisation and implementation programme. The following mechanisms will be used a conduit for the dissemination of the benefits of the scheme, elements that have worked well and lessons learnt:

- Dedicated knowledge and insights sharing plan
- Website created which will disseminate of key information on the project
- Provision of periodic workshops/seminars
- Progress reports issued at key milestone of the rollout programme
- Creation of demonstrator homes/hub where the public can walk in / also may double up as a council interface within each main town within the SBCR Local Authorities (where possible) perhaps in similar vein to the SOLCER House
- Dedicated conferences
- SPECIFIC which is a national innovation centre and will assist the SBCR with information dissemination across the UK
- Work closely with Universities and FLEXIS research programme in particular
- The project will aim to work closely with organisations such as Innovate UK, Energy Saving Trust, Constructing Excellence and BEIS etc. to ensure that there is national coverage of the programme

The Low Carbon Housing Programme will critically include data and information capture through effective monitoring to measure performance make available a knowledge base of lessons learned and the methodology that can be used to feed into national roll out.

Key elements of the project that will be disseminated will consist of:

a) Publish feasibility & design vision
b) Project management and implementation
c) Construction techniques/build-ability
d) Cost model for new build and retrofit
e) Life cost cycle analysis & maintenance strategy

f) Social science review (User integration/engagement and dissemination of user guidance)
g) Whole house/development metering strategy
h) Real-time monitoring & performance optimisation
i) Structured independent reporting of each development's performance
j) Lessons learnt, report written on what actually went well and issues/problems identified during the rollout of the programme
k) Low carbon and technology review
l) Predicted energy/carbon performance vs actual

Benefit/Impact	Wales – Lo/med/hi	Description	UK – Lo/med/hi	Description
New Housing	Hi	Pioneering innovative energy positive housing.	Hi	Extending the activity UK wide and further.
Retrofit housing	Hi	Development of a viable technical and financial model for housing energy retrofits.	Hi	Extending the activity UK wide and further.
Smart connections	Hi	Integrating energy efficiency and renewable energy generation with Internet connectivity and health.	Hi	Extending the activity UK wide and further.

How this project is innovative

Homes as power stations is a ground breaking innovative yet practical application for the delivery of a domestic smart low carbon improvement programme. The focal aim is to achieve modern, smart energy system homes within the region, that will provide safe, efficient, clean and affordable homes, addressing the Energy Trilemma which is one of the most pressing universal themes and global challenges of our time, to support communities and industries via project delivery. Accomplishing a programme which is innovative and UK leading, making the most of the region's assets and talent stimulating economic growth.

The innovation will occur in the development and integration of technologies, and in particular the connectivity across technologies, digitization, smart control and the links with smart grids. There will also be innovation in the associated design, planning and construction processes and performance quality checks. All these aspects will significantly alter the innovative landscape on a national and potential international scale.

The homes as power stations programme is not just about the provision of homes, the programme will deliver multiple aspects which will make the programme unique and innovative they are:

- Assist in the delivery of digital infrastructure aligned to the Integration of smart/intelligent technology into carbon neutral homes
- Assist in the reduction of fuel poverty/affordable warmth improving health and well being
- Create centre of excellence for shared expertise and lessons learnt
- The homes as power stations programme will be aligned to fibre-optical communication that will produce provision and tested and quality delivery model in Swansea/Wales that will be replicable across the UK and create a world leading intelligent, zero/low carbon sector. This aligned to BREXIT will create a valuable product that could offered across the world in similar vain to Passive houses
- Development of highly technologically advanced and skilled large scale supply chain
- Rolling out of a regional, national, government aligned supported training and education programme for industry professionals and trades
- Increase promotion and demand of quality smart zero and low carbon houses providing increased levels of understanding and skills within the building, energy and data/communication sectors
- Unprecedented scale and co-ordination of a carbon positive programme across significant geographical area
- Assist in the delivery of National CO_2 emissions reduction targets
- Create standardised smart carbon neutral design solutions
- Provision of a vehicle that will further development low carbon technology utilised within the programme
- Creation of specific programme vehicle for delivering large scale affordable low and zero carbon solutions
- Provision of smart adaptive functionality that will deliver well-being benefits to occupants
- Proven test bed led by publically recognised and trusted organisations, creation of a trusted brand
- Creation of self-optimising households that achieves optimum levels of consumption and generation aligned to required internal environment requirements
- Increased security supply at local (household) level
- Provision of an analytical platform for data management (this will be the CENGS building and data platform), enabling the manipulation of large volumes of information. Also creating analytical visualization enabling the identification of patterns and relationships in data that weren’t initially evident

- Creation of new technology for example, optimisation control devices that balance the various generation and storage equipment and the integration to the user interfaces
- Creation of smart sensor and metering network both internally and externally with the latter linked to smart grid functionality
- Innovative financial mechanisms that provide zero/carbon mortgages engaging with building societies and banks to offer discounted rates to encourage and stimulate uptake of low and zero carbon homes

To summarise in conjunction with the Digital Infrastructure proposal the Homes as Power Stations project is part of creating the necessary infrastructure and network to apply the internet of things to the modernisation of our ageing energy infrastructure helping to tackle 21st century challenges of delivering technologically advanced, safe, reliable and affordable energy assisting to reduce fuel poverty whilst creating jobs through the delivery of smart/intelligent carbon positive homes.

SPECIFIC Is a National Innovation Centre and has pioneered the "Building as Power" Stations model and has demonstrated the concept at a whole building scale. The additionality of the SBCR Low Carbon Project is to deploy this approach at large scale in the community and in synergy with other community initiatives. The program allows the SBCR to demonstrate the benefits of the synergy between the building as Power Stations approach at a community scale in a cross cutting way:

- Health: through a substantial reduction in fuel poverty
- Community energy and business models through sharing embedded generation and stored energy between buildings
- Transport and pollution: through combining EV and EV storage to grid through smart control
- Smart cities: by using high level “big data” to optimise energy flows across the community

9) Cross Cutting Themes

There will be interaction with other themes:

- Both new and existing housing will be IT enhanced, with smart meters and test bed for demand-side management.
- Developing economic activities and infra-structures to support housing within the region and export to other regions.
- Housing to reduce fuel poverty and provide improved well-being and health.
- The project will lead to an increase in demand for relevant skills in construction and retro-fit installation

There will be Inter-connection and scalability with the project contributing to the cross cutting themes of skills and connectivity:

- Application of innovative technology at scale.
- Use of technology including the Internet of Things and Big Data to gather information from homes to optimise energy supply and efficiency
- Sustainability through (i) lower heating bills (ii) lower usage of non-renewables
- A region-wide programme will enable local and regional supply chains to learn necessary construction/data handling and processing skills necessary to work on future similar builds, this gives local companies a competitive advantage.

- Demands for skills will have significant impact on (i) employment of young people across South West Wales via apprenticeship routes (ii) upskilling local construction companies and supply chains across design and build phases of construction projects (iii) encourage schools to promote STEM subjects and opportunities to school pupils at GCSE and A-Level, enabling students to become more competitive in the market place.

Synergy with the digital infrastructure project

There will be clear linkage and synchronisation to the digital and health themes of the SBCR programme. Intelligent and smart functionality will be integrated into new build and refurbished households within the programme to monitor and optimise the low carbon systems within each household to process the large quantity of data produced. Analytical infrastructure platforms will be implemented to ensure effective control and optimisation, the CENGS proposal will be utilised to deliver digital requirements of the housing proposal.

Future energy systems aim to be end-user centred, which will require connectivity through smart meters and demand side control, as well as increasing end-user awareness and legibility (easy to use). The programme will focus on innovation in this area, for example with industry partners such as SAP, as well as energy supply companies.

The same digital infrastructure can be used to develop well-being in the home related applications, well-being surveillance/monitoring, social care alarms, air quality monitoring/alarms (Internet of well-being theme) and link to proposed broadband developments.

> To summarise homes as power stations will deliver low carbon intelligent homes which will provide self-adaptive households that will fully optimise efficiency and consequentially improve the health and living standards of occupants.

10) Stakeholder Engagement

Full support from the four LA's following discussions of the proposal. There have also been extensive discussions with industry and government partners who are committed to economic development in the Region. These include National Grid, Wales and West Utilities, WPD, RWE, Welsh Water, Warm Wales Ltd, Local Authorities, Housing Developers.

The following provides evidence and detail of private sector engagement and support:

- Private house builders will have to comply with 2019/2020 EPBD for nearly zero carbon houses

- Recent meeting with house builders detected change of attitude and more positive approach to zero carbon houses

House builder organisations are receptive to the concept and delivery of Homes as Power Stations, ultimately they will have to meet legislative standards and anticipated future customer demand.

Private Sector engagement / commercialisation of the technology

The programme will initially focus on the public sector to develop and demonstrate the approach. At the same time there will be engagement with the private sector, e.g. mortgage lenders, volume house builders, private sector landlords, etc., to understand their concerns, and work together with them to achieve private sector buy-in. This work is already in progress. We have met with HBF and Mortgage lender and have held a workshop with private and public house builders. We will also continue to work closely with the Welsh Government in relation to their programmes for new build and retrofit, and how planning and building regulations can support.

The dialogue with private sector will seek to encourage the engagement and take up of new build and retrofit homes as power stations via the following drivers:

- Cheaper household energy bills
- Increased value of the asset
- Healthier living environment
- Protection against future energy market price increases
- Potential revenue stream from electricity generation
- Discounted mortgage rates for homes as power stations
- Support programme to ensure optimisation of household technology on an operational and maintenance perspective
- Private house builders will have to comply with 2019/2020 EPBD for nearly zero carbon houses
- Lower household carbon footprint
- Tailored awareness campaign with user friendly terminology

Structured dialogue with large-scale house builders will be made to ensure carbon neutral homes are adopted as standard. In recent meetings with house builders, there has been a change of attitude and more positive approach to the delivery of zero carbon houses. House builder organisations are becoming more receptive to the concept and delivery of Homes as Power Stations, ultimately they will have to meet legislative standards and anticipated future customer demand.

The commercialisation of the technology will be delivered via SPECIFIC which is a programme designed purposely to develop and evolve low/zero carbon technology from the conceptual stages through to the first generation testing and consequential full-scale commercialisation and deployment.

An additional catalyst to stimulate the adoption within the private sector will be the configuration of the financial model that will front load the public sector in the early stages of the programme to demonstrate and prove the effectiveness and increase the uptake within the private sector.

Innovate UK

Initial interaction with Innovate UK has been facilitated by Specific. Further, more detailed engagement will take place during the mobilisation stage of the programme with a focus on the technological aspects of the homes as power stations.

11) Delivery

The main delivery will be carried out by the four Local Authorities.

A detailed mobilisation programme plan is currently being formulated and scheduled for completion within the next two months, which will define an exact (timeline) programme with key milestones for the scheme. The pilot housing development at Neath will commence on site during September/October 2017. Currently in discussion with a range of developers and RSLs to formulate a privately financed housing development joint venture vehicle in conjunction with the SBCR Local Authorities

In terms of securing contractors for new build proposals, contractors will be evaluated and tested for suitability for the delivery of smart carbon neutral innovative housing solutions. Structured dialogue with large-scale house builders and specialist installers will be made to ensure carbon neutral homes are adopted as standard. In recent meetings with house builders and contractors, there has been a change of attitude and more positive approach to the delivery of zero carbon houses. House builder organisations, contractors, installers are becoming more receptive to the concept and delivery of Homes as Power Stations, ultimately they will have to meet legislative standards and anticipated future customer demand.

Risk	Likelihood	Impact	Mitigation	Who will lead?
Not achieving new build targets.	Medium in the early stages, but low after	High	Ensure that the LA's provide a land bank. Ensure that the right levels of skills and experience are applied through industry engagement. Soft start proposed in run up to programme.	LA consortium
Not achieving Retrofit targets.	Medium in the early stages, but low after	High	Ensure that the LA's and RSL partners provide housing stock for retrofit. Link with other housing improvement programmes to optimise efficiency of delivery. Ensure that the right levels of skills and experience are applied through industry engagement. Soft start proposed in run up to programme.	LA consortium

Not achieving smart connectivity and health benefits.	medium	medium	Link with other themes to integrate broadband services	LA consortium linked to other themes

Exit strategy and sustainability

The SBCR City Deal homes as power stations exit strategy will occur within the fifth year of the project programme after this point it will become autonomous from an operational perspective and financially self-sufficient.

At this stage the mechanisms and components listed below will have been developed and established during the five year programme and will ensure that a structured well co-ordinated exit strategy is achieved:

- Quality assured design and construction processes adhering to approved procedures
- Proven and established cost model
- Creation of a robust supply chain
- Delivered liveable zero carbon homes
- Formulation of effective partnership arrangements
- Established training programme
- Localised programme implemented on a regional scale
- Establishment of professional and informed workforce for programme delivery across relevant disciplines

The aforementioned elements will ensure longevity and the delivery of carbon neutral/houses as power stations for years to come on a regional scale contributing to future carbon and renewable generation targets.

12) Financials

Funding is needed to:

- Invest in supply chains to ensure economic benefits from supply chain activity in the Region.
- Test-bed and monitor early stage
- Develop quality assurance procedures
- Help secure land
- De-risk investment

The specific cost breakdown is as follows:

- Programme management: for both new build and retrofit programmes: to aquire land bank; Identify retrofit projects; develop supply chain activity; develop quality assurance procedures to ensure that both new build and retrofit houses achieve their design performance in practice; and, liaise with HE and industry on skills and training (£1M).
- To fund a trial new build development of around 15 housing units. This will test the rollout of the energy positive houses at scale (£2.5M).
- To provide a sliding scale of financial assistance for retrofits in order to support them whilst costs are being reduced through upscaling.
- To provide monitoring and evaluation over a 5 year period to provide feedback to the programme and disseminate to others (£0.8).

- Invest in supply chains that can manufacture the construction components within the region.
- Throughout the first 5 years the cost of both new build and retrofit will be reduced through scale-up activities and reflecting lower component costs.

The total private funding associated with new builds amounts to £281m and retrofits £101m giving a total private sector funding of £382m for the total project, with public sector funding of £119m. The SBCR ask £15m, was the indication given for this project from the Oversight Board.

The main source of match funding availability will be via house building construction companies, householders, existing and proposed European funding (e.g. Arbed), RSL private equity and social housing grant input from public funds.

PROGRAMME COSTS

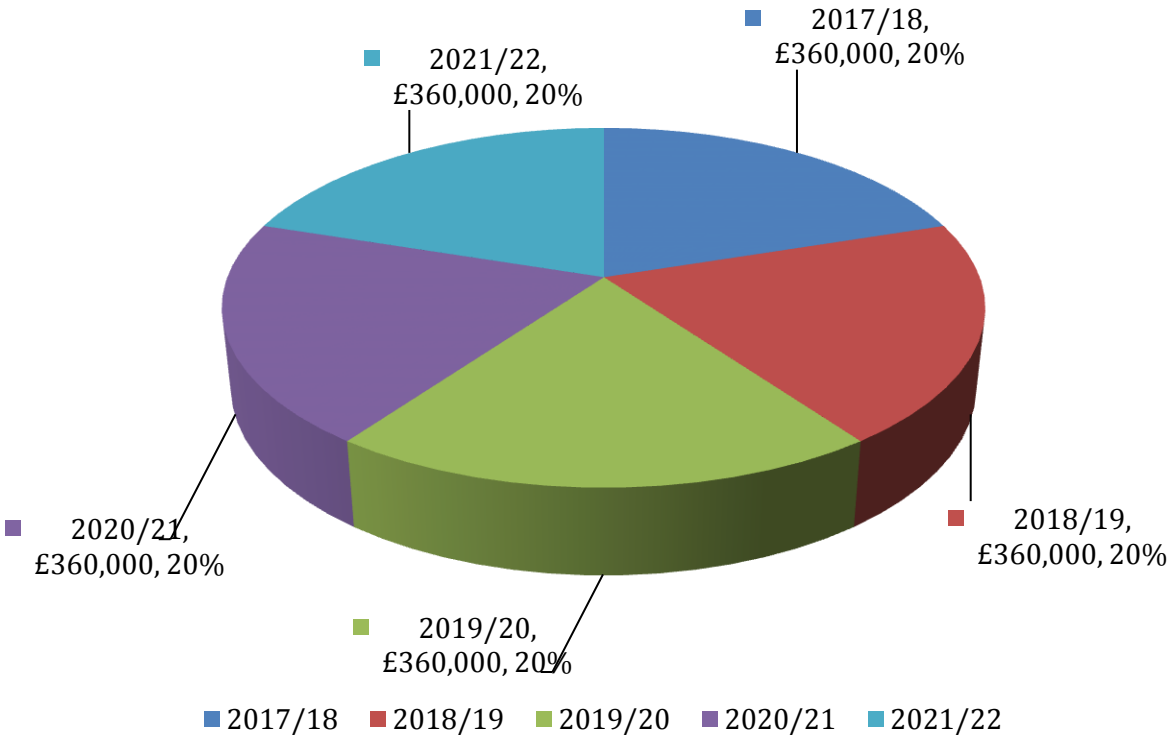
The components of the City Deal funding input (£15,000,000) are retrofits (£8,250,000), Supply Chain Development (£4,640,000), New Build (£1,160,000) and Core Funding (£1,800,000).

[1] *Costs based on social housing standards. Private sector developers may be able to reduce the cost through scaling and supply chain agreements.*

Programme strand:	*Internet of Energy (Efficiency)*					
*Financial summary**	*2017/18*	*2018/19*	*2019/20*	*2020/21*	*2021/22*	***TOTAL***
Total costs (£)	*32,400,000*	*66,150,000*	100,400,000	137,500,000	180,600,000	517,050,000
City Deal input (£)	*2,900,000*	*4,400,000*	*4,400,000*	*3,000,000*	*300,000*	15,000,000
Private Sector (£)	*23,075,000*	*47,675,000*	*73,050,000*	*102,600,000*	*136,500,000*	382,900,000
Other public (£)	*6,425,000*	*14,075,000*	*22,950,000*	*31,900,000*	*43,800,000*	119,150,000

* Includes an estimated 40% new houses developed by public sector.

Core Funding Annual Breakdown 2017 to 2022



2017/18	***2018/19***	***2019/20***	***2020/21***	***2021/22***	***TOTAL***
£360,000	***£360,000***	***£360,000***	***£360,000***	***£360000***	***1,800,000***

Core funding expenditure will consist of the following elements:

- Project management team vehicle
- Accommodation
- Programme review, testing, evaluation and reporting
- Qualitative assessment vehicle
- Test bed development across four Local Authorities
- Data and health analytics
- Knowledge dissemination/sharing
- Monitoring and evaluation
- Supply chain development
- Setup of LA land bank arrangement

Cost figures will be refined during the mobilisation stage.

Summary of GVA related value

The following is a summery of the main GVA related information contained in the above Template.

Project job creation: 5,184 new jobs related to the construction programmes. There will also be an estimated 6 new jobs associated with programme management and quality assessment.

Job creation broken down by sector:
Jobs in the construction industry (approx. 75%) and supply chains (approx. 25%).

Wider benefits overview

- Construction (new build) impacts will lead to increased economic activity and GVA through this sector.
- Retrofit programmes will also lead to direct job generation and increased housing value.
- Lower fuel bills will lead to an increase in household wealth and expenditure.
- The estimated energy savings on 10,800 houses will be around £5.36 million per year from year 5. This will increase by around £2.4 million a year from year 5 onwards.
- Reduced fuel poverty will lead to (i) increased household expenditure elsewhere (ii) reduced 'poverty trap' making employment and training more desirable option for workless households.
- Every £1 invested in reducing fuel poverty has a £0.42 value to NHS. If we assume 30% of retrofits are in Fuel poverty then the NHS value from a £72 million per year programme is £24 million per year [1].
- It has been estimated that the social value of £1 investment in energy retrofits yields a return of £4 [1].
- The increase in value of the new build for the initial 5 year programme is estimated at £350 million (based on build costs).
- The increased value in the retrofit housing from applied measures for the initial 5 year programme is estimated to be £214 million.
- 5,184 jobs will be created as direct jobs and indirect jobs in the supply chain. It is important to develop local supply chains in the Region.

([1] Towards the delivery of a national residential energy efficiency programme Appendix Issue, 8 July 2016, ARUPS.)

Project costs, investment profile and sources of funding, by year.

The SBCD will kick start a construction programme of £517,050,000 for an investment of £15 million (3% of the total programme value). The yearly profiles are presented in the tables above.

Exit strategy for the project to ensure it grows and is sustainable in the long term

The SBCR City Deal homes as power stations exit strategy will occur within the fifth year of the project programme after this point it will become autonomous from an operational perspective and financially self-sufficient.

At this stage the mechanisms and components listed below will have been developed and established during the five year programme and will ensure that a structured well co-ordinated exit strategy is achieved:

- Quality assured design and construction processes adhering to approved procedures
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- Formulation of effective partnership arrangements
- Established training programme
- Localised programme implemented on a regional scale
- Establishment of professional and informed workforce for programme delivery across relevant disciplines

The aforementioned elements will ensure longevity and the delivery of carbon neutral/houses as power stations for years to come on a regional scale contributing to future carbon and renewable generation targets.

Further detail about the delivery model of the 'not-for-profit' ESCO and how profits will be generated and returned to projects

The potential of incorporating an Energy Supply Company (ESCO) within the project programme will be evaluated during the project development stages and a decision taken whether to adopt across the City Region or not.

If a decision is taken to setup an energy supply company it would be centred around providing a localised independent energy supplier. The focal aim will be to provide household customers throughout the SBCR with cost effective gas and electricity prices via a stable price mechanism. The SBCR ESCO will operate in the same way as a typical energy supplier model. The ESCO will procure in bulk on the open market via the National Grid and then sell it onto SBCR customers.

The profit that the ESCO would generate from the supply energy will be used to cover operation overheads with profits recycled and assigned into specific projects and activities that will assist the development and delivery of the carbon neutral house as power stations programme.

Further detail on how the private sector will be encouraged to adopt energy positive houses and the commercialisation of the technology.

The private sector will be encouraged to engage and take up new build and retrofit homes as power stations via the following drivers:

- Cheaper household energy bills
- Increased value of the asset
- Healthier living environment
- Protection against future energy market price increases
- Potential revenue stream from electricity generation
- Discounted mortgage rates for homes as power stations
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An additional catalyst to stimulate the adoption within the private sector will be the configuration of the financial model that will front load the public sector in the early stages of

the programme to demonstrate and prove the effectiveness and increase the uptake within the private sector.

Further detail on how the private rented sector and owner-occupier properties will benefit from this programme

Detail how the private rented sector and owner-occupier properties will benefit from the programme are outlined below.

Private rented sector

The benefits to private landlords will be the attractiveness to prospective tenants of an energy efficient, carbon neutral cost effective household. Additionally the applicable generation technologies will be a potential source of income generation where incentives exist.

They will also address poor quality housing via the retrofit programme.

Key benefit to tenants will be the cost effectiveness of the electricity and heating costs of the carbon neutral house as power stations helping to alleviate fuel poverty within a sector where fuel poverty is prevalent. Additionally tenants will be protected from energy price increases as a consequence of the volatility of energy markets.

Existing owner-occupier properties

The retrofit element of the programme will assist private householders to improve the energy efficiency and renewable generation of their homes. Existing owner occupier properties will benefit from the following aspects:

- Reduced household energy costs
- Achieve affordable warmth
- Creation of healthier homes
- Improved household energy and carbon performance
- Increased in householders disposable income
- Discounted mortgage rates for zero carbon homes
- Potential positive income flow
- Alleviation of fuel poverty
- Adoption of sustainable cost effective lifestyle
- Improved quality of internal living and environment and comfort conditions
- Increased asset value of the property
- Protection for private householders from energy price increases as a consequence of the volatility of energy markets
- Provision of more self-sufficient electricity and heating systems increasing the security of both electricity and heat provision
- The programme will ensure that installed low/zero carbon and renewable systems will be installed to high qualitative standards