1. We have a dream….

We have a dream that we can scale up from the experience we have had with our own house to show how existing houses and existing communities could make a huge contribution towards solving problems of sustainable development. Policy-makers ignore existing communities because the problem is too difficult; we hope to show that this is not the case. We have refurbished our own house and reduced its energy consumption to 38% of the current UK average. We show how much further we could go, and how we could scale up the approach from one house to the neighbourhood, community and watershed scales.

2. Our concept: Scaling Sustainability

We believe that sustainable development is about realising the potential of each place to solve ecological problems. The potential must be maximised at each scale working from the smallest unit up. The problem must be understood at the scale of an ecological unit, the most meaningful of which is the watershed.

3. Our place

Starting from our own house, the scales we are working with are as follows:

Plot:	34 East Street	3-bed house, 4 inhabitants
Neighbourhood:	Osney Island	283 households, 600 inhabitants
Community:	West Oxford	1493 households, 2997 inhabitants
Watershed:	River Thames	23% of UK population and 27% of GDP on 10% of the land area

34 East Street was first built as a 'two-up, two-down' end of terrace cottage in 1869, part of the wholesale development of **Osney Island** which began in 1851. The Island had been a rubbish dump, but has an ancient history before that – the name means 'island in the river' and pre-dates the Saxon naming of Oxford. The resulting landscape of long terraces of houses, all slightly different but of the same period, is very highly valued. It was designated as a conservation area in 1976 and the local community is very active in protecting the perceived quality of their environment.

West Oxford developed along the causeway across the floodplain of the Thames which linked the city of Oxford to the village of Botley and the highway to the West. It consists of the neighbourhoods of Osney Island, New Osney, New Botley, Osney Mead Industrial Estate, and Botley Road warehouse retail estate. Most development is Victorian or Edwardian with the industrial and retail estates being late 20th century.

The **River Thames** catchment supports much of the population and business activity of the UK. It is naturally a humid temperate landscape with climax vegetation of close deciduous forest with meadow and wetland on the valley bottoms. It is an aquifer of minor importance with soils of high leaching potential. Average rainfall is below the world average at 690mm per annum. Forest cover in the upper reaches of the catchment is only 7% as against a UK average of 14%.

4. Our challenge

Our challenge is that, for the Thames Valley, global warming means an increase of winter rain but a decrease of summer rain. This imbalance is exacerbated by increased winter runoff and per capita water use. The result is that we are starting to experience both winter flooding and summer water shortages in consecutive seasons; West Oxford has suffered winter flooding in 2000-01, 2002-03 and 2006-7 but summer hose-pipe bans are in place. The detail is as follows:

- Low forest cover and increased autumn ploughing results in greater winter run-off. A 50% increase in forest cover could solve winter flooding problems in the UK[1];
- the Thames is either over-abstracted or has no further capacity for abstraction for its entire length[2]. Average water use per capita is at 160 litres per day, 10% more than 10 years ago and 600% more than 100 years ago;
- water quality has worsened from A to C since 1995 in the stretch of the river Thames which runs through Oxford between the Evenlode and Castle Mill streams;
- 918 megalitres of water per day is being lost in leakage across the Thames catchment[2];
- run-off due to autumn ploughing also causes soil erosion, in itself a major contributor to global carbon emissions and loss of ecological productivity.

5. Our proposal

Work with the existing community to solve the problem and contribute to the natural ecology of the Thames watershed

Carbon:
Reduce carbon emissions: currently 6.23 tonnes per capita per annum in the UK[3];
Increase carbon sequestration: replace lost landscape structure and conserve soils

Water:
Minimise winter flooding: dual strategy of affrorestation and rainwater harvesting for human use, target 21% forest cover (50% more than UK average of 14%)

Soils: **Minimise soil erosion:** change farming practices, ban winter ploughing, increase the use of no-dig, agroforestry and permaculture systems.

Design approach: We aim for energy and water autonomy at the smallest scale by taking advantage of the potentials of each location. We realise the maximum potential at the plot scale and then provide the back up necessary at neighbourhood and community scales. 21% forest cover at the watershed scale is paid for through savings - £1.1bn is saved against flood alleviation and new reservoir schemes – and re-directed farming subsidies.

6. How did we do?

We achieved autonomy for energy and water supply but we needed to combine plot, neighbourhood and community scales to do it. We reduced per capita carbon emissions by 86% to 0.87 tonnes per annum, household energy demand by 80% and per capita water consumption by 79%. We achieved 21% of forest cover and so minimised flooding problems. More forest along with development of wetland and woodland on public parkland increased carbon sequestration and wildlife habitat. Energy and water systems for East Street and Osney Island are described in detail in sections 7 and 8.

Brief		34 East St	Osney Island	West Oxford	Watershed
Carbon	Reduce energy use	**Annual demand reduced to 4,500kWh per annum, 20% of current average:** ▪ Unheated south-facing sunspace ▪ Heat pump provides underfloor heating and hot water ▪ Solar thermal panels provide hot water ▪ PV roof on office: 1000kWh per annum ▪ Pre-heat tank plus solar thermals increases efficiency of heat pump ▪ Micro wind turbine: 1000 kWh per annum ▪ led lights and hyper-efficient appliances	**Back-up supply for 283 houses:** ▪ 750,000 kWh per annum or 59% of the demand from micro-hydro; ▪ 1,000,000kWh from wind turbine of 40m hub height and blade diameter of 47m **East Street systems repeated:** ▪ Collective systems developed for heat pumps and solar thermals/PV	**Emergency supply:** ▪ Biomass CHP system at Community Centre for district heating in other neighbourhoods and emergency electricity supply. **Surplus supply:** ▪ PV roofs at industrial estate and retail warehouses	**Windfarm development at Harcourt Hill:** 1.3MW turbines generate hydrogen for community car pool
	Reduce transport use	**Annual emissions reduced to 0.87 tonnes per capita**: ▪ Most needs within 400m walking radius; ▪ Thames Path provides safe cycling; ▪ One adult works on plot one travels to work by train and bicycle; ▪ No air travel.	**New community uses** ▪ Shared office facilities support more home-working; ▪ Recycling shop and workshop at Hollybush pub ▪ Crèche/daycentre in redeveloped Democrats' Club ▪ Collective food production	**Low carbon transport system:** ▪ No car policy and new transit corridor ▪ Community car pool at Seacourt Park and Ride ▪ Car pool ultimately carbon neutral: PV and wind-produced hydrogen	
	Increase sequestration		**Landscape managed collectively:** Thames river frontage developed as part of community willow coppice production	**Landscape managed collectively:** ▪ Parkland edges developed as reedbed/wetland areas ▪ Willow coppice cropping supplies biomass CHP system	**Farmland returned to forest to achieve 21% cover:** particularly ridgelines and streamlines
Water	Slow run-off	**Rainwater harvesting** systems contribute to slowing of run-off			
	Reduce use	**Water use reduced to 76.64m3 (52.5 litres per capita per day):** ▪ ultra-efficient toilets ▪ reduced use for personal hygiene and laundry. **Total demand supplied from rainwater harvesting and greywater cycling;** ▪ 51.75 m3 harvested from roof area ▪ 30m3 cycled to toilets from other uses. ▪ Drinking water from community system.		**Drinking water supply and emergency back up:** ▪ 5 litres per capita per day drinking quality water supplied by rainwater harvesting and treatment system at the Osney Mead Industrial Estate ▪ System over-sized to allow back up supply in extreme drought conditions.	
Soil	Conserve and contribute to soil depth	Compost organic waste	Collective food production using no-dig permaculture systems	Allotments and Medley Manor Farm adopt no-dig permaculture systems.	Autumn ploughing banned and no-dig permaculture systems adopted

7. 34 East Street: detail

Energy system

We have reduced energy demand to 8,500 kWh per annum for the house and separate home-working office, 38% of the average UK household energy demand of 22,600 kWh per annum for a 3-bed house[4]. The household is carbon neutral for energy because it buys its surplus from a supplier using only renewable sources.

- Unheated sunspace on the south side provides both insulation and passive heating and cooling because it can be joined to or separated from the living space by folding, sliding doors.
- 6kW heat pump: an open loop system extracts heat from the Thames to feed underfloor heating. It uses 5,000 kWh of electricity per annum to supply all space heating requirements and all domestic hot water not supplied by solar thermal panels.
- 7.5m^2 Viessman solar thermal panels provide approximately 50% of hot water requirements and some contribution to underfloor heating. Not bolted on, they are part of the roof.
- 1.1kW PV array from Solar Century generates 1000kwh of electricity per annum.

Further measures reduce demand to approximately 4,500 kWh per annum:

- more solar thermal panels heating a water tank which pre-heats the river water feeding the heat pump. This increases heat pump efficiency by at least 1000-1500 kWh because the temperature differential is smaller.
- chimney-mounted wind turbine supplies up to1000 kWh per annum;
- an on-going programme of replacing lighting and appliances with LED lighting and hyper-efficient appliances reduces the energy demand by a further approximately 1500kWh per annum[4].

Water system

The current water demand of 233.6m^3 (UK average 160 litres per capita per day[2]) can be reduced to 76.64m^3 (52.5 litres per capita per day) by using ultra-efficient toilets and reducing water used for personal hygiene and laundry. This demand can be met by rainwater harvesting and greywater cycling. 51.75m^3 is harvested per annum from a roof area of 75m^2 and a rainfall average per annum of 690mm and 30m^3 is cycled to the toilets from personal hygiene, laundry and dish washing. A storage tank of 3500 litres provides holding capacity for one month's supply. Back up supplies from community harvesting systems are necessary for emergencies and drinking water quality supply comes from an expertly managed local rainwater catchment and treatment system.

Costs

Costs of the technologies used are shown in the table below along with offsets against the cost of conventional refurbishment. The total extra cost of the refurbishment is £16,050, 4% of the total house value.

Technologies	Per unit (£s)	After Offsets
Unheated south-facing sunspace	2,000	0 - Planned part of increase in house size
Heat pump	2,100 pipes to river, abstraction and discharge licences 3,100 heat pump	4,300 - Cost of conventional gas-boiler central heating system: £10,000
Underfloor heating on three floors	2,000	
7.5m2 solar thermal panels	3,600	
1.1 kW PV array	8,000	6,500 – roof and heating system
Pre-heat tank plus solar thermals	3,500	
Micro wind turbine	1,500	1,500
Ultra-efficient toilets x 3	1,000	550 - Cost of conventional toilets: £450
3500l rainwater and greywater system	3200	3200
LED lights and hyper-efficient appliances	Costs not yet known: technologies come to market by 2050	Replaced according to normal cycle: 3 replacements by 2050
Total	**30,000**	**16,050**

8. Osney Island: detail

Energy system

The combination of technologies used at 34 East Street is developed to provide a collective solution for all houses on the island. Houses with a river frontage have heat pumps fed from the river through shared pipework, those without a river frontage have heat pumps fed by a collectively owned and managed water channel. Live-work offices are developed alongside with solar thermal and PV arrays on the roofs. The investment required for all 283 houses, using the East Street costings as a guide, is about £4.54m.

Remaining energy demand is 1,273,500 kWh per annum. A recent survey of the Island community showed that over 90% were in favour of a micro-hydro scheme[5]. A survey of UK public attitudes by the Department of Trade and Industry showed that the most favoured technologies for renewable generation are hydro and wind[6].

Micro-hydro systems are developed in three places: at Osney Bridge sluice gates, Osney Lock buck gates and Osney Mill mill race. A study of the potential for the buck gates at the Lock indicates a conservative estimate of 42kWe with an associate output of 250,000 kWh per annum[7]. Developing the three schemes provides 750,000 kWh per annum or 59% of the demand and would cost £185,000 per turbine.

A wind turbine is put on Environment Agency land at the southern tip of the island. The DTI wind data base shows an average wind speed for this postcode of 5.8 metres per second at a height above ground level of 40m[8]. A 600kW turbine of 40m hub height and blade diameter of 47m provides 1,000,000 kWh at this average wind speed according to DTI statistics on the economics of onshore wind energy and would cost £420,000[9]. An average wind speed of 7 metres per second produces a third more energy per turbine (1,300,000 kWh) and so a pooling of community resources to develop a windfarm on Harcourt Hill to the west may be a better ultimate solution. Costs are summarised in the table below:

Technologies	Per technology (£s)	Per household (£s)
On-plot technologies	4,726,100	16,050
42 kWe micro-hydro scheme	185,000x3=555,000	1,961
600kWe wind turbine	420,000	1,484
Totals	**5,701,100**	**19,495**

10. How could the concept be realised?

Two main things are necessary to realising this concept: examples for people to follow in creating new norms of behaviour[11]; and pooling of knowledge and resources at the community scale. In the West Oxford example this is achieved by government support to pump prime development of the micro-hydro and wind turbine schemes through a Community Sustainability Trust, or CoST. A possible timeline follows below.

Timeline

Phase 1: 2007-2010

1.75m kWh electricity production in place and generating proceeds for CoST at £100,000 per annum. Money used for low carbon refurbishment – 12 per annum at cost of £200k. The CoST shares cost with householders according to need and reduces costs by bulk-buying expertise and technologies.

Phase 2: 2011-2030

All houses refurbished achieving 70% energy demand reduction and 100% water demand reduction. Community biomass, wind and PV generation developed along with a private micro-grid so West Oxford off-grid except for emergencies. Surplus energy sold to grid and proceeds put into CoST. 21% forest cover in place.

Phase 3: 2031-2050

90% energy demand reduction achieved by adoption of ultra-efficient lighting and appliances. Surplus energy generation makes hydrogen to supply car pool.

If all the 22 million existing houses in the UK formed into communities of the size of Osney Island and needed the same approximate level of £1m pump-priming, a 50% government contribution would cost the tax-payer £39 billion, or 7% of one year's current government expenditure[10]. It would leverage investment in low cost carbon housing of at least £370bn and would incidentally help to deal with problems of poor quality housing stock and associated fuel poverty.

Legislation would be needed to allow private micro-grids to be developed and to support devolution of energy and water supply responsibilities to communities. It would be so important to train communities in management of this order that a type of 'national service' could be developed where all young people would spend two years working for a CoST on energy, water and landscape maintenance and management.

Afforestation of the watershed would be done as a joint strategy with water demand reduction throughout the watershed to balance reductions in run-off and abstraction. It can be paid for through £1.3bn savings from a proposed West Oxford flood alleviation channel and a reservoir near Abingdon.

The concept is applicable to all climatic and geographic circumstances because all have watersheds and communities. Technological solutions will vary according to each particular place and community of people.

The three largest barriers to realising the concept are:

- **political will:** the radical approach to democracy advocated here looks a very hard thing to do successfully and requires the political elite both to surrender detailed control and make a substantial initial investment;
- **vested business interests:** current energy and water supply companies have an interest in selling big, simple solutions to a captive audience;
- **public demand for the legislative and institutional changes necessary:** people in the UK are very used to being dependent on big, centralized, 'Rolls-Royce' utilities and government.

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