St Just energy and carbon audit

Report for

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CORNWALL
NEW ENERGY

Contents

0 Summary

The energy use and consequent carbon emissions for St Just Parish area have been estimated and show an overall energy demand of 88,000 MWh for 2016. This produces around 27,000 tpa CO_2e.

Energy supply and demand St Just 2016 MWh

Energy source	Domestic	Non Domestic	Transport	Totals	%
Coal, LPG	2,207	2,700	-	4,907	6%
Oil	3,487	10,500	34,000	47,987	54%
Electricity	15,361	19,845	-	35,206	40%
Gas	-	-	-	-	
Totals	**21,055**	**33,045**	**34,000**	**88,100**	**100%**
Percentages	24%	38%	39%	100%	

Given the high percentage of energy demand from oil , at 55%, changing away from this fossil fuel source is a key action for moving towards Zero Carbon for the town and the surrounding area.

Carbon emissions for 2016 figures

Energy source	Total energy use		Emissions coefficient kg CO2e/kWh	Carbon emissions	
	MWh	%		Emissions t CO2 e	%
Coal/lpg	4,907	6%	0.34208	1,678	6%
Oil	47,987	54%	0.24516*	11,764	44%
Electricity	35,206	40%	0.3844	13,533	50%
Gas		0%			0%
Totals	**88,100**	**100%**		**26,976**	**100%**

** weighted average of domestic oil, petrol and diesel at the pump – 5% biofuel mix*

The Parish therefore produces nearly 27,000 tonnes of CO_2e a year from the local energy demand, of which in 2016 around 44% was from oil use and 50% from electricity use.

The potential for renewable energy has been assessed. The main resources in Cornwall as a whole are solar and wind energy and this is also the case in the St Just area.

There is high potential for both wind and solar electricity in the area, with high windspeeds and open space potentially available. The present renewable electricity supply is from roof mounted PV and some small wind turbines which together produce under 3% of local electricity demand.

The assessment of the potential for larger wind turbines shows that around ten sites are technically possible and a programme of around four wind turbines would produce a high percentage of local energy demand.

To reach Zero Carbon the area could also invest in around 13MW of PV on land arrays or less if more roof top installations are included.

The hydro resource whilst not large could provide a useful amount of electricity with lower intermittency than solar and wind energy.

A Zero Carbon programme would require a change of heating systems from electricity and fossil fuels to heat pumps and wood heating from new local coppice woodland. Heat pumps cut the energy demand from the system by two thirds, and hence reduce the amount of supplying renewables needed.

Equally a change to electric vehicles cuts the energy demand by two thirds as EVs are three times as efficient as internal combustion engines. This change also allows the local production of renewable electricity to supply the energy for the vehicles.

An integrated programme to lead to Zero Carbon could involve the elements noted in the tables below.

Some approximate fossil fuel and energy demand reductions

Energy savings potential MWh pa		**present energy**	**future demand**		
			fossil fuel savings	**electricity**	**wood**
Electricity					
Domestic		2,894			
Commercial		11,907			
Change	domestic lighting to LEDs		450		
Change	switch off appliances not in use		1,100		
	Total electricity	**14,801**	**1,550**	**13,251**	
Heat					
Domestic		18,160			
Change	one quarter wood heat		4,540		4,540
Change	3/4 heat pumps		13,620	4,540	
Commercial		21,138			
Change	heat pumps		21,138	7,046	
	Total heat	**39,298**	**39,298**	**11,586**	**4,450**
Transport					
Change	All electric vehicles in use	**34,000**	**34,000**	**11,100**	
Totals		**88,099**	**74,848**	**35,937**	**4,450**

The remaining demand after implantation of the demand reduction options can then supplied by local renewable electricity as in the table below, supplemented for heating, with local wood supplies as deemed appropriate from new local coppice woodlands

Electricity demand and local supply options for Zero Carbon MWh pa

		Domestic	Non domestic	Transport	Totals
New electricity demand looks like					
Electrical appliances +heating+ EVs		8,947	18,953	11,111	**39,012**
Seasonal demands changes		**Summer**	**Winter**		
	electricity	33%	67%		
	heat		100%		
	transport	70%	30%		
Demand by type and season					
	Electricity for appliances	4,884	9,917		14,801
	Electricity for heat		13,099		13,099
	Electricity for transport	7,778	3,333		11,111
	Total each season	**12,662**	**26,349**		**39,012**
Renewables supply by season		**Summer**	**Winter**		
	PV availability by season	73%	27%		
	If 80% of summer demand PV supply	10,130	3,675		**13,805**
		80%	14%		
Still required		***2,532***	***22,675***		
	Wind availability by season	25%	75%		
	4 wind turbines 2MW	7,400	22,200		**29,600**
	Hydro	205	615		**820**
total RE available		**17,735**	**26,490**		**44,225**
supply vs demand		**140%**	**101%**		
Shortfall			**- 140**		

Overall this programme would lead to Zero Carbon and save St Just around 28,000 tpa CO2e from local energy use.

1 Energy demand and supply for St Just

The key feature of energy supply in St Just is the lack of mains gas and the impact this has on space heating fuel supply. The area is also rural which tends to increase the need for transport fuels. 1MWh equals 1,000 kWh.

1.1 Electricity demand

The most accurate source of information on energy supply in each local area is for electricity and mains gas. The table below shows the demand information available for electricity only as the gas grid does not extend to the Parish. The Office of National Statistics used to provide very detailed neighbourhood level statistics, but the present level of information is less detailed. This shows that ten years ago around 63% of electricity demand was for off-peak use, generally for space and water heating. The split is not known now, but the total demand has only increased a small amount between 2008 and the latest information for 2016, as shown in the table below.

Domestic electricity in the Parish

	2008	2016	% increase
MWh electricity	15,007	15,361	2%
meters	2,565	2,687	5%
E7 use % of total	63%		

Source: ONS electricity use by LSOA

Commercial electricity in the Parish 2016

Demand type	MWh	meters
non half hourly	6,704	517
half hourly	13,141	not known
total	**19,845**	

The commercial electricity demand was estimated fro m interpolated data as the statistics are more aggregated, covering larger areas than the domestic data. In addition the larger consumers are not identified except at the Cornwall level. For Cornwall as a whole the half hourly customers use 196% of the non half hourly customers. This ratio has therefore been applied to the St Just data, once it was separated out from the wider area it covers. The codes in the Appendix show the areas covered. The separation out has been pro rata by population percentages.

Space heating demand

In areas on mains gas, this is the major fuel for domestic and commercial heating. As no direct surveys of fuels used for space heating in the Parish are available, a country wide survey of off-gas grid space heating was used as the starting point for estimating this element of domestic energy demand.

Estimate of space heating energy demand in Parish

Heat energy source	home location			Heat demand MWh
	urban	rural	average St Just	
oil	1%	53%	19%	3,487
LPG	8%	8%	8%	1,453
coal	1%	10%	4%	754
electricity	90%	29%	69%	12,467
Totals	**100%**	**100%**	**100%**	**18,161**

Source: Percentages from OFT study of off-gas grid space heating in UK

Whilst the study on which this is based was carried out over eight years ago, it is recognised that domestic heating systems are changed only infrequently, when house refurbishment or a required new heating system occur. This suggests that direct fossil heating provides nearly one third of heating and electricity over two thirds of local space and water heating.

1.2 Oil demand

Oil is used in the St Just area for transport and for heating in both domestic and non domestic buildings. The major use is for transport. Statistics for transport energy use are less disaggregated that for electricity, with the smallest regional information available being at the local authority ie Cornwall level. Two approaches have therefore been analysed to approximate the local oil use for transport.

Firstly the 2011 census provided information on travel to work and the distance travelled. This information has been extracted for the St Just Parish area and the table below shows the base data.

Travel to work: Census 2011

Distance travelled to work number of people						
Vehicles in household	**all**	**<10km**	**10km to <30km**	**>30km**	**mainly at home**	**distance other**
All workers	2,565	719	537	350	635	324
No car/van	168	56	30	19	36	23
1 car/van	960	299	182	111	240	128
2 or more cars/ vans	1,441	364	325	220	359	173

Although this is old data it is the only data available which is locally disaggregated to the St Just area. Transport availability has not changed dramatically in Cornwall over the last few years, so this is taken as a basis for an updated energy calculation. The average age of cars in Cornwall is 7+ years. The table below analyses the energy needs of the above travel to work.

Analysis of energy needs for car/van travel to work for Helston area

	<10km	10km to <30km	>30km	mainly at home	distance other	Totals
Average km	**4**	**20**	**40**		**50**	
Av/wk/person	34	170	340	0	425	
total km per week in distance bands						
no car/van	1,904	5,100	6,460		9,775	
1 car/van	10,166	30,940	37,740		54,400	
2 or more	12,376	55,250	74,800		73,525	
total all travel	22,542	86,190	112,540		127,925	349,197
Total miles pa	**651,325**	**2,490,359**	**3,251,712**		**3,696,243**	**10,089,640**
2011 (2000 cars)	**20,155**	**77,062**	**100,622**		**114,377**	**312,216**
2016 (2011 cars)	**15,911**	**60,838**	**79,437**		**90,297**	**246,483**

It is assumed that each week on average 4.25 days are travel days, for 46.5 weeks a year. Taking average fuel efficiency of cars at the years in the table indicates the following:-

2011- 15,376 MWh 2016 –12,139 MWh

This is only a snapshot of the car travel miles each year in the St Just area, but gives a basis to work from for the estimated totals.

Transport fuels estimate – from travel to work calculation

Travel demand	**MWh**
travel to work	12,139
home/social	12,139
total domestic	24,278
commercial from County wide stats	10,000
Total all travel	**34,278**

The other method of estimating the transport energy for St Just is pro rata from the Cornwall statistics using the local population percentage. This method indicates that around 33,300 MWh is used for transport in the Parish.

However the calculation above on travel to work suggests higher travel energy demands, presumably due to the geographical isolation of the Parish. It is assumed that each household uses around the same amount for social and family purposes as the travel to work energy. Energy use in transport is therefore estimated at 34,000 MWh a year.

1.3 Total energy demand

The table below indicates the key elements which need to be addressed as part of moving to Zero Carbon for energy, with over half of local energy needs being met by oil, which also indicates the vulnerability of the local area to oil supply shocks, with over half of local energy being oil. This may be remembered in the context of the tanker drivers strike of some years ago, when local petrol stations took up to a fortnight to receive new fuel supplies after the strike ended

Energy supply and demand estimate for St Just 2016 MWh

Energy source	Domestic	Non Domestic	Transport	Totals	%
Coal, LPG	2,207	2,700	-	4,907	6%
Oil	3,487	10,500	34,000	47,987	54%
Electricity	15,361	19,845	-	35,206	40%
Gas	-	-	-	-	
Totals	**21,055**	**33,045**	**34,000**	**88,100**	**100%**
Percentages	24%	38%	39%	100%	

1.4 Fuel poverty

In considering the issues around getting to Zero the area will wish to work on equity issues, which in relation to energy issues tend to show up as fuel poverty.

The table below indicates the statistics for each local area within the Parish and shows an average of 15% of households being in fuel poverty. This was defined as households where fuel costs are 10% or more of household income. However this has been changed and the definition is now less clear, resulting a reduction of apparent fuel poverty.

Estimated fuel poor households in 2016

Area	Households number	estimated fuel poor number	% fuel poor
Pendeen & Morvah	715	116	16.2
St Just rural	768	125	16.3
St Just town	836	117	14.0
Totals	**2,319**	**358**	**15%**

Source ONS Annual fuel poverty statistics by LSOA

2 Carbon footprint for energy supply

It is recognised that energy use is responsible for 75% of greenhouse gas emissions in each region, and agriculture and land use for the other 25%. The land use emissions figures are much less reliable. This report focuses on the energy emissions and how to reduce that element of GHG emissions.

Carbon emissions for 2016 figures

Energy source	**Total energy use**		**Emissions coefficient kg CO2e/kWh**	**Carbon emissions**	
	MWh	**%**		**Emissions t CO2 e**	**%**
Coal/lpg	4,907	6%	0.34208	1,678	6%
Oil	47,987	54%	0.24516*	11,764	44%
Electricity	35,206	40%	0.3844	13,533	50%
Gas		0%			0%
Totals	**88,100**	**100%**		**26,976**	**100%**

** weighted average of domestic oil, petrol and diesel at the pump – 5% biofuel mix*

This table shows clearly which energy sources produce the largest proportion of carbon emissions for the area. It is important however to be aware that the carbon content of electricity in the UK is dropping every year. The emissions co-efficient figure used in this table is for 2017 electricity, but 2018 electricity is somewhat lower at 0.3072 kgCO2e/kWh used. This figure includes the Transmission and Distribution losses – ie the line losses between generator and customer. In Cornwall this is likely to be lower, because of the relatively high local generation from renewables, but within the confines of this work it is not feasible to estimate how much lower this would be.

The emissions coefficient figures are from:-

UK Government GHG conversion factors for company reporting.

This is a joint BEIS and DEFRA report produced each year with updated emissions factors, as each fuel varies a little, and electricity varies more.

3 Renewable energy supply for St Just

3.1 Present renewable energy supply in St Just

The Renewable Energy Foundation database was checked to determine the local installation numbers of wind and PV systems. This can be searched by postcode, but only for the first four digits ie TR19 in this instance. The populations of the St Just postcode vs the whole of TR19 was determined at 52% of the whole of TR19. This figure was applied to the installations of TR19.

This suggests the following installations are probable within the St Just area.

Existing renewable energy installations in St Just area - estimate

Technology	kW scale	kW installed	Number	Estimated output MWh pa
PV				
	1 to 2.5kW	67	34	
	2.51 to 4.99 kW	448	123	
	5 to 9.99 kW	14	2	
	10 to 19.99 kW	38	2	
	20-50 kW	155	3	
	Totals	**722**	**164**	**794**
Wind	5-11kW	**50**	**8**	**140**
Totals		**772**		**934**

These figures are approximate, and along with local information on small wind turbine numbers, give an indication of the local generation capacity at present. This is possibly nearly 1,000 MWh pa or some 2.7% of present electricity demand.

3.2 Potential for renewable energy supply in St Just

3.2.1 Wind

The prominent wind flagging of the few trees in the Parish, suggests that the windspeed is high enough to enable financial viability for wind turbines in the local area.

A key issue for harvesting energy from the wind is that the windspeed increases with elevation and that the energy available varies with the cube of the windspeed. This means that a small increase in windspeed can give a large increase in electricity output. These facts drive the aim of larger windturbines on taller towers in the highest windspeed areas.

An analysis of the technical potential for wind energy has been made for two scales of wind turbine. These two scales are determined by the distance required to ensure that no houses would experience a noise nuisance. The distances between open spaces and nearby homes allow for the following two options.

Technical potential for wind

Turbine scale	**Distance to homes m**	**Potential sites no.**	**Approx. potential output MWh pa**
850kW 45-55m hub	350	c.16	41,600
2-2.3MW 57-85m hub	500	c.10	74,500

This shows how much more electricity a single larger wind turbine will produce compared to several smaller ones. The maximum technical potential for wind in the area , avoiding the coastline, is around 74,000 MWh pa. This is approaching the present demand for all energy for the Parish.

However, the major issue for any wind project development would be the presence of the Area of Outstanding Natural Beauty designation. Traditionally AONB officers have viewed wind turbines as not welcome in their designated landscapes, although the Bonython windfarm on the Lizard is an exception to this. The need to have major conversations and consultations on how to move Cornwall to Zero Carbon and the potential changes to the AONB regions in Cornwall is one of the issues which Cornwall Council aims to address in its climate emergency plans in the near future. Local discussions on this issue could potentially help move Cornwall collectively to a recognition of the strong need for changing land use approaches.

It is important to be aware that small wind turbines have permitted development rights including in AONB areas, and hence rural homes and farms in the Parish could well install their own 1kW wind turbines without planning issues. There are already as noted above several small scale wind turbines in the area, and providing many more would enable improved resilience at the rural household level. It is also clear from the locality that the existing small wind turbines have a very small visible footprint in this landscape.

3.2.2 Solar

Solar energy is a large resource and can provide a valuable asset for local energy supply. The main methods of solar use are either solar hot water panels or photovoltaic panels producing electricity.

The roof top resource can be estimated by reference to the Land Use statistics. The Generalised Land Use Database is not often updated and the latest detailed information is from the 2005 survey.

This indicates that the buildings area in the statistical area of St Just, Pendeen and Morvah is 20ha for domestic and 11 ha for non domestic buildings.

Local surveys have suggested that about 40% of Cornish homes are potentially suitable for PV installation. Allowing for half the roof facing away from the sun suggests around 40,000m^2 would be facing towards the sun. However not all of this would be unshaded for most of the day. Approximately half could be potential PV locations, ie some 20,000m2 minus edges say 15,000m2

The average size of existing systems is just over 3kW. However the newer solar panels are more efficient and so for the same area, the kW installed is increased by about 50%. This suggests that around 700 properties could each install 4.7 kW enabling local supply of 3.29MW generating around 3,600 MWh pa. This is equivalent to 10% of present electricity demand.

A similar calculation for commercial and industrial systems indicates that there are potentially also opportunities for PV on commercial rooftops.

Examples of non domestic buildings which may have PV potential

Building		Potential kW	Notes
Cape Cornwall School		440	some already
St Just car park -PV canopies		240	requires canopies as part of installation
Warrens		106	
Geevor		86	
Farm buildings			
examples	Murley	129	
	No Go Hill	56	
Airport		74	
Jackson Gallery		26	some already
Churches	Parish	14	
	Methodist	38	
Sports Clubs			
	Football	25	
	Rugby	9	
	Cricket	7	
Total		**1,250**	

This table shows that potentially at least 1,250 kW of PV could be installed on these buildings. However this assessment has not taken account of whether the roof is strong enough, nor the potential wind loading on the structure. A range of smaller buildings identified indicates that over 1,300k W could be installed facing from East round by South to West or on flat roofs.

If one megawatt is installed this could yield around 1,100 MWh a year, or some 3% of electricity for the Parish.

Total rooftop technical potential is therefore around 4.3 MW generating around 4,700 MWh pa or some 13.7% of present electricity demand.

Land arrays

Present electricity demand would require some 47ha of land based PV systems: although this would not yield the required winter electricity supplies, as such a high proportion of electricity supply from PV arises in the summer months.

In order to provide a balanced electricity demand through the year, solar PV would help signficantly reduce any energy storage needs vs wind energy alone. Around 75% of wind energy comes in the winter and a similar proportion of solar energy comes in the summer months. In addition transport demand tend to be higher in the summer, making solar PV a good complement to an electric vehicle culture.

Whilst it is sometimes argued that solar arrays reduce the area of agricultural land available to food production, this does not have to be the case. Solar PV arrays tend to be well fenced for security reasons, and such fences are also fox proof allowing a higher number of free range hens, geese etc. Sheep grazing under solar arrays are known to heft to individual panels and gain from the wind and rain protection provided by the panels.

In Mediaeval times in Britain around 20% of agricultural land use was devoted to transport crops – ie feeding horses. As well as this a high proportion of land was forested from which wood was harvested for all heat energy. If this level of allocation is followed today as an example of the potentially available land for PV arrays this would indicate that some 660ha could be used for PV arrays.

This would however produce far more electricity than would be used under present energy demands.

The potential for PV land arrays is perhaps more usefully defined by reference to the aims of the Parish and the need to take the pathway to Zero Carbon as soon as possible, given the climate emergency.

This will therefore be addressed in the final section of the report.

3.2.3 Biomass

Biomass could be produced by increasing the amount of tree planting within the Parish. At present there is little woodland, but the high windspeed locally would require consideration of the location and type of trees to be planted. The high rainfall and granite derived soil would also have an impact on which trees could flourish in the locality. Archaeological studies in the local area show that many native tree species used to flourish, such as birch, pine, elm, oak, lime, alder, yew, willow and hazel, with holly, beech, ash and rowan also present.

Once these factors are taken into account it can be recognised that there is good potential for tree planting, and in particular the local landscape could encompass coppice tree planting with a view to regular cutting on small areas to provide the broken landscape effect already present in this area.

A zero carbon plan could determine in conjunction with local landowners which areas could be used for trees and their cropping to provide wood fuel, and other useful coppice products.

3.2.4 Hydro

There are some small rivers and streams which flow from the higher ground and off the cliffs in this area. This has been recognised for many years as is shown by presence of nearby historic mill sites. The Cornwall Energy Project hydro survey of Cornwall identified the following sites in the Parish.

Potential hydro sites in Parish

Site		**Catchment area km2**	**Head m**	**Capacity kW**	**Potential output MWh pa**
The Ledden					
	Boswedden	8	68	115	520
	Kenidjack Fm.	7	10	13	50
	Busvargus	4	20	20	80
	Bostraze	3	40	30	120
Nanven – Cot Valley		Total 6	Four sites		360
Portheras				70	300
Totals				**248**	**1,430**

This table shows the potential for around nine hydro sites which collectively could generate around 1,400 MWh pa from around 248kW of plant, or some 4% of present electricity demand.

4 Zero Carbon options

A key element of determining how to achieve a Zero Carbon St Just is to balance reductions of energy demand with potentially increasing populations over time and the possibilities for local renewable energy supplies. This section aims to show some of the options for achieving Zero.

The options outlined below are not the only approach possible and which directions are taken by the area depend crucially on the views held by the townsfolk on the kind of town and communities preferred and which local people are willing to work towards achieving. The options outlined here allow for the possibility that local resilience is high on the agenda alongside local ownership and increasing local economic activity.

It is feasible to encourage local ownership and strong local action on energy issues, but within the confines of this report such issues are not discussed.

4.1 Potential local renewable supplies

Options for renewable energy supply for St Just include wind and solar energy with biomass and hydro providing useful adjuncts to local energy supply.

The summary table below shows that the theoretical potential for renewable energy supply for the local area is over twice the present demand. If the aim of a plan to reach Zero Carbon is undertaken this can be done with the approximate renewable energy supplies as indicated above. This indicates a local self reliance of 94%, with the use of around 3.5% of local land and a major roof top involvement.

Summary of renewable energy options: estimates

Energy source		Theoretical		Possible aim		
		MW	**MWh pa**	**MW**	**MWh pa**	**agricultural land % used**
Wind						
	850kW turbines	13.6	41,600	4.25	11,500	0
or	*2-2.3MW turbines*	20	74,500	10	37,000	0
Solar						
	PV land arrays	80	87,400*	30	33,000	1.8%
	PV domestic roof	3.3	3,600	2.0	2,200	0
	PV commercial roof	1.3	1,430	0.75	825	0
	Solar hot water- domestic		4,500		3,000	
Biomass						
	Small power plant	0.25	1,100 plus 3,400 waste heat	Investigate option to supply heat to local protected cropping. Wood requirement of 90ha coppice		
	Domestic wood heat : new coppice woodland			say 25% of homes	2,000	50ha or 1.4% of open land
Hydropower		0.248	1,430	0.185	820	0
Total electricity		**105**	**168,000**	**43**	**73,800**	2.1%
Total heat			**12,400**		**8,400**	1.4%
Compared to present energy			**206%**		**94%**	

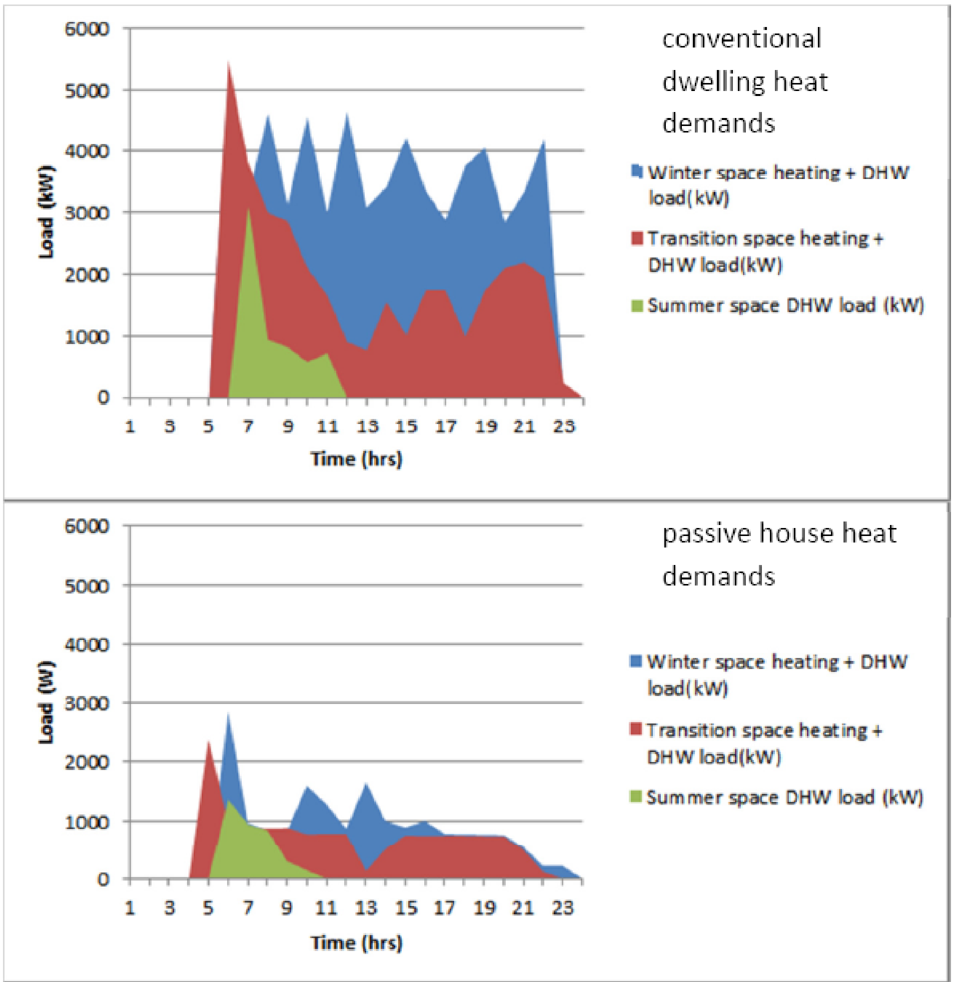
** example to show impact of all present energy demand*

However the resource intensiveness of this approach can be ameliorated with suitable energy efficiency measures to reduce energy demand to the minimum, which is required in any case in the long term when considering world resource depletion issues.

4.2 Demand reduction options

The key elements for reducing demand relate to energy efficiency and demand reduction actions. These range from simple actions such as closing curtains on winter evenings and switching off lights in unoccupied rooms to insulation of buildings, hot water tanks and people (ie put on more clothes in winter- so that reduced indoor temperatures are comfortable), alongside better controls for appliances and heating systems.   Highly insulated homes with appropriate windows on the south side require little extra heating, and conservatories can reduce the heating season by a month in spring and autumn – provided they are not themselves heated. Equally porches cut heat loss in winter, particularly in windy areas such as West Penwith.

Comparison of standard vs high insulation home



Source: Future energy demand in the domestic sector: report for EP 1031707/1 Nick Kelly et al University of Strathclyde 2012

As the diagrams above show full insulation and passive house standard detailing reduces the demand for heating to less than one third of present standard homes.

An programme to reach Zero Carbon will therefore need to address full house retrofit as well as major behaviour change programmes. This is likely to be high capital cost as most homes in the area are solid wall granite with very low insulation values and no cavities available to insulate. Solid wall insulation is expensive, and may be best tackled through programmes to insulate many homes at once to reduce individual house costs.

Heating: heat pumps

One of the two main methods of reducing energy demand are to change fossil fuel heating in buildings to renewable energy supply either via electricity or solar or wood fuel. If changing space and water heating to electricity from renewables the most effective method of reducing demand is a change to heat pumps. There are several sources of ambient energy which can be used by a heat pump, with an electrically driven system to supply heat from the environment to the building. The heat sources in common use are air, water and the ground.

On average these heat pumps will supply three times the electricity used, as heat to the building space and water heating system, thus reducing demand by approximately two thirds, depending on the efficiency of the replaced system.

The heat demand of the domestic sector at present is taken to be the sum of lpg, oil and coal demand for this sector. This amounts to around 18,000 MWh pa. A similar calculation for the non domestic ie business sector suggests around 21,000 MWh is used for heat, although this figure should be regarded with caution as restaurant and hotel energy demands can also include a high level of chilling requirements, using electricity.

A major programme of retrofitting heat pumps, would therefore potentially save 23,000 MWh pa of the 39,000 MWh used for heating, with an increase in electricity demand of around 10,000 MWh pa, which for Zero Carbon can be supplied from renewable sources.

Heating: wood heat

As the assessment of coppice wood energy shows the energy supply from woodland is most efficiently used via modern wood or pellet stoves which can be 90% efficient. If such stoves and boilers are used in place of older systems, which potentially have an average efficiency of around 75%, then substantial fossil fuel demand is replaced with a lower renewable heat demand.

One quarter of local homes could be heated this way, increasing local business and employment and providing 600 tpa wood to local homes from 1.4% of open land within the boundaries.

If a wood stove/furnace/boiler path was taken this would reduce the need for heat pumps and hence for some of the winter electricity needed to operate them.

Transport: fossil fuel demand reduction

Internal combustion engines are extremely inefficient and only provide some 25% of the fuel tank energy to move the vehicle. An immediate reduction in energy demand occurs when vehicles are changed to electric, as electric motors and batteries are much more efficient with a system efficiency of around 77%[1]. This saves two thirds of the transport energy needed.

At present the transport energy demand is around 47,900 MWh pa, so a total change to EVs would reduce demand for oil by 47,900 MWh and increase electricity demand by 16,000 MWh.

As this demand is still requiring installations to provide renewable electricity all year round it also makes sense to focus efforts on reducing the demand for travel. There are many methods of effecting such changes. The second phase is to change the mode of transport to walking, cycling and public transport. To do this, a key source of information is the travel to work data, detailed earlier, from the last census which indicates where it is feasible to encourage change.

Given the high mineral resource implications of a full battery driven EV transport fleet, it is important to reduce the local demand for individual powered vehicles for daily living.

Lighting

Research for the government indicates that changing lighting in homes from incandescent and halogen bulbs to LEDs can save around 250 kWh/home pa. A major programme of LED fitting could if 80% of homes participated therefore save around 450 MWh pa with two thirds of that in the winter period[2].

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[1] See government fuel efficiency tables for cars standard fossil fuel vs electric vehicles, same type.

[2] Further analysis of the household electricity survey: lighting study final report May 2013. Nicola Terry et al Cambridge Architectural Survey and Loughborough University.

4.3 Conclusions

A potential programme for St Just and Pendeen to reach Zero Carbon in a reasonable timeframe is outlined in the tables below. A key element of this report is the recognition that there are many pathways to Zero, each of which will have different costs, difficulties and local relevance.

These potentials are therefore suggested as a starting point for the area to determine is own way to Zero.

Not considered in this analysis is the increase in energy demands from any increased population or new commercial or industrial companies.

The costs and planning implications are likewise not considered as within the study owing to constraints on time available.

The tables below indicate the potential for some of the demand reductions and replacement of fossil fuels with electricity which could then be met with local renewable energy sourced supplies.

Some approximate fossil fuel and energy demand reductions

Energy savings potential MWh pa		**present energy**	**future demand**		
			fossil fuel savings	**electricity**	**wood**
Electricity					
Domestic		2,894			
Commercial		11,907			
Change	domestic lighting to LEDs		450		
Change	switch off appliances not in use		1,100		
	Total electricity	**14,801**	**1,550**	**13,251**	
Heat					
Domestic		18,160			
Change	one quarter wood heat		4,540		4,540
Change	3/4 heat pumps		13,620	4,540	
Commercial		21,138			
Change	heat pumps		21,138	7,046	
	Total heat	**39,298**	**39,298**	**11,586**	**4,450**
Transport					
Change	All electric vehicles in use	**34,000**	**34,000**	**11,100**	
Totals		**88,099**	**74,848**	**35,937**	**4,450**

This table indicates what measures could be undertaken which would give a reduction of fossil fuel demand of 85%. Once heat pumps replaced direct fossil fuel supplies and electric vehicles/hydrogen powered transport replace oil burning vehicles the total energy demand is also cut by some 54% to around 40,500 MWh pa.

This remaining energy demand in the form of wood and electricity is more easily supplied from local supplies. A suitable programme to implement this aim is indicated in the table below.

Electricity demand and local supply options for Zero Carbon MWh pa

	Domestic	Non domestic	Transport	Totals
New electricity demand looks like				
Electrical appliances +heating+ EVs	8,947	18,953	11,111	**39,012**
Seasonal demands changes	**Summer**	**Winter**		
electricity	33%	67%		
heat		100%		
transport	70%	30%		
Demand by type and season				
Electricity for appliances	4,884	9,917		14,801
Electricity for heat		13,099		13,099
Electricity for transport	7,778	3,333		11,111
Total each season	**12,662**	**26,349**		**39,012**
Renewables supply by season	**Summer**	**Winter**		
PV availability by season	73%	27%		
If 80% of summer demand PV supply	10,130	3,675		**13,805**
	80%	14%		
Still required	***2,532***	***22,675***		
Wind availability by season	25%	75%		
4 wind turbines 2MW	7,400	22,200		**29,600**
Hydro	205	615		**820**
total RE available	**17,735**	**26,490**		**44,225**
supply vs demand	**140%**	**101%**		
Shortfall		**- 140**		

This table indicates a near balancing of summer and winter electricity demand with the installation of:

- Wind turbines: four of 2MW each
- PV: around 13MW installed amounting to up to 20ha of land arrays – or less if a major rooftop programme is undertaken
- Hydro: two largest sites totalling 185kW installed capacity

This table gives an indication of the potential and a rough estimate of how to balance the demand with local supply through the seasons. However this is only an indication and does not cover the day to day and hour to hour supplies from these intermittent sources.

To achieve a completely resilient and locally balanced demand and supply system would also require investment in energy storage and demand side management. These issues are beyond the scope of this report. At a wider regional level the implementation of storage to balance intermittent supplies with intermittent demand is an increasing issue.

In addition the local planting of coppice woodland would give a secure energy supply which could be used when needed, helping to balance heat supplies with local wind and solar energy. Whilst this is not seen as a natural location for tree planting because of the high winds, local history shows that much higher levels of tree coverage have existed in the past with successful use of the resource for energy, tools and building materials as well as furniture and boat building.

This investigation indicates how St Just and Pendeen could reach Zero Carbon for energy supplies within a relatively short period of time.

A programme such as that indicated here could save around 27,000 tpa C02e, as well as providing local investment opportunities and ways to reduce fuel poverty in the area.

Appendix

Codes for statistics

Lower Super Output Areas

E01018991	Cornwall 065C	Pendeen and Morvah
E01018992	Cornwall 069A	St Just in Penwith Rural
E01018993	Cornwall 069B	St Just in Penwith Town

Parish

E04011559	St. Just
E04011490	Morvah

electoral division

E05009258	St Just in Penwith

Medium Super Output Area

St Just and Lands End	E02003950	Cornwall 069

Population

Statistics for the relevant populations

Cornwall 069	91%
Cornwall 065	23%

St Just Parish population 4,912

Generalised Land Use Database 2005

St Just Pendeen & Morvah

Land use type	**ha**	**%**
domestic buildings	20	0.6%
gardens	71	2.0%
non domestic buildings	11	0.3%
road	56	1.5%
path	2	0.1%
greenspace	3,398	93%
water	53	1%
total	**3,647**	100%