

Technical Paper E3

Comparing Cornwall's Renewable and low carbon energy Resource Potential with its Energy Consumption

Cornwall Council
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Headlines

The renewable energy resource assessment demonstrates that we have the potential to source the following proportions of our energy requirements from renewable and low carbon sources:

The proportion of our energy needs that can be met from Cornwall's renewable energy resources.

Scenario	Current situation	Future situation (2030)	UK Target for 2020
Proportion of our total energy needs from renewable and low carbon sources	26.4%	28.2%	15%
Proportion of our total electricity needs	85.5%	68.7%	30%
Proportion of our total heating needs	12.6%	15.7%	12%
Proportion of our domestic electricity needs	100%	100%	-
Proportion of our domestic heating needs	26.5%	32.8 %	-

1. Introduction

- 1.1 In order to provide some context to the renewable energy resource assessment¹ and any policies developed for the Local Plan to support deployment of renewable and low carbon energy, it is reasonable to try to compare Cornwall's our potential supply with its energy consumption. This will help to develop a greater understanding how much of the energy we use can be supplied through renewable and low carbon energy sources in Cornwall.
- 1.2 Renewable and low carbon energy sources can be exploited to generate energy in the form of electricity, heat and to provide fuel for transportation. Depending on the energy generation technology used some renewable and low carbon sources can be exploited to produce any of the energy types, or a combination of the three.
- 1.3 With this in mind it is possible to consider the contribution that Cornwall's renewable and low carbon energy resource could make to our total annual energy demands as a whole and to look in more detail at the contribution we can make to our electricity, heat and transport needs separately. The following sections set out how the potential can be assessed against our needs in terms of each energy type.

1.2 Meeting our Electricity needs from renewable and low carbon energy resources – factors to be considered

- 1.2.1 In order to truly meet our electricity needs from renewable and low carbon energy sources it would be necessary to generate electricity as and when it is required, or to find a way to store it in order that it can be used when it is needed.
- 1.2.2 Both storage and generation 'on demand' present significant challenges. Current electricity storage technologies do not present an economically viable solution to storing electricity on this scale. The amount of electricity we need at any given time, although predictable to an extent, varies on a moment by moment basis. In addition to this many renewable and low carbon electricity resources vary naturally in intensity in a way that cannot be controlled (although with reasonable predictability). For example, one cannot control when and at what speed the wind blows. When

¹ *Technical Paper E2 – An Assessment Renewable Energy Resource Potential in Cornwall.*

addressed on a national and international scale there are ways of overcoming the issue of variable electricity supply from some renewable and low carbon sources. However, meeting supply with demand (on a temporal basis) is more difficult at the local scale, because the mechanisms that help to balance variable electricity supply (such as national scale electricity supply networks) cannot reasonably be replicated at the local scale. It is worth noting that the introduction of local level 'smart' grid infrastructure offers potential to resolve to some extent the relationship between supply and demand. However, while Cornwall Council is exploring the opportunities to support the deployment of community smart grids widespread coverage is uncertain and likely to take some years to realise.

1.2.3 It is therefore unrealistic to attempt to consider the potential contribution to our electricity needs from renewable and low carbon resources within Cornwall on a moment by moment basis. It is, however, possible to consider the contribution renewable these resources can make to our electricity needs over a set period of time. On that basis this paper outlines the contribution that renewable and low carbon electricity supply can make to our *annual* electricity consumption. Simply put - what proportion of our annual electricity use can be generated from renewable and low carbon resources each year?

1.2.4 In addition to this the report will set out the number of Cornish homes whose electricity requirements could be offset by renewable energy sources if Cornwall's potential is realised.

1.3 Meeting our need for heat from renewable and low carbon energy resources – factors to be considered

1.3.1 Assessing the contribution that can be made from renewable and low carbon energy sources to our heat requirements is also complex. While renewable and low carbon heat can be generated on demand and can be stored (as fuel) the heat needs to be generated close to the point of use and, once generated, it cannot be distributed across Cornwall in an even manner, or in response to unplanned demand.

1.3.2 Furthermore, fuel that can be used to generate renewable and low carbon heat can be used in a variety of ways to deliver different

amounts and grades of heat that can be used for different purposes. The same applies to the way that energy consumption is recorded². The amount of fuel used by each sector is recorded, but the end use of this fuel is not always recorded. This makes it very difficult to say with any certainty exactly how much of our overall heat energy requirements can be met from renewable heat energy sources in Cornwall.

- 1.3.3 It is, however, possible to compare the overall consumption of energy that is used primarily to generate heat to give an approximate indication of the potential to offset carbon-intensive heat generation with renewable and low carbon heat generation.
- 1.3.4 It is also possible to make an assessment of the contribution that can be made towards our domestic space heating requirements.
- 1.3.5 On that basis this paper will set out the proportion of our annual heat producing fuel consumption (that would normally be met from gas, petroleum, coal & manufactured fuels) that can be generated from renewable and low carbon resources and the proportion of our household heating needs that can be generated from renewable sources.

1.4 Meeting our need for transportation fuel from renewable and low carbon energy resources – factors to be considered

- 1.4.1 The transport sector currently accounts for approximately 33% of the total energy use in Cornwall. At present this energy is all derived from petroleum sources (with some biogas included in standard fuel mixes). It is therefore possible to compare the potential to replace this carbon-intensive fuel with renewable and low carbon alternatives in Cornwall on an annual basis. However, to do this an assessment of the potential bio-diesel resource would need to be made. To date this assessment has not been conducted.
- 1.4.2 It is recognised that the amount of energy used for transportation in Cornwall is significant and an understanding of the proportion of this energy requirement that can be met from renewable and low carbon energy sources would be valuable. A resource assessment could be undertaken to provide this information subject to resources being available to do so. It is, however, noted that land

² Technical Paper E1b - *Projected Energy Consumption in Cornwall up to 2030*.

required for the production of bio-diesel would (based on current renewable and low carbon energy sources and technologies) compete with heat-generating biomass. It is therefore necessary for any resource assessment to consider the desirability of giving more land over to energy crops or sharing the amount of land considered available for heat-generating energy crops with the production of bio-diesel.

- 1.4.3 It is also recognised that there are a small number of electric vehicles in operation in Cornwall at present and this is projected to increase. Once this sector grows it will be possible to compare the electricity consumption with the renewable and low carbon electricity potential as part of the wider electricity consumption and supply comparison.

2. Using a common measure of energy

- 2.1 To enable energy supply and demand to be compared easily all reference to energy figures will be made in tonnes or kilo tonnes of oil equivalent (ktoe). Oil equivalent is a standard metric used by the energy industry to enable energy content comparisons between different energy sources or fuels. The International Energy Agency provides an energy conversion tool that calculates the oil equivalence of a given energy amount³. The conversion factor for 1 tonne of oil equivalent is 11.63 megawatt hours.

³ The International Energy Agency energy conversion tool is available at: <http://www.iea.org/stats/unit.asp>

3 Targets

- 3.1 The drive to produce renewable and low carbon energy in the UK is underpinned by the need to derive energy from sources that are secure (in political and technological terms) and do not increase the likelihood of harmful changes to our climate occurring. In order to add meaning to the contribution that can be made from renewable and low carbon energy resources it is useful to consider how this contribution would compare to national and international renewable and low carbon energy targets.
- 3.2 The 2009 Renewable Energy Directive (Directive 2009/28) set the UK a target of 15% of its final energy consumption to come from renewable and low carbon sources by 2020.
- 3.3 The UK Renewable Energy Strategy 2009 sets out a strategy for meeting the 2020 target of 15% of our final energy consumption from renewable and low carbon sources (thus reflecting the 2009 Renewable Energy Directive). The strategy states that we would need to achieve an electricity target of 30% from renewable and low carbon sources, a heat target of 12% and a transport target of 10% by 2020.
- 3.4 This paper will set out the contribution that Cornwall's renewable and low carbon energy resources can make towards these national targets expressed as proportion of Cornwall's energy needs.

4 Assumptions

- 4.1 The figure for the current consumption of energy in Cornwall is based on a 2010 baseline which uses 2010 population statistics from the Office of National Statistics. This baseline was chosen because it was the most recent data set on energy use at the time of preparing the report.
- 4.2 The energy consumption projections forecast in the energy projections report are based on the Department of Energy and Climate Change's (DECC) projections for the energy sector and the expected impacts of the implementation of policies aimed at reducing our dependence on carbon-intensive energy sources. These projections also take account of likely future changes in the population of Cornwall, based on the same assumptions that are being used to inform the Cornwall Local Plan (up to 2030).
- 4.3 Finally, comparisons made in this report assume that the deployment of technology to exploit all our renewable energy potential can be achieved by 2030. This is possible with the right level of investment, but further delivery planning work will be required to determine whether this is considered feasible.

5 Comparing projected energy demand in Cornwall with renewable and low carbon energy supply potential

5.0.1 This section outlines the contribution that we might make to our energy needs from our renewable and low carbon resources in Cornwall. The section starts by looking at our overall energy needs and then focus on electricity, heat and transport in turn.

5.0.2 For each comparison the proportion of energy that can be generated from renewable and low carbon sources has been calculated for our current use (2010) as well as our projected use for 2030. It is acknowledged that this is not a 'real life' scenario, because, at present, only a small proportion of our renewable energy potential is being released. However, the comparison is useful in that it illustrates the contribution we could make to our energy needs based on our current population, economy and behaviour. It also helps us understand how our energy needs are likely to change over the next 20 years and what impact this may have on the proportion of our energy needs that can be met from renewable and low carbon energy resources.

5.0.3 The table below shows the total energy consumption for Cornwall in kilo tonnes of oil equivalent, the current situation (2010) and projected forward to 2030.

Table 1: Current and future energy consumption by energy type

Energy Type/Source	Current Consumption (ktoe)	Projected Consumption in 2030 (ktoe)
Electricity	238	255
Gas	266	219
Petroleum	472	355
Coal/ Manufactured fuels	10	9
Renewables and bio-fuels	15	101
TOTAL	1,001	939

5.0.4 The Cornwall Renewable Energy Resource Assessment (2011) report shows that the total annual renewable and low carbon energy generation potential in Cornwall is 264.587 ktoe. The resource assessment expresses the renewable and low carbon energy potential as a range, because some resources are estimated to provide a range of yields. The figure that represents high end of the range is used in this paper to reflect the maximum possible

generation based on the constraints applied in the resource assessment. The table below summarises the total annual renewable and low carbon resource potential by energy source.

Table 2: Cornwall's renewable and low carbon energy potential by resource

Resource	Potential in thousand tonnes of oil equivalent per year (ktoe).	
	Electricity	Heat
Solar PV	94.078	-
Wind	90.95	-
Hydro	0.883	-
Biomass – Energy Crops	1.374	3.209
Biomass – Forestry Residue	3.912	9.128
Waste – Energy Recovery	7.39 – 14.55	12.32 – 24.28
Livestock Slurry	1.97 – 4.18	4.73 - 9.913
Solar Thermal	-	8.13
Total	200.557 – 209.927	35.517 – 54.66

Taken from the report An Assessment of the Renewable Energy Resource Potential in Cornwall (2012).

5.0.5 The table below summarises the total renewable and low carbon energy potential as a proportion of our current and future energy consumption.

Table 3: Cornwall's renewable and low carbon energy potential as a proportion of our current and future consumption

	Current situation	Projected situation in 2030
Total energy consumption	1,001	939
Total renewable and low carbon energy resource potential as a proportion of the energy consumed (%)	26.4	28.2
The proportion of our energy consumption that comes or is projected to come from renewable source (%) ⁴	1.5	10.8

⁴ This is the proportion of the current and future energy use in Cornwall that is expected to come from renewable and low carbon sources based on energy mix modelling undertaken by DECC.

- 5.0.6 The energy consumption forecast figures have been developed using projections from the Department of Energy and Climate as a starting point. These projections suggest that in 2030 101 ktoe will be consumed in Cornwall from renewable energy sources (10.8% of our project energy mix). The resource potential demonstrates that Cornwall has sufficient resources to produce enough renewable and low carbon energy in Cornwall to exceed this projected level of use.
- 5.0.7 In fact the resource potential is such that more renewable and low carbon energy can be generated than the projections anticipate will be used on Cornwall in 2030. There is potential to supply a further 17.4% of our projected energy needs in 2030 from renewable sources, thus allowing reducing our carbon-intensive energy use beyond that expected in the projections.
- 5.0.8 In total the resource assessment indicates that there is the potential to provide approximately 28.2% of Cornwall's annual energy needs from renewable and low carbon sources in 2030.

How does this relate to the UK targets?

- 5.0.9 The 2009 Renewable Energy Directive set the UK a target of 15% of its final energy consumption to come from renewable and low carbon sources by 2020. Cornwall has the renewable and low carbon energy potential to meet approximately 28.9% of our 2020 energy needs. This figure is significantly greater than the UK target.
- 5.0.10 Table 3 (above) demonstrates that this figure decreases slightly by 2030 due to the projected increase in energy consumption.

5.1 Meeting Cornwall's electricity consumption from renewable and low carbon energy resources

- 5.1.1 The table below summarises the proportion of Cornwall's annual electricity consumption that can be met from renewable and low carbon electricity sources and how it relates to existing national renewable electricity targets.

Table 4: The proportion of Cornwall's electricity needs that can be met from Cornwall's renewable energy resources

	Current situation	Projected situation in 2030
Total electricity consumption (ktoe)	245.5	305.5
Total renewable and low carbon electricity resource potential (ktoe) ⁵	209.927	
Total resources as a proportion of the consumption (%)	85.5	68.7
Relevant target/s	30% of the total electricity use by 2020	

Note: the total electricity consumption includes the assumption that half of the energy that comes or is projected to come from renewable energy sources (see table 1) is used as electricity and half as heat.

5.1.2 Table 4 demonstrates that there are sufficient unconstrained renewable and low carbon energy resources in Cornwall to provide nearly 69% of our projected annual electricity needs in 2030.

How does this relate to the UK targets?

5.1.3 The 2009 UK Renewable Energy Strategy sets the UK a target of 30% of its final electricity consumption to come from renewable and low carbon sources by 2020. The renewable and low carbon energy resource potential indicates that Cornwall can achieve a significantly higher level of deployment as a proportion of our own energy needs in 2020 (75.2%). As table 4 illustrates, that figure decreases to 68.7% by 2030.

5.2 Meeting our domestic electricity needs from renewable and low carbon energy resources

5.2.1 It is also possible to consider what contribution our renewable electricity resources might make to specific energy requirements. For example, it is possible to consider the proportion of our

⁵ The total electricity potential as identified by the report A Renewable Energy Resource Assessment of Cornwall (2011).

household electricity needs we might be able to generate from renewable sources in Cornwall.

5.2.2 Electricity currently accounts for 35% of the total energy consumed by households in Cornwall (116 ktoe). By 2030 the amount of electricity used by households per year is projected to drop to approximately 105 ktoe of electricity a year due primarily to energy performance improvements in our housing and the appliances we use. The resource assessment shows that there is potential in Cornwall to generate all of our domestic electricity requirements both now and in 2030.

5.3 Meeting the need for heat from renewable and low carbon energy resources

5.3.1 In order to calculate the proportion of heat energy that can be met from renewable and low carbon sources within Cornwall it is first necessary to understand the proportion of energy used that is consumed as heat or produces heat as a bi-product of the electricity generation process.

5.3.2 The table below outlines the energy (by fuel type) that is used in Cornwall primarily to produce (or capable of producing) heat and the amount of energy consumed for each fuel type.

Table 5: Cornwall's heat generating energy mix

Fuel Source	Current consumption (ktoe) (2010)	Projection consumption in 2030 (ktoe)
Gas	266	219
Petroleum	151	70
Coal/Manufactured fuels	10	9
The biofuel proportion of the renewable energy production (in the current and projected energy mix) ⁶	7.5	50.5

Taken from Appendix A of the Energy Projections for Cornwall report⁷.

⁶ Note that the current and projections for the future energy mix include a proportion of energy sourced from renewables and biofuels.

⁷ Technical Paper E1b - *Projected Energy Consumption in Cornwall up to 2030*.

5.3.3 Note: the figure for the total renewable heat consumption includes the assumption that half of the energy that comes or is projected to come from renewable energy sources (see table 1) is used as electricity and half as heat.

5.3.4 The figures in table 5 do not include the energy used in the transport sector, because this energy is used to power vehicles rather than generate heat.

5.3.5 The table below summarises the proportion of Cornwall's current heat-generating energy mix that could be met from renewable and low carbon energy sources and how this relates to existing national renewable electricity targets.

Table 6: The proportion of Cornwall's heat energy needs that can be met from Cornwall's renewable energy resources

	Current situation (2010)	Projected situation in 2030
Total consumption of heat generating energy (ktoe)	434.5	348.5
Total renewable and low carbon heat generating resource potential (ktoe) ⁸	54.66	
Total resources as a proportion of the consumption (%)	12.6	15.7
Relevant target/s	12% of the total electricity use by 2020	

5.3.6 The table demonstrates that there are sufficient unconstrained renewable and low carbon energy resources in Cornwall to provide nearly 16% of our projected annual energy needs for producing heat in 2030.

How does this relate to the UK targets?

5.3.7 The 2009 UK Renewable Energy Strategy sets the UK a target of 12% of its final heat energy consumption to come from renewable and low carbon sources by 2020. The renewable and low carbon energy resource potential indicates that Cornwall can achieve a higher deployment as proportion of our own energy needs in 2020

⁸ The total heat energy potential as identified by the report *An Assessment of the Renewable Energy Resource Potential of Cornwall* (2012).

(approximately 15.8%). Table 6 demonstrates that this figure decreases very slightly to 15.7% by 2030.

5.4 Meeting requirements for domestic heating from renewable and low carbon energy resources

5.4.1 It is also possible to consider what contribution our renewable heat-generating resources might make to specific energy requirements. For example, it is possible to calculate the proportion of household heating that we might be able to generate from renewable sources in Cornwall.

5.4.2 Currently, the total annual domestic energy requirement in Cornwall amounts to 356 ktoe. This equates to 1.43 tonnes of oil equivalent per household (based on 249,000 households). Estimates for the UK suggest that 58% of domestic energy is used for space heating. This means that on average each Cornish home requires 0.829 tonnes of oil equivalent to meet its annual heating requirements.

5.4.3 In 2030 the total domestic energy consumption is projected to be 303 ktoe. This equates to 1.02 tonnes of oil equivalent per household (291,250 households). The Energy Projections for Cornwall report⁹ does not include projections for the amount of domestic energy used for space heating in 2030. Therefore the following assumptions have been used to estimate the amount of energy to be used for domestic space heating to enable a comparison between potential supply from renewable and low carbon sources and consumption in 2030.

1. On average all new homes built up to 2030 are 50% more thermally efficient than current homes.
2. The space heating consumption for all homes projected to exist in 2030 (new and old) will reduce proportionate to the drop in overall energy demand in the domestic sector.
3. The number of new homes built each year has been taken from the figure proposed in the Cornwall Local Plan (2,100 dwellings/year).

5.4.4 The following calculation provides an illustration (rather than a precise projection) of the domestic heat consumption in 2030.

⁹ Technical Paper E1b - *Projected Energy Consumption in Cornwall up to 2030*.

1. Total space heating requirement for homes built between the baseline year (referred to as new homes) and 2030 = $42,250 \times (0.829/2) = 17.513$ ktoe.

5.4.5 The table below shows the proportion of the total homes standing in 2030 that are new and already existing and their total annual energy requirement as a proportion of the projected total for the sector in 2030.

Table 7: Proportion of new and old homes in 2030 and their total energy consumption

Home	Proportion of total homes (%)	Total projected energy consumption (ktoe) 2030
Already existing	85	257
New	15	45

2. Total domestic space heating in 2030 for homes that have already been built = 58% of 257 which is 149 ktoe. This means that the proportion of the total energy per already built home that is used for space heating will drop to 0.59 toe by 2030 (from the current figure of 0.841 toe).
3. Total domestic space heating requirement for all homes in 2030 = $149 + 17.513 = 166.513$ ktoe.

5.4.6 Based on these estimations the average home in Cornwall will require 0.57 tonnes of oil equivalent a year to meet its heating requirements in 2030.

5.4.7 The table below summarises the proportion of Cornwall's household heating needs that could be met from renewable and low carbon energy sources within the County.

Table 8: The proportion of Cornwall's heat energy needs that can be met from Cornwall's renewable energy resources

	Current situation (2010)	Projected situation in 2030
Total heat energy consumption for domestic space heating (ktoe)	206.48	166.513

Total renewable and low carbon heat resource potential (ktoe)	54.66	
Total resources as a proportion of the consumption (%)	26.5	32.8
Number of properties that could be heated from Cornwall's renewable heat potential	65,985	95,894

5.4.8 The table indicates that, if all of our heat generating renewable energy sources were used to heat our homes in 2030 we would be able to heat 32.8% of our homes (95,894 homes) with renewable and low carbon energy.

6 Transportation Fuel

- 6.1 An assessment of the renewable and low carbon diesel resource has not yet been conducted and it is therefore not possible to assess the proportion of our transportation energy needs that can be met from renewable and low carbon sources at this stage. However, the consumption forecast predicts that one thousand tonnes of oil equivalent will be consumed by the transport sector in the form of electricity in 2030. The renewable electricity resource assessment shows that this figure can be met entirely from renewable and low carbon electricity sources in Cornwall.

7 Conclusion

- 7.1 The resource assessment is based on technology and resources that are currently understood and in use. It does not seek to estimate the potential for untested or unknown sources. There is, however, potential for such unknown sources to contribute to the provision of renewable energy generation in Cornwall. One example of this is deep geothermal energy. Two planning applications have been granted for this technology, but to date no systems are in operation in the UK (Engineered Geothermal Systems). Should geothermal prove to be successful and sustainable then a higher overall level of energy generation may be achieved than is expressed in the resource assessment.
- 7.2 The renewable energy resource assessment used to underpin this report set out to quantify the amount of energy that could reasonably be extracted from Cornwall's renewable energy resources. The assessment indicates that it would be possible to achieve nearly a third of our total energy needs from renewable and low carbon sources over the next 20 years subject to the renewable energy development coming forward within that time frame.
- 7.3 While it is recognised that realising the installation of the level of renewable energy generation in Cornwall may require investment in supporting infrastructure, analysis of recent levels of deployment indicates that the market could deliver the renewable energy capacity outlined in the resource assessment¹⁰ if renewable energy support mechanisms remains constant.
- 7.4 Renewable electricity deployment levels indicate that an installed capacity of 1427 MW can be achieved by 2030 (including a current installed capacity of 172 MW). Installation rates over the last 18 months (January 2011 to October 2012) indicate that approximately 1205 MW could be achieved by 2030 (assuming that the deployment rate remains relatively constant). Installation rates over the last 6 months suggest that over 1560 MW can be installed by 2030. Both these figures would be additional to the current installed capacity in Cornwall.
- 7.5 Recent renewable heat deployment rates also indicate that an installed capacity of approximately 190 MW is achievable by 2030

¹⁰ The total heat energy potential as identified by the report *An Assessment of the Renewable Energy Resource Potential of Cornwall* (2012).

(including a current installed capacity of approximately 28 MW). Deployment rates over the last 2 years (January 2010 to January 2012) suggest that deployment would fall short of that figure – indicating that just over 120 MW might be achieved if installation rates remained constant until 2030. However, deployment rates between January 2011 and January 2012 indicate that 190 MW can be realised (indicating just over 230 MW would be installed).

- 7.6 It might be possible to generate higher levels of renewable energy in Cornwall, but it is likely that a higher level of generation would result in compromises being accepted. For example a higher level of wind energy deployment is possible if decision makers are willing to accept significant changes to the Cornish landscape or our residential amenity. A higher biomass yield might be achieved if we are prepared to give over a larger proportion of our higher grade agricultural land. Alternatively a higher proportion of our needs could be met if we are prepared to undertake enhanced measures (above that set to be implemented through national policy and regulation) to reduce our consumption of energy. This is likely to include further physical changes to our infrastructure and changes to the way we use it (behavioural change).