Current and future water availability – addendum

A refresh of the Case for Change analysis

December 2013

We[1] refreshed the Case for Change[2] analysis of future water resource availability. Our Case for Change analysis includes refreshed projections for water demand to provide a plausible envelope of future water demand. The analysis also includes, for the first time, projections for future water demand in relation to electricity generation.

1. Introduction

We developed our Case for change: current and future water availability report in 2011 in support of the UK Government's Water White Paper, Water for Life[3] and proposals to reform abstraction licensing.

It sets out current evidence on the availability and reliability of water now and in the future, based on different climate change, environmental and socio economic scenarios. It explores and projects water demand for different sectors to provide an envelope of plausible future water use. In understanding the potential range of future demand we can begin to understand the risks for future water availability.

Our 2011 analysis focused on demand projections relating to household use, leakage, industry and commerce sectors and agricultural use. Projections of demand for water in relation to electricity generation were not included in the original analysis; it assumed that demand stayed constant. Following publication of the Water White Paper and to support the abstraction reform programme, we were asked to look at the future demand for water by the electricity generation sector and to feed this into a refreshed Case for Change.

This briefing note is an addendum to the existing Case for Change publication and sets out what changed in the 2013 refresh of the Case for Change and the subsequent results of the analysis.

2. What's new in the 2013 analysis?

We adopted the same approach to the analysis to ensure results are comparable with 2011. The analysis is based on testing sensitivity of demand around three elements: our four socio-economic scenarios, four climate change scenarios, and three Environmental Flow Indicator (EFI) thresholds. We used the same four Regional Climate Model (RCM) simulations, that are one component of UKCP09, to reflect a reasonable range of predicted

[1] On 1 April 2013, the Environment Agency in Wales, the Countryside Council for Wales, Forestry Commission Wales and some functions of Welsh Government were brought together to become Natural Resources Wales. This is a joint Environment Agency / Natural Resources Wales document.

[2] The case for change – current and future water availability. Environment Agency (2011) Report No: GEHO1111BVEP-E-E

[3] Water for Life. Defra (December 2011).

climate change outcomes from minimal changes in flows (scenario A) to greater changes in flows at different locations (scenarios C, G and J)[4].

We developed our original socio-economic scenarios (Uncontrolled demand, Innovation, Sustainable behaviour and Local resilience) in 2006. These allow us to set out a plausible envelope of future water demand. In advance of developing electricity generation water demand projections, we considered it timely to revisit the scenarios to ensure that they take account of lesson learnt from recent world events and shocks to the economic systems. Very minimal changes were made to the scenarios to ensure that they are still robust and fit for purpose.

The analysis now includes the recently developed projections for water demand relating to the electricity generation sector. We explored future water demand for the electricity generation, taking into account future levels of demand for electricity, differing mixes of generation, different cooling technologies and shifts in location of generation in relation to the refreshed core socio-economic scenarios. Alongside modelling demand under the Environment Agency's four socio-economic scenarios, demand under the four Department of Energy and Climate Change (DECC) Updated Energy and Emissions Projections (UEP's) scenarios out to 2030 and the four example 2050s pathways included in DECC's Carbon Plan 2011 were modelled. This has provided a plausible envelope of future water demand for the sector. See annex 1 for a summary of the key facts about future water use in the power sector and annex 2 for graphs of potential freshwater demand.

The 2013 analysis also includes refreshed demand forecasts relating to the agriculture sector[5], the industry and commerce sectors, households and leakage in light of the changes to the socio-economic scenarios. See annex 3 for graphs showing the overall water demand relating to all sectors.

We also take into account different assumptions on the water flow requirements for future environmental protection. We used three EFI thresholds to provide a range of future environmental protection. The 2011 analysis included a 'fixed' EFI[6] and a 'proportionate' EFI[7]. To support abstraction reform modelling, in the 2013 analysis, a third EFI scenario was introduced relating to the Water Framework Directive principle of 'no deterioration'. The 'no deterioration' EFI sets future environmental protection at whichever is the lower of either the current EFI threshold or current level of recent actual flow.

3. Results

The above provides us with 48 scenario combinations of supply and demand balances in the 2050s. This plausible envelope allows us to understand the potential range of impacts and what this might mean for future water availability and reliability and a set of scenarios against which to test options for abstraction reform.

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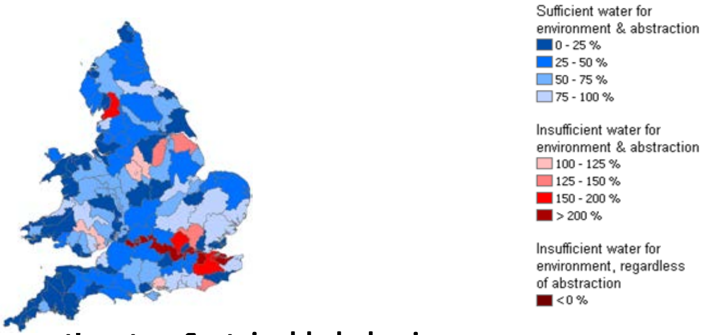
[4]Future flows and groundwater levels. NERC Centre for Ecology & Hydrology (CEH) and the NERC British Geological (2012)
[5]Assessing climate and land use impacts on water demand for agriculture and opportunities for adaptation. Cranfield University (2013)
[6]'Fixed' EFI is the current EFI threshold and assumes that flow is fixed at those levels to meet environmental requirements.
[7]'Proportional' EFI is the same percentage deviation from natural flow as the current EFI thresholds, but applies them to future flow scenarios

The maps in figures 1 and 2 below illustrate the results[8] from the refreshed analysis. The results are broadly similar to the original 2011 analysis, showing that the geographical spread of unmet demand is closely related to the pattern of climate change impacts on river flows from the four climate change scenarios (A,G,C and J) and linked very closely to the level of environmental protection.

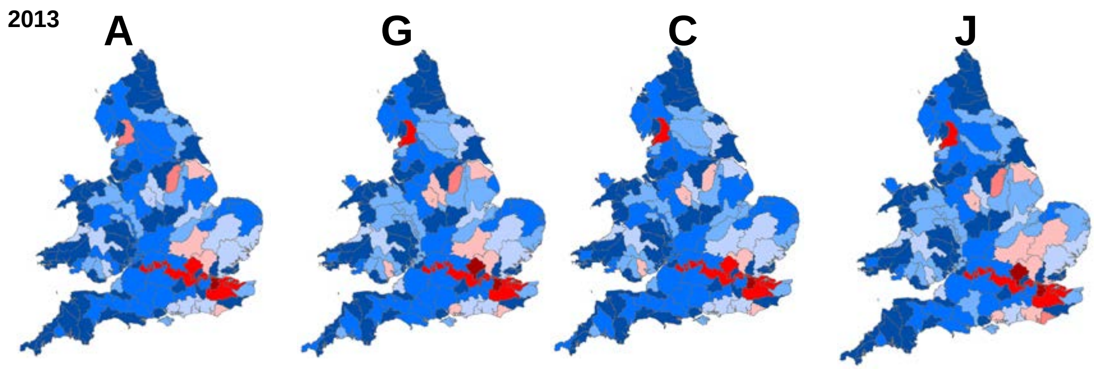
[8] Results are shown as demand as a percentage of water available (100% indicates supply = demand, less than 100% shows that supply is greater than demand, more than 100% shows that supply is less than demand)

Figure 1: Case for change results: Sustainable behaviour

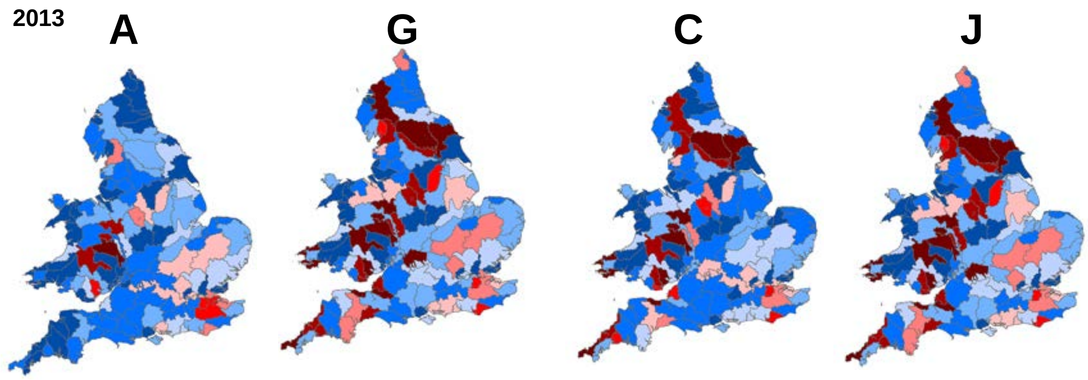
2013 Q70 Current baseline



Q70 - EFI Proportionate – Sustainable behaviour



Q70 - EFI 'no deterioration' – Sustainable behaviour



Q70 – EFI Fixed– Sustainable behaviour

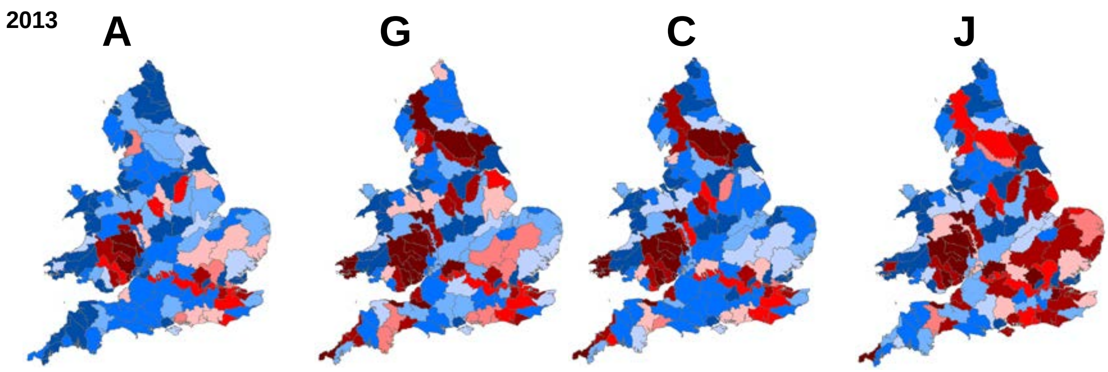
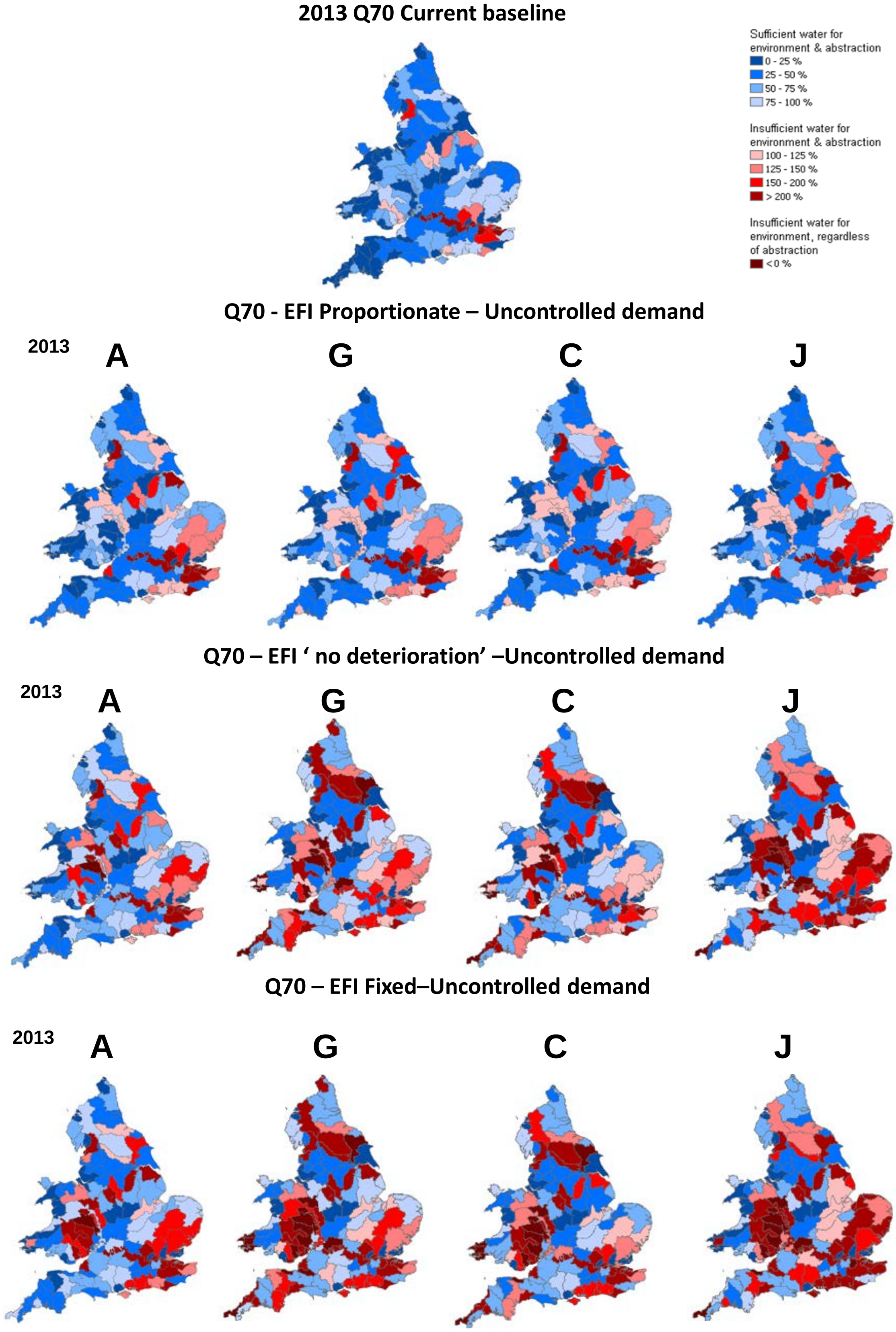


Figure 2: Case for change results: Uncontrolled demand



4. Conclusions

Whilst the analysis illustrates a broad range of potential future demand and differing pressures on resources there are a number of clear conclusions from the work which align to those of the 2011 analysis.

Already a quarter of water bodies in England and seven per cent of water bodies in Wales will provide a reliable source of water for new consumptive abstraction for less than 30 per cent of the time.

Changing lifestyles and an increase in population could have a substantial impact on demand for water. By the 2050s, the total population of England and Wales is expected to grow by an extra 15 million people, so despite forecasts of reductions in per capita consumption as a result of recent demand management initiatives by water companies, overall use is likely to grow.

The plausible envelope of future water demand in the 2050s is from 28 per cent lower to 49 per cent higher than today. The Uncontrolled demand and Sustainable behaviour scenarios mark the two extremes of the demand envelope.

Despite some changes in elements of the 2050's demand forecast resulting in a wider envelope of demand than the 2011 analysis, the supply demand pictures within the case for change show minimal change. This emphasises the significant impact that climate change and environmental protection have on future water availability and reliability.

Future demand projections relating to electricity generation have minimal impact on the overall picture of future freshwater availability. This is because of the significant reliance of the industry on saline / tidal waters.

The climate change scenarios predominantly show decreases in summer flows through the UK, but range from +20 per cent to -80 per cent.

The combined impacts of climate change and increases in population show there are significant risks of less water available for people, businesses, agriculture and the environment than today.

The level of protection given to the environment has a significant bearing on the percentage of time resource is reliable to abstract. Unmet demand is closely related to the increasing level of environmental protection under the different EFI scenarios. Fixed EFIs place the most restriction of future availability for abstraction; the proportionate EFI placing the least.

The challenge of future water resource availability is not likely to be limited to the south and east of England. The geographical spread of unmet demand is closely related to the pattern of climate change impacts on river flows from the four climate change scenarios. Catchments across Wales, south west and northern England are predicted to experience significant unmet demand under many of the scenario combinations.

Annex 1: Key facts about future water demand in the electricity generation sector

Future demand is dependent on a number of critical factors:

- the future electricity generation mix
- cooling technology used
- future location – the split between freshwater and tidal water is fundamental assumption in results

The overall trend is that total water demand for the electricity generation sector is set to increase:

- Highest future demand is under the DECC's 2050 Higher Nuclear scenario, where all nuclear is on the coast and uses once through cooling with high water rate.
- Lowest future demand is under the Environment Agency's Local Resilience scenario, which has the lowest level of generation and highest share of non-water using renewable forms of electricity generation such as wind power.

Projections for future freshwater demand are more variable and could increase or decrease depending on the future electricity generation mix, future location and the cooling technology used. Some scenarios show a decrease.

- Greatest freshwater demand is under the DECC's 2050 Higher Carbon Capture and Storage (CCS) scenario, due to the fact that water use for CCS could vary between 45-140% higher than unabated thermal generation.
- Lowest future demand is under the DECC's Higher Nuclear due to the assumption that new nuclear is situated on the coast, resulting in a decrease in the demand on freshwater.

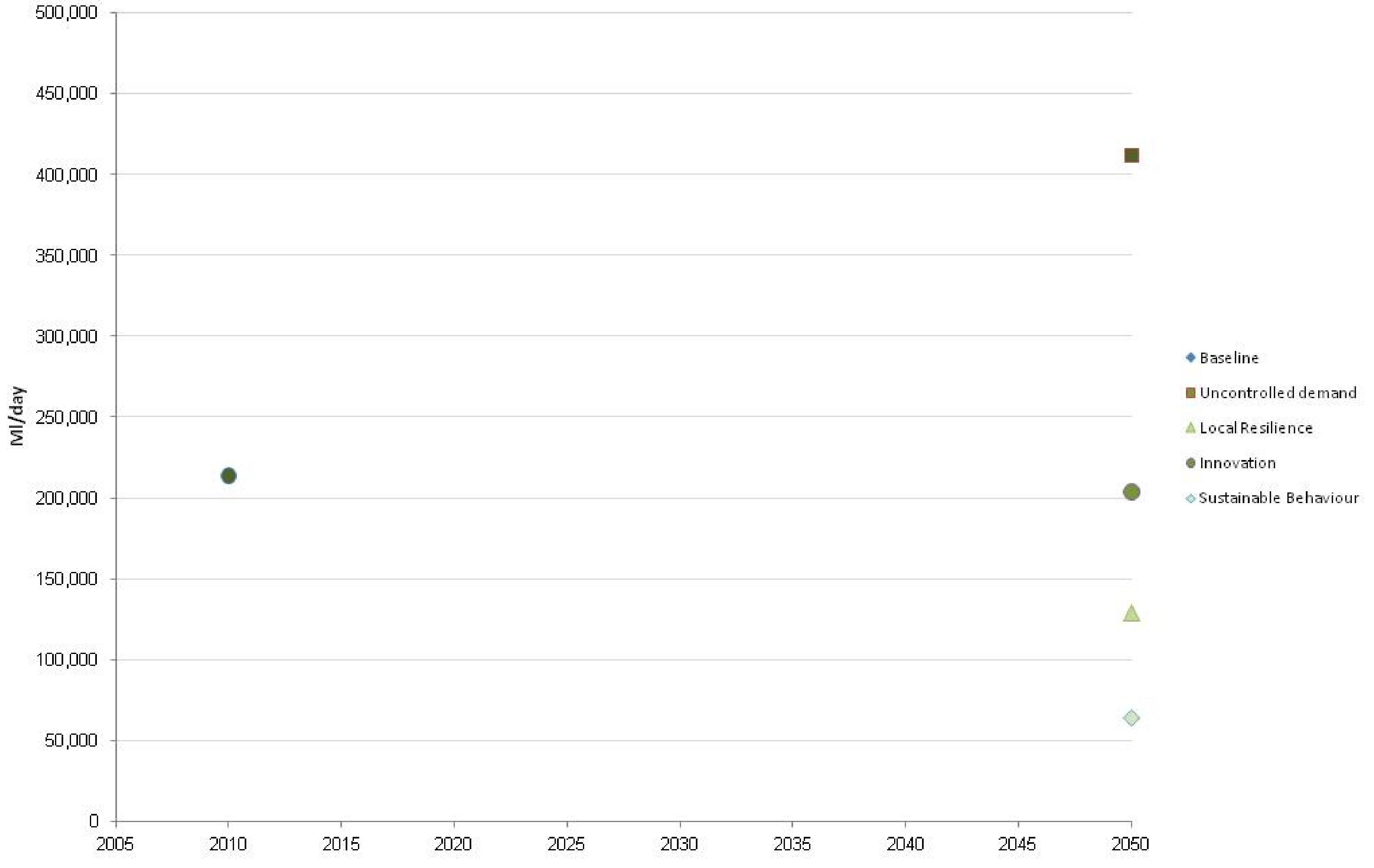
The projections found for the Environment Agency's socio-economic scenarios sit within the range of those found for DECC's 2050 Higher CCS scenario and DECC's Higher Nuclear scenario discussed above.

- Uncontrolled demand shows the highest freshwater demand due to expanse of nuclear generation. This is the result of the assumption that 10% of this could be inland and tower cooled which has a higher gross water use rate. This scenario also has the lowest share of renewables.
- Sustainable behaviour has the lowest freshwater future demand of the Environment Agency's scenarios due to shift in thermal generation to the coast so any uptake of CCS places the demand on coastal waters. Also has the highest share of non-water using renewables.

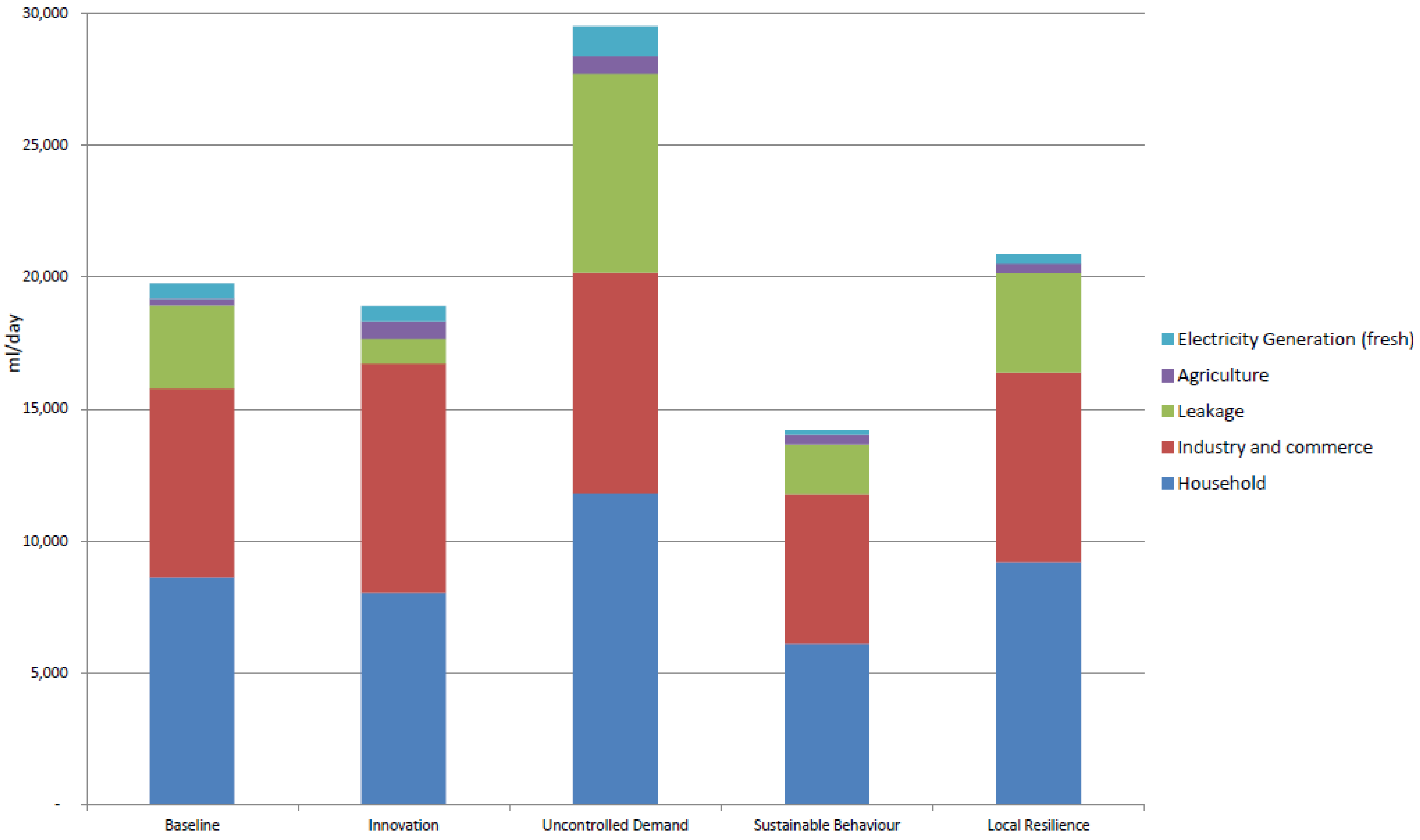
Freshwater projections show fluctuating levels of demand out to the 2050s.

- There is a potential increase out to 2025, followed by a pronounced drop with a possible increase or decrease by 2050.
- The dip and the start of the potential rise under the DECC Markal and the Higher CCS scenario is the result of the drop in unabated thermal generation from 2030 onwards and varying increases resulting from differing uptakes in CCS.
- Whilst a number of scenarios project a decrease in freshwater demand, this is countered by increases in the projected tidal / coastal demand, resulting in the overall increase in demand by the sector.

Annex 2: Total future freshwater cooling water demand (excluding hydropower) under Environment Agency socio-economic scenarios



Annex 3: Projected 2050s water demand relating to all sectors (excluding hydropower)



Annex 4: Summary of 2050s demand scenario results and assumptions.

	Baseline[9]	Innovation	Uncontrolled demand	Sustainable behaviour	Local resilience
Population	**55,250,000**	**72,770,000**	**78,340,000**	**66,600,000**	**64,930,000**
Household (Ml/d)	**8,628**	**8,038**	**11,812**	**6,101**	**9,201**
		High rates of retrofitting and use of grey/rainwater. Significant innovation in self-cleaning / waterless materials and appliances.	Poor attitude to water efficiency increases use, but some gains through improved flushing technology and efficient appliances.	Reductions due to strong belief in water efficiency. High rate of waterless appliances and easy fit water efficiency devices.	Shift in attitude to saving water, but lack of innovation.
Leakage (Ml/d)	**3,135**	**940**	**7,524**	**1,881**	**3,762**
		Strong regulation, central network management and well-maintained infrastructure leads to large reductions. High levels of innovation and technology.	Very weak regulation and poor attitude to leakage, leakage up to levels similar to the 1980's. Little investment, repairing leaks seen as expensive.	Strong reduction as result of significant technological improvements. Company & Government willingness to invest.	Weak regulation and limited maintenance.
Industry & Commerce (Ml/d)	**7,160**	**8,696**	**8,369**	**5,682**	**7,197**
		Despite innovation, significant shift in water replacing chemicals in manufacturing processes as a cleaner resource. Greater reliance on UK focussed food production.	Drive to produce more and quickly. Less focus on water efficiency and innovation across the sector. Potential for water to be used as substitute for chemicals.	Significant shift to greater reliance on UK focussed food growing and production to mitigate unsustainable transportation of food. Shift away from fuels that require refining.	Despite potential reduced demand, greater focus on UK / local production. Potential for greater demand from local industries, i.e. greater mineral extraction at local scale drives up demand.
Agriculture (Ml/d)	**192**	**492**	**513**	**272**	**269**
		Increase due to population growth, but mitigated by greater choice in technology, increased yield, and focus on efficient application of water.	Increase in population drives up demand and farming intensity. Higher expectation of horticultural goods.	Greater reliance on UK grown produce, but efficiencies found in technology and improved yield. Acceptance to grow crop where climate allows.	Increase in area under cereal and vegetable crops to meet demand from population growth. Marginal reduction in demand from innovation.
Energy Generation (Ml/d)	**585**	**559**	**1129**	**176**	**355**
		Greatest increase in demand for electricity, mitigated by greatest share of non water using renewables and all nuclear generation on the coast.	Increase in nuclear generation, with 10% inland, greatest biomass generation and lowest share of non-water using renewables.	Shift in thermal generation to the coast with uptake of CCS using coastal water, a large share of non water using renewables and nuclear generation on the coast.	Low levels of generation and lowest uptake of carbon capture and storage technologies.
Total demand	**19,699**	**18,726**	**29,347**	**14,112**	**20,783**
% change from baseline		**-5**	**49**	**-28**	**6**

[9] Based on Environment Agency Water Resources GIS 6-year average annual returns.

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