

The impacts of climate change on nuclear power stations sites

a review of four proposed new-build sites on the UK coastline

All the UK's existing nuclear power stations are located on coastal sites because of the need for an isolated location with a plentiful supply of cooling water. Many are built at very low elevations, and are consequently highly vulnerable to the rising sea levels which global warming is expected to bring. Despite this the Government is proposing to build new reactors at these same locations.

A review commissioned by Greenpeace shows that the siting of a new generation of power stations raises serious issues which have not been addressed. The review looks at the predicted impacts that climate change, through sea level rise and increasing storm surges, will have on the coastal environment around a selection of established power station sites which have been proposed as new-build locations. These predicted impacts have been examined over the lifetime of both the existing and the proposed reactors, which are not likely to be fully decommissioned and therefore safe until 2195¹.

The review makes for compelling reading and the results are crystal clear – building new nuclear reactors on coastal sites will not be economically or physically sustainable. As the UK Government looks set deliver a vision of a nuclear future fixated on the technology and infrastructure of the past, this review underlines why nuclear power is nothing more than a dangerous and expensive distraction from the real solutions to climate change.

Climate change and the UK coast

predictions and assumptions

The coast is a dynamic system, subject to change over short, medium and long-term timescales. Building a significant structure with a very long lifespan, such as a nuclear power station, on the coast requires action to fix the coastline, entailing an ongoing battle with a dynamic physical environment that would normally be undergoing constant change. Given the vulnerability of nuclear power stations and their potential for disastrous failure, the likely effects of climate change on any individual site must be viewed in the context of the behaviour of the surrounding coastal system as a whole – it is not enough to consider only the site itself. Moreover, in attempting to predict the likely impacts of climate change on such vulnerable and dangerous installations as nuclear power stations, especially when located in such an unstable environment as the coast, it is vital that consideration be given to both progressive climate² trends and ‘climate surprises’ – sudden, dramatic changes which are harder to model, but which, given their potentially major impact, must be taken into account.

Progressive climate trends

Greenpeace’s review concentrates on two climate change trends which are of particular relevance to coastal settings: average sea level rise and storm surges. Rising sea levels are a direct consequence of global warming and mainly caused by thermal expansion of ocean water, with the melting of mountain glaciers and the Greenland ice-sheet contributing smaller amounts. A storm surge is caused primarily by high winds pushing on the ocean’s surface, which causes the water to rise higher than the ordinary sea level. Storm surges are particularly damaging when they occur at high tide, combining the effects of the surge and the tide.

While the century-scale rise in average sea level may exert a significant threat to the low-lying unprotected coastal areas shown in Table 1, the extremes of sea level resulting from storm

surges will likely cause the most damage. Estimates of increases in the once-in-50-years maximum storm surge level for the east, south-east and west of England by 2080 are given in Table 2. These predictions, for three different global emission scenarios, show that the largest increase in surge height, up to 1.4m for the high emissions scenario, occurs along the south-east coast of England.

Climate surprises

Examples of climate surprises include the shutdown of the oceanic thermohaline circulation (the global temperature- and salinity-driven circulation of the oceans which includes currents such as the Gulf Stream and plays a critical role in regulating our current climate); the release into the atmosphere of large quantities of methane (a far more potent greenhouse gas than carbon dioxide) currently locked in sediments beneath the deep ocean; and the collapse of the West Antarctic Ice Sheet (WAIS), which some scientists think may occur during the 21st century and which would trigger an abrupt and extreme rise in sea level, estimated at 5–6m³. Given that the collapse of the ice sheet would have the most immediate effect on sea levels, it has been taken as the basis for the worst-case scenario used in the review.



TABLE 1: PROJECTED NET SEA-LEVEL CHANGE TO 2080 FOR LOW AND HIGH EMISSION SCENARIOS⁴

	Low emissions	High emissions
Eastern England	0.22m	0.82m
South-east England	0.19m	0.79m
South-west England	0.16m	0.76m

TABLE 2: ESTIMATED VALUES OF THE PREDICTED INCREASE IN 50-YEAR SURGE HEIGHT BY 2080⁵

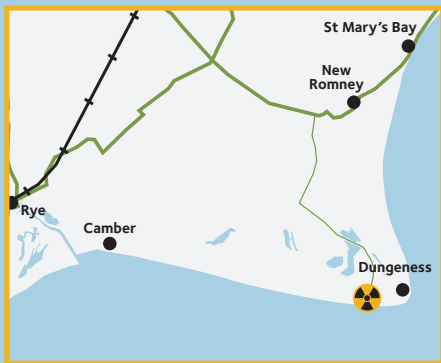
Emission scenario	East England	South-east England	South-west England
Low	0.6–1m	0.2–0.4m	0
Medium-High	1.3m	0.6–0.8m	0.2–0.3m
High	1m	1.4m	0.7–0.8m

Impacts on nuclear power station sites



N.B. The graphics used in this report are a simulation of the predicted impacts of climate change, through sea level rise, on the UK coastline.

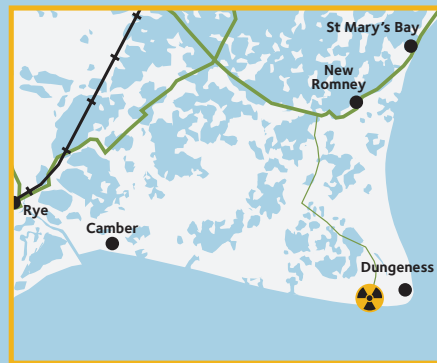
Dungeness



Present day

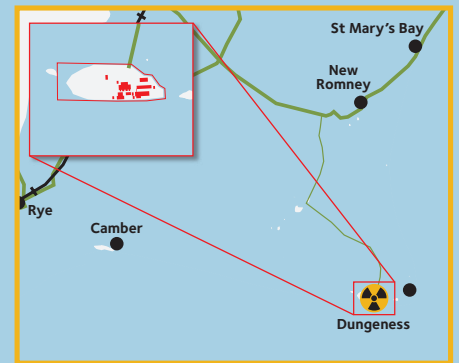
The two Dungeness reactors are located on a shingle foreland on the south-east coast of Kent, immediately inland from the shore and shielded from the sea by a shingle ridge. The site is currently maintained by the continuous dumping of large quantities of shingle to protect it from erosion. Without this, the foreshore would be breached and the site subsequently flooded.

The predicted high emission scenario of a 0.79m increase in sea level for the south-east by 2080 would exert significant additional stress on the system, increasing



Impact of storm surge height of 1.4m, predicted for 2080

the susceptibility of the site to erosion and its vulnerability to flooding. Even a low sea level rise estimate of 0.19m will have implications for the sustainability of current practices on this low-lying and sediment starved coastline. Predicted increases in storm surge height along the south-east coast, up to 1.4 metres in the high emissions scenario (Table 2), will increase the susceptibility of break-down and breaching of the shingle ridge, thus impacting the site further. Adding the increase forecast under the high-emission scenario to the current value highest predicted tide (Appendix 1 in

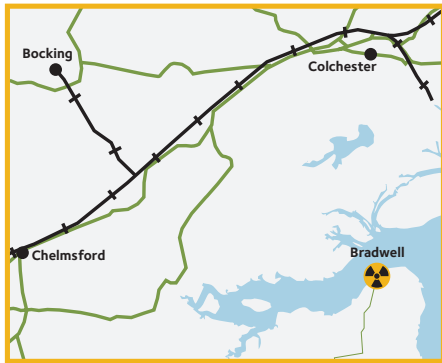


Impact of sea level rise of 6m, worst case scenario for end of century

main report) suggests that by 2080 high tides could be around 4.35m. Breaching of the shingle ridge under such conditions would result in widespread flooding of the site. Further sea level rise by 2195 would be likely to result in more frequent and/or more serious flooding.

A sea level rise caused by loss of the WAIS could be expected to have a devastating impact on the nuclear site, with potential total loss of the power station site and also a significant portion of the surrounding area through erosion and flooding.

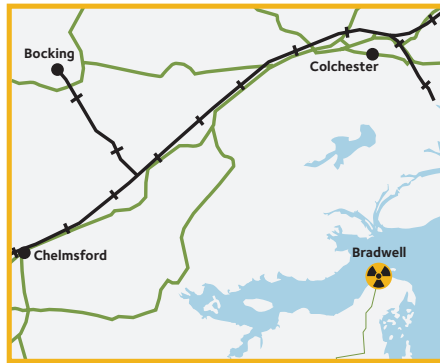
Bradwell



Present day

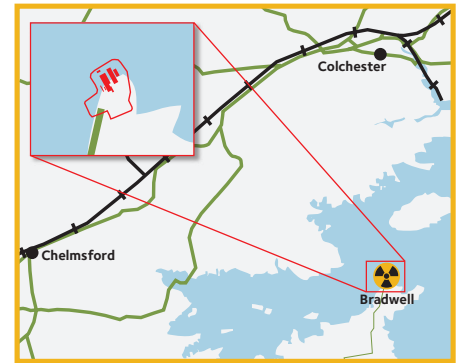
Bradwell reactor is located on the Blackwater estuary in Essex, on an area of reclaimed intertidal salt marsh. The site is protected from the sea by a 5m embankment and raised above the surrounding land to a height of 5m above sea level.

Accumulation of sediment on the seaward side of the embankment is already increasing the risk of it being over-washed, consequently flooding the land around the power station site. As sea level rises, the natural tendency would be for the shoreline to move landward, accumulating



Impact of storm surge height of 1m, predicted for 2080

further sediment, so keeping pace with the rising tides. But the embankment prevents such accumulation on the land behind it, so that this will get progressively lower with respect to the sea level. As a result, flooding of this area will not only become likelier, but will potentially be much more severe. A 1m increase in 50-year storm surge height, as predicted for 2080 under the high emission scenario, would be enough to bring about over-washing of the embankment. Conversely, if the current policy of maintaining the embankment was not continued, the power station site



Impact of sea level rise of 6m, worst case scenario for end of century

could potentially become an island: even the lowest sea-level rise estimate would result in the low-lying area around the power station being inundated at least at every high spring tide. Increased magnitude and frequency of storm events would significantly increase the vulnerability of the area. Over the longer term, given either of the global average sea level rises predicted for 2195, it may become unsustainable to maintain the current power station site, while a WAIS-magnitude increase in sea level would result in total inundation of the nuclear site and surrounding area.

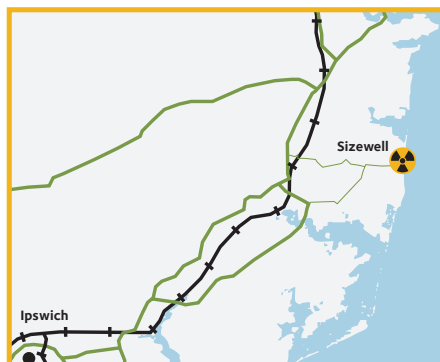
Sizewell



Present day

Located on the Suffolk coast, the reactors at Sizewell have been constructed behind the tidal beach at between 5m and 10m above sea level, along a coastline considered to be vulnerable to change. Apart from a few localised areas, including the power station site itself, this coastline has no hard defences and is subject to rapid erosion.

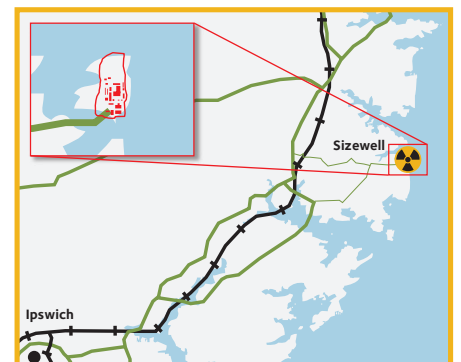
The rapid periodic erosion of the soft cliffs at Dunwich and Minsmere to the north releases sediment which moves south along the coast. This input of sediment counters erosion and thus helps maintain a stable coastline in the vicinity of the power station. This factor, along with the current management of the shingle beach and dunes fronting the



Impact of storm surge height of 1m, predicted for 2080

power station, means that the current threat to the station from erosion and flooding is relatively low.

Although the coast is generally stable, rising sea levels and greater frequency and magnitude of storm surges would result in increased erosion of the Dunwich and Minsmere cliffs. Any attempt to defend this section of coastline for economic or environmental reasons (the area includes settlements and an internationally important nature reserve) would have highly significant impacts on the Sizewell frontage. Prevention of erosion of the cliffs would cut off the supply of fresh sediment to the south, resulting in a thinning of the beach and



Impact of sea level rise of 6m, worst case scenario for end of century

increased wave attack on the shoreline, leading to coastal retreat.

Even leaving aside this possibility, and notwithstanding the general stability in the region of the power station, the coastline is considered to be vulnerable to change in the long term, with extensive coastline retreat a possibility. This would have high significance for the siting of any new nuclear plant within the area. Moreover, with an extreme sea level rise such as would be caused by the collapse of the WAIS, there would be significant erosion and flooding across the region: with a 6m sea level rise, sections of the power station would be flooded, and storm surges could threaten virtually the whole site.

Hinkley Point



Present day

The Hinkley Point reactors overlook the Bristol Channel and are defended by a sea wall with additional defence structures behind it. The shoreline is subject to strong winds, powerful waves and storm surges: this means that the greatest current risk to the power station comes from inundation from extreme events.

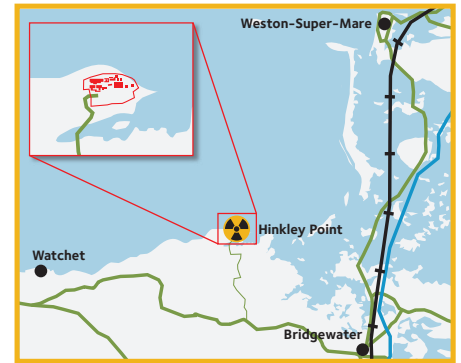
Accelerated sea level rise and predicted increases in storm surges could have significant impacts on this shoreline. Higher sea levels would narrow the wide foreshore which



Impact of storm surge height of 0.8m, predicted for 2080

currently diminishes wave energy, leading to both increased erosion and a threat of inundation at the power station site. Current storm events are already overtopping the sea wall. The 0.7–0.8m increase in the 50-year surge height predicted by 2080 under the high emission scenario may add significant additional stress to the power station's defence structures (a sea wall, backed by gabions).

Siting a new nuclear plant to the east of the present stations would not be



Impact of sea level rise of 6m, worst case scenario for end of century

advisable or indeed feasible under current conditions, let alone with the predicted impacts of climate change. The more elevated land to the west of the current site boundary is at present a relatively more resistant site. However, given that the cliff line in this area is currently subject to erosion, and that the rate of erosion may increase over the lifespan and decommissioning period of a new power station, this site is also likely to become problematic in the long term and cannot be considered a practicable option.



Siting a new nuclear plant to the east of the present stations would not be advisable or indeed feasible under current conditions, let alone with the predicted impacts of climate change.

Conclusion

In summary, with sea level rises and increases in storm surge as predicted under a high-emission scenario, Dungeness is at risk of flooding by 2080, and by 2195 would be highly threatened. Bradwell is under significant threat in both the short and long term and Hinkley Point is also vulnerable. The situation at Sizewell is less clear, but none of the sites are completely threat-free as a location for a new nuclear power plant. It is also important to note that even the lowest estimates of sea level rise could significantly increase long-term dependence on expensive defences at the stations and have negative impacts on the physical stability of the coastal environment around the stations. Defending three of the four power station sites studied is already a difficult and costly undertaking, and in the long-term future they are likely to become economically unsustainable: in this light they cannot be considered as suitable locations for new reactors.

In wider terms, it is clear that any potential coastal site is likely to be subject to similar constraints, and that no site should be approved without full consideration of the long-term development surrounding coastal systems in the face of predicted sea-level rise and increasing storm surges. Given the potential economic, environmental and human cost of a misjudgement, it is vital that such consideration be based around the available worst-case scenarios – to gamble on ‘things not turning out so badly’ would be insanely irresponsible. Given the uncertainties of climate prediction over a 200-year timescale, it is hard to escape the conclusion that the most sensible approach would be to reject all nuclear new-build on coastal sites.

These findings challenge the political bravado which argues that ‘tough choices’ have to be made in favour of nuclear power. They make it clear – even for those who still believe that nuclear power is clean, safe and the answer to our energy problems – that building new nuclear power stations at existing sites, or at similar coastal locations, would be costly and dangerous. Building new reactors in these locations would deliver an appalling legacy to future generations, who could find themselves saddled with the impossible burden of averting a potential catastrophe for the marine environment and the human population as a result of their ancestors’ inexcusable lack of foresight.

If we are serious – as we must be – about tackling climate change, we should not be distracted by the false promises of a nuclear future. There are much safer, more reliable, and significantly cheaper approaches, such as increased energy efficiency, renewable power technologies and the decentralising of our energy infrastructure. Decentralised energy involves generating energy near to its point of use and using heat as well as power. It allows us to make the most efficient use of fossil fuels during the long-term transition to a renewable energy future. If the UK decentralised its energy system, while also expanding the use of clean, renewable energy and reducing our demand through energy efficiency measures, there would be no need for nuclear power. Notwithstanding the biased findings of the Government’s energy review, it is to these sustainable alternatives that we must look if we are to achieve a clean energy future and halt the rising tide of global warming.

For a copy of the full report, please visit:
www.greenpeace.org.uk/nuclear-flooding

Endnotes

- 1 See main report: ‘The impacts of climate change on nuclear power stations sites: a review of four proposed new build sites on the UK coastline’ at: www.greenpeace.org.uk/nuclear-flooding
- 2 The review uses regional predictions developed by the UK Climate Impacts Programme (UKCIP) (Hulme et al., 2002) for a range of emissions scenarios. The emissions scenarios chosen by UKCIP reflect the global scenarios published by the Intergovernmental Panel on Climate Change (IPCC) in its Third Assessment Report – Emissions Scenarios 2001
- 3 Oppenheimer, M. and Alley, R.B. (2004) ‘The west Antarctic ice sheet and long term climate policy’. *Climate Change* 64, 1-10
- 4 UK Climate Impacts Programme (UKCIP) (Hulme et al., 2002)
- 5 UK Climate Impacts Programme (UKCIP) (Hulme et al., 2002)

fhrc

**Flood Hazard
Research Centre**

This review was commissioned by Greenpeace and authored by Middlesex University Flood Hazard Research Centre.

The Flood Hazard Research Centre (FHRC) has been active since 1970 and therefore comprises one of the oldest research centres in the world concerned with water and environmental management. It comprises of a group of committed social and environmental scientists working to improve policy making and implementation in the fields of hazard, coastal and integrated water management.

GREENPEACE

Greenpeace’s clean energy campaign is committed to halting climate change caused by burning oil, coal and gas. We champion a clean energy future in which the quality of life of all peoples is improved through the environmentally responsible and socially just provision of heating, light and transport.

We promote scientific and technical innovations that advance the goals of renewable energy, clean fuel, and energy efficiency.

We investigate and expose the corporate powers and governments that stand in the way of international action to halt global warming and who drive continued dependence on dirty, dangerous sources of energy, including nuclear power.

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