The Value of Water Level Management

Electricity Supply

Elizabeth Lawrence

ada

Introduction

Foreword from the Chairman

A growing population and climate change are likely to put immense stress on areas such as food production, water management and energy. In order to achieve both economic well being and environmental sustainability we need to develop strategies to address the challenges facing these vital areas.

I strongly believe that for Britain to continue to be a prosperous and world leading nation we must strive to make the most out of our land resource for the benefit of society and the environment. This report marks the first of what I hope will be a series by ADA exploring the importance of water level management to the prosperity of England and Wales.

Our first report focuses on electricity supply. Electricity consumption in England and Wales has increased substantially since World War II and it is set to increase further. Consequently, the UK electricity supply industry, which produces, transforms and supplies electricity to all sectors, is a fundamental asset, vital to the UK's economic and national security.

ADA and the Internal Drainage Boards are keen to play their part in delivering practical and affordable solutions on the ground. There comes a time when doing is more important than talking.

Henry Cator OBE DL FRICS

Chairman

Association of Drainage Authorities

INTRODUCTION

About this report

This report emphasises the importance of water level management to ensuring the security of electricity supply in England and Wales. Furthermore, it highlights the important role Internal Drainage Boards (IDBs) play and how IDBs are likely to become progressively more relevant as demand for electricity increases.

> *"A secure and reliable energy supply is a crucial input into almost every aspect of UK citizens' lives. Energy provides an essential foundation for the UK economy and its future growth prospects."*
>
> HM Treasury and DECC, Energy Market Assessment 2010

About ADA

The Association of Drainage Authorities (ADA) is the membership organisation for water level management organisations in the United Kingdom.

Our members include Internal Drainage Boards (IDBs), the Environment Agency, Regional Flood & Coastal Committees (RFCCs), and the Northern Ireland Rivers Agency. Associate Members include local authorities, consultants, contractors and suppliers. ADA was established in 1937 to watch over and support the interests of drainage authorities at a national and parliamentary level, provide a forum for the exchange of ideas and discussions, and disseminate information of common interest.

ADA is recognised as the national representative of the Internal Drainage Boards in England and Wales.

Ian Moodie

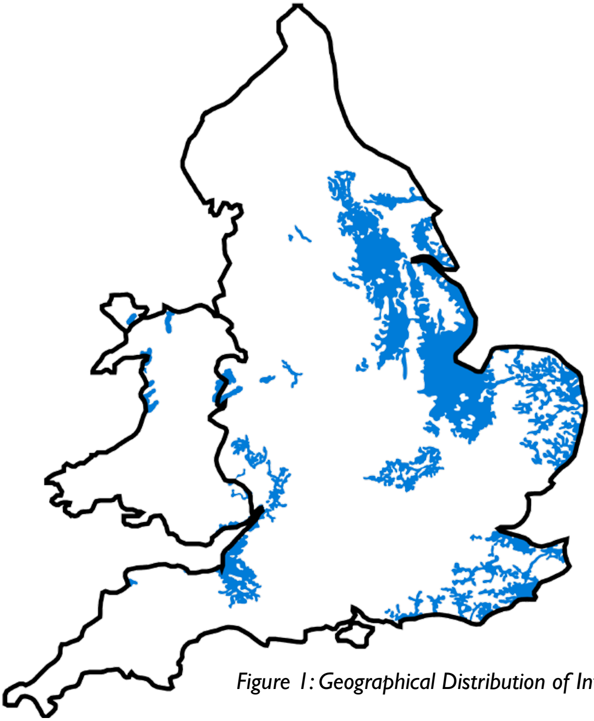

Figure 1: Geographical Distribution of Internal Drainage Districts in England and Wales

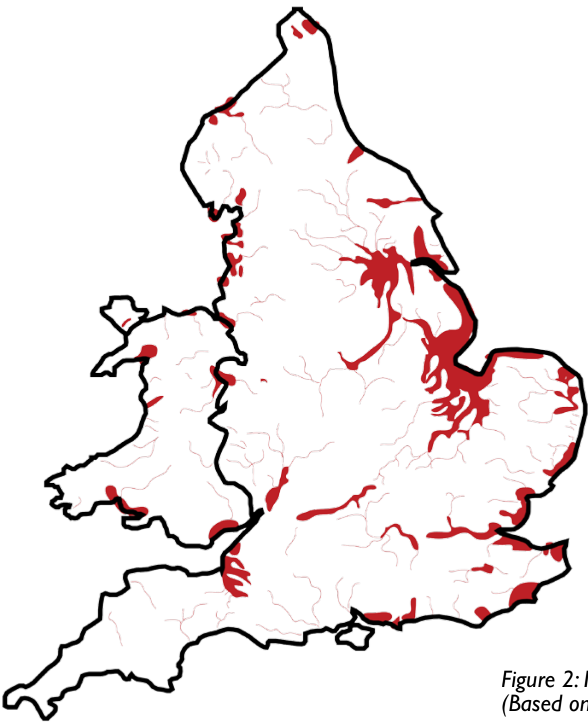

Figure 2: Indicative Flood Risk Map for England and Wales (Based on Environment Agency Flood Zone 2 data)

Water Level Management

About Water Level Management

Water Level Management is the close management of water levels in watercourses and underground for the purpose of reducing the risk from flooding and for the sustaining of land uses and the environment.

Low lying areas of England and Wales particularly require the daily close attention of specialist local water level management bodies to actively manage and reduce the risk of flooding. ***Internal Drainage Districts*** (IDD) across England and Wales can be used as an effective proxy for areas where careful water level management is required, as figures 1 and 2 illustrate. However, it should be noted that there are no longer Internal Drainage Districts in Cumbria, Essex, Lancashire, Northumbria and the Thames catchment.

About Internal Drainage Boards

Internal Drainage Boards (IDB) are local public bodies established by law in areas of special drainage need in England and Wales to undertake works to reduce flood risk and manage water levels on behalf of their community. They carefully manage water levels within their Internal Drainage Districts for land drainage, flood risk management, irrigation and environmental benefit.

Internal Drainage Boards cover 11.1% of England and Wales' total land area. They are geographically concentrated in the Broads and Fens of East Anglia, the Somerset Levels, Kent, Nottinghamshire and Yorkshire. The actions of IDBs contribute to the security of civil infrastructure within their districts including electricity supply for England and Wales.

Challenges facing the UK Electricity Sector

The electricity sector will undergo a dramatic transformation in the future owing to ongoing reforms of regulation and the electricity market. It faces three main challenges:

- **The retirement of existing generators**

  By 2020 up to a quarter of the UK's present power station capacity will reach the end of its operating life.

- **Installation of new low-carbon and renewable generators**

  Legislation such as the Climate Change Act 2008 and the EU Renewable Energy Directive 2009 requires around 30% of electricity to come from renewable generators by 2020 (Department of Energy and Climate Change) and electricity supply to be almost carbon free by 2030 (The Committee on Climate Change).

- **Increasing electricity demand**

  It is predicted that, as the greenhouse gas emissions associated with electricity generation decrease, sectors such as heating and road transport may shift to use electricity to reduce their emissions. This has the potential of doubling overall electricity demand by 2050.

These challenges will lead to increased development of power stations, particularly nuclear, wind and biomass. From current information available on the proposed location of new power stations it is highly likely that the management of water levels, particularly by IDBs, will play a pivotal role in the positioning and defence of these new developments.

Current Electricity Supply:

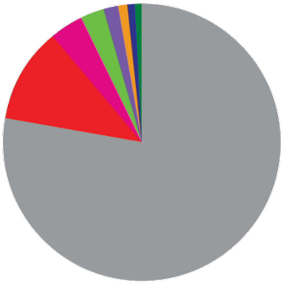

Figure 3: Operational power stations

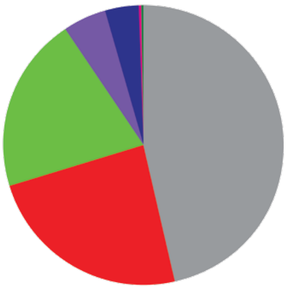

Figure 4: Power station installed capacity

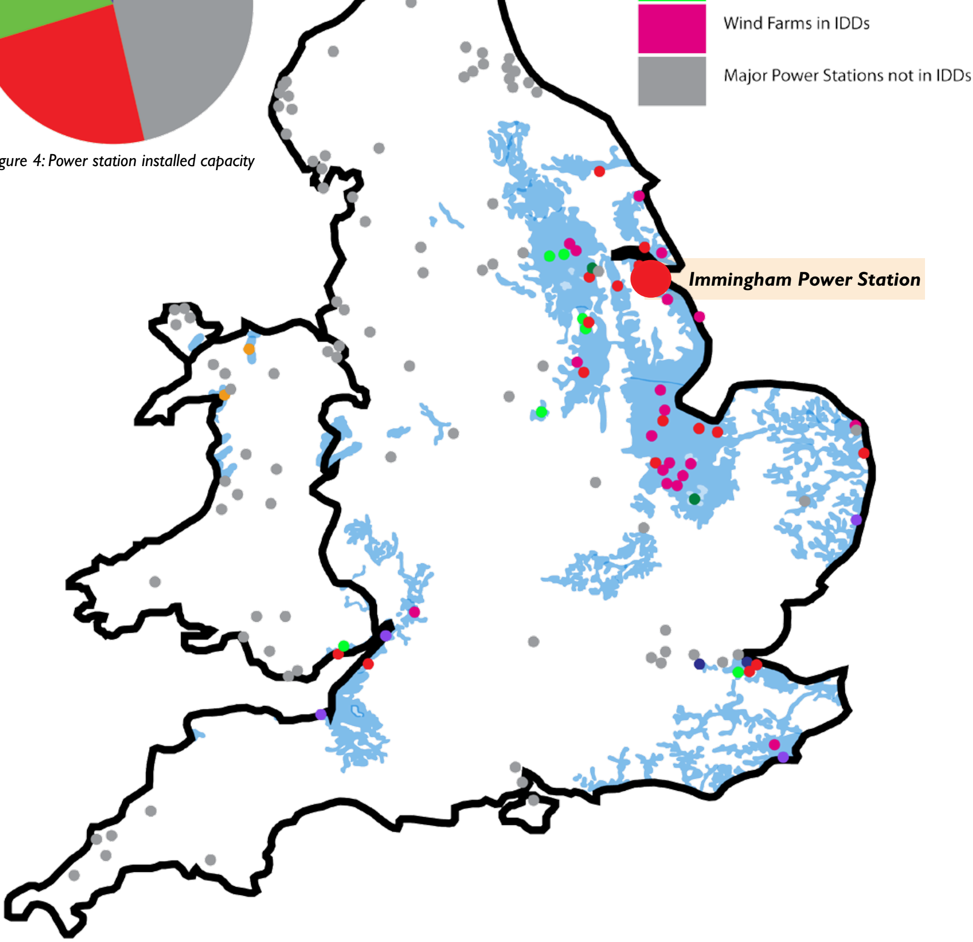

Figure 5: Major power stations in England and Wales and Internal Drainage Districts*
** Power stations with an installed capacity of greater than 1MW*

Generation

Within England and Wales there are 201 operational major power stations (those with an installed capacity >1MW) to meet the UK's high demand for electricity. These power stations use a variety of fuels – gas, coal, nuclear, wind, hydro-electric, biomass and oil – with the majority of electricity generation coming from gas (46%) and coal (32%). Of these major power stations 56 (or 28%) are located within an Internal Drainage District. This is a significant number considering that IDBs make up just 11.1% of the total land area of England and Wales.

Moreover, 53% of the installed capacity (potential maximum power output) of major power stations in England and Wales are located within an IDB. This demonstrates that a large proportion of significant power stations occur within Internal Drainage Districts and actively benefit from the actions of IDBs. If IDBs ceased to exist and their activity stopped, the majority of installed capacity is likely to become highly vulnerable to flooding. Furthermore, the infrastructure supporting these power stations such as power lines, roads and railways also benefit from the work of IDBs, securing their continued safe working.

There are other major power stations in England and Wales that occur in areas of potential flood risk, but are not located within an IDB. Tilbury and Coryton power stations in Essex would be at risk of flooding without existing flood defences. Interestingly, almost thirty years ago most of these power stations would also have been located within an IDB. Many of our major power stations also occur along our coastline behind sea defences maintained, in the main, by the Environment Agency.

Case Study: Immingham Combined Heat and Power Plant

There are four gas fired power stations within North East Lindsey IDB's drainage district in North East Lincolnshire. These, together with nearby oil refineries and chemical plants, require a very high standard of watercourse and drainage infrastructure maintenance to ensure the system operates efficiently at all times. The first two power stations were constructed at Killingholme in 1993, followed by the South Humber Bank Station at Stallingborough in 1997.

In 2001 Conoco Phillips proposed building a gas power station adjoining their oil refinery near Immingham with a capacity of 700 MW, providing power and steam for nearby refineries and electricity into the National Grid. The IDB was commissioned to conduct a feasibility study into the impact on the South Killingholme Drain arising from surface water from the 13 hectare site.

The drain extends 4 km from the power plant to an outfall into the River Humber, and contains a flood storage area developed by Lincolnshire Wildlife Trust and the IDB. In times of heavy rainfall excess water enters the storage area over a control weir, evacuating through flapped outfalls when water levels subside.

The study confirmed that the direct discharge of surface water from the plant could be accommodated by a combination of drain widening, culvert replacement, and additional water storage and control structures, which were agreed between the IDB and Wildlife Trust.

The improvement works were carried out by the IDB in 2003 and the plant commissioned in 2004. The liaison between the IDB and Conoco, from a very early stage, demonstrates what can be achieved by detailed consultation and local technical knowledge. The IDB is using its experience to assist with plans for a new 290 MW bio-energy plant to be built in 2012, 1 km from the Immingham plant.

South Killingholme Drain and Immingham Power Plant

Current Electricity Supply:

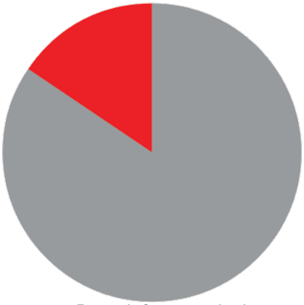

Figure 6: Operational substations

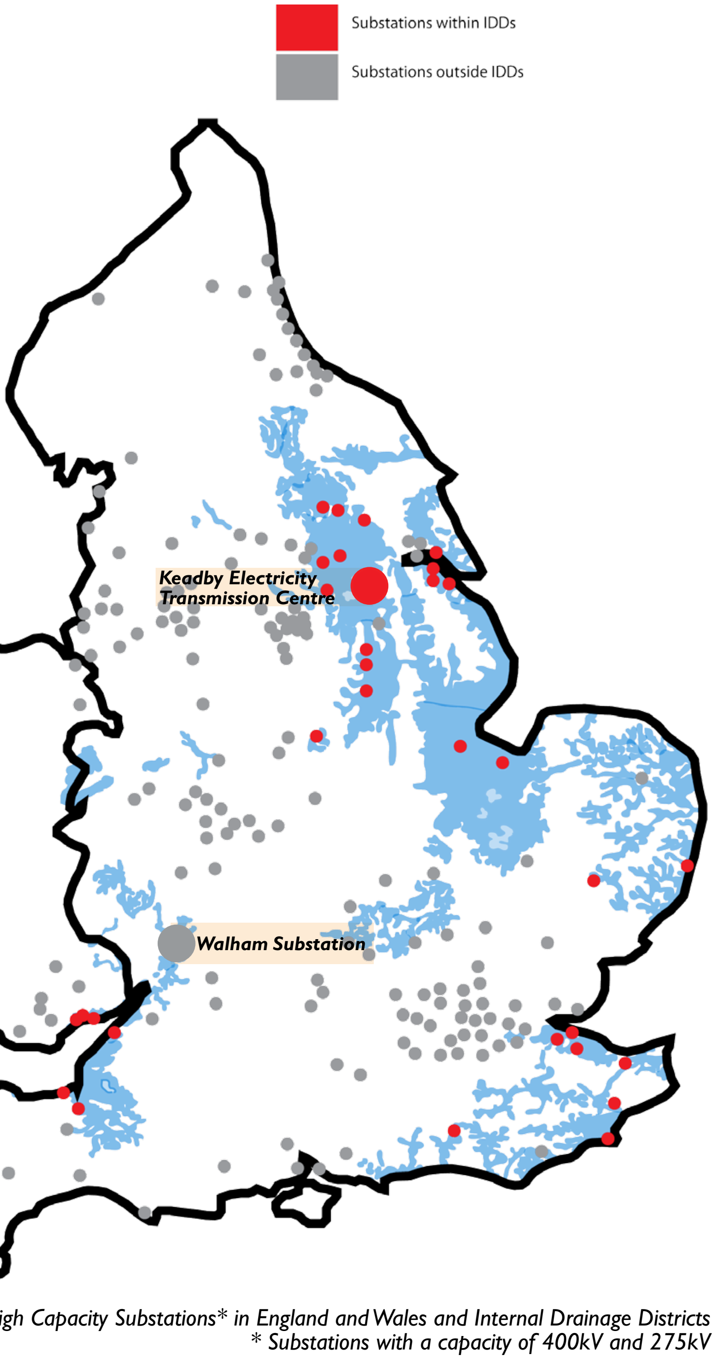

Figure 7: High Capacity Substations in England and Wales and Internal Drainage Districts*
** Substations with a capacity of 400kV and 275kV*

Distribution

Electricity distribution is as important to electricity supply as generation itself. The electricity grid is the national infrastructure for transmitting electricity from power plant to end user. It comprises a network of thousands of kilometres of cables that move electricity at high voltages, and numerous lower voltage regional distribution networks supplying electricity to homes and businesses.

Substations are necessary for the efficient operation of the transmission system, switching circuits or transforming voltage. Almost all homes, businesses, services and industries are reliant on the electricity transmitted through substations. Of the high capacity 400kV and 275 kV substations in England and Wales, 16% are found within Internal Drainage Districts. The actions of IDBs reduce the risk of flooding and damage to these sites and associated infrastructure (e.g. roads and pylons). This in turn helps ensure an uninterrupted energy supply to all that depend upon it.

Case Study: Walham Substation

Walham 400kV substation in Gloucestershire supplies electricity to half a million people. In 2007 the substation came within two inches of flooding. The army and fire service constructed an emergency one km wall around the site. However, the nearby Castle Mead substation did flood, disconnecting 42,000 homes and Netheridge sewage treatment centre. More permanent defences have been constructed around both substations since the floods.

Case Study: Keadby Electricity Transmission Centre

At Keadby, North Lincolnshire, there is a 400kV Electrical Transmission Centre operated by National Grid, and a 132kV Substation. The transmission centre is considered an Economic Key Point as many major power stations are connected to it, such as the nearby Keadby gas power station. The site serves part of the north-south power flow, vital to the electricity supplies of the UK.

Marshalling kiosks within both sites are less than 3 metres above mean sea level and contain wiring for control systems that would be rendered inoperable by flooding. The cost of outage would be far in excess of the cost of physical damage, with a best-case scenario of a one week outage to dry the circuits and a worst-case of up to nine months outage to repair a severely damaged control system.

Both stations lie within the Crowle catchment of the Isle of Axholme & North Nottinghamshire Water Level Management Board's drainage district. Water levels around the stations are reliant on 9 km of drainage channel and the catchment's outfall into the River Trent at Paupers Pumping Station. The pumping station's three pumps drain a catchment of 4,200 hectares and are currently being assessed for an upgrade as part of a drainage strategy being developed by the IDB. The IDB maintains the pumping station and the 105 km of drainage channels in the system with annual bank mowing and rodding, and reprofiling work every 15 years. If the IDB were to 'walk away' from providing this service, the transmission centre would soon flood as the catchment's outfall into the River Trent became inoperable and the watercourse blocked.

Figure 8: Planned nuclear power stations within England and Wales and Internal Drainage Districts

Nuclear Power

The Government stated in the 2008 Nuclear White Paper that nuclear power will have a key role to play in the UK's future energy mix. Nuclear power produces more energy than from the combustion of carbon and it emits less carbon dioxide. Subsequently, the Government has announced eight new locations for nuclear power stations in England and Wales. Of these 3 are located within IDBs. It is therefore imperative that those developing plans for these new power stations work closely with IDBs to ensure the proposed sites have adequate water level management. It is interesting to note that four other sites were nominated for nuclear development but were rejected. Dungeness was one such site that was rejected due to potential environmental impacts and concerns about future coastal erosion and flood risk.

Sizewell B Nuclear Power Station, located in the catchment of the East Suffolk Internal Drainage Board

Case Study: Hinkley Point C

The proposed EDF Hinkley Point C nuclear power station has been given the green light for preconstruction. It is anticipated to have an installed capacity of 3260 MW and will supply over 5 million homes in the south west. It is to be situated next to existing Hinkley Point B nuclear power station near Bridgwater, Somerset. Part of the site falls within the Parrett Internal Drainage District.

The IDB manages the Wick Moor and West Brook Rhyne which flows across the proposed site and is estimated to have a 1 in 100 year probability of flooding. The IDB has been meeting with EDF and other relevant companies to understand the impacts on and from the drainage regime in the area.

Although the positioning of the new power station only falls partially within the drainage district, there are six satellite sites around the development which are potentially at greater flood risk. These satellite sites include accommodation for workers, materials sites, bypasses and a park and ride scheme. It will be necessary to culvert some of the watercourses to secure access to these sites. EDF are working with the IDB to understand how this will affect the drainage system.

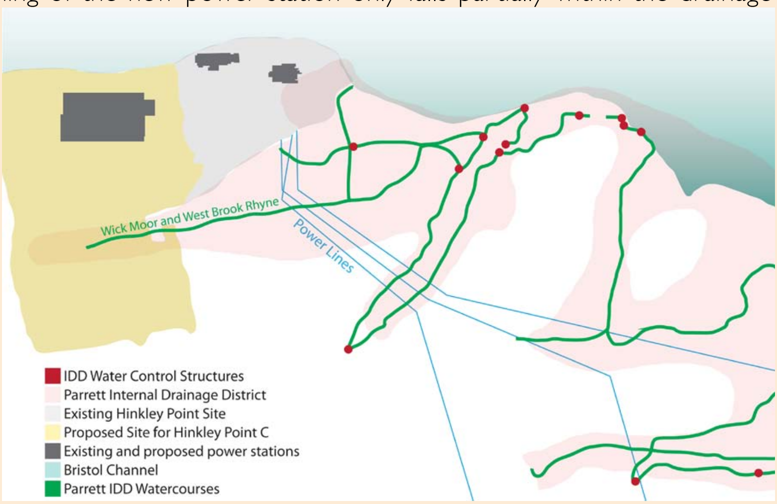

Figure 9: Water level management surrounding Hinkley Point

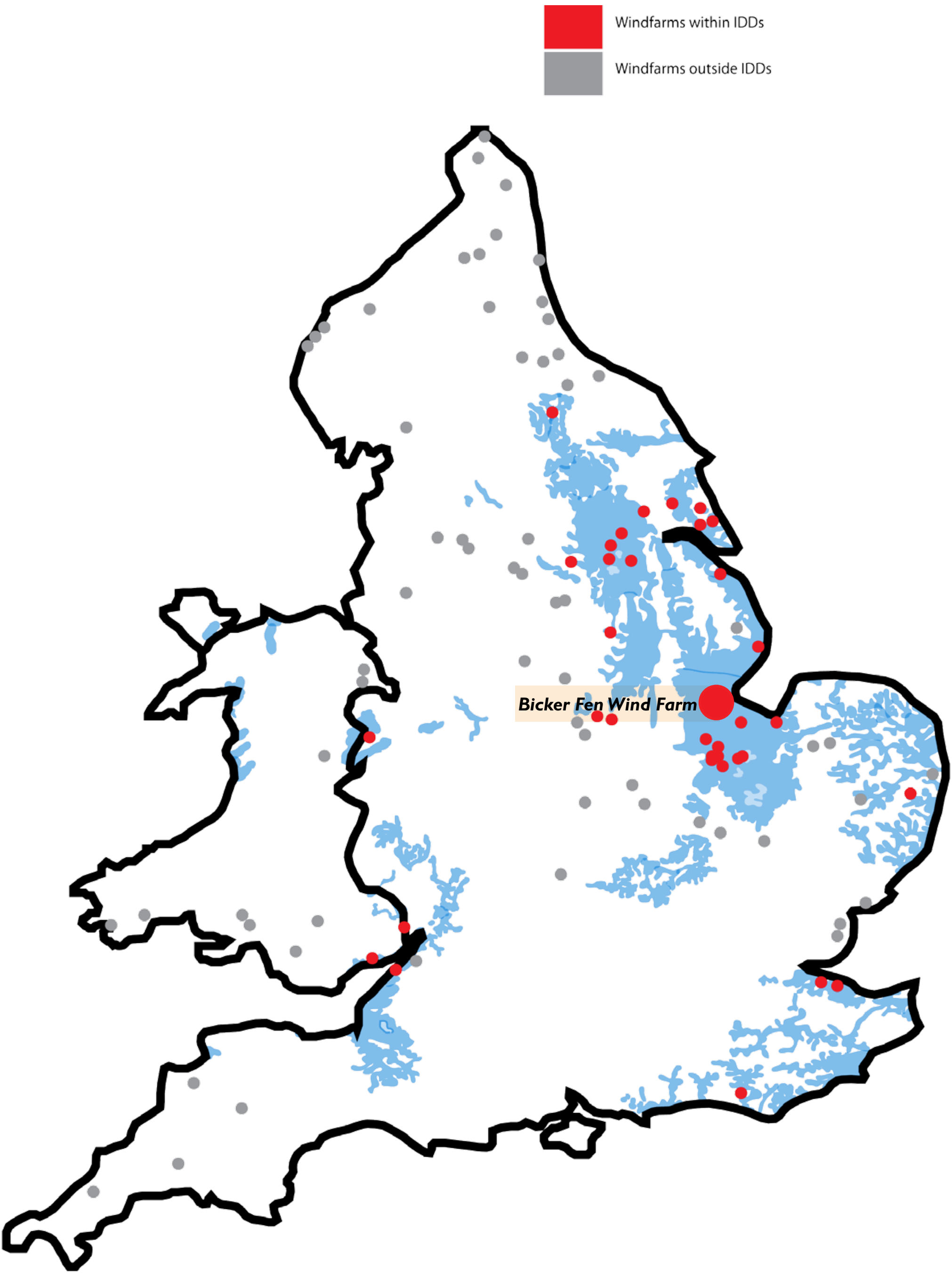

Figure 10: Consented wind farms within England and Wales and Internal Drainage Districts

Our renewable energy commitment

The EU Renewable Energy Directive 2009 commits the UK to sourcing 15% of its energy consumption from renewable sources by 2020. The UK Government's Renewable Energy Strategy suggests that by 2020 around 30% of our electricity could come from renewable sources, compared to around 6.7% today. Government policy is to encourage investment over the next 10 years in renewable energy, predominantly wind power and bio-energy, to achieve these targets.

Wind Power

Wind power is considered crucial to achieving the Government's Renewable Energy Strategy, with the capacity of electricity generated by wind power expected to increase by 2 GW per year for the next 5 years. Already 113 new onshore wind projects have been granted consent in England and Wales, a further 102 projects are in planning. Currently, 13% of major onshore wind farms in England and Wales are located within Internal Drainage Districts. This percentage is likely to grow as electricity suppliers look for exposed, flat sites for new wind farms. Such sites will need careful water level management to avoiding flooding or damage to associated infrastructure.

One of five wind turbines in Ransonmoor Drainage Commissioners district, near March, Cambridgeshire.

Case Study: Bicker Fen Wind Farm

Bicker Farm Wind Farm, Lincolnshire, consists of 13 turbines with an installed capacity of 26MW. The wind farm falls within the Bicker Fen catchment of the Black Sluice IDB. The lowest land level within the catchment is just 1.4m above mean sea level. The area would be at immediate risk of flooding without the drainage work of the IDB who maintain the principle watercourses in the 848ha catchment and pump its water into the South Forty Foot Drain. The pumping station, located North West of the wind farm, has a pumping capacity of 1416 litres per second. The construction of the turbines and related infrastructure required the culverting of a number of watercourses in the catchment, which was done in close consultation with the IDB. Another proposal for 28 turbines at East Heckington with a total installed capacity of 54MW is currently being considered by the IDB.

Figure 11: Water level management Bicker Fen Wind Farm

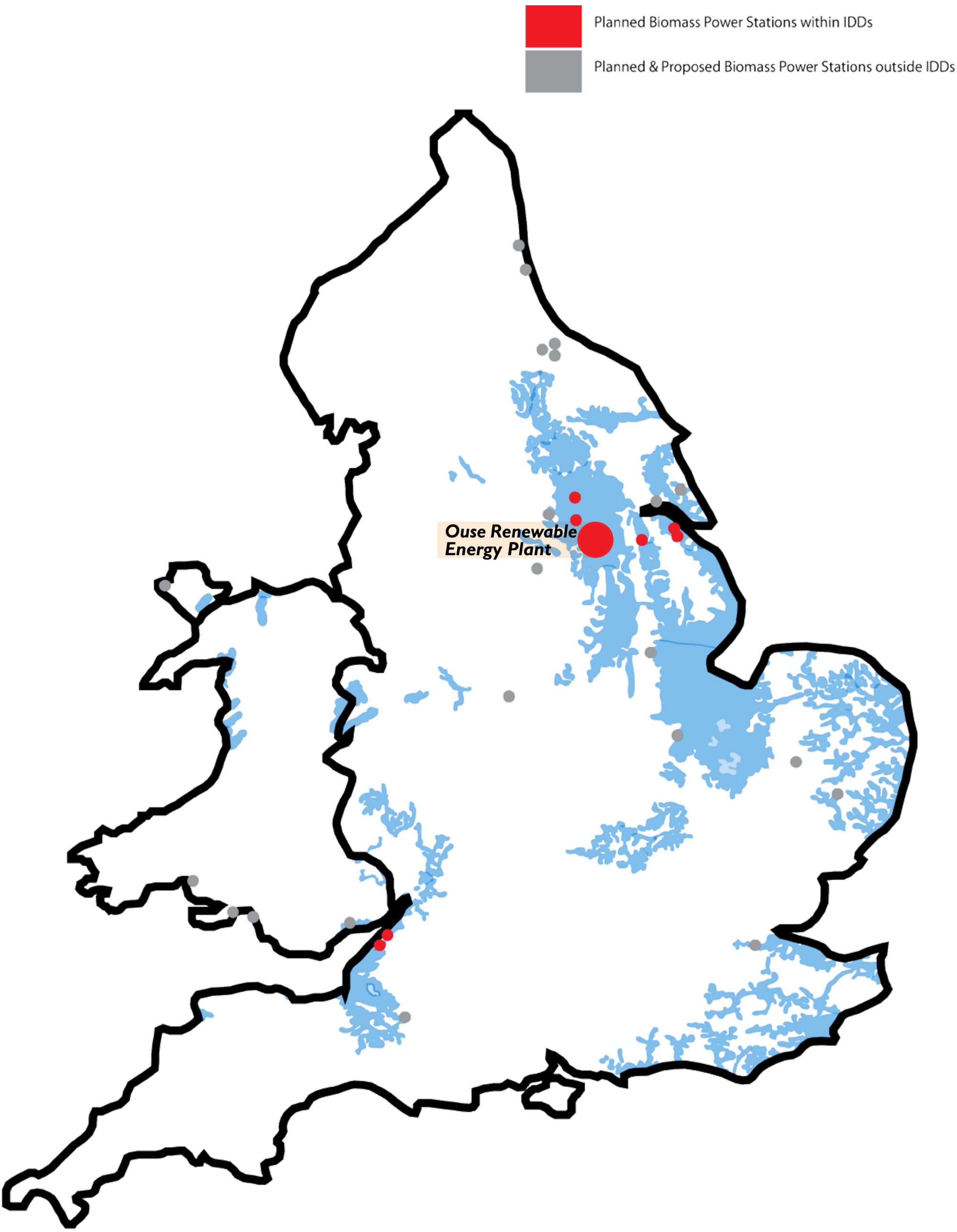

Figure 12: New Biomass power stations within England and Wales and Internal Drainage Districts

Bio-Energy

Bio-energy is renewable power made from material of recent biological origin derived from plant or animal matter, known as biomass. There are a range of biomass sources identified by the Department of Energy and Climate Change (DECC): virgin wood, wood residues, agricultural energy crops, agricultural residues, sewage sludge, animal manure, food waste, organic biodegradable waste, commercial, industrial and construction waste. Waste that would ordinarily be destined for landfill seems the most viable biomass source. Diverting waste from landfill and generating energy from it is both environmentally and economically sustainable.

At present, bio-energy is relatively new with only eleven significant biomass power stations operational in England and Wales, one of which is located within an IDB (Glanford power station in Scunthorpe & Gainsborough IDD, Lincolnshire).

Bio-energy could potentially provide about 30% of the 2020 target and hence will play a crucial role in achieving the Government's Renewable Energy Strategy. As of October 2010, 28 biomass power stations were in planning and four others have been proposed. Seven of these are located in IDDs. IDBs will need to be consulted on the planning and construction of new bio-energy power plants within their areas.

Case Study: Ouse Renewable Energy Plant

In August 2011, the Energy Minister Charles Hendry MP gave the go ahead for the construction of a 299MW biomass-fuelled power plant at the existing 4000MW Drax Power Station site in Selby, Yorkshire. The plant is predicted to save 1,800,000 tonnes of carbon dioxide each year and provide enough renewable electricity to supply 512,000 homes. The development is located in a low lying location close to the River Ouse within the Selby IDB. The site is drained by the Carr Dyke, maintained by the IDB. Drax is developing a drainage strategy for the development to ensure that runoff is controlled and the plant protected from any potential flood risk. Selby IDB has agreed a discharge of up to 1.4 litres per second per hectare from the new site into their system, an important aspect of the proposed plant's drainage strategy.

Micro-Generation

Micro-generation is the production of low or zero carbon, or renewable energy at a 'micro' scale. The main micro-electricity technologies are solar photovoltaic, and micro wind, hydro, and combined heat and power plants. These technologies could potentially reduce energy bills and increase energy security as part of a distributed grid of energy generation. Using financial incentives, the Government is encouraging consumers and communities to install micro-electricity technologies to help achieve its 2020 target.

The positioning of new micro-generation schemes is important as they can impact water level management, particularly in the case of micro-hydro schemes. The Environment Agency has developed a good practice guide for those implementing new hydro-power schemes. This includes assessing the impact on flood risk by analysing a variety of aspects such as the impact on river flow, river channel, and flood plain area. Some IDBs are considering installing micro-generation to offset the financial and carbon cost of their pumping activity.

Case Study: Low-head hydropower in Italy

In Italy, land owners and electricity companies are working with the Italian equivalent of IDBs to generate electricity from low head hydropower for isolated rural communities. Energy is generated from water rotating an Archemedian hydroscrew as it flows down a drop of as little as 1.5 metres.

CONCLUSIONS

- Much of the existing electricity supply network in England and Wales occurs in areas of potential flood risk. Many major power stations and substations are located within IDB areas and therefore benefit every day from the water level management IDBs carry out.
- New legislation and an increasing demand for electricity will lead to increased development of power stations (mostly nuclear and renewable) in areas of potential flood risk.
- These new developments will need to have good water level management, and IDBs will prove to be very important in helping to achieve this.
- It is vital that developments within or near IDBs consult with those responsible for water level management at all stages of the project, especially early in the planning phase.

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