

# The power of water

Helping create an affordable,  
low carbon economy for Northern Ireland.

Report



The  
power  
of water

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# Introduction

## by Chairman and Chief Executive of NI Water

Addressing climate change is the moral and practical challenge of our times. Not just for the health of our planet, but for the health of our children and grandchildren.

As the beneficiaries of the fossil fuel era, coming generations will expect us not just to have dealt with the consequences of climate change, but also to have put in place a sustainable future, including here in Northern Ireland.

Doing that, however, means being clear about three things: what needs to be done; the policy drivers required to make it happen; and the individual and collective role of organisations such as NI Water, in pursuing that net zero, sustainable future.

### **First, what needs to be done.**

To build a zero-carbon economy there is a clear need to green both the generation of electricity and the way companies such as NI Water use it. The generation technologies - solar, wind, hydro, hydrogen - exist, as do the means to significantly increase the efficiency of power usage. The key is to find the way, collectively, to apply them.

That includes de-carbonising the transport system, public and private. Mostly that will be by electrification, but for heavy transport, including buses, sustainable fuels such as green hydrogen offer a realistic alternative.

And there is also a need to find the means to reduce industrial emissions in

production in areas such as cement, plastic and chemicals as well as re-imagining our agrifood sector.

To achieve all this there needs to be a clear sense of direction in public policy, as well as a recognition of the need to fully embrace all the available economic, social and natural capital. No one sector can deliver the sheer scale of investment required. Public, private and third sectors all need to work together to create the level of innovation and investment required to build a sustainable future.

And in Northern Ireland that is possible. We may be a small region on a small island, but we have at our fingertips the means to be an exemplar in the net zero world.

We have a key natural resource - the wind. We have an all-island single electricity market committed to net zero. We have universities at the leading edge of enabling digital technology. What we now need to find is an agile way to harness administrative and governance systems designed for a different era to deliver the innovation, collaboration and urgency needed to make net zero a reality in Northern Ireland. Just as Climate Change does not respect institutional boundaries, neither should the response.

And it is in that spirit that this report has been written. What it details is work in progress, a contribution to the conversation, not the final word.

What it does underline, however, is the potential for NI Water's assets to become a catalyst for transforming our energy system.

Northern Ireland has made huge progress in recent years in transitioning from fossil fuels to renewable energy, helped by our status as one of the windiest parts of Europe.

Half our electricity now comes from renewable sources, but we are still dependent on fossil fuels to maintain supply when the wind doesn't blow, or the sun doesn't shine. In addition, we still waste valuable resources by turning off wind turbines when demand is low, at night-time for example.

It is that paradox we need to address. Collectively we need to create much greater flexibility in the way we generate, store and use energy. Using existing, proven technologies NI Water is working towards a range of potential answers.

Our Intelligent Operations Centre will use advanced data analytics to actively control when and how much electricity we use. As the biggest consumer of electricity in Northern Ireland this will help Northern Ireland Electricity Networks balance supply and demand at peak times.

Our 3,000 sites spread across Northern Ireland also have the potential, planning policy permitting, to host batteries which can store electricity from renewable sources and feed it into the grid and local networks as required.

Our reservoirs could also be used not just to store water, but also as a source of energy which could be released at critical times of the year when demand exceeds renewable energy supply.

More radically, results from our recent Hydrogen and Oxygen Pilot at Kinnegar Wastewater Treatment Works (WwTW) have shown how NI Water's early investment in electrolysis has the potential to be a real energy game-changer.



The supply of green hydrogen that electrolysis produces could help start the shift away from our historical dependence on diesel to power Northern Ireland's public transport, including buses, and heavy goods vehicles - and improve our air quality in the process.

Equally significant, however, the Kinnegar Pilot confirms that the oxygen 'by-product' that electrolysis produces could increase the capacity of some of our wastewater treatment plants by 25%. Whilst more work needs to be done, that is a significant development in helping us think about how we address the constraint on growth in too many of our towns and cities.

Taken together what these projects confirm, is that change is possible, if collectively we can agree and implement a common approach. NI Water is all too aware that we cannot deliver a sustainable future on our own and will need to keep working with our partners across government, the other utilities, the regulator, business and the third sector. This report is intended to help facilitate those conversations - now all of us must innovate, collaborate and act with urgency.

**Dr Leonard J. P. O'Hagan CBE DL Chairman  
& Sara Venning CEO**

# The Changing Energy Context

As Northern Ireland decarbonises, most of our future energy requirement will be for green electricity.

In the next ten years we will need to double our renewable generating capacity. Most of that could come from wind generation to take advantage of Northern Ireland's position as one of the windiest locations in Europe.

That, however, means we must find new ways both to store the surplus energy wind farms produce when demand, as at night-time, is low, and to cope with the lack of available energy when the wind doesn't blow.

Already 15% of generating capacity must be turned off, and is therefore wasted, and that figure is only going to grow as we move from 50% of our electricity coming from renewable sources to 70%.

It is that need for flexibility both to maintain security of supply and make full use of our generating capacity that is the defining challenge as we enter the renewable energy era.

In the fossil fuel age that flexibility came on the 'supply side'. To make sure supply always matched demand fossil fuel power stations increased or decreased their output according to need. As we move towards Net Zero, that safety net will disappear, so we need to find new ways to create the resilience the system needs.

And, fortunately, new ways of creating that flexibility are emerging to help us both deliver against our carbon commitments whilst ensuring we maintain a reliable and secure supply at an affordable cost.

**15%**  
of generating capacity has to be turned off.

**50%**  
of our electricity coming from renewable sources.

**Northern Ireland needs to double its renewable generation by**  
**2030**

Demand side response and energy storage are two key components of this new flexible energy:

**Demand side response -**

Consumers will be rewarded by paying less for changing how and when they use electricity, using more at off peak times and less at peak times.

**Energy Storage -**

New methods need to be deployed to store energy when it is plentiful for use at times when it is needed.

In combination these two components will help spread the load on the network creating short-term flexibility during periods of peak demand, or for even longer stretches when there is an imbalance in demand and supply caused by variations in the weather or unplanned outages.

The more we develop our capability both to manage demand and support supply through storage, the more we will be able to integrate sustainable energy sources into our supply

system. NI Water can use its experience and assets to help do both and to do so affordably.

For years large energy users in Northern Ireland such as NI Water have bought electricity linked to the price of gas which is the main fossil fuel used to generate power. As we move towards a decarbonised society, we have identified the ability to buy electricity linked directly to the price of indigenous renewables in Northern Ireland. This brings price visibility and cost certainty as well as enabling the local electricity system to decarbonise in a cost-efficient way for all.

The key is to use each of these different elements in a coherent, strategic way.



# Intelligent Operations Centre

As a public body and Northern Ireland's largest consumer of electricity, NI Water has an obvious responsibility, and needs to manage its demand for electricity in the most efficient and effective way to help ensure the resilience and security of supply in the wider market - using less at peak times, and more when the supply is greater than demand.

Key to that, is the creation of the NI Water Intelligent Operations Centre (IOC) currently under construction. This uses high resolution data from our water and wastewater 'production line' assets to create the necessary flexibility in our energy usage.

- Better day-to-day management of when we use our pumps and other equipment.
- Increasing our ability to predict, and therefore manage, peaks and troughs in the water and waste systems in the short and medium term.
- Delivering a holistic view of the overall operation which will allow a more strategic, joined up approach to planning future investments whilst considering the extra capability innovation can deliver.



NI Water is Northern Ireland's single, largest electricity consumer.





# Batteries

# 3000

widely distributed  
grid-connected sites.

Whilst the IOC will help NI Water, and by extension Northern Ireland, manage its demand for electricity, batteries could be equally vital in helping support supply at periods when the wind isn't blowing and the sun isn't shining - the key variability in a Renewable Energy System.

Batteries can store renewable electricity at times when demand is low and then release it when it is high, but to be effective that may require consideration of an enterprise battery solution for Northern Ireland - a solution which could help balance supply and demand at a local and regional level.

That, in turn, may need multiple sites on which to install the batteries, the access to wind or solar energy, and the cyber secure connections to link the batteries in each location to the grid.

NI Water already owns some 3,000 sites spread across Northern Ireland with connections which meet the highest technical requirements. It also has, as it is required to for resilience in operating critical national infrastructure, a fleet of 250 diesel standby generators which will need to decarbonise to align with future emission regulations.

There seems, therefore, an obvious synergy between NI Water's assets and the role an enterprise battery solution could play in helping to balance demand and supply in the renewable energy era.

Such an alignment would cut costs by doing away with the need to buy new sites for the batteries and construct the necessary grid

connections. It would seem likely that any alternative solution would have to meet each of those substantial costs so adding to the overall price of supplying electricity and water in Northern Ireland.

Avoiding duplication of effort and costs, therefore, has clear advantages for Northern Ireland as a whole, but it would need to be delivered, and funded, as a joint enterprise across government, the utilities and the regulator.



**Opportunity  
to lower costs  
for water and  
electricity  
customers.**



Tentative steps in that direction have begun. To show the potential of such an approach NI Water plans to install 6 MWh of batteries as part of our PC21 work at sites including Dunore near Antrim. This will provide greater resilience for both NI Water and the wider network, as well as generating income which can be used to offset other costs.

NI Water and NIE Networks (NIEN) have also begun to map how their physical assets align to understand the full potential and feasibility of such a joint approach.

# Pumped Hydro Storage

Batteries are one key tool in addressing the impact of intermittent weather on the electricity supply, but at this stage of their development they are most effective over a short to medium duration.

Another solution is needed to address more prolonged periods of intermittency such as in winter when the wind may not blow or the sun shine sufficiently for several weeks at a time.

In Britain nuclear power will help to address this challenge in the future. However, there are no nuclear plants on the island of Ireland.

## **We need, therefore, alternative solutions.**

Pumped hydro storage could be one. It uses surplus electricity from renewable sources at off-peak times to pump water from low ground to a reservoir at a higher elevation so increasing its gravitational potential energy.

When it is needed the reservoir is then opened and the gravity pulls the water down through turbine generators creating electricity which could be used over a prolonged period.



NI Water inherited a diverse range of such reservoirs - some large, some small, some in use and some de-commissioned - which could be used to produce hydro power. At Camlough, for instance, a pumped hydro scheme was under construction in the early seventies but was halted.

The demands of the renewable energy era, however, suggest that we need to think again about how we can revitalise such assets as part of an integrated energy plan for Northern Ireland.

# Electrolysis: the power of water released

Whilst using our electricity supply more intelligently and efficiently through the Intelligent Operations Centre and using a combination of locally deployed batteries and hydropower could be vital ingredients in securing our renewable energy system, the greatest potential game-changer could be through electrolysis. This has been confirmed by the results of a 10 kilowatt (kW) pilot project which has just completed at Kinnegar WwTW in Holywood and a large 1 megawatt (MW) Demonstrator model will arrive in Belfast by the end of 2021.

Using recycled wastewater and renewable power sources, electrolysis produces hydrogen and oxygen which can be used both to help decarbonise our transport and heating systems whilst the oxygen, which is produced simultaneously, can increase waste processing capacity and enable our towns and cities to grow.

It is possible that deploying 120 MW of electrolysis capacity across the top 30 wastewater sites in Northern Ireland would incentivise wind and solar farm developers to invest to a similar scale, safe in the knowledge that the output of such schemes could be put to maximum use rather than having to be curtailed off-peak.



**Increase processing capacity and reduce carbon emissions**

Such certainty is often the difference between a decision to invest or not and, therefore, will be vital if Northern Ireland is to add the extra 1,600 MW of renewable generation needed to meet its 2030 target.



# Green hydrogen

In the next decade electric vehicles will increasingly replace petrol and diesel cars.

That transition is technically more difficult for heavier goods and passenger vehicles. A different form of alternative fuel will have to be found for them and green hydrogen is the most likely candidate.

A network of electrolyzers spread across Northern Ireland at 30 locations could give each major town ready access to their own low-cost green hydrogen to power local transport. Knowing hydrogen is available could give the owners of bus, lorry and agricultural fleets the confidence to switch from polluting diesel to a green, locally produced fuel.

**We could produce enough hydrogen to fuel**

**1300** large vehicles running a day.

It is estimated enough hydrogen could be produced to keep 1,300 large vehicles running per day without having to rely on imports, some of which might come from less renewable processes.

Another use for the hydrogen would be to feed into the local gas network to help its low carbon transition as is already being piloted in Britain.



# Oxygen

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The results of the 10 kW electrolyser pilot just completed at Kinnegar WwTW showed how the use of oxygen could transform the operation of some of our major wastewater treatment works.

These conclusions will be further tested using a larger scale 1 MW Demonstrator model which will arrive by the end of 2021.

Already it is clear, however, that oxygen - along with other measures - can be used to improve the aeration process by 25% and, therefore, increase the efficiency and capacity of existing wastewater treatment plants, potentially creating more headroom for local development.

A legacy of underinvestment in our wastewater treatment works has meant that the ability of too many of our towns and cities to grow has been constrained meaning they cannot reach their natural potential.

Under current plans, it will take 18 years to address the issue through traditional means, even with elevated levels of funding. Using oxygen produced by electrolysers at a local level, along with other measures, offers the possibility of a different solution.

Clearly much will depend on the outcome of the Belfast Demonstrator, but there is already enough evidence to suggest that a network of electrolysers, and the oxygen they produce, could be part of the answer to this long-standing problem in Northern Ireland.



# A low carbon economy?

The drive for green growth is also encouraging NI Water to think about how it can help other sectors of the Northern Ireland economy benefit from the transition to low carbon by building on our traditional strengths of engineering and agriculture.

The need for electrolyzers at scale opens at least the possibility of constructing them in Northern Ireland, using both our early engagement and history of engineering excellence as a platform to launch our involvement in what is going to be a significant global market.

There would also seem to be major opportunities in agriculture.

Northern Ireland can be rightly proud of its agriculture sector and the quality of food it produces. But that success has come at a price to the environment. It is carbon intensive. In 2019, 26% of Northern Ireland's carbon emissions came from agriculture compared to 10% in the UK as a whole.

Vertical, multi-layered greenhouse farming is one possible solution. It requires a combination of water, heat and land - all which NI Water has at its wastewater plants.

Wastewater effluent has an ambient temperature of 15 degrees which is currently not harnessed. Vertical farming would allow that surplus heat to be harnessed and used at our wastewater treatment works turning them, in effect, into renewable resource hubs, a key ingredient of the circular economy.

This is already beginning to happen elsewhere in the UK.





# Next steps

Transitioning to a low carbon, green growth economy poses huge challenges for Northern Ireland, but also creates huge opportunities.

The greatest of those opportunities is to substitute local, low carbon sources of energy for our historic dependence on imported, high carbon fuels.

Key to that is innovation, collaboration, and a sense of urgency in addressing how Northern Ireland, as a whole, can maximise its natural assets to power its water, electricity and transport infrastructure.

That involves issues which go beyond NI Water's remit, but there are clear steps we can take, and are taking to help create the necessary momentum.

## Electricity storage



NI Water and NIEN are currently engaged in a joint exercise to map their assets and understand the synergies between them and how they could be used to develop new and existing demand response and energy services.

This exercise will look specifically at how the two organisations could align their control systems and cyber secure infrastructure to maximise their use of both existing assets such as water pumps and potentially new and innovative assets such as electrolysers, stand-by generators and new forms of energy storage whatever form that takes, battery, kinetic or heat.

Hydro pump storage systems are another storage option, and a similar mapping exercise/study needs to be carried out to understand the potential of NI Water's past and present reservoirs to act as a reserve power system for when the wind isn't blowing and the sun isn't shining.



# Electrolysis



The 1 MW Belfast Demonstrator will build on the results of the successful 10 kW Kinnegar Pilot.

It is intended that its emerging findings will then be used to test the benefits of applying 10-15 MW of electrolyzers to the operation of an entire works before a potential roll-out across Northern Ireland.

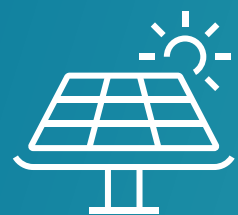
The deployment at a single plant would demonstrate how electrolyzers can:

- Optimise the performance of a wastewater treatment works using oxygen to increase capacity.
- Deliver enough hydrogen to fuel 150 buses or large vehicles.
- Be used to help SONI (Electricity Transmission System Operator for Northern Ireland) flex supply and demand in the wider Northern Ireland electricity market.

In doing so it could help create the confidence amongst users and investors that a full roll-out is both feasible and desirable - and indicate the potential to address the constraints on growth that wastewater capacity issues currently pose at a local level.

To enable this rapid scaling up to happen, discussions have begun about the possibility of building and operating an electrolyser factory in Northern Ireland to supply both the local and international market. It is estimated that this could create 50 to 100 highly skilled jobs, as well as helping Northern Ireland get ahead of the quickly growing global demand for electrolyzers. That demand means there is already a waiting list of up to two years for fresh orders, but in Northern Ireland, because of the early stage at which NI Water engaged, there is the opportunity both to keep ahead of the queue and participate in a booming global industry. Failure to do so would mean that opportunity being lost and Northern Ireland losing its early advantage.

# A low carbon economy?



The transformation of our wastewater treatment works into Renewable Resource Hubs could encapsulate the transition to a low carbon economy in Northern Ireland.

Using the ambient heat from our works to power large scale greenhouse agriculture could not only address Northern Ireland's biggest source of carbon, but also help diversify farming in this country.

Two such schemes are already under construction in East Anglia. Northern Ireland has the chance to learn from those early adopters, as well as to apply the additional lessons we are learning from our own early investment in electrolyzers. Clearly this will require a comprehensive study which goes beyond NI Water's remit, but the potential to transform one of our leading industries is there.

# Conclusion

The transition to a renewable energy era is gathering pace. 2030, when new petrol and diesel cars will no longer be available is less than a decade away.

The speed of that transition, and the time it takes to devise and implement new ways of doing things, means that we must start thinking now about how we are going to adapt to the demands of the new era.

Northern Ireland is no different in that regard from any other country. We do, however, have some natural advantages.

Wind power, because of our geography, is one. But it is how we harness that natural advantage that counts. Can we create the kind of integrated, flexible, low carbon, low energy cost system the new era will demand?

Can we align the need to decarbonise with the need to grow our economy?

Answering those questions will require three basic things: innovation, collaboration and a sense of urgency. Northern Ireland has shown repeatedly that we can innovate - and NI Water hopes that the developments outlined in this report build on that rich history.

The key, therefore, is whether we can summon the institutional and political will to realise the potential that innovation can unlock. In the answer to that lies Northern Ireland's future, and that of generations to come.



**#PowerOfWater**

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