Protecting Consumers: Our onshore wind energy opportunity

A detailed analysis of the potential for more onshore wind energy in Ireland

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FOREWORD FROM WIND ENERGY IRELAND

Energy independence, a prize worth fighting for

Onshore wind energy is our most affordable source of new electricity.

It is clean, it is secure, it creates jobs at home and it supports communities in rural Ireland.

Irish wind farms provide more than a third of the country's electricity – a higher share from onshore wind than anywhere else in Europe – and have saved consumers nearly €840 million since 2000.

Without them we would spend more than a billion euro a year on gas, chiefly imported, for electricity generation.

While momentum continues to build behind offshore wind energy it is on our onshore projects we must rely for our 2030 targets and which will continue to provide the bulk of our renewable power until well into the next decade.

Build faster

Put simply, we need to build more, faster, and more affordably or face billions in fines identified by the Irish Fiscal Advisory Council and the Climate Change Advisory Council.

This new report from MKO, Protecting Consumers: Our onshore wind energy opportunity, a detailed analysis of the potential for more onshore wind energy in Ireland, shows us that we can do just that.

We have just over 5,000 MW connected to the electricity grid. Another four thousand have secured, or applied for, planning permission which could get us close to our existing 9,000 MW target.

MKO's detailed and painstaking analysis maps every single household and business in Ireland, identifies every environmentally protected area, every river, lake and stream, develops a coherent national approach on landscape and identifies the total space left in Ireland for onshore wind energy development.

Out of this area – roughly 1,302 square kilometres or less than 2 per cent of the country – the authors estimate, conservatively, that at least another 6,000 MW of onshore wind energy could be produced beyond the current 9,000 MW target.

Challenges

There are still challenges.

Some of the most suitable locations identified are in areas with a weak electricity grid network. That is why investing in upgrading our grid is so important, to get affordable, clean, energy from where it is produced to where it is needed.

Other locations might be difficult to develop at the right cost. That is why we, supported by the rest of the renewable energy industry, have been calling – for five years – for a cross-departmental and independently chaired task-force to identify how we can lower the price of renewable electricity in Ireland.

They may be big challenges, but the prize is big too – energy independence.

We cannot build a strong, resilient, low-carbon economy if we are relying on imported expensive fossil fuels.

Our future must be our own, one built on a foundation provided by the clean, affordable and secure energy that only our industry can provide.

Ireland's onshore wind farms, supported by new offshore wind projects, solar, storage and a new generation of advanced interconnectors, will secure the future of a prosperous, competitive, country in which our families and our businesses can thrive.

That's a prize worth fighting for.

Noel Cunniffe

CEO, Wind Energy Ireland

EXECUTIVE SUMMARY

Wind Energy Ireland commissioned MKO to assess and quantify the potential for further onshore wind energy development in Ireland. The government target for onshore wind deployment is ambitious, set at 9GW, as outlined in the Climate Action Plan, 2024. This target partly delivers on the Government's broader goals of decarbonising the economy, meeting growing electricity demand, and transitioning away from dependence on imported fossil fuels.

At present, over 9 GW of onshore wind farm projects are at various stages of development. Of these, approximately 5.25 GW are already connected and operational or currently under construction, approximately 2.5 GW have secured planning permission but are not yet built, and another 1.5 GW are seeking planning permission or are the subject of judicial reviews. This study took account of 365 wind farms and 3,190 individual wind turbines, which together make up the 9+ GW of existing, permitted and projects in planning, currently occupying two percent of the country's land area.

The path to delivering on the Government decarbonisation and energy transition goals is fraught with a multitude of restrictions, barriers, and blockages to wind farm developments. These challenges include physical, environmental, geographical, regulatory, technical, and commercial factors. Recognising the finite quantum of land in the country and the resultant finite onshore wind energy potential, this study provides a comprehensive, methodical assessment of Ireland's future onshore wind energy resources.

This assessment involved a detailed constraints analysis and capacity analysis, taking into account project attrition to estimate the future potential. A GIS-based constraints analysis and mapping methodology was employed to identify likely or potential impediments to onshore wind energy development, map these constraints, and determine unconstrained areas suitable for wind energy projects.

This analysis has established that the 'Theoretical Viable Area' (TVA) that could potentially accommodate wind energy development, taking account of all the planning, environmental and design constraints considered, measures 1,302 km^{2}.. This area represents 1.86% of the mainland area of Ireland (excluding offshore islands) used as the study area in this analysis.

To quantify the future generation capacity for onshore wind energy based on the TVA, it was first necessary to establish a realistic generation capacity for modern wind farms development in Ireland. Analysis of the 14 most recent wind farms permitted by An Bord Pleanála up to February 2025 established they are achieving a generating capacity of 27.67 MW/km^2 of TVA mapped in this study, which is a higher range capacity figure used further in the analysis. A lower range capacity figure of 16.9 MW/km^2 was also calculated in this analysis, which may be more realistic of what can reliably be achieved across the entire country in future wind energy developments across the TVA.

Project attrition is highlighted in this report as a key risk to project development, resulting in a large theoretical potential becoming a much smaller realistically achievable potential. Project attrition risks arise at the land assembly, site feasibility, planning, grid connection and financing stages of projects. This report outlines how project attrition may result in a cumulative effect of a 74% reduction in an initial notional number of potential projects, with the consequence that a significantly larger quantum of land is required to deliver a desired installed generating capacity, than might initially be expected.

Based on the analysis undertaken in this study, depending on whether the higher or lower range MW/km^2 capacities can be achieved across the country, the potential future onshore wind energy capacity of Ireland, is estimated to range from 5,768 MW to 9,444 MW of new wind farm projects, over and above the approximate 9.25 GW already in operation, permitted or in planning. This study did not consider the repowering potential of the existing wind farm sites.

Recognising that spatial planning policy for wind energy development is going to be developed at a regional level, the future onshore wind energy capacity has also been assessed regionally. The Northern and Western Regional Assembly area accounts for 45% of the country's future onshore wind energy potential mapped in this study. The Southern Regional Assembly area accounts for 29%, and the Eastern and Midlands Regional Assembly area accounts for 26% of the country's future onshore wind energy potential.

Other potential impediments to wind energy development, but which are or could be policy-driven rather than physical or environmental constraints, were also considered in this study, and their potential impact on the TVA were quantified. These other factors include planning policy, potential Air Corps restrictions, and peatland.

Finally, this report makes five recommendations to ensure the full potential of the country's onshore wind energy resource can be harnessed to the greatest degree, as soon as possible. These recommendations relate to an increased Government target for onshore wind energy, a clear policy framework, significant transmission grid development and reinforcement, updated guidance and a national or regional-level landscape sensitivity calibration exercise.

This study has confirmed that Ireland has significant future onshore wind energy potential. The land and space undoubtedly exists across the country to significantly increase the amount of onshore wind energy that can contribute to the Government's broader goals of decarbonising the economy, meeting growing electricity demand, and transitioning away from dependence on imported fossil fuels, provided the correct policies are in place to harness this future potential.

1. INTRODUCTION

MKO were commissioned by Wind Energy Ireland to objectively assess and quantify the potential for the deployment of further onshore wind energy developments within Ireland.

The current Government target for onshore wind deployment is 9GW, as set out in the Climate Action Plan, 2024.

There is already over 9GW of onshore wind farms projects at various stages of development. Approximately 5.25 GW is currently connected and operational or currently under construction, approximately 2.5 GW is permitted but not yet constructed and a further approximate 1.5 GW is currently seeking planning permission or the subject of ongoing judicial review proceedings. Significant additional development activity is underway amongst Wind Energy Ireland's members to further assist in decarbonising the Irish economy, meet the growing electricity demand and transition away from a dependence on imported fossil fuels.

There are a multitude of restrictions, barriers and blockages to wind farm developments, including physical, environmental, geographical, regulatory, technical and commercial. There is a finite quantum of land in the country, and the country's onshore wind energy potential is also finite, but the full potential of the country's onshore wind energy resource has not been objectively and methodically assessed and quantified.

This study has quantifed Ireland's future onshore wind energy potential. This has been undertaken using detailed constraints analysis and capacity analysis while also taking account of project attrition to estimate the future onshore wind energy potential.

2. CONSTRAINTS ANALYSIS

To establish Ireland's future onshore wind energy potential, a GIS-based constraints analysis and mapping methodology was used. Constraints mapping involves identifying likely or potential impediments or restrictions to onshore wind energy development, mapping those constraints, and then overlaying those mapped constraints. Areas outside of the mapped constraints are deemed to be unconstrained and depending on a number of factors, potentially available for wind energy development.

All mapping was undertaken using ArcGIS Pro (Version 3.2.2) software.

2.1 Primary Constraints

Multiple constraints were identified and mapped as primary constraints for the purposes of this study. In the majority of cases, buffer zones were applied to the constraints. A buffer zone is a defined separation distance around an identified constraint, which for the purposes of this exercise, is considered to also be a constraint to wind farm development.

The primary constraints identified for this study were selected as being accurately representative of the constraints that would be applied in the identification of areas with potential to accommodate wind energy developments, and typical of the types of constraints that would be applied in the design of wind energy projects. The constraints identified and setback buffer zones applied to those constraints are typically always considered on a site-specific basis, when the precise nature of a proposed site is investigated and more fully understood. Therefore, the setback buffer zones applied to the primary constraints used in this study should not be considered as minimums or maximums, or industry standard, but are considered representative of what would be typically applied in design of wind energy developments at present. In this study, such constraints and setback buffer zones were applied to the entire country.

Some setback buffer zones around constraints for wind farm development relate to the dimension of a proposed wind turbine. In such cases, for the purposes of this study, a proposed wind turbine of 175-metres in tip height, 100-metre hub height and 150-metres in rotor diameter was selected. These dimensions are considered typical of a commercial scale wind farm based on current turbine technology and is representative of the size and scale of such wind farm projects currently progressing through the planning system.

Each primary constraint is described further below.

2.1.1 Properties

All domestic and commercial Eircodes from the 2024 Q3 Eircode dataset were used to identify the locations of properties nationwide. A "x4" tip height setback buffer zone was applied to each Eircode, to recognise the setback distances stipulated in the Draft Revised Wind Energy Development Guidelines[1], 2019, referenced off the tip height of any proposed turbine. For the purposes of this study, a turbine of 175 metres tip height was selected, resulting in a setback distance of 700 metres from each property when the x4 setback is applied. As a result of this approach, all settlements, villages, towns and cities are constrained out.

[1] *Draft Revised Wind Energy Development Guidelines. Department of Housing, Planning and Local Government, 2019*
https://assets.gov.ie/46097/6e68ea81b8084ac5b7f9343d04f0b0ef.pdf

2.1.2 Archaeological Sites and Monuments

All recorded sites and monuments from the National Monuments Service's SMR database were identified as potential constraints to wind farm development and the siting of wind turbines. For the purposes of this study, a 100-metre setback buffer zone was applied to each recorded monument in the SMR database. Given the scale of wind farm sites, wind turbines can be sited around and adjacent to recorded monuments, once the significance and setting of the monument is considered and fully assessed as being appropriate in the course of a planning permission application.

2.1.3 Rivers

All rivers and streams mapped in the Environmental Protection Agency's surface waters dataset were identified as potential constraints to wind farm development and the siting of wind turbines. For the purposes of this study, a 50-metre setback buffer zone was applied to each of these surface watercourses.

2.1.4 Lakes

All lakes mapped in the Environmental Protection Agency's surface waters dataset were identified as potential constraints to wind farm development and the siting of wind turbines. For the purposes of this study, a 100-metre setback buffer zone was applied to each of these lakes.

2.1.5 Special Areas of Conservation

All Special Areas of Conservation (SACs) mapped in the National Parks and Wildlife Service's (NPWS) December 2024 designated area spatial data[2] were identified as potential constraints to wind farm development and the siting of wind turbines. For the purposes of this study, a 200-metre setback buffer zone was applied to each of these SACs.

2.1.6 Natural Heritage Areas

All Natural Heritage Areas (NHAs) and proposed Natural Heritage Areas (pNHAs) mapped in the National Parks and Wildlife Service's (NPWS) designated area spatial data were identified as potential constraints to wind farm development and the siting of wind turbines. For the purposes of this study, a 200-metre setback buffer zone was applied to each of these NHAs and pNHAs.

2.1.7 Special Protection Areas

All Special Protection Areas (SPAs) mapped in the National Parks and Wildlife Service's (NPWS) designated area spatial data were identified as potential constraints to wind farm development and the siting of wind turbines. For the purposes of this study, a one kilometre setback buffer zone was applied to each of these SPAs.

2.1.8 National Parks

All National Parks mapped by the Department of Housing, Local Government and Heritage and published via the data.gov.ie data portal, last updated on 24/03/2023, were identified as potential constraints to wind farm development and the siting of wind turbines. For the purposes of this study, a 200-metre setback buffer zone was applied to each of these parks.

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[2] *National Parks and Wildlife Service* https://www.npws.ie/maps-and-data/designated-site-data/download-boundary-data

2.1.9 Overhead Electricity Transmission Lines

All overhead electricity transmission lines operated by EirGrid with rated voltages of 110kV, 220kV and 400kV were identified as potential constraints to wind farm development and the siting of wind turbines. For the purposes of this study, a 525-metre setback buffer zone was applied to the centre line of each transmission line, that being x3.5 the 150-metre rotor diameter (3.5RD) of the turbines modelled in this study, based on EirGrid's policy on wind turbine clearance to overhead lines[3].

2.1.10 Railways

All railways forming part of the Irish Rail network were identified as potential constraints to wind farm development and the siting of wind turbines. For the purposes of this study, a 300-metre setback buffer zone was applied to railways, that being x2 the 150-metre rotor diameter of the turbines modelled in this study.

2.1.11 Motorways, National Roads

All motorways and national roads forming part of the Transport Infrastructure Ireland road network were identified as potential constraints to wind farm development and the siting of wind turbines. For the purposes of this study, a 300-metre setback buffer zone was applied to motorways and national roads, that being x2 the 150-metre rotor diameter of the turbines modelled in this study.

2.1.12 Regional Roads

All regional roads forming part of the county road networks were identified as potential constraints to wind farm development and the siting of wind turbines. For the purposes of this study, a 150-metre setback buffer zone was applied to regional roads, that being one rotor diameter of the turbines modelled in this study.

2.1.13 Local Roads

All local roads forming part of the county road networks were identified as potential constraints to wind farm development and the siting of wind turbines. For the purposes of this study, a 75-metre setback buffer zone was applied to all local roads, that being one-half of the 150-metre rotor diameter of the turbines modelled in this study, thereby ensuring there is no oversail of turbine blades over local roads.

2.1.14 Landslide Susceptibility

All areas rated as having a "High" susceptibility to landslides according to the Geological Survey of Ireland's landslide susceptibility map[4] were identified as potential constraints to wind farm development and the siting of wind turbines.

2.1.15 Landscape Sensitivity

There is no single coherent landscape policy for the country that can be easily used as a constraint for as exercise such as this study. Existing landscape policies originate at Local Authority level and relate to

[3] *Policy on Wind Turbine Clearance to OLH's Rev 1. EirGrid, July 2014*
https://cms.eirgrid.ie/sites/default/files/publications/Wind-Turbine-Clearance-Policy.pdf
[4] *National Landslide Susceptibility Mapping Project, Geological Survey of Ireland, 2016*
https://www.gsi.ie/en-ie/programmes-and-projects/geohazards/projects/Pages/Landslide-Susceptibility-Mapping.aspx
https://www.gsi.ie/en-ie/publications/Pages/National-Landslide-Susceptibility-Map.aspx

individual counties and show significant incoherence and variation in terms of methodologies, terminologies and classifications across different counties. The need for rapid decarbonisation of the Irish economy via the deployment of renewable technologies such as wind energy is clearly outlined in international and national policy and legislation. These international and national targets and obligations have frequently run into the barrier of local landscape policy, in the absence a coherent national or even regional approach to classifying landscape sensitivity to development such as wind energy.

To overcome the lack of a national or regional landscape policy and in order to incorporate a landscape sensitivity dataset into this Future Onshore Wind study, MKO separately conducted a Landscape Sensitivity Calibration Exercise and prepared a separate report for that exercise which informs how landscape sensitivity was assessed as a potential constraint to wind farm development. The Landscape Sensitivity Calibration Exercise provides a model for how a coherent landscape policy can be developed to direct wind energy developments to the most appropriate landscapes that have the greatest capacity to accommodate them. The development of such a policy at national or regional level, would greatly assist in the proper spatial planning of wind energy developments.

The Landscape Sensitivity Calibration Exercise report[5] assigns a landscape sensitivity classification, specifically in the context of wind energy development, to the existing Landscape Character Areas (LCAs) already established and mapped by the Local Authorities in each county. This approach enables greater consistency across county boundaries and a more logical consideration of sensitivity in a regional and national context. The rationale for the Landscape Sensitivity Calibration Exercise is to provide a coherent, practical, logical, and fit-for-purpose approach to quantify landscape sensitivity for wind energy development, which could inform the preparation of regional renewable energy strategies and generate a dataset to identify Ireland's future onshore wind energy development potential.

The Landscape Sensitivity Calibration Exercise uses the five classifications of landscape sensitivity outlined in Table 2.1 below.

Table 2.1 Landscape sensitivity classifications used in Landscape Sensitivity Calibration Exercise

Landscape Sensitivity	Definition
International (highest)	LCAs comprising a landscape of international renown, value or importance.
National	LCAs comprising nationally valuable/important landscape characteristics and receptors.
Regional	LCAs comprising regionally valuable/important landscape characteristics and receptors.
County	LCAs comprising prominent landscape receptors of value at a county level.
Local (lowest)	LCAs with some distinctive landscape receptors & characteristics of local value or which are commonplace.

For the purposes of this future onshore wind study, the 'international', 'national' and 'regional' landscape sensitivity classifications were identified as potential constraints to wind farm development and the siting of wind turbines. Areas assigned a 'county' and 'local' landscape sensitivity classification were considered unconstrained for the purposes of this study, on the basis that if wind farm developments are to be directed away from the international, national and regional areas, they cannot be arbitrarily precluded in county and local areas. Any proposed wind farm project will be subject to

[5] *Landscape Sensitivity Calibration Exercise Report. MKO, 2025.* https://mkoireland.ie/insights/landscape-sensitivity-calibration/

environmental impact assessment (EIA) which must include detailed a landscape and visual impact assessment (LVIA), which assesses the landscape and visual effects of the proposed project on a site-specific, location and landscape-specific basis. A planning authority or An Bord Pleanála will ultimately determine whether a proposed wind farm is acceptable in a proposed location and landscape setting, and potential projects in the county or local classification areas should at least be afforded the opportunity to have their landscape effects assessed and considered on a site-specific basis.

2.1.16 Existing, Permitted and Proposed Wind Farms

Existing operational, permitted and proposed (in planning) wind farms and their related wind turbines were analysed as part of this study and considered as constraints to further wind farm development on the basis that if a wind farm is already built on a suitable site, the land is not available for further development. This study did not considerer the repowering potential of the existing wind farm sites because this was previously reported on in a 'Repowering Ireland' report[6] published by Wind Energy Ireland and also prepared by MKO.

A total of 292 existing operational wind farms (inclusive of wind farms with multiple phases or grid connections) and their related 2,488 existing operational wind turbines were analysed in this study. A total of 44 permitted wind farms and their 417 related wind turbines were also analysed in this study. Finally, a total of 29 proposed wind farms currently still in the planning process, and their 285 proposed wind turbines were analysed in this study. Combined, this study utilised map datasets relating to 365 wind farms and 3,190 wind turbines. The wind turbine datasets were drawn from an ongoing internal MKO exercise to map all existing, permitted and proposed wind turbine coordinates to facilitate cumulative environmental impact assessment.

For the purposes of this study, a 600-metre setback buffer zone was applied to all existing, permitted or proposed turbines. The 600-metre setback buffer zone reflects a four rotor diameter (4RD) separation distance for the turbine modelled in this study, such that any future proposed turbines would have to be setback a minimum of that distance from any existing, permitted or already proposed turbines. This separation distance would be a standard wind farm design requirement to minimise turbulence and wake losses between adjacent or downwind turbines.

2.1.17 Primary Constraints Summary

The primary constraints and setback buffer zone distances are summarised in Table 2.2 below.

Table 2.2 Primary constraints and setback buffer zone distances

Constraints	Constraint Setback Buffer Distance
Properties	700 metres (4 x 175m tip height)
Archaeological sites and monuments	100 metres
Rivers	50 metres
Lakes	100 metres
Special Areas of Conservation (SAC)	200 metres
Special Protection Areas (SPA)	1,000 metres

[6] *Repowering Ireland – How we stay global leaders in onshore wind energy. Wind Energy Ireland, 2024*
https://windenergyireland.com/images/files/final-repowering-ireland-report-june-2024.pdf

National Heritage Areas (NHA)	200 metres
Proposed National Heritage Areas (pNHA)	200 metres
National Parks	200 metres
Overhead Lines	525 metres (3.5 x 150m rotor diameter)
Railways	300 metres (2 x 150m rotor diameter)
Motorways	300 metres (2 x 150m rotor diameter)
National Roads	300 metres (2 x 150m rotor diameter)
Regional Roads	150 metres (1 x 150m rotor diameter)
Local Roads	75 metres (½ rotor diameter)
Landslide susceptibility	High
Landscape sensitivity	International, National and Regional sensitivity
Wind farms	Operational, Permitted and Proposed (in planning)

With the benefit of site-specific information, including on-site surveys, site investigations and further analysis, the primary constraints and related setback buffer zone distances listed above, may be adjusted when designing a specific wind farm development on a specific site. For the purposes of this national-scale study, a range of commonly used constraints and setback buffers were selected that are generally representative of current wind farm site identification and design techniques.

2.2 Constraints Not Considered

A number of constraints that must be taken account of at a site-specific level, could not have been and therefore were not considered in this higher-level nationwide study.

Aeronautical Aviation

The safeguarding of aeronautical aviation in proximity of civil airports, including take-off and landing routes and radar installations, can only be considered on a site-specific basis as the wind energy potential of a specific site is identified and investigated further. There is no single available dataset that can reliably be applied on a nationwide basis, given the nature of these technical constraints, differences in technical approaches taken to assess the potential effect of a wind farm on an airport's operations and aeronautical navigation, but also the technical solutions available to mitigate any potential effects identified. For these reasons, aeronautical aviation was not considered as a constraint in this study but is recognised as a potential constraint that would have to be considered and managed on certain sites, in certain locations, on a case-by-case basis.

Telecoms

Point-to-point telecommunications and broadcast transmission link corridors are frequently encountered when designing wind farm and identifying site-specific constraints to inform a project layout design. The route of any transmission link in proximity to a potential wind farm site are established via contact with the telecommunications and broadcast network operators, typically as part of a project feasibility exercise of as part of the scoping of an environmental impact assessment. It was beyond the scope of this study to attempt to identify all the radio links that might impact on viable areas. It was also thought not necessary to establish the routes of any such link corridors, because turbines can often be placed either side of a restricted link corridor, which need not necessarily reduce the overall capacity of a potential wind farm site, but could be a project layout design consideration. For these reasons, telecoms links was not considered as a constraint in this study but is recognised as a potential constraint that would have to be considered by individual projects, on a case-by-case basis.

Slope

Slope is a key site-specific consideration in wind farm design, primarily in terms of roads layout, geotechnical engineering, peat stability assessment and peat and spoil management planning. Steeper slopes are often identified as constraints at the site-specific constraints mapping and project layout design stage. Different engineering solutions are also available for road construction and turbine transport on steeper slopes, which can only be considered on a site-specific basis. For these reasons, slope was not considered as a constraint in this study but is recognised as a potential constraint that would have to be considered by individual projects, on a case-by-case basis.

2.3 Constraints Overlay

Each primary constraint was individually mapped and overlain on the Republic of Ireland land area, to establish how much of the country's land area is potentially impacted by each constraint. For the purposes of this study, only the mainland area of the Republic of Ireland was used as the study area, which excluding any offshore islands amounts to 69,871 km^2.

Maps of the primary constraints are included as Figures 2.1 to 2.9 on the following pages.

The individual constraints maps for each primary constraint were then overlaid and combined to establish a combined constrained area. Any area not within the combined constrained area is potentially suitable for wind farm development by virtue of it being unconstrained. Such unconstrained areas are deemed to be potential "viable areas" for the purposes of this study, in that none of the primary constraints are precluding wind farm development in these areas.

The effect of overlaying each constraints individually on the study area and the consequential reduction in the study area potentially remaining for wind farm development is summarised in Table 2.3 below.

Table 2.3 Constraints analysed and their effect on study area

Constraint	Constraint Setback Buffer Distance	Constrained Area (km^2)	Unconstrained Area (km^2)	% Study Area Constrained
Properties	700 metres	60,242	9,629	86.2%
Archaeological sites and monuments	100 metres	6,437	63,435	9.2%
Rivers	50 metres	3,644	66,227	5.2%
Lakes	100 metres	2,435	67,437	3.5%
Special Areas of Conservation (SAC)	200 metres	11,169	58,702	16.0%
Special Protection Areas (SPA)	1,000 metres	9,862	60,009	14.1%
National Heritage Areas (NHA)	200 metres	971	68,900	1.4%
Proposed National Heritage Areas (pNHA)	200 metres	9,964	59,907	14.3%
National Parks	200 metres	879	68,992	1.3%
Overhead Lines	525 metres	7,312	62,559	10.5%
Railways	300 metres	966	68,905	1.4%
Motorways	300 metres	629	69,242	0.9%
National Roads	300 metres	2,669	67,202	3.8%
Regional Roads	150 metres	3,940	65,931	5.6%
Local Roads	75 metres	11,572	58,299	16.6%
Landslide susceptibility	High	2,449	67,422	3.5%
Landscape sensitivity	International	510	69,362	0.73%
	National	1,662	68,209	2.4%
	Regional	4,141	65,730	5.9%
Wind Farms – Operational	600 metres	1,045	68,826	1.50%
Wind Farms – Permitted		204	69,667	0.29%
Wind Farms – Proposed		160	69,711	0.23%

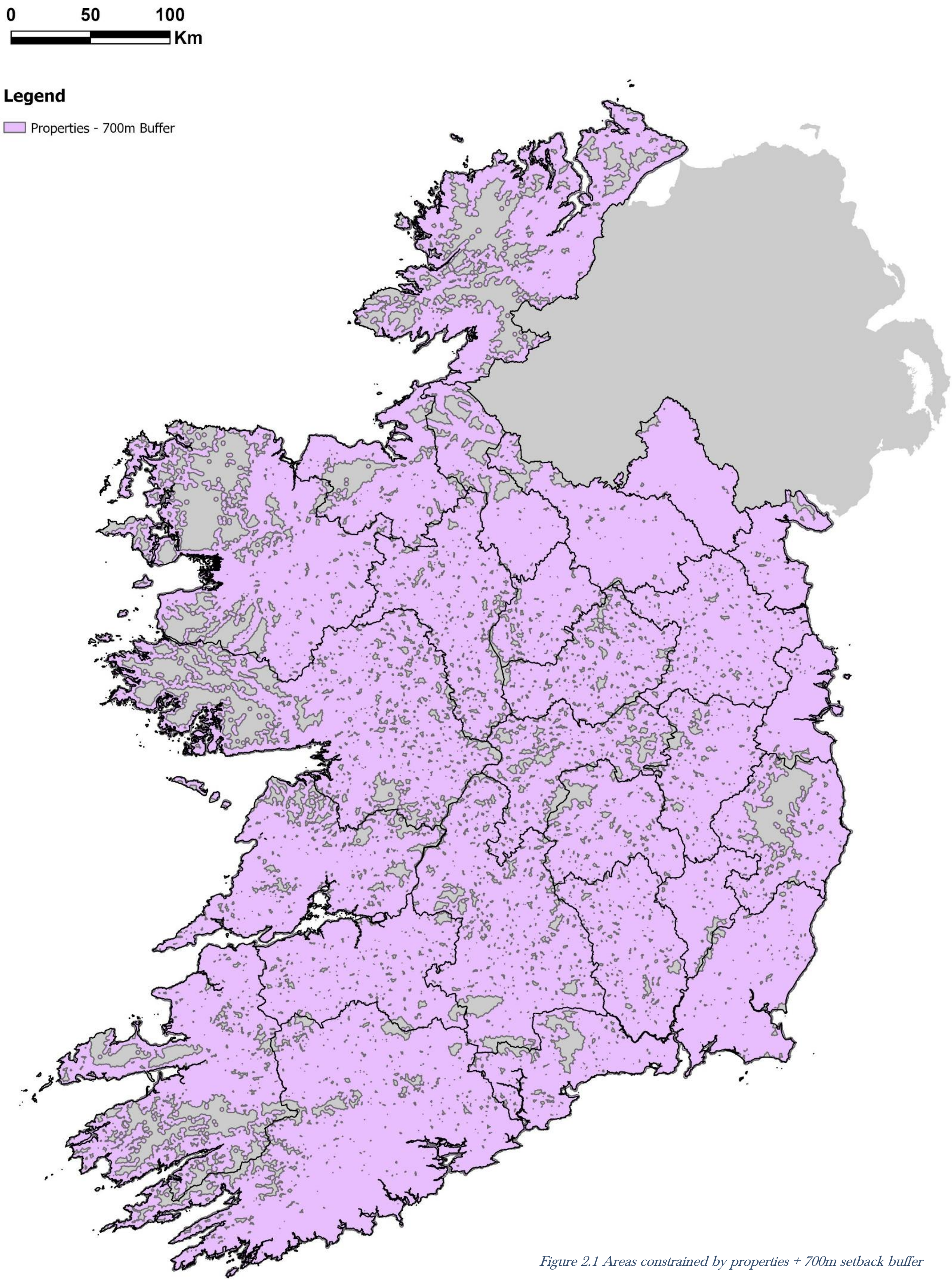

Figure 2.1 Areas constrained by properties + 700m setback buffer

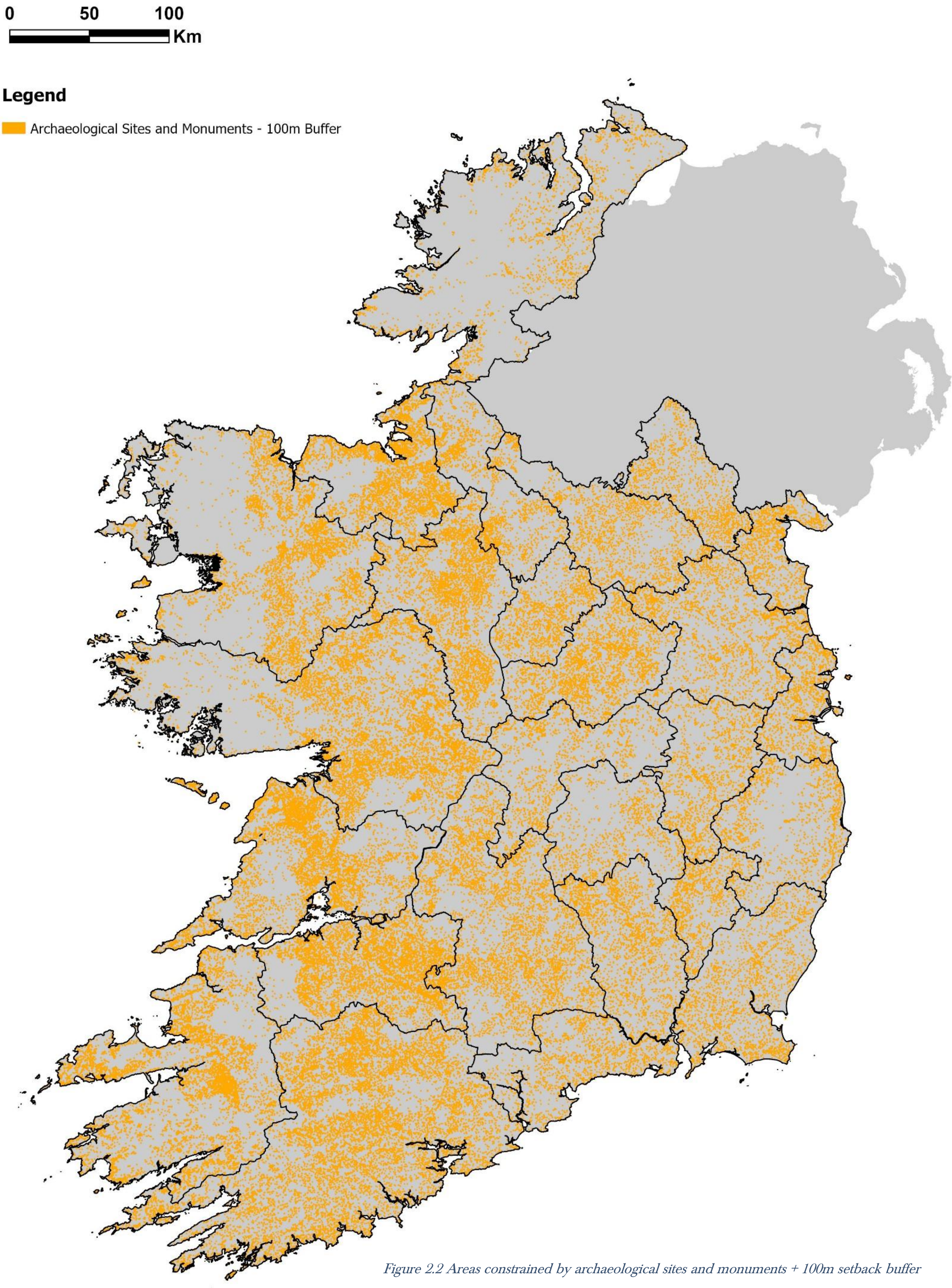

Figure 2.2 Areas constrained by archaeological sites and monuments + 100m setback buffer

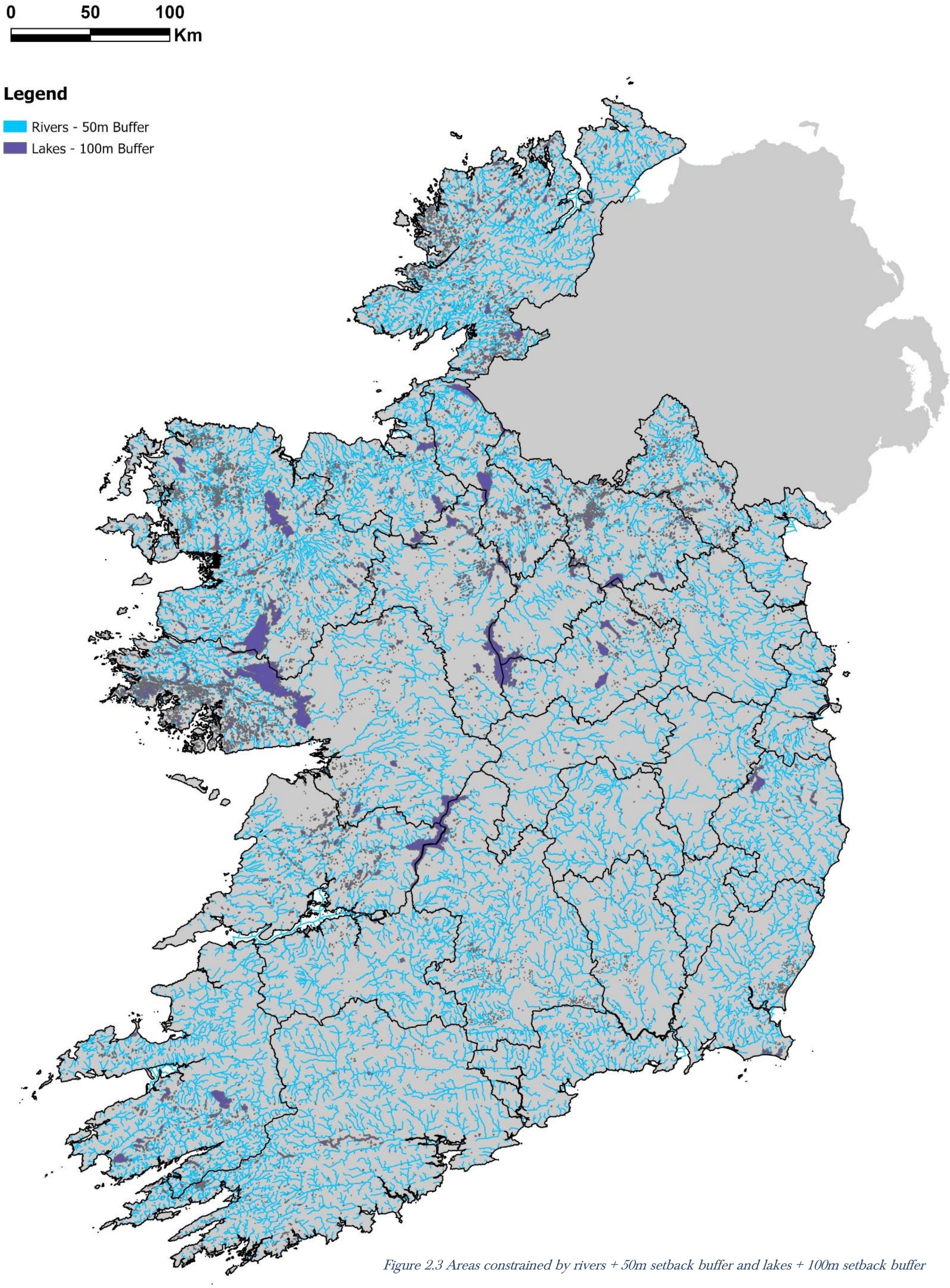

Figure 2.3 Areas constrained by rivers + 50m setback buffer and lakes + 100m setback buffer

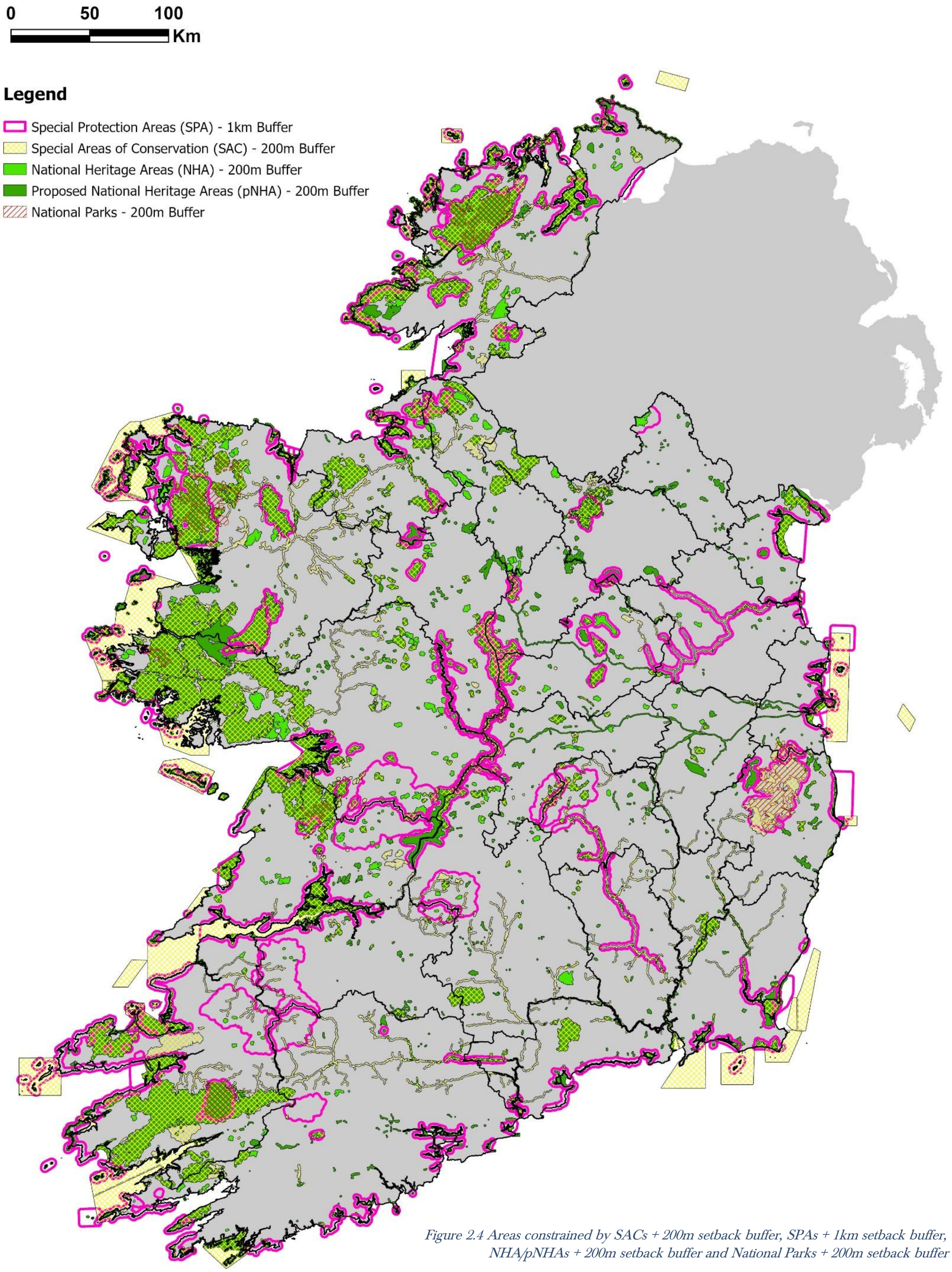

Figure 2.4 Areas constrained by SACs + 200m setback buffer, SPAs + 1km setback buffer, NHA/pNHAs + 200m setback buffer and National Parks + 200m setback buffer

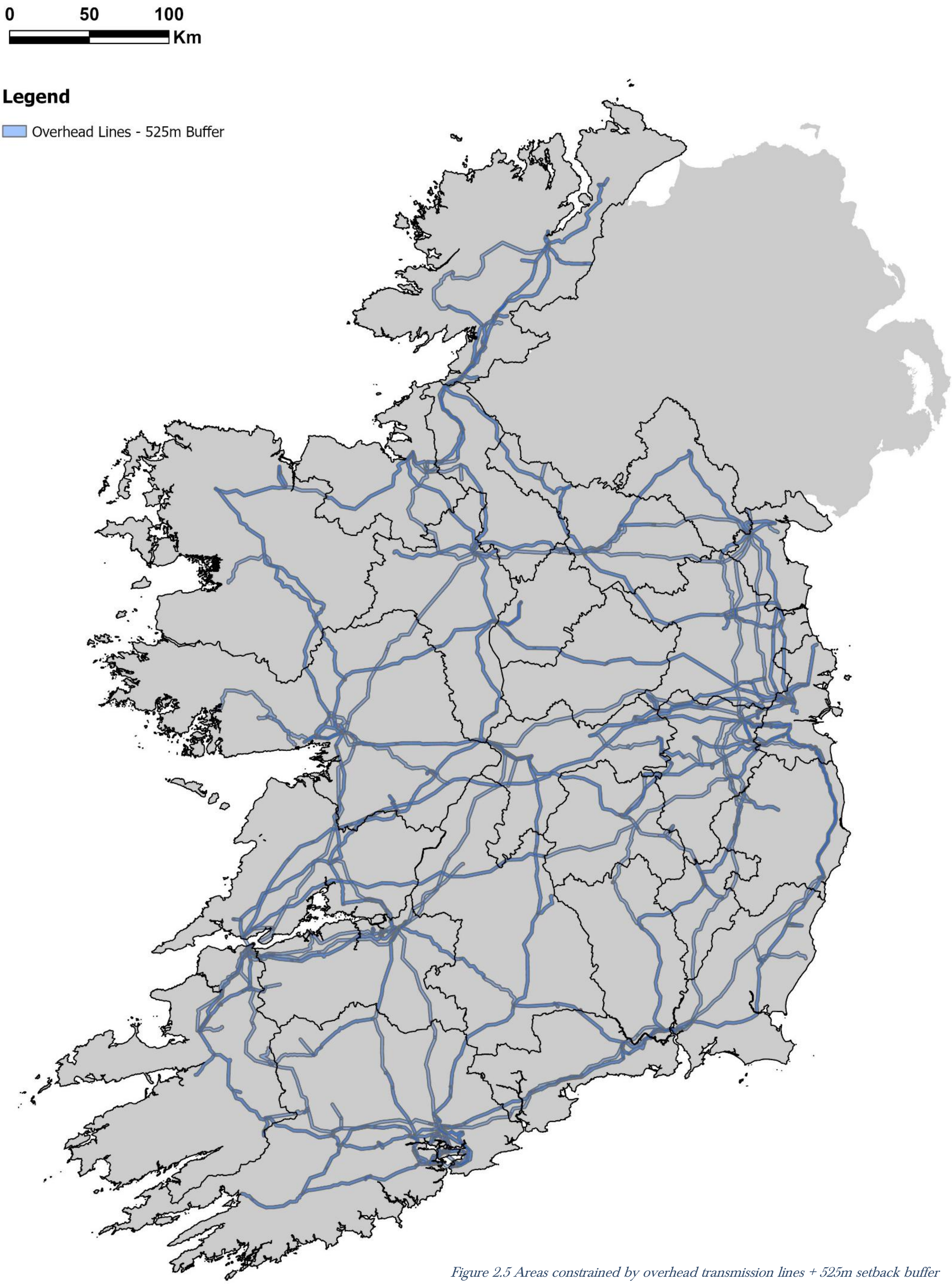

Figure 2.5 Areas constrained by overhead transmission lines + 525m setback buffer

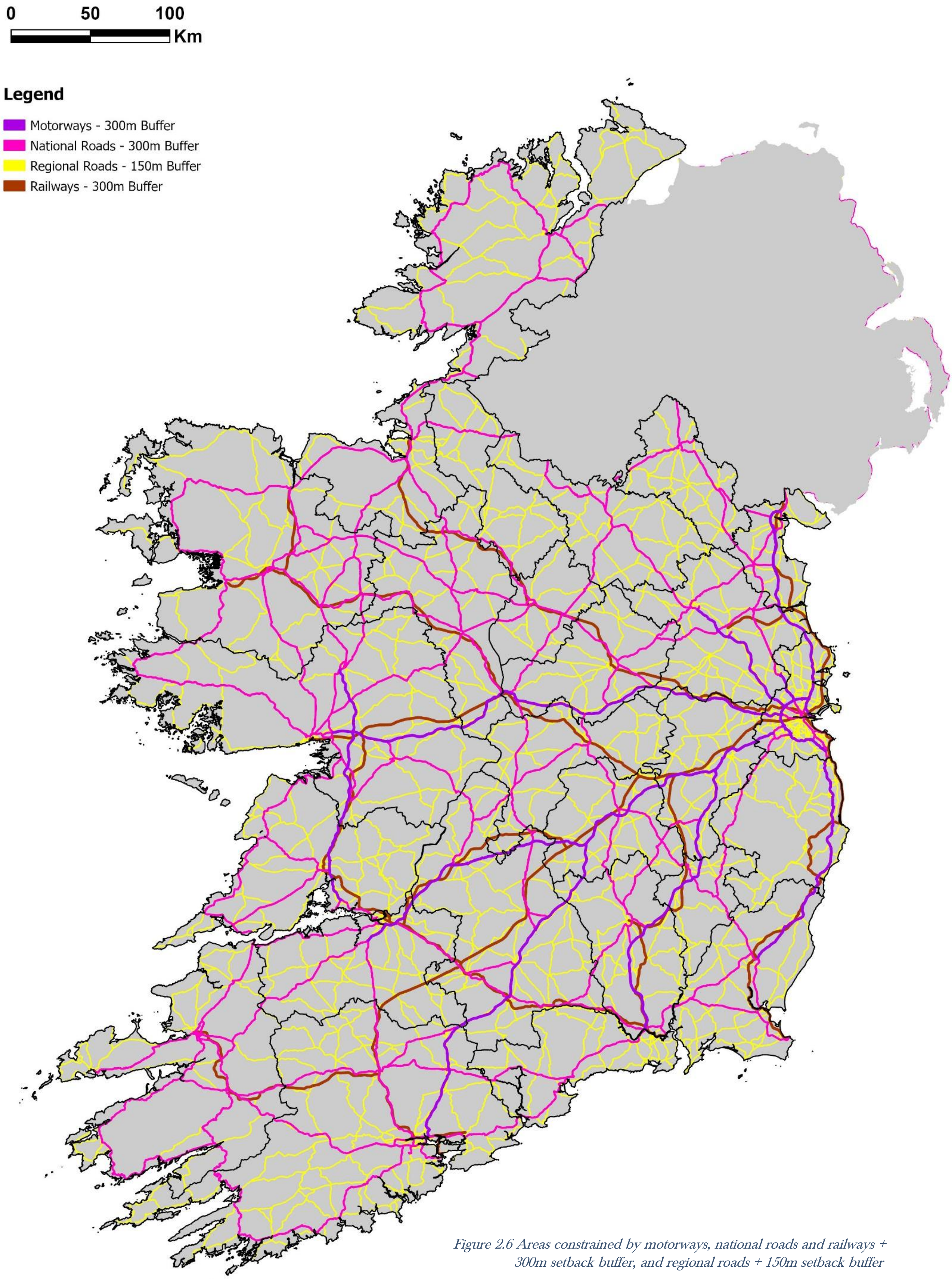

Figure 2.6 Areas constrained by motorways, national roads and railways + 300m setback buffer, and regional roads + 150m setback buffer

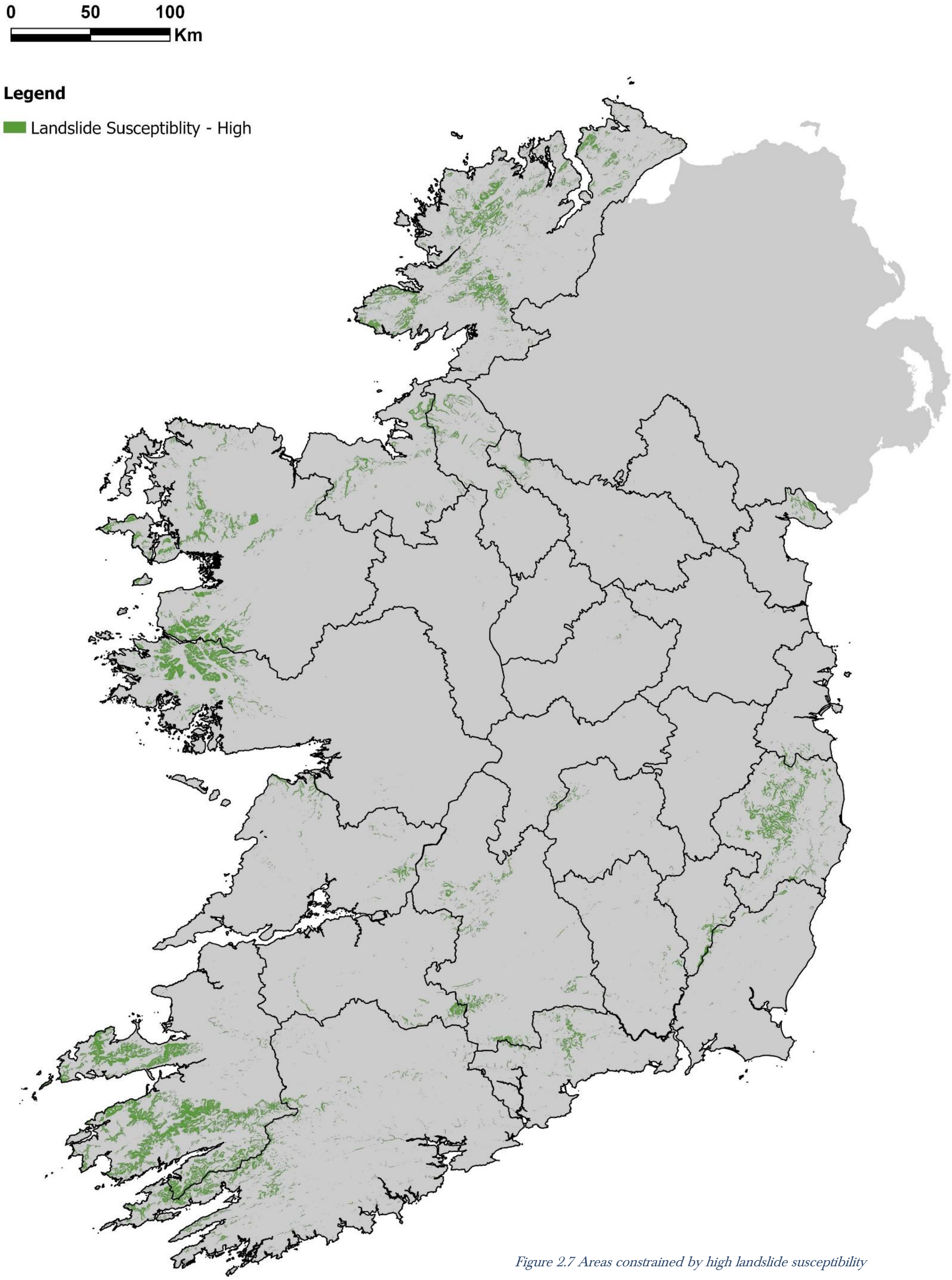

Figure 2.7 Areas constrained by high landslide susceptibility

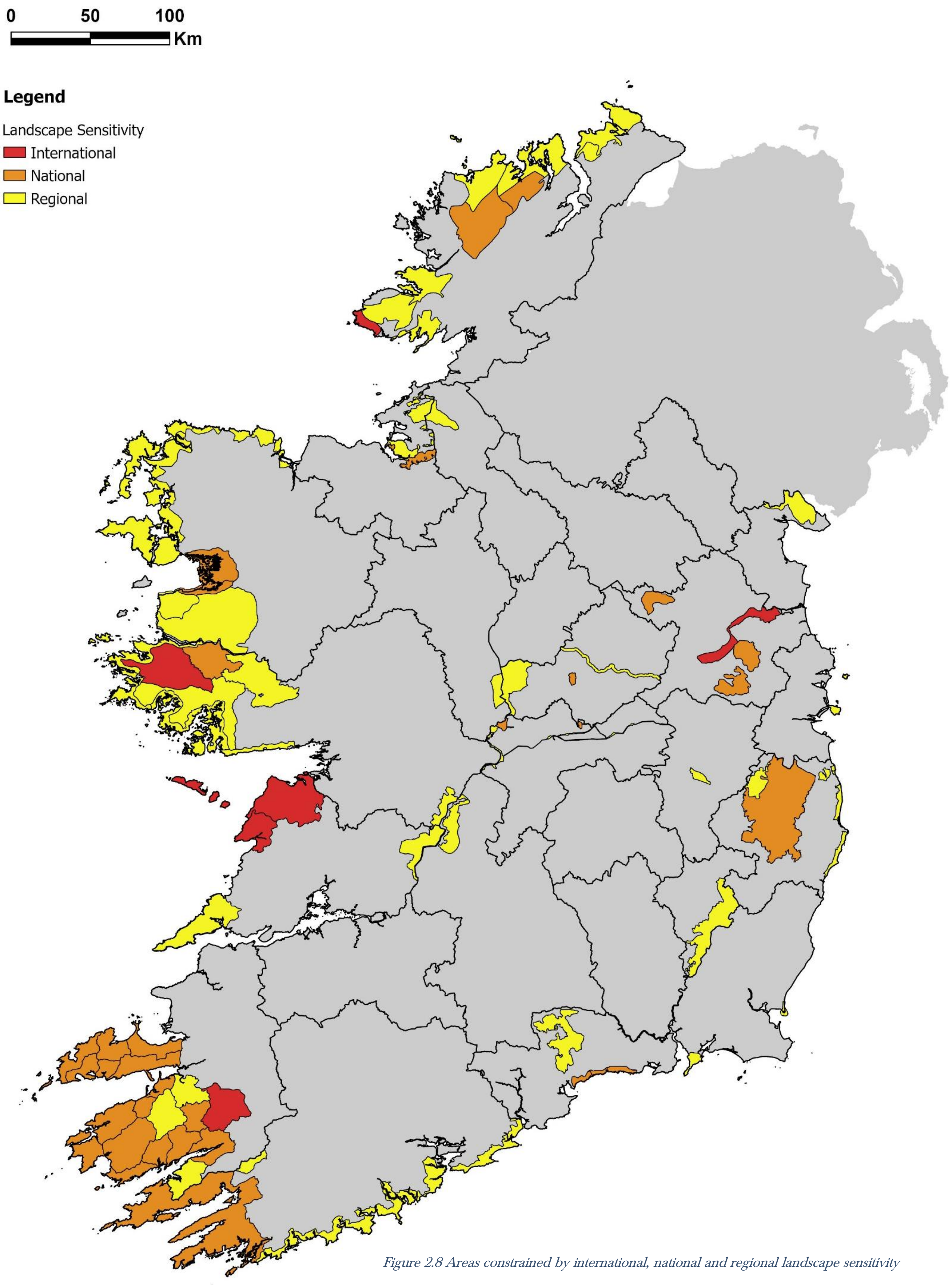

Figure 2.8 Areas constrained by international, national and regional landscape sensitivity

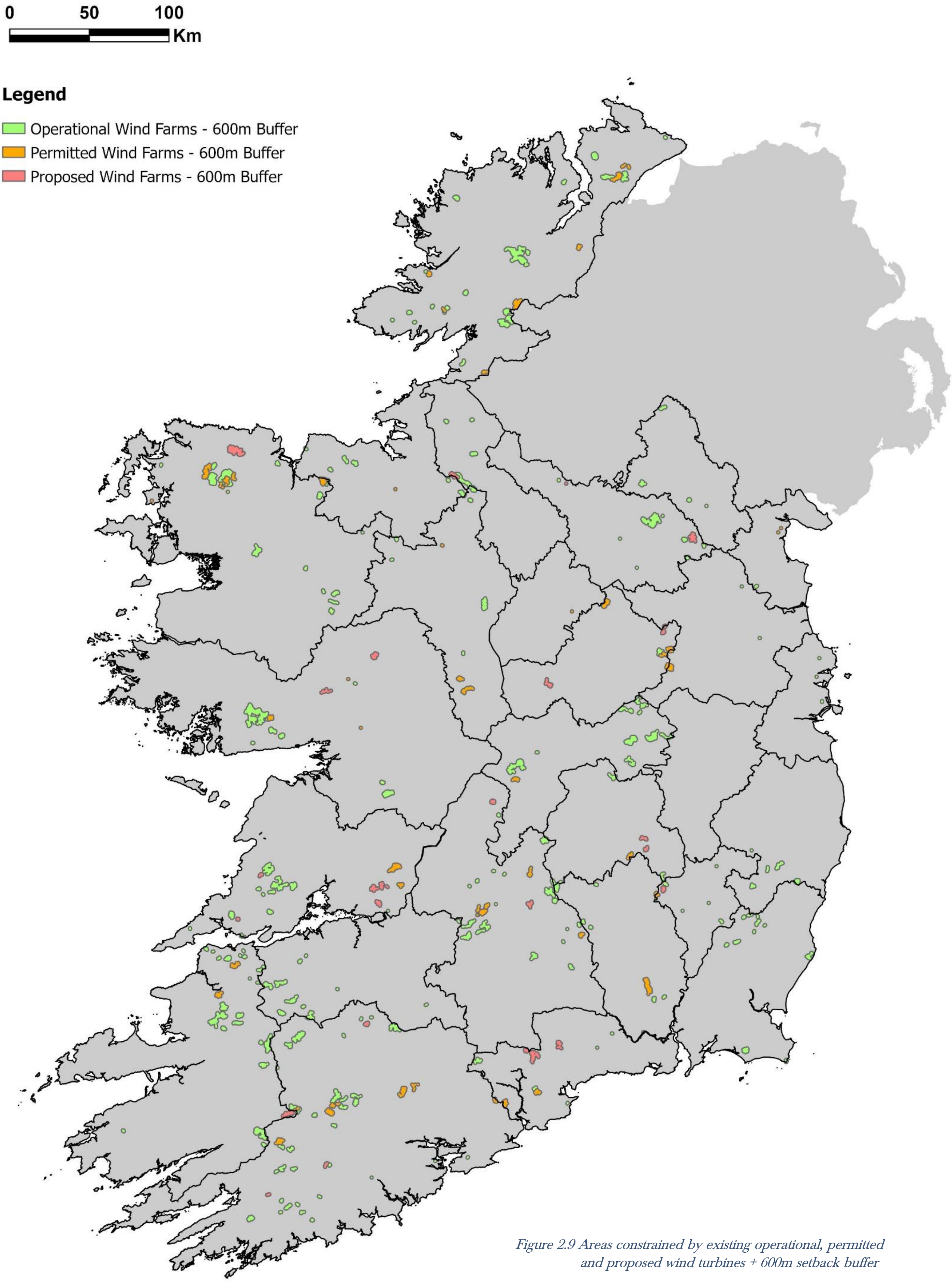

Figure 2.9 Areas constrained by existing operational, permitted and proposed wind turbines + 600m setback buffer

2.4 Constraints Analysis

2.4.1 Small Area Filter

The unconstrained viable areas mapped in the constraints overlay exercise included thousands of very small areas not large enough to support a wind farm development.

For a wind farm to be commercially viable, it must be able to pay for the cost of the physical grid connection works required to connect the wind farm to the national electricity grid, and secure a route-to-market for the electricity generated either by way of a Renewable Electricity Support Scheme (RESS) auction or a corporate power purchase agreement (CPPA). Connecting a wind farm to the national electricity grid typically requires the construction of an underground or overhead transmission line off-site to a nearby electricity substation, often the upgrade of that electricity substation, or in some cases the construction of a new or extended substation at some point on the nearby transmission grid. Such grid connection costs can be substantial and are typically divided across the number of megawatts (MW) of installed generating capacity in the wind farm development for the purposes of quantifying the grid connection costs of a particular wind farm. A grid connection cost of €10 million for a 50MW wind farm would result in a grid cost of €200,000/MW. Expecting the cost of the same grid connection infrastructure to be borne by a 20MW wind farm would increase the grid cost to €500,000/MW and would make the commercial viability of the wind farm extremely challenging and likely uncompetitive in RESS auctions or in the CPPA market.

Wind energy developments must be of a certain scale to justify the required investment in grid connection infrastructure and still be commercially competitive. Therefore, very small unconstrained and potentially viable areas, particularly where they are isolated from larger viable areas and remote from existing grid infrastructure, are unlikely to be able to support the development of a commercially competitive wind farm. To account for this commercial reality, a “small area filter” was applied to the viable areas mapped in this study, to identify and discount areas below a certain size from being considered further in the study.

Two criteria were used for the small area filter, as described below and illustrated in Figures 2.10 below.

1. *Areas must be greater than 1km^2 in area, or*

2. *Areas less than 1km^2 must be located within 1.5 kilometres of a viable area greater than 1 km^2, such that the smaller areas could be considered as potential locations for wind turbines and part of a larger wind farm development involving the area greater than 1 km^2.*

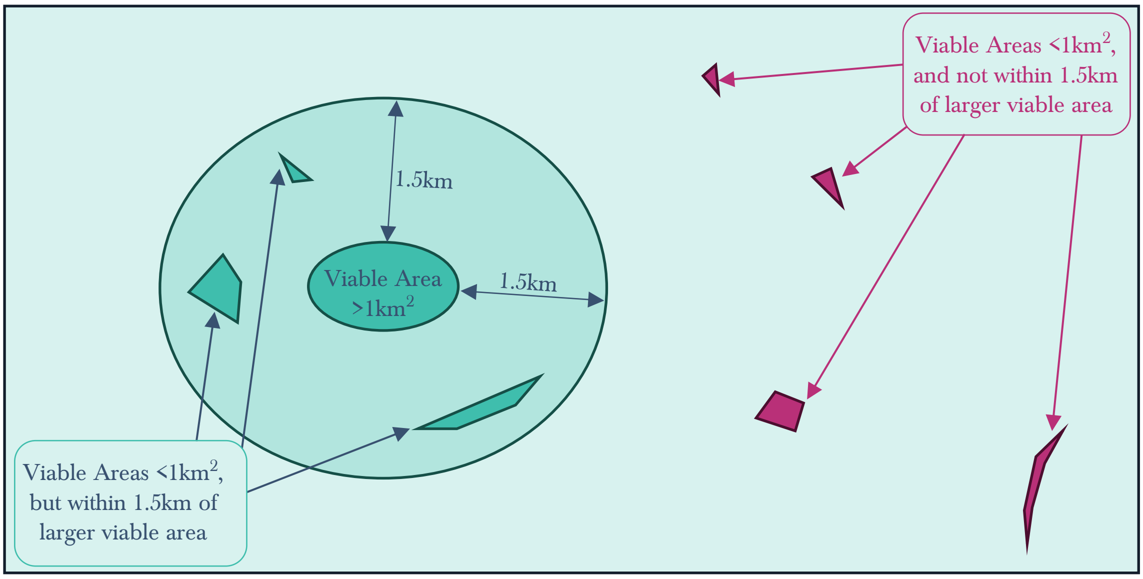

Figure 2.102.11 Illustrative example of the application of the small area filter

Small unconstrained and potentially viable areas that were not greater than 1 km^2 or within 1.5 kilometres of an area greater than 1 km^2, were discounted, and not considered further in this study. The removal of the small areas eliminated 514km^2 of otherwise potentially viable area.

The use of very small viable areas for single turbine wind energy developments was not considered as part of this study, because of the limited cumulative contribution such turbines could make to national renewable energy targets, and the limited opportunities for such developments where the turbine can be connected to a nearby electricity grid with minimal upgrade costs. There is only very limited precedence for such single-turbine developments in Ireland, and it is not considered realistically possible that they would make any meaningful contribution to the country's renewable energy targets.

2.4.2 Theoretical Viable Area

The mapped viable areas (as referenced in Section 2.2 above) that remained following the removal of the unviable small areas (as referenced in Section 2.3.1 above), gave rise to a reduced area, termed the 'Theoretical Viable Area' (TVA). The TVA, on the basis of the analysis undertaken in this study, is unconstrained with reference to the primary constraints, and meets the small area filter criteria.

The TVA has been mapped and measures 1,302 km^2. Due to commercially sensitive nature of the data, maps of the combined unconstrained areas or the TVA are not included in this report as it may be misinterpreted as being a map of potential wind farm sites. In reality, it is a national-scale screening exercise intended to quantify future wind energy potential, and any part of the TVA would require further detailed analysis before it could be fairly presented as a potential wind farm location.

A TVA of 1,302 km^2 represents 1.86% of the mainland area of Ireland (excluding offshore islands) used as the study area in this analysis.

3. CAPACITY ANALYSIS

To quantify the future generation capacity for onshore wind energy based on the TVA, it is first necessary to establish a realistic generation capacity for modern wind farms development in Ireland. Assessing their generation capacity and geographical footprint can provide a MW/km^2 figure that can be applied to the TVA to quantify the total national wind energy potential.

To establish the MW/km^2 figure, the 14 wind farm projects granted planning permission by An Bord Pleanála (including Strategic Infrastructure Development applications and appeals) between 1st January 2024 up to 28th February 2025, were analysed. Decisions of An Bord Pleanála on single-turbine, extension of life and substitute consent wind farm applications were not considered in the dataset of projects analysed.

Projects that have been granted planning permission by An Bord Pleanála would have been subject to Environmental Impact Assessment (EIA) and the full rigours of the planning process. They will typically have undertaken 2+ years of environmental surveys and studies, prior to the preparation of the Environmental Impact Assessment Report (EIAR) that would have accompanied the planning application. Having been granted permission by An Bord Pleanála, they would have been deemed appropriate proposals for the subject locations and would have been designed to meet all current guidelines and best practice requirements.

The planning application documentation for each of the 14 projects was reviewed to establish the expected generating capacity (in megawatts, MW) of the turbines that were proposed and subsequently permitted. The turbines were also mapped using GIS and overlaid on the TVA that emerged from the primary constraints mapping exercise. This process enabled the total generating capacity of each wind farm [(number of turbines) X (expected turbine generating capacity)] to be established relative to the area of the TVA. For the purposes of this exercise, any TVA within a 600-metre distance from the permitted turbines were considered to be part of the viable area for each project.

The 14 wind farms projects analysed are listed in Table 3.1 below, including the Figure numbers on the following pages which map the turbine locations of each project, relative to the mapped TVA.

It is important to note that the TVA mapped in this study and used to calculate a MW/km^2 capacity for each of the 14 projects, is solely based on the constraints identified and buffer zones applied in this study. This study did not take account of site-specific environmental, planning or technical constraints or factors that would have been known to the project developers of the 14 projects, following their extensive site investigations, surveys and analysis of the environs of their respective projects' sites. Some of the proposed and subsequently permitted turbines across the 14 projects may be located outside of the mapped TVA, but that does not mean and should not be interpreted as them being in unsuitable locations. The locations of off mapped turbines were clearly considered to be suitable and appropriate given that they all secured planning permission.

Table 3.1 Wind farm projects granted permission by An Bord Pleanála 01/01/2024 – 28/02/2025 used to derive capacity analysis

Wind Farm Project	ABP Ref. No	Date Permission Granted by ABP	No. of Turbines Permitted	Figure No.
Dernacart, Co. Laois	PL11.310312	03/01/2024	6	Figure 3.1
Fahy Beg, Co. Clare	PL03.317227	06/03/2024	8	Figure 3.2
Sheskin South, Co. Mayo	PA16.315933	13/03/2024	18	Figure 3.3
Borrisbeg, Co. Tipperary	PA92.318704	12/09/2024	9	Figure 3.4
Pinewoods, Co. Laois	PL11.316305	18/09/2024	11	Figure 3.5
Knockranny, Co. Galway	PL07.318723	30/09/2024	11	Figure 3.6
Cush, Co. Offaly	PA19.318816	04/11/2024	8	Figure 3.7
Ballynagree, Co. Cork	PA04.312606	19/11/2024	16	Figure 3.8
Firlough, Co. Mayo/Sligo	PA16.317560	19/11/2024	13	Figure 3.9
Bilboa, Co. Carlow/Laois	PL01.318295	21/11/2024	5	Figure 3.10
Ballivor, Co. Westmeath	PA25M.316212	22/11/2024	26	Figure 3.11
Oweninny 3, Co. Mayo	PA16.316178	21/01/2025	18	Figure 3.12
Gortyrahilly, Co. Cork	PA04.314602	25/02/2025	13	Figure 3.13
Glenard, Co. Donegal	PA05E.312659	26/02/2025	15	Figure 3.14

Figure 3.1 Dernacart, Co. Laois

Legend

● Turbine Locations   Turbine Locations 600m Buffer   Viable Area (based on methodology outlined in this report)

Figure 3.2 Fahy Beg, Co. Clare

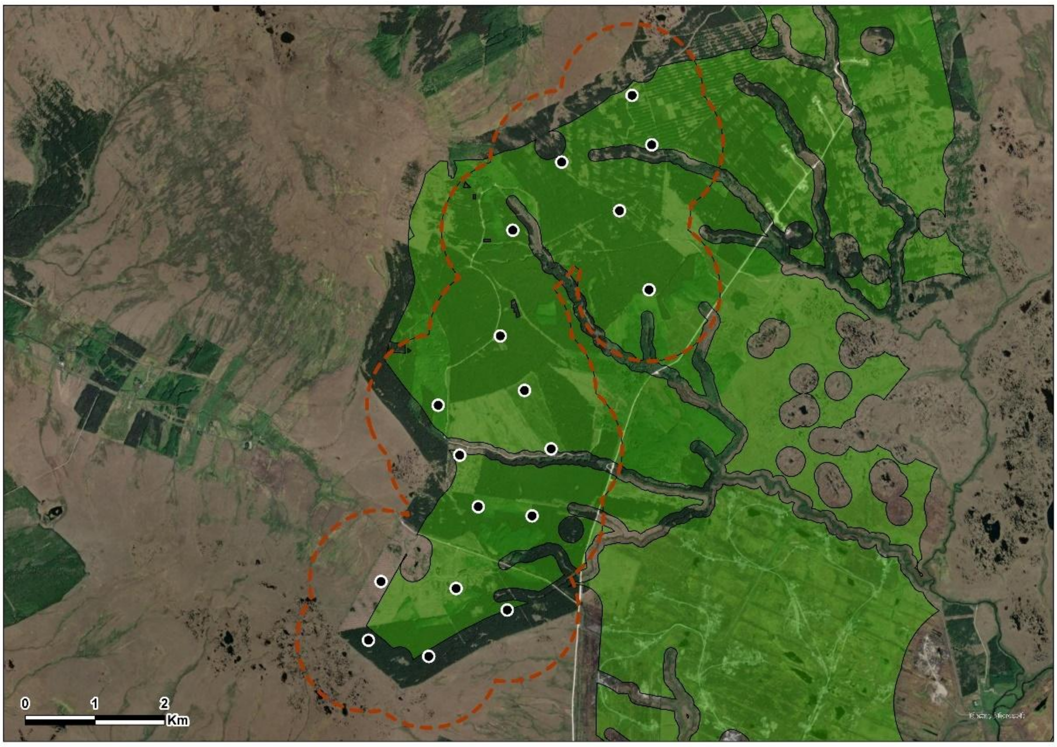

Figure 3.3 Sheskin South, Co. Mayo

Legend

● Turbine Locations

Turbine Locations 600m Buffer

Viable Area (based on methodology outlined in this report)

Figure 3.4 Borrisbeg, Co. Tipperary

Figure 3.5 Pinewoods, Co. Laois

Legend

Turbine Locations | Turbine Locations 600m Buffer | Viable Area (based on methodology outlined in this report)

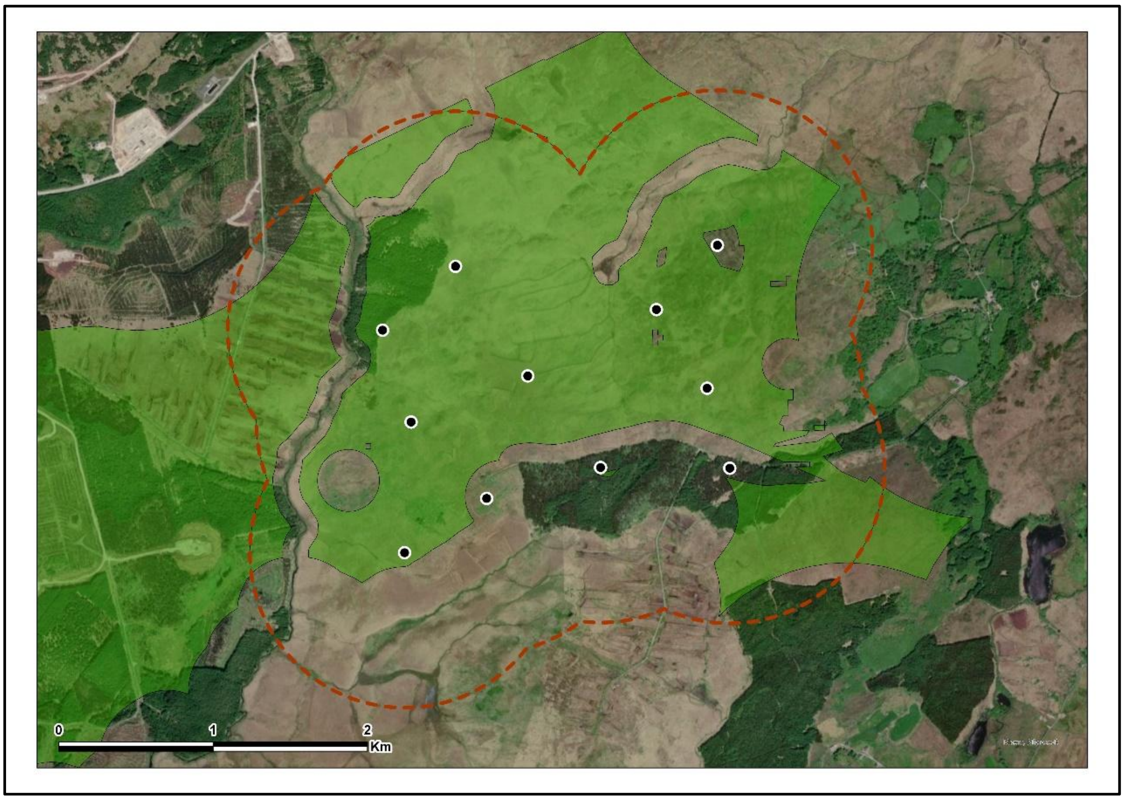

Figure 3.6 Knockranny, Co. Galway

Figure 3.7 Cush, Co. Offaly

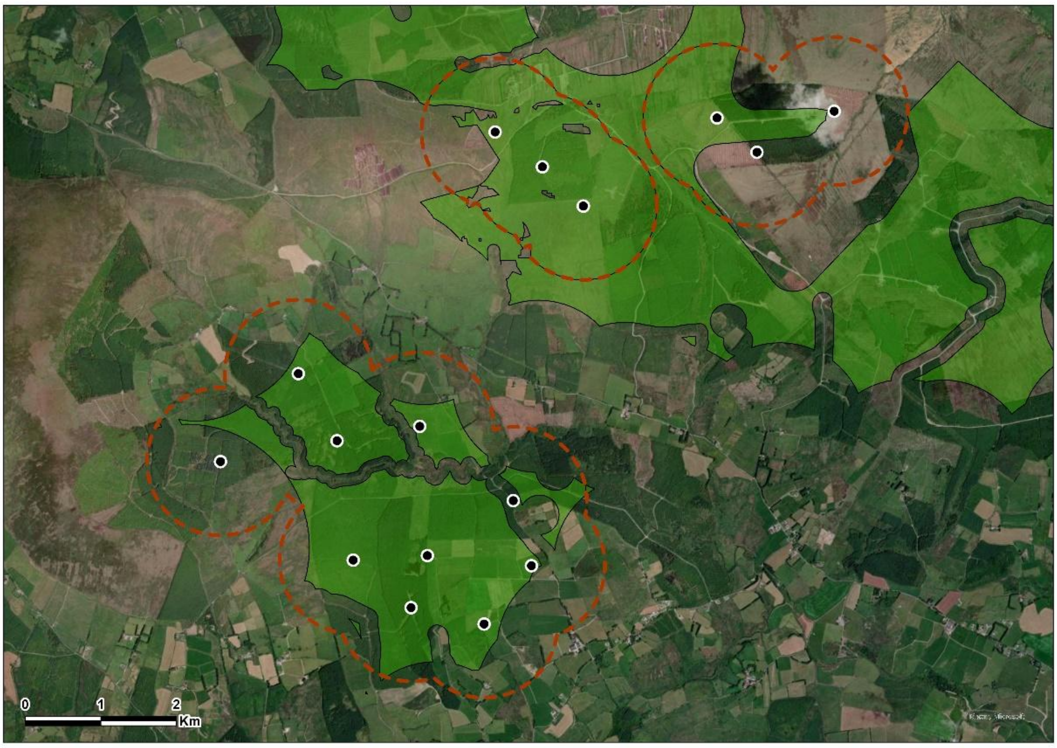

Figure 3.8 Ballnagree, Co. Cork

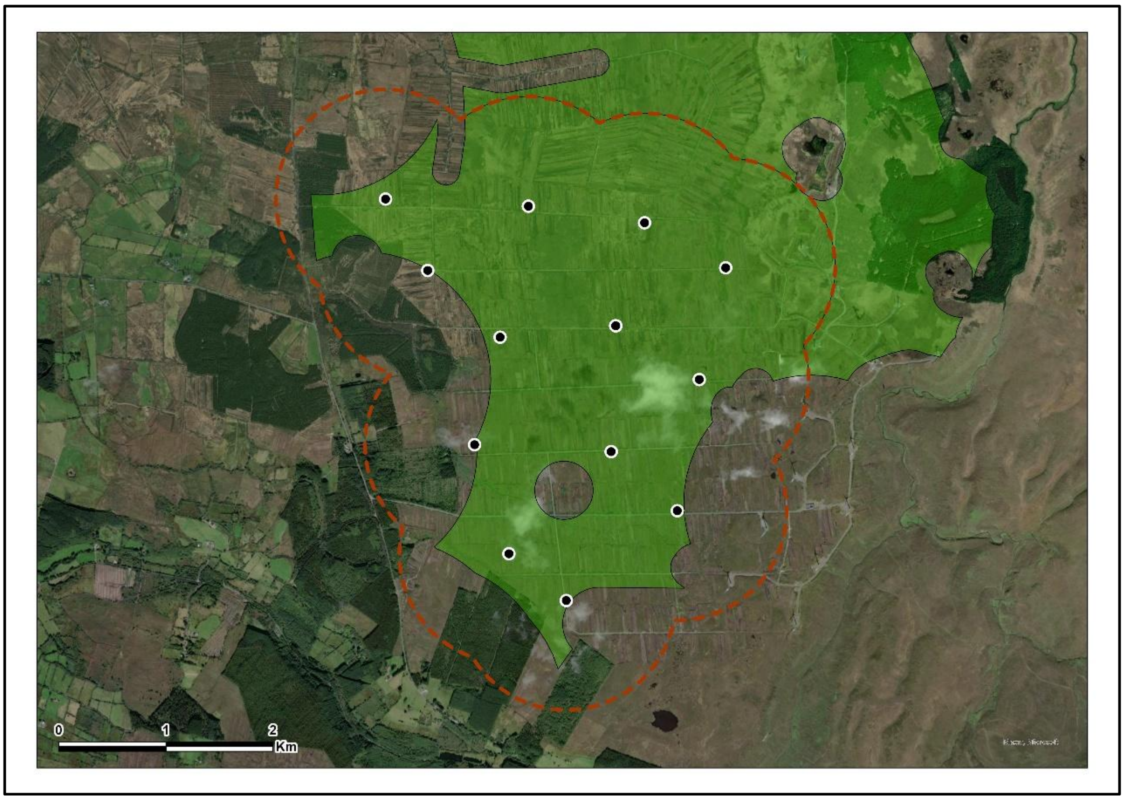

Figure 3.9 Firlough, Co. Mayo/Sligo

Legend

● Turbine Locations | Turbine Locations 600m Buffer | Viable Area (based on methodology outlined in this report)

Figure 3.10 Bilboa, Co. Carlow/Laois

Figure 3.11 Ballivor, Co. Westmeath

Legend

Turbine Locations
Turbine Locations 600m Buffer
Viable Area (based on methodology outlined in this report)

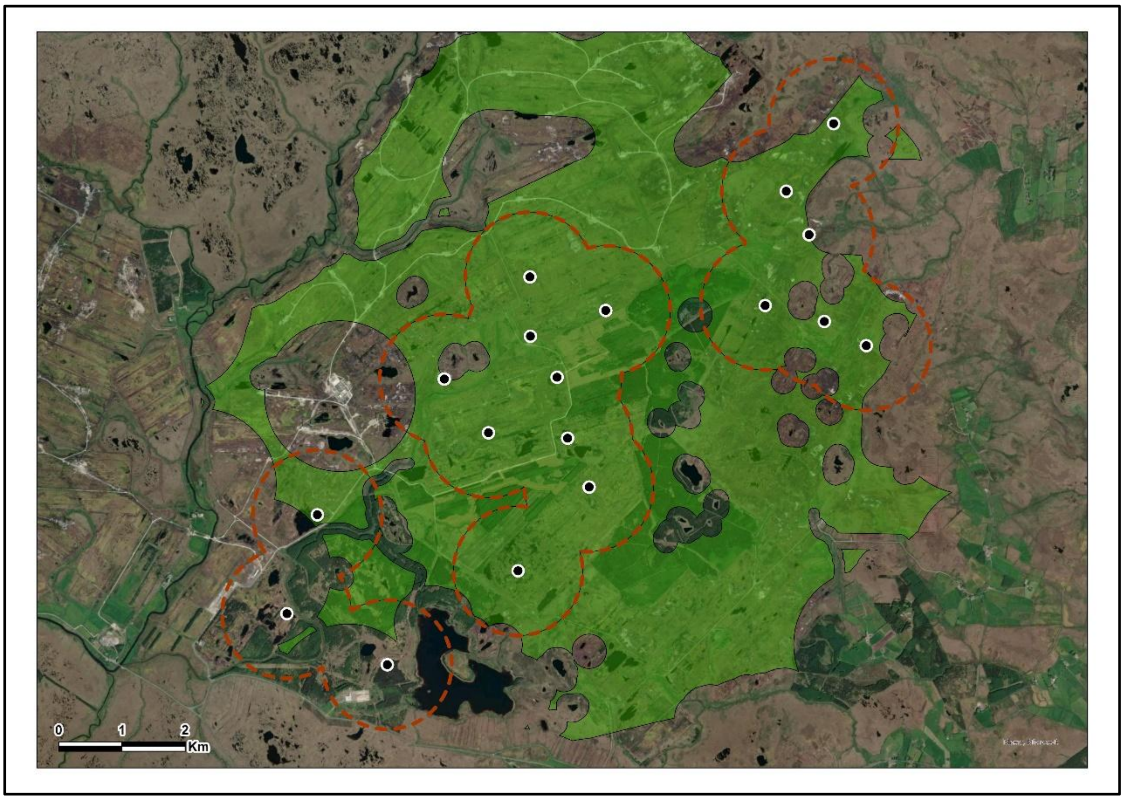

Figure 3.12 Oweninny 3, Co. Mayo

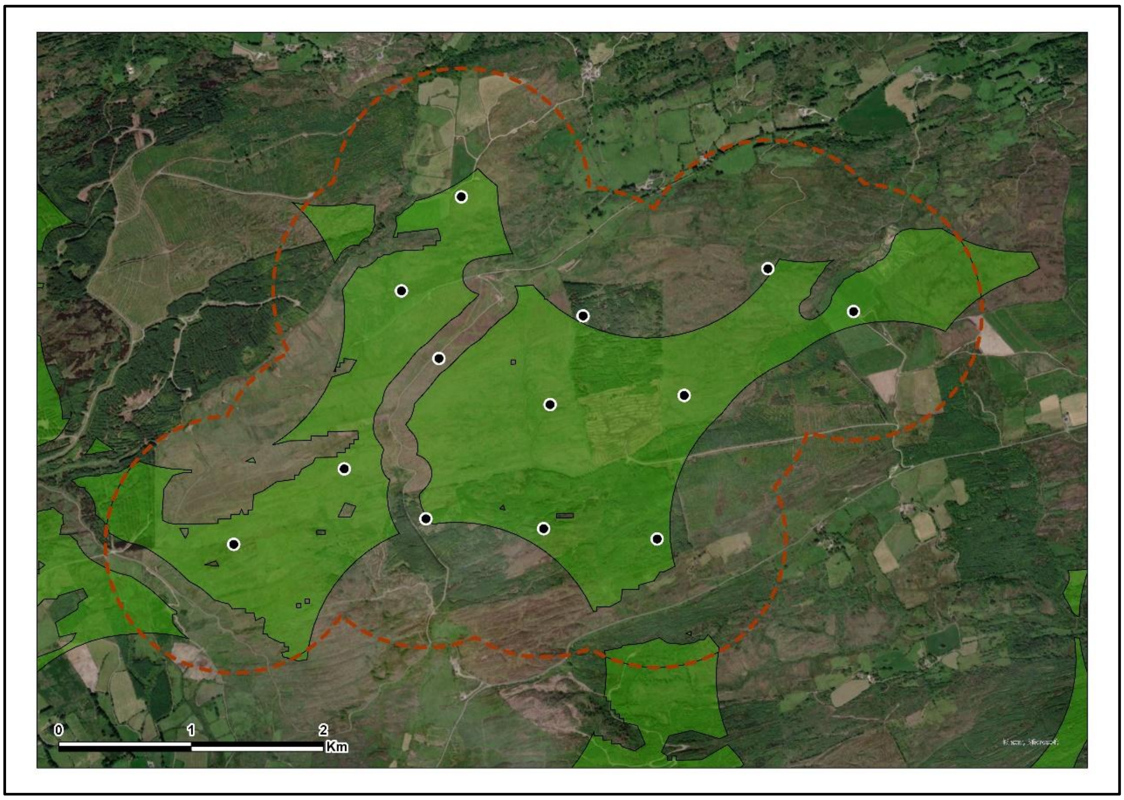

Figure 3.13 Gortyrahilly, Co. Cork

Legend

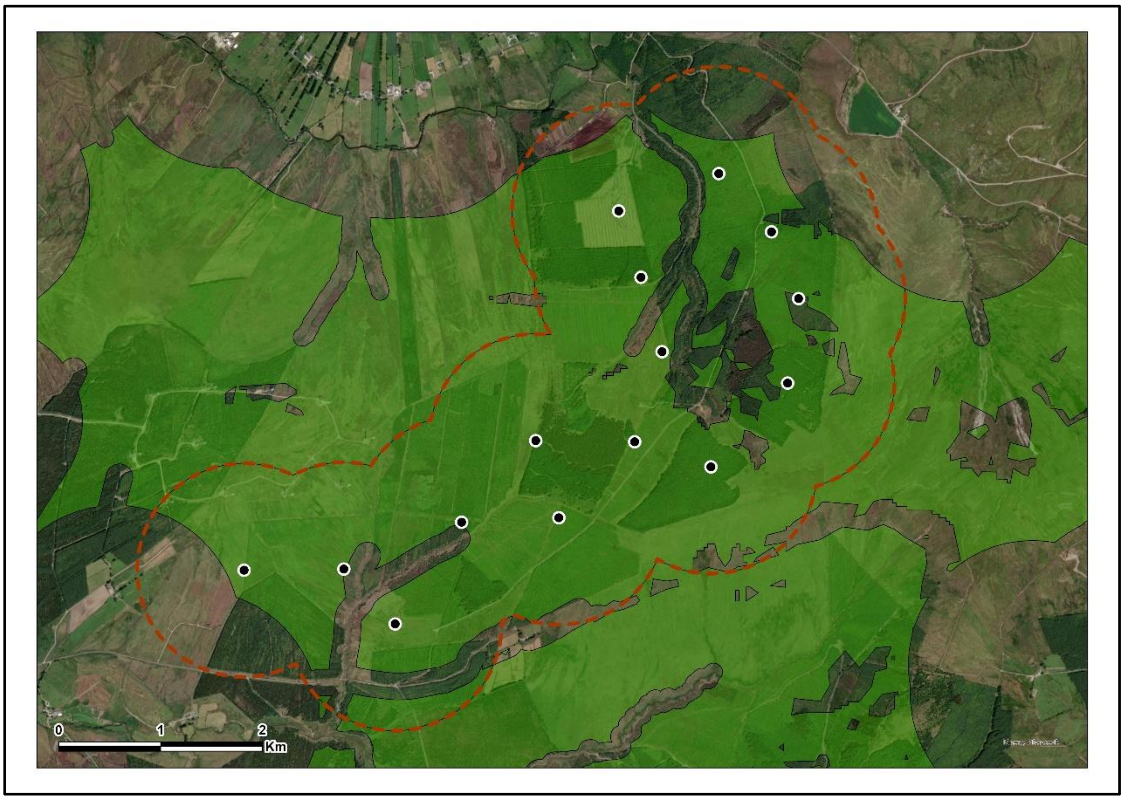

Figure 3.14 Glenard, Co. Donegal

As is evident from the above figures, the TVA in the immediate vicinity of the 14 sites is often made up of multiple, isolated or fragmented unconstrained viable areas, rather than a single, larger contiguous area.

In some cases, the mapped turbine locations are not located on the mapped TVA. This can happen for a variety of reasons. Dwellings identified as constraint properties in this study may not actually be occupied or could be owned by landowners involved in a proposed project, and therefore may not require the full, or any, setback buffer such as was applied in this study. Overhead lines may not require the full 3.5RD separation buffer from proposed turbines, once a technical assessment of the line is undertaken. This study did not have the benefit of site-specific design information or survey data, which might have deemed a proposed turbine location suitable, but which would not have been known in undertaking a nationwide exercise such as this.

In contrast, there are areas mapped as TVA on which turbines were not proposed or permitted, most likely because the land was not available to the project developer and could not be secured to be included in the project. In some cases such as Figure 3.1 (Dernacart) and Figure 3.7 (Cush), large areas that were subject to industrial peat extraction, are evident within the TVA and within the 600-metre turbine buffer zone, but these lands were likely not available to be included in those projects.

The underestimation of the TVA on some projects as a result of not taking account of site-specific constraints, and overestimation of the TVA on other projects as a result of not considering land availability, is assumed to have a balancing effect of cancelling out both any underestimation or overestimation to project capacities.

Table 3.2 below provides the outputs of the capacity analysis conducted on the 14 projects illustrated in the above capacity analysis mapping.

Table 3.2 Capacity analysis of wind farms granted planning permission by An Bord Pleanála 01/01/2024 – 28/0122025

Project	No. of Turbines Permitted	TVA within 600m of permitted turbines (km^2)	MW capacity of permitted project	MW/km^2
Dernacart, Co. Laois	6	2.81	60	21.35
Fahy Beg, Co. Clare	8	0.56	34.8	62.14
Sheskin South, Co. Mayo	18	7.51	135	17.31
Borrisbeg, Co. Tipperary	9	1.08	63	58.33
Pinewoods, Co. Laois	11	0.82	47.3	57.68
Knockranny, Co. Galway	11	2.69	47.5	17.66
Cush, Co. Offaly	8	1.37	57.6	42.04
Ballynagree, Co. Cork	16	6.41	100	15.6
Firlough, Co. Mayo/Sligo	13	4.39	71.5	16.29
Bilboa, Co. Carlow/Laois	5	0.82	22.5	27.44
Ballivor, Co. Westmeath	26	12.71	143	11.25
Oweninny 3, Co. Mayo	18	9.56	90	9.41
Gortyrahilly, Co. Cork	13	3	46	15.33
Glenard, Co. Donegal	15	5.98	93	15.55
	Totals:	**59.71 km^2**	**1,006.2 MW**	
			Average:	**27.67 MW/km^2**

The MW/km^2 capacities per project range from 9.41 to 62.14 MW/km^2, which admittedly is a large range.

The disparity in MW/km^2 capacities is representative of the differing shapes, sizes and constraints found across differing wind farm sites. The two lowest capacities are found on 'Oweninny 3' (9.41 MW/km^2) and 'Ballivor' (11.25 MW/km^2), both of which are projects permitted for large contiguous landholdings on former Bord na Móna peat extraction sites. In contract, the highest capacities relate to 'Fahy Beg' (62.14 MW/km^2) and 'Borrisbeg' (58.33 MW/km^2), both of which are projects proposed for private landholdings, which are heavily constrained, but due to the shape and orientation of the viable areas remaining after constraints are applied, are able to accommodate a relatively high number of turbines in relatively small viable areas.

The average of all 14 projects' MW/km^2 capacities is 27.67 MW/km^2. This figure will be used as a higher range capacity figure to calculate a higher range future onshore wind energy potential figure.

However, this 27.67 MW/km^2 may not be entirely representative of what can reliably be achieved across the entire country, as it relates to specific projects that have successfully secured planning permission and avoided other development obstacles. Of the potential wind farm project sites that remain to be developed, these 14 projects must be considered the 'lowest hanging fruit' amongst the potential sites that remain to be developed. "Easier" sites will already have been developed before these 14, with those being deemed easier for multiple reasons including wind speed, proximity to grid, ease at which lands could be assembled, etc. As further wind farm development takes place in future years, potential sites are likely to be more challenging to develop, and therefore the MW/km^2 capacities achieved on the 14 projects studied, may not be achievable on every other part of the nationwide TVA mapped in this study.

Given that this national-level study is estimating the potential capacity of all potentially viable areas that are not yet developed as wind farms, a lower range capacity figure has also been derived from the totals of the 14 projects analysed, as per Table 3.3 below.

This lower range capacity figure, based on professional experience and judgement of wind farm development, may be more representative of the realistic future onshore wind energy potential.

Table 3.3 MW/km^2 derived from totals of 14 projects analysied

Project Dataset	Total TVA within 600m of permitted turbines	Total MW capacity of permitted projects	Total MW/km^2
14 projects granted planning permission by ABP 01/01/2024 – 28/02/2025	59.71 km^2	1,006.2 MW	**16.9 MW/km^2**

The lower range capacity figure of 16.9 MW/km^2 will be used to calculate a lower range future onshore wind energy potential figure.

Either the higher or lower range capacity figures will be different to the MW/km^2 figures established in similar exercises undertaken to establish MW/km^2 capacities previously. The key difference is the area the MW generating capacity is divided into. In similar exercises previously undertaken, the area of the site would have been established by referencing the planning application site boundary area, or the area encircled by the outermost turbines in a wind farm project. The TVA established in this study and from which the MW/km^2 figure is derived, takes account of site-level constraints and therefore is naturally going to be a smaller area than the planning application site boundary or the area encircled by the outermost turbines. The MW capacity of a project spread across a smaller TVA, is always going to generate a higher MW/km^2 capacity.

4. PROJECT ATTRITION

The theoretical viable area (TVA) mapped via the application of the primary constraints and the further analysis of those constraints described in Section 2 above, outlines the theoretical areas that could be developed for wind energy development dependent on certain conditions. There are six conditions that must exist for a theoretically viable area to become a developed, operational wind farm. The failure of a wind farm project due to any one of the six conditions not being met, and the ultimate failure to get to a construction and operational stage, is known as 'project attrition'. Project attrition results in a large theoretical potential becoming a much smaller realistically achievable potential. Project attrition is part of the risk that project developers expect when attempting to develop wind farm projects.

The six conditions that must exist for a theoretically viable area to become a wind farm in reality and withstand project attrition, are outlined below.

1. ***Landowner consent.*** *The required landowner(s) must be willing and able to enter into long-term agreements with a wind farm developer to make their lands available for wind farm development. This requires there to be no insurmountable title, ownership or legal issues relating to the land. It is now commonplace for up to 20+ landowner agreements to be required to assemble the necessary lands for a wind farm site and the access and grid connection routes thereto. Fragmented landholdings, uncertain/disputed land title or landholdings owned as commonage, can make it unviable and unrealistic to secure all the landowners agreements required to secure robust legal rights to develop a wind farm.*

2. ***Site feasibility.*** *Technical, site-level constraints often only emerge when site investigations or other work relating to the project design or the environmental impact assessment of a wind farm project commences and may often be insurmountable. Any potential wind farm must be deemed sufficiently feasible to justify the developer's decision to invest and risk the cost of preparing a planning permission application. Such constraints that can render site unfeasible or simply too high-risk to be progressed further, include ornithology risks relating to bird activity on site, geotechnical risks relating to slope or peat stability, aeronautical aviation risks relating to radar or flight path approaches around airports, amongst others.*

3. ***Planning permission.*** *A proposed wind farm development and its associated grid connection, must be capable of securing planning permission, from a local authority, on appeal from An Bord Pleanála, or directly from An Bord Pleanála if submitted as a strategic infrastructure development.*

4. ***Judicial review.*** *A proposed wind farm that secures planning permission and may have its granted permission judicially reviewed, must withstand any such judicial review.*

5. ***Grid connection.*** *A proposed wind farm must be able to secure a grid connection to connect to the electricity grid at a cost that is commercially viable. The physical extent or type of grid connection method specified in a grid connection offer may be cost prohibitive for a project. Similarly, the level of grid constraints and resultant dispatch down implications for a proposed wind farm, may make it unviable to develop.*

6. ***Route to market.*** *A proposed wind farm must be able to secure a route to market for the electricity it could generate, either by way of a Renewable Electricity Support Scheme (RESS) auction or a corporate power purchase agreement (CPPA). Both routes to market are commercially competitive, and by their nature require a certain number of projects to fail if others are to succeed. Fully consented, 'shovel-ready' wind farm projects, have failed to secure RESS contracts or fail to even enter the RESS auction process because they cannot meet the specific price cap.*

The concept of project attrition was outlined in the SEAI Methodology for Local Authority Renewable Energy Strategies[7] (LARES) with reference of a 'sieve analysis' approach to identifying wind energy potential. The LARES-referenced concept refers to a theoretical wind energy resource being reduced to a technical resource, further reduced to a practical resource, further reduced to an accessible resource and finally reduced to a cost competitive resource, as illustrated in Figure 4.1 opposite.

The LARES approach does not take account of all the stages in the development of a wind farm project, each of which is a potential hurdle the potential project must successfully clear.

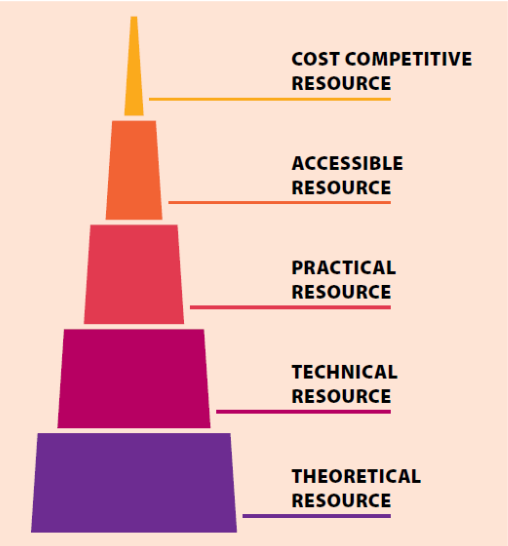

Figure 4.1 Graphical representation of 'sieve analysis' approach from SEAI LARES methodology

The six conditions referenced above that must exist for a theoretically viable area to become a wind farm in reality and withstand project attrition, could also be barriers and result in project failures. If lands for a potential wind farm project cannot be secured or landowners are not agreeable to accommodating a wind farm development on their land, the project cannot proceed. If site level constraints rule out a site as being suitable or render a wind farm project too high a risk for a developer to proceed with, the project will not proceed. If a proposed wind farm project cannot secure planning permission or does and later fails to withstand a judicial review legal challenge, the project cannot proceed. It a wind farm cannot secure a grid connection to connect to the electricity grid at a cost that is commercially viable, the project cannot proceed. If a wind farm project cannot secure a route to market for the electricity it will generate, it will not be able to secure project finance required to fund the construction, and the project cannot proceed.

These multiple, successive challenges at the various stages of project development have a significant cumulative effect. If 80% of projects (4 out of 5) are successful at each stage, and only 1 in 5 (20%) potential projects fails at each successive stage, the cumulative effect is a 74% reduction in the initial notional number of potential projects, as illustrated in Figure 4.2 below.

[7] *Methodology for Local Authority Renewable Energy Strategies. Sustainable Energy Authority of Ireland, 2013* https://www.seai.ie/sites/default/files/publications/Methodology-for-Local-Authority-Renewable-Energy-Strategies.pdf

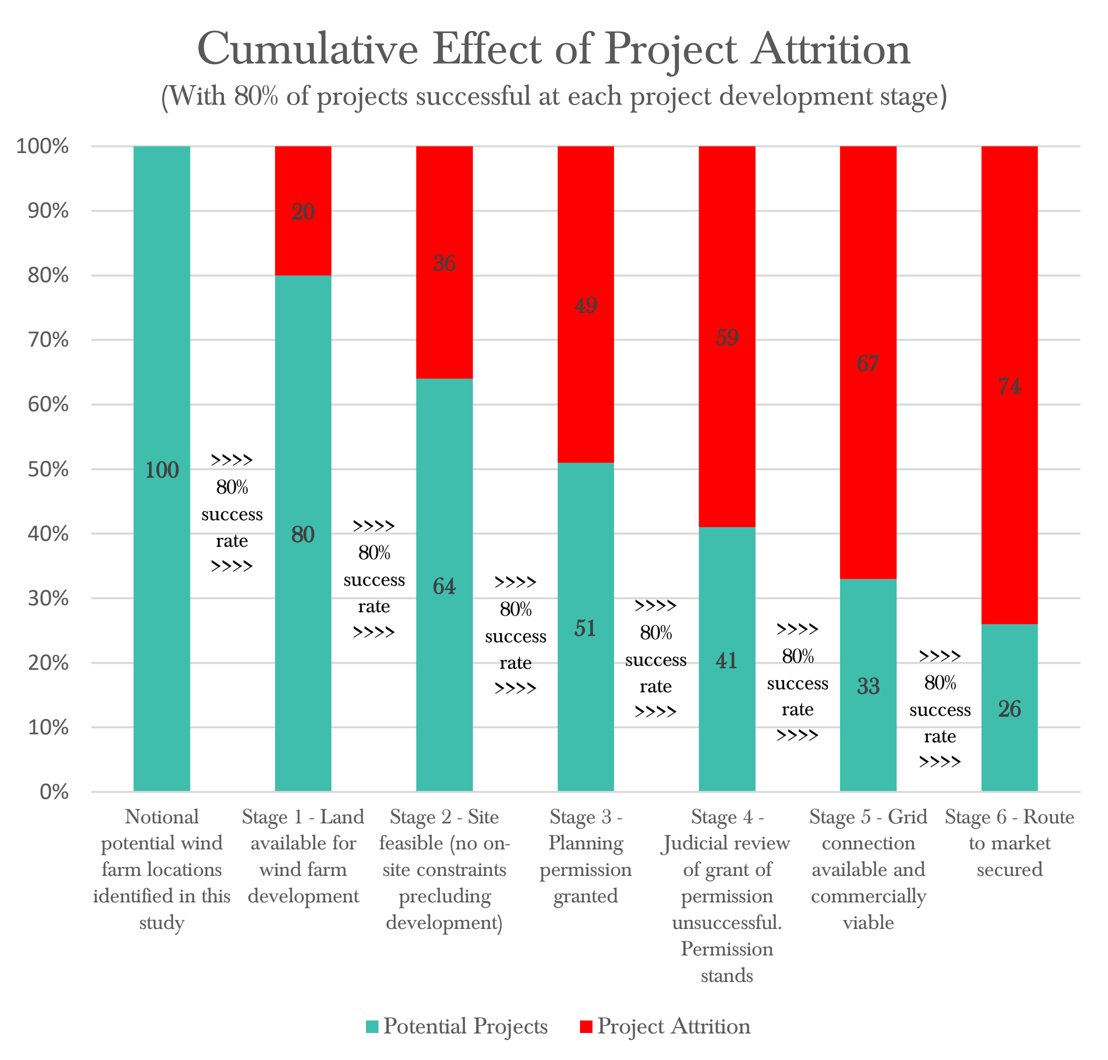

Figure 4.2 Project attrition illustration

A comprehensive historical analysis of attrition rates across the Irish wind energy industry's development pipeline was beyond the scope of this study. However, the professional experience of MKO, with over 20 years' experience at the forefront of the wind industry development in Ireland and direct experience of hundreds of wind farm projects, is that an 80% success rate at each stage should be achievable with the right Government policy supports, but may be optimistic based on recent and current observations, such as:

- The proportion of lands across the country in State ownership, and not available for wind farm development due to other requirements for that land.
- The highly-fragmented ownership structure of privately-owned, viable lands not already developed as wind farm projects, including large areas of commonage.
- The 59% success rate for wind farm cases decided by An Bord Pleanála between January 2022 and February 2025 (31 grants; 20 refusals; 1 partial grant), although there has been a notable increase to 82% in the proportion of decisions to grant permission by An Bord Pleanála over the last six months to February 2025.
- The lack of transmission grid infrastructure in areas such as Donegal and Mayo and the grid costs a project in those locations would have to incur.
- Wind farms in locations with high levels of grid constraints (e.g. Donegal) not bidding in RESS auctions because of being unable to bid in under the maximum price cap.

The consequence of project attrition is that a significantly larger quantum of land is required to deliver a desired installed generating capacity than might originally be expected.

Based on the Capacity Analysis undertaken in Section 3 above, if 1km^2 can accommodate 16.9 MW using the lower range capacity figure, applied nationally and allowing for project attrition, each 1km^2 of the TVA would only deliver 26% of 16.9 MW, or 4.39 MW/km^2, when applied nationally.

If the same 1km^2 could accommodate 27.67 MW using the higher range capacity figure, applied nationally and allowing for project attrition, each 1km^2 of TVA would only deliver and average of 26% of 27.67 MW, or 7.19 MW/km^2 when applied nationally.

5. FUTURE ONSHORE WIND CAPACITY

5.1 Results

The combined result of the constraints analysis, capacity analysis (using the higher and lower range values) and project attrition is outlined in Table 5.1 below.

Table 5.1 Potential future onshore wind energy capacity

Parameter	Lower Range Future Onshore Wind Potential	Higher Range Future Onshore Wind Potential
Theoretical Viable Area (TVA)	1,302 km^2	
MW/km^2 Capacity	16.9 MW/km^2	27.67 MW/km^2
Theoretical MW Capacity of TVA	22,004 MW	36,026 MW
Project Attrition Rate	74%	
Potential MW Capacity of TVA	**5,768 MW**	**9,444 MW**

Based on the analysis undertaken in this study, but dependant on whether the higher or lower range MW/km^2 capacities can be achieved across the country, the potential future onshore wind energy capacity of Ireland, is estimated to range from 5,768 MW to 9,444 MW.

The 5,768 MW to 9,444 MW of future onshore wind energy capacity, could be in addition to all currently operational or under construction wind farm projects (~5,250 MW), along with those projects that have already secured planning permission (~2,500 MW) or have applied for planning permission (~1,500 MW). However, the projects not yet operational or still in the planning process are likely to be subject to project attrition as referred to in Section 4 above. How many of the projects that have secured planning permission ultimately get built, depends on grid connection availability and constraints, and them finding a route to market for their power, or other policy or market-related factors, rather than physical, planning or environmental factors. The projects that are still seeking permission, are further exposed to the risk they will not secure permission, or any permission may be subject to judicial review and ultimately be annulled or remitted back to An Bord Pleanála for reconsideration.

5.2 Regional Potential

Recognising that spatial planning policy for wind energy development is going to be developed at a regional level, the future onshore wind energy capacity has also been assessed regionally, in the context of the country's three Regional Assembly areas, as mapped in Figure 5.1 below.

Figure 5.1 Regional Assembly areas

The Climate Action Plan 2024 includes Action EL/234/4 to *"Publish Regional Renewable Electricity Strategies"*. The updated Draft Revised National Planning Framework also includes National Policy Objective 74, which states *"Each Regional Assembly must plan, through their Regional Spatial and Economic Strategy, for the delivery of the regional renewable electricity capacity allocations indicated for onshore wind and solar reflected in Table 9.1 below, and identify allocations for each of the local authorities, based on the best available scientific evidence and in accordance with legislative requirements, in order to meet the overall national target"*. Please note the reference to Table 9.1 above related to a table in the updated Draft Revised National Planning Framework, not a table in this report.

The TVA and consequent potential future onshore wind energy capacity for each of the three Regional Assembly areas is shown in Table 5.2 below.

Table 5.2 Regional future onshore wind energy potential

Region	TVA (km^2)	% of Total TVA	Lower Range Future Onshore Wind Potential	Higher Range Future Onshore Wind Potential
Northern and Western	590	45%	2,614 MW	4,279 MW
Southern	374	29%	1,657 MW	2,713 MW
Eastern and Midlands	338	26%	1,497 MW	2,452 MW
	1,302 km^2	100%	5,768 MW	9,444 MW

5.3 Sensitivity Analysis – Secondary Constraints

Other factors that are potential impediments to wind energy development, but which are or could be policy-driven rather than physical or environmental constraints, were considered as secondary constraints in this study. These other factors were considered and analysed to illustrate the impact of certain existing, proposed or possible policy measures, on the country's future onshore wind energy potential.

5.3.1 Wind Energy Policy

The majority of Irish planning authorities now incorporate renewable energy strategies, or in some cases dedicated wind energy strategies, into their development plans. Such strategies typically identify mapped areas, where wind energy developments would be considered most appropriate, less appropriate or not appropriate. The development plans are required to set out the overall strategy of the Local Authority for the proper planning and sustainable development of the area.

There is a high degree of variability in the age, quality and ambition of the wind energy strategies that form part of planning authorities' development plans. As part of a previous 'Repowering Ireland' report[8] published by Wind Energy Ireland and also prepared by MKO, the wind energy policy classifications in the individual local authority areas were mapped for the entire country and consolidated into three simplified categories: 1) favourable, 2) unfavourable or 3) unclassified areas.

As part of this Future Onshore Wind study, the consolidated wind energy policy classification areas were overlaid on the theoretical viable area (TVA), to assess and quantify the quantum of the country's future onshore wind potential relative to existing local authority development plan policy for wind energy.

Table 5.3 provides the areas and percentages of the TVA in the consolidated wind energy policy areas. Figure 5.2 illustrates the percentage of the TVA in each of the consolidated wind energy policy areas in chart format.

Table 5.3 Area and percentage of TVA in wind energy policy areas

Policy Classification	TVA (km^2)	% of TVA
Favoured	469	36.1%
Not Favoured	619	47.5%
Unclassified	214	16.4%
Total:	**1,302 km^2**	**100%**

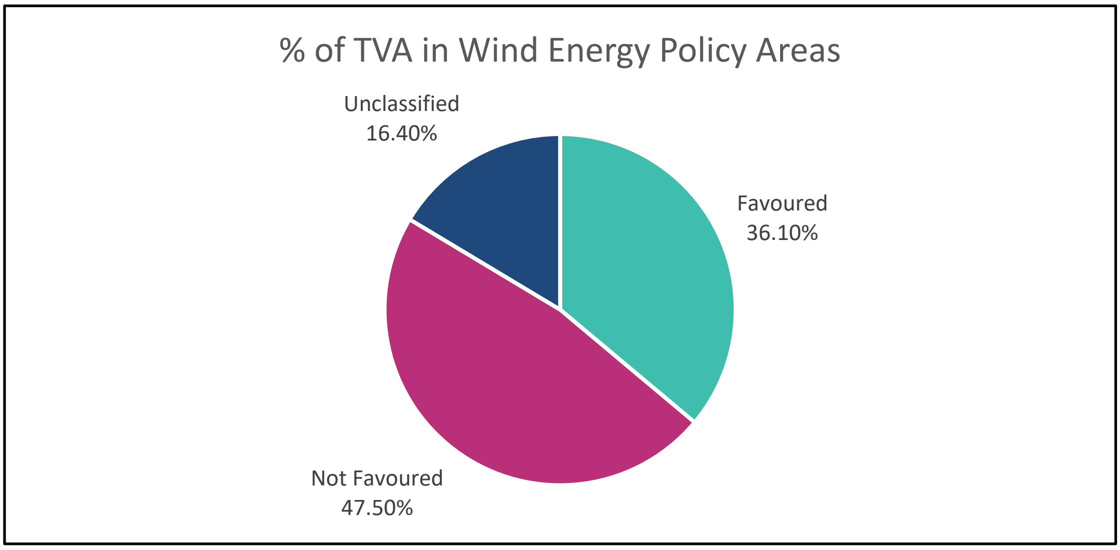

Figure 5.2 Percentage of TVA in wind energy policy areas

[8] *Repowering Ireland – How we stay global leaders in onshore wind energy. Wind Energy Ireland, 2024*
https://windenergyireland.com/images/files/final-repowering-ireland-report-june-2024.pdf

5.3.2 Air Corps

The development of onshore wind energy has been made more challenging in recent years by the policy position of the Department of Defence (DoD), and specifically the Air Corps, in relation to the siting of wind energy projects in certain areas and objections to the development of specific wind energy projects. A 2014 draft position paper entitled *Air Corps Wind Farm/Tall Structures Position Paper* makes a series of recommendations to restrict the development of onshore wind energy though fails to provide any evidence-base to support these proposals. These include:

- No wind farms to be built within 3 NM (Nautical Miles) of a motorway or national primary road.
- No wind farm to be built within 5 NM of a 'military installation' (a term which is not defined)
- No wind farm to be built within several identified areas. The paper identifies several parts of Ireland from which it proposes to restrict the development of onshore wind farms. Some of these relate to airspace delegated for military use under the Irish Aviation Act 1993 (IAA Act) and notified under S.I. 806/2007, but others appear to have never been formally published or designated.

The restricted areas referenced in the 2014 position paper were mapped and overlaid on the theoretical viable area (TVA), to assess and quantify the magnitude of the impact on the country's future onshore wind potential, if the 2014 position paper were to be adopted and implemented as drafted.

Table 5.4 provides the areas and % of the TVA in the suggested restricted and unrestricted areas. Figure 5.3 illustrates the percentage of the TVA in the suggested restricted and unrestricted areas in chart format.

Table 5.4 Area and percentage of TVA in Air Corps suggested restricted areas

Air Corps Areas	TVA (km^2)	% of TVA
Restricted	439	33.7%
Unrestricted	863	66.3%
Total:	1,302 km^2	100%

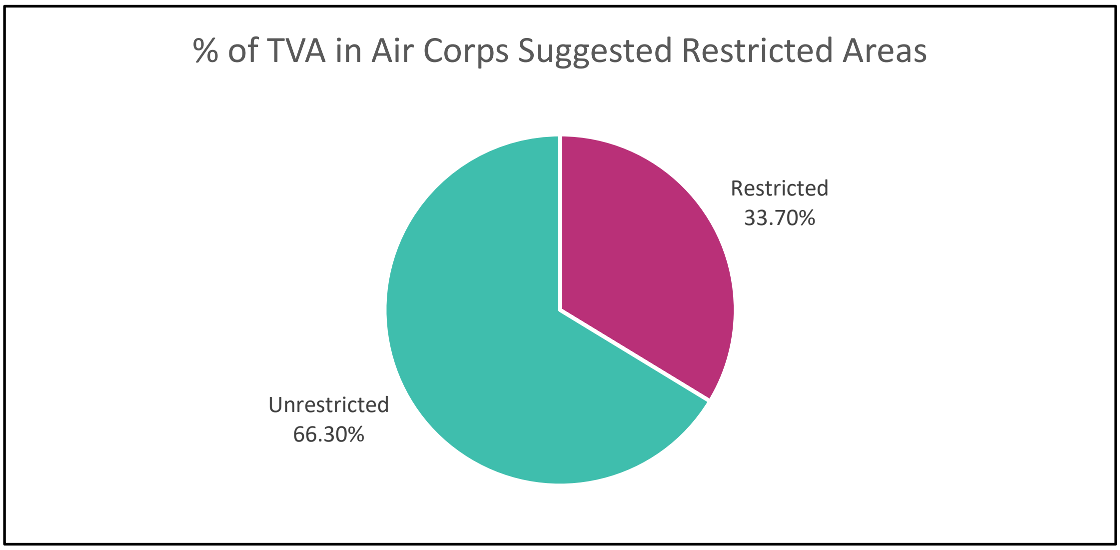

Figure 5.3 Percentage of TVA within Air Corps suggested restricted areas

5.3.3 Peatland

The majority of the Irish uplands are dominated by peat soils and these areas were amongst the first to see wind farm development in Ireland from the 1990's, due to their higher elevations and higher wind speeds. The Irish midlands saw vast areas of raised bogs drained for peat extraction from the 1930's until recent years, and many of these have already been, or are intended for repurposing to accommodate renewable energy developments such as wind farms.

Peatlands have become better understood and more valued in recent years, as carbon stores, biodiversity resources and for their water retention abilities which reduce flooding in downstream catchments. Many wind farms are already developed on peatland sites across Ireland. The construction of a wind farm development, or any type of development in a peatland environment, has the potential to cause the release of carbon from the peatland to the atmosphere. The embodied carbon required to construct a wind farm development on peatland is usually offset by the operation of the wind farm and resultant reduction in fossil fuels use, in less than two years[9],[10]. Environmental impact assessments reports prepared to accompany planning application for wind farms, must calculate their carbon balance, using methods such as the Scottish Government's wind farm carbon calculator for peatlands[11].

To assess how much of the TVA was located on peat soils and in peatland environments, the TVA was overlain on the Geological Survey of Ireland's quaternary sediment dataset. All areas classified as blanket peat, cut-over raised peat and fen peat, were mapped.

Table 5.5 provides the areas and % of the TVA within peatland areas. Figure 5.4 illustrates the percentage of the TVA within peatland areas in chart format.

Table 5.5 Area and percentage of TVA in Peatland areas

Peatland and Other Areas	TVA (km^2)	% of TVA
Peatland	815	62.6 %
Other Areas	487	37.4 %
Total:	1,302 km^2	100%

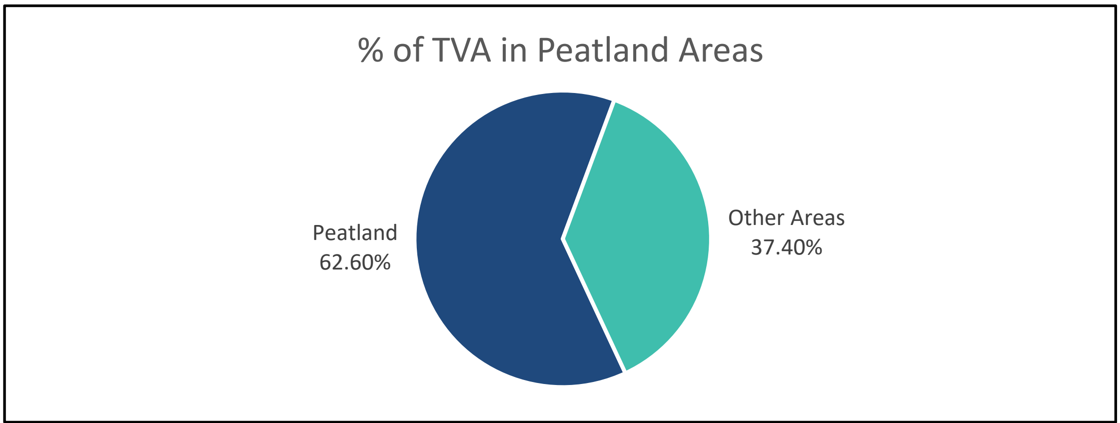

Figure 5.4 Percentage of TVA in peatland areas

[9] *Life cycle analysis of the embodied carbon emissions from 14 wind turbines with rated powers between 50Kw and 3.4Mw. Smoucha, EA., Fitzpatrick, K., Buckingham, S., & Knox, OGG. (2016). Journal of Fundamentals of Renewable Energy and Applications, 6(4), Article 1000211. Advance online publication.* https://pure.sruc.ac.uk/ws/portalfiles/portal/15258225/14430.pdf
[10] *Developing onshore wind farms in Aotearoa New Zealand: carbon and energy footprints. Pincelli, I. P., Hinkley, J., & Brent, A. (2024). Journal of the Royal Society of New Zealand, 1–23.* https://doi.org/10.1080/03036758.2024.2344785
[11] *Carbon calculator for wind farms on Scottish Peatlands. Scottish Government 2022*
https://www.gov.scot/publications/carbon-calculator-for-wind-farms-on-scottish-peatlands-factsheet/

5.4 Recommendations

On the basis of the research undertaken in this study and the results presented above, the following recommendations are made to ensure the full potential of the country's onshore wind energy resource can be harnessed to the greatest degree, as soon as possible.

1. ***Increased target****. This study clearly demonstrates there is potential to deliver significantly more onshore wind energy beyond the Government's current 9GW target. That target for onshore wind energy could be significantly increased to provide a clear signal to regulators, the wind energy industry and all stakeholders, that significantly more onshore wind energy will be required to decarbonise the economy, and is required to combat climate change.*

2. ***Clear policy.*** *A clear regional planning policy framework for wind energy development (and other renewable technologies) is urgently required to replace the disjointed county-level policies that are outdated and often designed to restrict wind energy development. Regional policy should identify the preferred areas for wind energy development that maximise the full potential of the regions' wind energy resource. Any spatial wind energy plans or policies must recognise project attrition as a reality of project development and ensure that a sufficient quantum of land is identified as being appropriate for wind energy development that allows for inevitable project attrition.*

3. ***More grid.*** *Significant reinforcement of the electricity transmission grid will be required to ensure that the full potential wind energy resource identified in this study can be harnessed. This will require significant upgrade of the existing transmission network, but also significant new grid development.*

4. ***Updated guidance.*** *Draft revised Wind Energy Development Guidelines (WEGs) were published in 2019 but have not yet been finalised. It is important that the guidelines are updated to bring certainty to the physical and operational constraints (e.g. noise, shadow flicker) wind farm projects will have to take account of in their layout designs. It is also vital that a balanced approach is taken in the WEGs to ensure the country's significant future wind energy resource can be effectively harnessed, without unnecessarily restricting the wind energy developments that will be required to help decarbonise the economy.*

5. ***Landscape calibration****. A calibration exercise on landscape sensitivity to wind farm development should be undertaken, to inform the preparation of any national or regional renewable energy strategies, and guide any further policy development at a local (county) level. For the country's full onshore wind energy potential to be harnessed, landscape sensitivity to wind energy development must be considered at a higher level than just within the confines of individual counties. The method used to derive the landscape sensitivity mapping used in this study provides a basis for such an exercise.*