Met Éireann's International Subscriptions

Focused Policy Assessment
February 2017

Strategic and Business Support Unit

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Department of Housing, Planning, Community and Local Government

This Focused Policy Assessment has been carried out by staff of the Strategic and Business Support Unit of the Department of Housing, Planning, Community and Local Government in their capacity as members of the Irish Government Economic & Evaluation Service, in accordance with the provisions of the Public Spending Code. It does not necessarily reflect the policy position of the Department, the Minister for Housing, Planning, Community and Local Government or the Government.

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Introduction

The Objective

Met Éireann has been a member of several international meteorological organisations for several decades.[1] These memberships bring with them many benefits, from satellite imagery to access to sophisticated computing facilities to opportunities for Met Éireann to influence the international meteorological agenda. However, the memberships are also costly, consuming a considerable proportion of Met Éireann's annual budget in any given year. Given the scale of recurring costs the Department of Housing, Planning, Community and Local Government, of which Met Éireann is a constituent Division, decided to review the costs and benefits of Met Éireann's memberships of international meteorological organisations. The purpose of the review is to determine the direct contribution of membership to the services Met Éireann delivers and to the wider achievement of Met Éireann's goals.

Purpose of Focused Policy Assessments

The Department has opted to conduct a Focused Policy Assessment, which is a form of Expenditure Review. The objectives of an Expenditure Review are to systematically analyse what is being achieved by a programme of Exchequer spending, thereby providing a basis on which more informed decisions can be made on priorities within and between programmes. A Focused Policy Assessment is intended to be a sharp and relatively narrow evaluation[2] designed to answer specific questions of policy configuration and delivery by reference to one or more evaluation criteria, with a view to quick conclusion to high standards of quality.

Guidance from the Central Expenditure and Evaluation Unit of the Department of Public Expenditure and Reform states that the process of conducting a Focused Policy Assessment should be flexible and not overly prescriptive, however such assessments should:

- Operate under a clear mandate;
- Be conducted by a Department's evaluation unit;
- Have tightly framed terms of reference;
- Not require a steering committee;

[1] In some cases Ireland is a member, as opposed to Met Éireann, however for simplicity's sake references in the text are generally made to Met Éireann's membership.

[2] As opposed to a full Expenditure Review, which can be a lengthy process requiring considerable resources.

- Be completed within tight timeframes; and,
- Be routinely published on http://publicspendingcode.per.gov.ie subject to any necessary redactions arising under Freedom of Information legislation.

The completion of expenditure reviews is also in line with the Public Spending Code requirement that expenditure programmes be subject to periodic evaluation and review.[3]

Terms of Reference

The Terms of Reference governing this assessment are presented in Appendix I. Revisions to the Terms of Reference were made in September 2016, to better reflect the Department's new configuration following its reorganisation in July 2016 and to refine the scope of the assessment to concentrate on the central issue of value for money.

Structure of the Assessment

This Focused Policy Assessment is organised and presented as follows:

- *Summary*: A summation of the assessment's principal findings, conclusions and recommendations;
- *Chapter One*: A description of Met Éireann in terms of its objectives, structure and the services it provides, in addition to a treatment of previous relevant audits and reviews;
- *Chapter Two*: A description of the principal international meteorological organisations of which Met Éireann is a member;
- *Chapter Three*: A discussion of the method adopted to conduct the assessment;
- *Chapter Four*: Presents the findings of the assessment of current and potential policy options, and presents recommendations arising from the assessment and related considerations.
- *Appendix I:* The Terms of Reference of the Focused Policy Assessment.
- *Appendix II:* The calculations of Net Present Costs.

Acknowledgements

This assessment has received considerable cooperation from the management and staff of Met Éireann, and has also benefitted from input provided by the Department of Public Expenditure and Reform.

[3] See Part C-02 of the Code, available here.

Summary

Met Éireann's strategic goal, objectives and the array of services it provides are very much related to the benefits of membership of the international meteorological organisations. Recent audits and reviews of Met Éireann have separately affirmed the vital nature of Met Éireann's memberships and Met Éireann's social and economic roles.

The total net present cost, of Met Éireann's membership of international meteorological organisations, including membership subscriptions, travel and accommodation costs and staff time, is approximately €27.6m over 2016 to 2020.

An assessment of various policy options strongly indicates that the 'no policy change' option, that is continued membership of the international meteorological organisation, is optimal.

This assessment recommends that Met Éireann continues its longstanding policy of international engagement and remains a member of the:

- World Meteorological Organisation, which is a specialised agency within the United Nations system;
- European Organisation for the Exploitation of Meteorological Satellites;
- European Centre for Medium-Range Weather Forecasts;
- High Resolution Limited Area Model; and
- EUMETNET.

In relation to optional programmes associated with memberships of these bodies, Met Éireann should continue to obtain the appropriate assents to participate.

Met Éireann is a member of several other international meteorological organisations, which fall outside the terms of reference for this assessment as their annual subscription costs are relatively minor.

This assessment recommends that Met Éireann, in the context of the development of its long-term strategic roadmap 2017 to 2026, prepares a short strategy document, by end-Q2 of 2017, setting its goals and expectations in respect of each membership with a view to securing the most advantageous impact and coherence with Met Éireann's wider operational and research agendas.

Chapter One - Context

Prior to conducting the formal Focused Policy Assessment, it is of obvious importance to gain an understanding of Met Éireann's role, of the institutional context within which Met Éireann operates, and of the services Met Éireann provides. Relevant to this assessment are two recent Departmental examinations of Met Éireann; the 2012 audit of subscriptions to international meteorological organisations carried out by the Department's Internal Audit Unit and the 2014 strategic and operational review of Met Éireann carried out by the Strategic and Business Support Unit of the Department. Also relevant is the outcome of a 2015 survey of weather forecast consumption behaviours which was commissioned by Met Éireann.

Met Éireann's Institutional Context[4]

Met Éireann, first established in 1936, has long had an international perspective. The organisation's original *raison d'être* was to support international civil aviation. In the intervening decades Met Éireann has retained its civil aviation role while developing its forecasting services; today, in addition to specialist services to the aviation industry and climatological research, Met Éireann's core responsibility is to provide public service weather forecasts to the general public and to organs of the State. Met Éireann is closely associated with the national Emergency Response Coordination Committee.

Since 2002 Met Éireann has been a component of the Department of Housing, Planning, Community and Local Government, having previously operated as part of the Department of Transport. Met Éireann's existence as a corporate entity is integrated with that of the Department; Met Éireann's Accounting Officer is the Department's Secretary General, the Director of Met Éireann is a member of the Department's Management Board and the Department's corporate publications, such as annual reports and statements of strategy, encompass Met Éireann.

Met Éireann has a staff of 165, and is headquartered in Glasnevin, Dublin. Met Éireann is composed of six divisions:

- Aviation services;
- General forecasting;
- Climatology and observations;
- Research, environment and applications;

[4] A more detailed history of Met Éireann is provided in the 2014 *Strategic and Operational Review of Met Éireann*.

- Business services; and,
- Technology.

Met Éireann's Objectives

An assessment of the merits and demerits of Met Éireann's participation in international meteorological organisations must in the first instance be grounded in an understanding of Met Éireann's mission. The most recent expression of Met Éireann's role and objectives are found in the Department's 2016-19 Statement of Strategy. The statement notes that Met Éireann will expand and develop its range of weather and climate services, including by the modernisation of aviation observation systems and the establishment of a new flood forecasting unit. The statement of strategy is organised in accord with a hierarchy of organisational goals, actions to be undertaken and anticipated outcomes.

Strategic Goal

The Strategic Goal set for Met Éireann in the statement is to serve society through the production and communication of reliable weather and climate information to protect life and property and to further enhance Met Éireann's role as the authoritative voice for high impact weather in Ireland.

Objectives

The objectives assigned to Met Éireann in the statement are:

- Expand and develop the delivery of authoritative impact based weather and climate services. (Objective A)
- Provision of high quality meteorological services for aviation in compliance with International Civil Aviation Organisation standards, the European Air Navigation Plan and European Regulations. (Objective B)
- Support the Office of Public Works in establishing a new national flood forecasting system to provide regular, detailed and localised information on flood forecasting. (Objective C)
- Maintain and develop expertise and skills and meteorological infrastructure required to deliver on Met Éireann's strategic goals. (Objective D)
- The further development of Met Éireann's research role. (Objective E)

Selected Actions

The actions included in the statement which Met Éireann will pursue and which are of most

relevance to this assessment include:

- Expand range and scope of forecast products and climate information services available to sectoral stakeholders and policy makers through digital media.
- Continue to participate as members of international meteorological organisations to exchange high quality satellite, observational and other data to feed into our forecast models as well as collaborating in international best practice in various fields of meteorology.
- Achieve improved forecast capability through research and upgrade of Met Éireann's numerical weather prediction suite.
- Maintain, develop and certify scientific and technical competence in line with international standards.
- Ensure Met Éireann's meteorological infrastructure meets the evolving requirements of weather and climate services.
- Increased participation in national and international research programmes in collaboration with other national meteorological services, agencies and academia by greater engagement in funding opportunities such as Horizon 2020.
- Retain designation as Irelands Meteorological Service provider for International Civil Aviation Organisation Annex 3 services and maintain Aviation Services Division ISO 9001 accreditation. Continuously improve the provision of high quality observations and forecast services in consultation with aviation users.

The Services Provided by Met Éireann

To deliver on its mandate Met Éireann provides services, primarily a suite of regularly updated forecasts and warnings. Short-term weather forecasts to the public, to the aviation industry and to other sectoral concerns are the services one most associates with national meteorological services. Naturally, much of Met Éireann's daily efforts go towards producing these forecasts and, when relevant, responding to other short-term contingencies, such as extreme weather. The specific services Met Éireann provides to the public and to other State bodies include:

- In each 24 hour period the Forecast Division produces:
  - Four National Forecasts, focused on today, tonight and tomorrow's weather, updated every 6 hours;
  - Eight Short Forecasts which are national in scope and intended primarily for radio, updated every 3 hours;

- Four Sea Area Forecasts, updated every 6 hours;
- Three Inland Lakes Forecasts (for each of Lough Derg, Lough Ree, Loughs Corrib & Mask, and Loughs Key & Allen), updated three times a day;
- Two updates to the Met Éireann website / application charts;
- Approximately 90 site-specific forecasts of road weather conditions in season (to inform road ice prevention measures); and,
- Approximately 20 bespoke forecasts for a variety of public bodies and commercial interests.

- The Forecast Division also produces on a daily basis:
  - 11 television weather broadcasts, five of which are delivered directly to air by forecasters, the other six are provided as script and graphics to RTÉ Weather Presenters;
  - Five live radio weather broadcasts on RTÉ Radio One; and,
  - Approximately 100 local radio weather forecasts daily.
- In each 24-hour period the Aviation office of the Forecast Division produces:
  - 16 "Long" Terminal Area Forecasts, provided for the four state airports; Dublin, Shannon, Cork and Knock and updated four times per day;
  - 20 "Short" Terminal Area Forecasts, provided for Casement, Waterford, Kerry, Sligo and Donegal airports and updated four times per day;
  - Four Low Level Significant Weather charts;
  - Four Wind Forecast charts;
  - SIGMETs, i.e. warnings of significant en-route weather for aviators, are produced as required;
  - Aerodrome warnings for Dublin, Shannon, Cork and Knock airports are produced as required;
  - Tailored forecasts for search and rescue missions are produced as required; and,
  - Two tabular forecasts for Dublin Airport, specifying a range of weather parameters for up to 5 days ahead.
  - General aviation phone briefings, typically for airline personnel, as required; and,
  - Weather information to airline representatives, airport authorities and Air Traffic Control, as required.
- The Forecast Division also contributes daily forecasts, looking five days ahead and for eight locations in Ireland, to the World Weather Information System co-ordinated by the World Meteorological Organisation.
- The Forecast Division contributes to meetings of the Government Task Force on Emergency Planning, the Inter-Departmental Working Group, the National Coordination Group on Severe

Weather, the Dublin Airport Operations Group, the Marine Safety Working Group, the Environmental Protection Agency Office of Radiological Protection and the Environmental Protection Agency Air Quality Group, amongst others.

- The Aviation Services Division organises the provision of operational observations, forecasts and warnings to support civil and military aviation in Ireland which form an element of an integrated international real-time database of meteorological conditions pertinent to aviation operators. The aviation forecasters are under the management of the Forecast Division following a re-structuring in 2009.
- The Climate and Observations Division:
    - Publishes Monthly, Seasonal and Annual Weather Statistics;
    - Updates and maintains the National Climate Archive, which contains data from the mid-1800s, and in a mix of electronic and paper formats. Currently, approximately 1 million observations a day are added to the database as observations are processed;
    - Provides advice and assistance to State Agencies and Departments of Government which require advice on infrastructure projects, European Directives and the updating of building standards. Advice and data is also provided to the renewable energy sector; and,
    - Issues climatological data to customers, which is a direct service to the public for which a charge is levied, provided by telephone or through a request facility on Met Éireann's website. There are also international obligations which the Division meets, including to the World Meteorological Organisation, the World Meteorological Organisation Region VI climate centre, the European Flood Awareness System and the European Climate Assessment and Dataset.
- The Research, Environment and Applications Division:
    - Manages and runs the numerical weather prediction models which underpin all forecast services and provide primary guidance to the forecasters.
    - Develops special products for specific applications, such as those modelling road surface temperatures and the modelling systems for forecasting the dispersion of noxious materials in the atmosphere;
    - Develops and runs climate models to provide information on the future climate under the National Climate Change Adaptation Framework;
    - Provides specialist products for the farming industry, including forecasts concerning expected growing conditions, information on weather related plant and animal diseases, and general advice;

- Conducts environmental monitoring. A laboratory in Dublin analyses air and rainfall samples for contaminants; and,
- Operates the national meteorological library.

Note that the preceding list is intended to encompass the services provided by Met Éireann to the public, State bodies and other consumers of forecasts and weather related products. Naturally, much of Met Éireann's other activities are not captured in this list. For instance, the development of the numerical weather prediction model, which is the cornerstone of Met Éireann's weather forecasts, is an important ongoing task which must be undertaken to support Met Éireann's capacity to provide quality services.

The 2012 Audit

In September 2012 the Department's Internal Audit Unit finalised its Report of the Audit of Subscriptions to international meteorological organisations by Met Éireann. The objective of the audit was to assess the adequacy and effectiveness of the systems and procedures used by Met Éireann in managing and paying subscriptions to international meteorological organisations. As such, the focus of the audit was somewhat different to this exercise, largely focussing on procedural matters, file management and so forth, as opposed to policy assessment. The Audit's Executive Summary states that, "in general the audit found that the administration and payment of subscriptions to IMOs [*international meteorological organisations*] was generally satisfactory and that membership of the IMOs is vital to Met Éireann's business objectives." Weaknesses were identified, however these concerned issues such as approval documentation shortcomings, weak file management and so forth. The audit noted that Met Éireann had begun to actively address and implement a number of the report's recommendations.

The 2014 Strategic and Operational Review of Met Éireann

Conducted in 2014, the ambit of the 2014 review included:

- The institutional and governance arrangements for Met Éireann;
- The effectiveness of Met Éireann's management and organisational arrangements;
- The quality of services delivered to end users; and,
- Met Éireann's capacity to carry out its scientific and technical tasks to a high standard consistent with best practice.

Prior to its finalisation, a draft of the 2014 review was peer-reviewed by three external experts, including by a former head of the Royal Netherlands Meteorological Institute.

A number of the specific findings of the 2014 review are of relevance to this assessment. In respect of the annual value to the Irish economy of Met Éireann's services, the review noted that the specific aggregate value thereof is not readily observable as Met Éireann's services are provided, in the main, free of charge. So, insofar as price reflects the value a consumer places on a service, there is limited visibility of the value placed by consumers on the general forecast and warnings produced by Met Éireann. The review noted the World Meteorological Organisation estimates that the ratio of economic benefits to the budget of a national meteorological service typically falls in the range of 5-10, and described several studies conducted in respect of industrialised, western countries which have estimated the cost to benefit ratios as ranging from 1:4 to 1:6, depending on the country in question. The 2014 review stated that "the services Met Éireann provides are vital to the wellbeing and economic welfare of Ireland, ranging from general short-term weather forecasting to extreme weather warnings, from specialist services for the aviation industry to climatological research."

The 2015 Market Survey

Arising from a recommendation contained in the 2014 Review, Met Éireann commissioned a market survey in 2015 to gain a better understanding of the weather forecast consumption behaviours of the Irish public, and in particular to determine:

1. The primary methods which the public use to obtain weather forecasts;
2. The elements of weather forecasts which are considered to be most useful to the general public; and,
3. The benefits obtained by the public from access to forecasts.

The results of the survey, which was conducted in October and November of 2015, are of obvious relevance to this assessment as they demonstrate the extent to which the public rely on Met Éireann forecasts for information about the weather and the degree to which Met Éireann's forecasts are regarded as reliable. The principal results include that:

- Met Éireann weather forecasts are the main source of weather information for people in Ireland. On average, people use Met Éireann forecasts 60 times per month, or twice a day;

- Confidence in Met Éireann forecasts is high when compared with alternative sources such as non-Met Éireann forecasts broadcast on local radio stations or available on social media;
- 'Localised forecasts for any location for up to 5 days' is the most desirable feature for Met Éireann's website and app and was included in 52% of respondents' top 3 features; and,
- Since 2001, there has been an increase from 45% to 64% in those agreeing that Met Éireann's forecasts are a help in planning their daily activities.

These results indicate Met Éireann's important role in informing the public and the public's confidence in Met Éireann's services. They also indicate that there exists considerable demand for 5 day localised forecasts, which is relevant to this assessment, as the production of such forecasts is heavily reliant on observation data, modelling capacity and computing power which Met Éireann currently has access to by virtue of its membership of international organisations.

Chapter Two - The International Organisations

Since its establishment as an organisation primarily focused on providing services to international aviation in Irish airspace, Met Éireann has had a commitment to international collaboration and a clear interest in working with sister organisations in other countries and with international organisations intended to foster and assist meteorological cooperation.

International meteorological cooperation since the middle of the Twentieth Century has undoubtedly been a very successful field of international scientific collaboration, resulting in tangible benefits to participating States and their citizens. Broadly speaking, such international cooperation has been focused on:

- Establishing and refining international standards and coordinating collective efforts in areas such as training and scientific collaboration;
- Generating and disseminating observations data used by national meteorological services to prepare forecasts;
- Providing specific services to the aviation industry which is particularly dependent on quality forecasts; and,
- Developing shared techniques and methodologies, such as approaches to numerical weather modelling.

All of the memberships under assessment are of organisations which are primarily concerned with one or more of these fields of activity.

Technology, Observations and International Meteorology

It is important to emphasise the importance of technology to modern meteorology. Data, in the form of observations, are fed into a mathematical model to produce forecasts. Setting aside human skill and judgement, the accuracy and detail of a given forecast can be thought of as primarily being a function of two sets of inputs; firstly, the volume and quality of data, and secondly, the capacity of the mathematical model to translate that data into a forecast which closely approximates the actual weather.

In general, the greater the quantity of quality data available, the more robust the forecast. Much of the required data is extra-territorial, especially for a small country like Ireland which lies on the periphery of a large ocean; usually the weather experienced in Ireland travels across the Atlantic

Ocean unobserved by the national observation network until a given weather system is relatively close.

Similarly, complex high definition mathematical models which depend on considerable expertise to develop and refine and which require very considerable computing power will outperform simpler models in terms of forecast accuracy. In particular, the production of medium range forecasts such as 5 day localised forecasts, which, as noted in Chapter One are in considerable demand, are especially reliant on extra-territorial observations and sophisticated models.

As such, national meteorological organisations across the world, and Ireland in particular, rely on technology to, firstly, generate and communicate large volumes of observational data and, secondly, to process that data using specialised computing facilities capable of handling very large volumes of data and complex numerical models. Such technology requires considerable investment; fixed capital costs associated with establishing the observation networks, radar, computers and satellite systems which generate and process the required data are undoubtedly high. Much of this equipment depreciates rapidly and must be maintained, upgraded and improved to avoid obsolescence.

The Nested Nature of the International Organisations

The international organisations of which Met Éireann is a member are not independent, isolated entities. For instance, the observations made available by satellites operated by EUMETSAT are used by ECMWF medium range weather prediction models which provide the boundary conditions for the HIRLAM short-range weather forecasting system.[5] These organisations are inter-dependent, interlocking and mutually supportive. The international meteorological organisations have been designed and have evolved based on the assumption that national meteorological services are members of all relevant organisations. Therefore, it would make little sense to consider a scenario of piecemeal withdrawal, in which Met Éireann picks and chooses among the organisations, opting to remain in some and to withdraw from others. The benefits of selective membership of some organisations would be compromised by non-membership of other organisations.

An additional consideration is that there exist strong links from international meteorological organisations to the wider international institutional framework; to the United Nations through the

[5] See pages 18-21 for the non-acronym titles of the organisations.

World Meteorological Organisation, to the European Space Agency and, importantly, to the European Union.

Costs 2011 to 2020

The following tables describe the direct financial costs associated with Met Éireann's membership of the international organisations from 2011 to July 2016, and the anticipated annual costs from 2016 to 2020.

Table 2.1: Overview of Spend, 2011 to 2016

Organisation	2011	2012	2013	2014	2015	2016*
EUMETSAT	1,0295,703	2,354,753	2,713,921	2,958,270	3,205,272	3,705,028
ECMWF	625,998	602,923	591,468	626,718	612,541	574,120
WMO	253,756	272,113	268,569	223,041	272,013	264,384
HIRLAM	149,530	113,300	113,300	115,150	115,900	75,900
EUMETNET	78,860	76,269	79,200	79,104	66,027	67,747

* To 13 July 2016.

Table 2.2: Proportion of Total Spend, 2011 to 2015

Organisation	2011-2015	% of All International Subscriptions[6]	% of Met Éireann Spend 2011-2015
EUMETSAT	12,527,919	69.2%	13.0%
ECMWF	3,059,648	16.9%	3.2%
WMO	1,289,492	7.1%	1.4%
HIRLAM	607,180	3.4%	0.6%
EUMETNET	379,460	2.1%	0.4%

* To 13 July 2016.

[6] Note: A further four minor memberships account for an additional ~1%.

Table 2.3: Anticipated Spend by Subscription, 2016 to 2020

Organisation	2016	2016	2017	2018	2019	2020	Total
EUMETSAT[7]	4,153,483	4,153,483	4,765,735	5,489,382	5,467,935	4,831,179	24,707,714
ECMWF	622,066	622,066	638,889	647,666	672,116	706,272	3,287,009
WMO	279,943	279,943	279,943	279,943	279,943	293,940	1,413,712
HIRLAM	75,900	75,900	78,177	80,522	82,938	85,426	402,963
EUMETNET	67,011	67,011	72,531	74,707	78,442	82,364	375,055

The membership subscriptions paid by Met Éireann are calculated on the basis of an agreed method set out in the financial rules or regulations of the relevant organisation. For instance, the annual contributions made by Met Éireann in respect of EUMETSAT's general budget and mandatory programmes[8] is based on a pro-rata of Ireland's Gross National Income, calculated as an average for the latest three years for which the relevant statistics provided by EUROSTAT are available. As such, negotiations over membership subscriptions do not arise as prices are mandated by international agreements.

The International Meteorological Organisations

The following pages describe in turn each of the major international meteorological organisations of which Met Éireann is a member. Also specified are the Met Éireann Objectives, as defined by the Statement of Strategy, which are most relevant to each subscription; the five Objectives are labelled Objectives A to E on page 8.

World Meteorological Organisation

The World Meteorological Organisation is an agency of the United Nations established in 1950 to facilitate and coordinate cooperation and activities in weather and climate meteorology, hydrology and related geophysical sciences. Met Éireann acts as a representative for Ireland; Ireland's membership dates from March 1950.

Programmes operated by the World Meteorological Organisation are intended to facilitate and promote:

[7] Note that the relative decline in EUMETSAT spend in 2020, as compared to 2018 and 2019, is due to the cyclical nature of investment in satellite programmes.
[8] See page 21 in respect of optional programmes.

- The creation of standards for observation and monitoring;
- The application of science and technology in operational meteorology and hydrology to aviation, transport, water resource management and agriculture;
- The coordination of research and training in meteorology and related fields;
- The establishment of observational networks to provide weather, climate and water-related data; and,
- The establishment and maintenance of technical and operational protocols, data management centres and telecommunication systems for the provision and rapid exchange of weather, climate and water-related data.

The World Meteorological Organisation also houses the repository of global weather observations and information.

Percentage of Actual International Subscription Spend 2011 to 2015:[9] 6.8%
Percentage of Anticipated International Subscription Spend 2016 to 2020:[10] 4.6%

Met Éireann's participation in the World Meteorological Organisation contributes to the attainment of Objectives A, B, C, D and E of the 2016 to 2019 Statement of Strategy (see page 8).

European Organisation for the Exploitation of Meteorological Satellites
The European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) is an intergovernmental organisation, the purpose of which is to supply weather and climate-related satellite data, images and products to the National Meteorological Services of Member and Cooperating States in Europe, and other users worldwide. EUMETSAT operates a fleet of meteorological satellites that observe the atmosphere and ocean and land surfaces. The data generated by the satellite network is provided to the National Meteorological Services of EUMETSAT's Member and Cooperating States. The satellite network includes:

- The Meteosat 7, 8, 9 and 10 satellites operational over Europe and Africa providing detailed imagery of Europe, the North Atlantic and Africa every 15 minutes, for operational use by meteorologists;

[9] All subscriptions, including minor subscriptions.
[10] All subscriptions, including minor subscriptions.

- The Metop-A and Metop-B satellites providing detailed observations of the global atmosphere, oceans and continents, including remote sensing capabilities which augment the accuracy of temperature humidity measurements, readings of wind speed and direction, and atmospheric ozone profiles; and,
- The Jason 2, Jason 3 and Sentinel 3 satellites, which provide ocean measurements and monitoring, including of sea surface height, sea-surface topography, sea-surface temperature and ocean-surface colour, which support forecasting for fisheries, other maritime industries and search and rescue.

EUMETSAT was formed in 1986. Ireland is a founding member among 30 EUMETSAT Member States.

Percentage of Actual International Subscription Spend 2011 to 2015: 71.2%
Percentage of Anticipated International Subscription Spend 2016 to 2020: 81.1%

Met Éireann's participation in EUMETSAT contributes to the attainment of Objectives A, B, C, D and E of the 2016 to 2019 Statement of Strategy (see page 8).

European Centre for Medium-Range Weather Forecasts

The European Centre for Medium-Range Weather Forecasts (ECMWF) produces numerical weather forecasts, carries out scientific and technical research to improve forecast skill and maintains an archive of meteorological data. ECMWF specialises in global numerical weather prediction for up to about 2 weeks ahead, which in meteorological terms are medium range. ECMWF provides twice-daily global numerical weather forecasts, air quality analysis, atmospheric composition monitoring, climate monitoring, ocean circulation analysis and hydrological prediction. ECMWF also provides scientific training to staff from the national meteorological services of Member States, which Met Éireann avails of.

Met Éireann's membership provides access to ECMWF's numerical prediction data in real time which is an important element of forecast preparation. Met Éireann may also access ECMWF's computing facilities, including supercomputers, and to the ECMWF's meteorological archive. ECMWF was formed in 1975. Met Éireann is a founding member and acts as a representative for Ireland.

Percentage of Actual International Subscription Spend 2011 to 2015: 15.9%
Percentage of Anticipated International Subscription Spend 2016 to 2020: 10.8%

Met Éireann's participation in ECMWF contributes to the attainment of Objectives A, B, C, D and E of the 2016 to 2019 Statement of Strategy (see page 8).

High Resolution Limited Area Model

The High Resolution Limited Area Model (HIRLAM) is a research cooperation programme of 11 European meteorological institutes; the aim of the programme is to develop and maintain a numerical short-range weather forecasting system for operational use by the participating meteorological institutes. The current iteration of the programme, HIRLAM B, provides access to a number of mathematical models which are integral to Met Éireann's forecasting operations, including the HARMONIE model which operates at a high resolution of 2.5km, and a short-range prediction system suitable specifically for severe weather.

Percentage of Actual International Subscription Spend 2011 to 2015: 3.0%
Percentage of Anticipated International Subscription Spend 2016 to 2020: 1.3%

Met Éireann's participation in HIRLAM contributes to the attainment of Objectives A, B, C, D and E of the 2016 to 2019 Statement of Strategy (see page 8).

EUMETNET

EUMETNET is a grouping of 31 European national meteorological services intended to provide a framework to organise co-operative programmes between members in the various fields of basic meteorological activities, including observation systems, data processing, basic forecasting products, research and development and training. The cooperation programmes focus on enabling enhanced networking, interoperability, optimisation and integration across national meteorological services. EUMETNET is based in Brussels and provides, on behalf of the national meteorological services, collective representation with European Union institutions.

EUMETNET, supported by the World Meteorological Organization, also operates the Meteoalarm system which integrates and reports on all severe weather information originating from almost all European countries. In view of Met Éireann's role in helping ensure better preparedness and decision-making in relation to extreme weather events, Meteoalarm is an important programme.

Percentage of Actual International Subscription Spend 2011 to 2015: 2.0%
Percentage of Anticipated International Subscription Spend 2016 to 2020: 1.2%

Met Éireann's participation in EUMETNET primarily contributes to the attainment of Objectives A, D and E of the 2016 to 2019 Statement of Strategy (see page 8).

Optional Programmes

The international meteorological organisations of which Met Éireann is a member tend to divide the programmes they each operate into two categories, mandatory and optional. Mandatory programmes account for the bulk of spending by each of the international organisations and are funded by the subscriptions paid by the participating meteorological services. Optional programmes are operated on the basis that meteorological services which choose to participate may opt in and financially contribute; meteorological services which choose not to participate are not required to contribute.

Met Éireann participates in several optional programmes. In the main the cost of these programmes to Met Éireann are not high. Of the 16 optional programmes in which Met Éireann is involved during 2016, 13 programmes will collectively cost circa €21,000, the other three will cost circa €53,000.

Typical optional programmes include:

- E-SURFMAR, the Surface Marine observation programme operated by EUMETNET, the objective of which is to coordinate, optimise and progressively integrate European activities for surface observations over the sea in support of Numerical Weather Predictions. The programme delivers marine observations from vessels operated by member services, as well as from drifting and moored buoys. As a maritime nation, this is an important programme for Met Éireann as the observations in the seas around the Irish coast act as a primary source of information for the Sea Area Forecast, and Gale or Storm Warnings; services focused on the safety of ferry services, the Irish fishing fleet, and leisure craft. The 2011 to 2016 cost of participation in the E-SURFMAR programme by Met Éireann has been circa €57,000; and,
- The Operational Programme for the Exchange of Weather Radar Information (OPERA) operates and develops the ODYSSEY data hub, which collects radar volume data, distributes quality flagged volume data to modellers and other radar data users, and produces quality controlled radar products. OPERA makes available a Data Information Model and provides support to its members in environmental and societal issues related to weather radars, such as radar siting, radio-frequency interference and the impact of wind farms. It also provides a

European platform for exchange of experience in the field of weather radars. Weather radar information is vital in supporting forecasts of rainfall, and forecasts and warnings of heavy rain. The recent government decision to ask Met Éireann to develop a National Flood Forecast and Warnings Service will put even greater emphasis on the need for high-quality weather radar data. The 2011 to 2016 cost of participation in the OPERA programme by Met Éireann has been circa €22,000

The more expensive optional programmes are related to maritime satellite programmes. The Jason 2 and Jason 3 programmes operated by EUMETSAT provide oceanography and climate change information of considerable socio-economic value. The satellites provide scientists with data concerning circulation patterns in the ocean and about both global and regional changes in sea level and the climate implications of a warming world. The Jason 2 and Jason 3 programmes are nearing the end of their life-cycles; the costs to Ireland associated with these programmes are declining and will be extinguished in 2018. Met Éireann intends for Ireland to participate in the successor programme, known as Jason CS, subject to final approval which Met Éireann is in the process of securing. Participation in the Jason CS programme will result in increases to Met Éireann's optional programme spend of approximately €1.25m in total over the 2016 to 2020 period.

It is important to note that Met Éireann has demonstrated selectivity in respect of its participation in optional programmes; the motivation to participate in a specific optional programme is the relevance or practical application to Met Éireann's strategic objectives allied to the availability of personnel and other resources. Met Éireann has not to-date actively participated in optional programmes such as EUMETNET's EMMA-H Hydrology Programme and the WMO's Marine Meteorology and Oceanography Programme.

Chapter Three - Method and Approach

Scope

This assessment is not an appraisal of the international organisations themselves, nor of their internal controls, audit practices, financial and other governance etc. Rather, the Terms of Reference of this assessment require that a consideration and evaluation of Met Éireann's membership of international meteorological organisations be made in terms of the costs and benefits of the memberships, including the direct contribution of the membership to the services Met Éireann delivers and to the wider achievement of Met Éireann's goals. In terms of the temporal scope, the assessment is principally concerned with actual and anticipated costs and benefits over the 2016 to 2020 period.

Methodology

As discussed in the Introduction, a Focused Policy Assessment is intended to be a relatively narrow evaluation designed to answer specific questions of policy configuration and delivery by reference to one or more evaluation criteria, with a view to quick conclusion. The 2007 Value for Money and Policy Review Initiative Guidance Manual, published by what is now the Department of Public Expenditure and Reform, is the principal detailed guidance document available to inform how best to undertake such an evaluation.

The 2007 Manual sets out the theoretical foundation for Value for Money reviews. Value for Money reviews attempt to ascertain whether or not a robust rationale exists for the allocation of public monies to pay for the programme in question and, where such rationale is deemed to exist, whether potential alternative means of delivery are available which may be more efficient or effective without detracting from the quality of programme outcomes. The guidance emphasises the exercise of evidence based judgement in reaching conclusions about the value of public programmes and projects.

This assessment therefore requires the employment of a mechanism to weigh the merits and demerits of the various policy options. In the normal course, the Value for Money Expenditure Review guidance suggests the use of the programme logic model,[11] however this model is not suitable in this particular context, principally as the international subscriptions cannot be considered to be a discrete expenditure programme in the traditional sense. Rather, much of the value of the

[11] See Value for Money and Policy Reviewers' Network, Value for Money and Policy Review Initiative Guidance Manual, 2007, page 28.

membership of international meteorological organisations is the extent to which they provide inputs to various programmes operated by Met Éireann and it would be difficult to disentangle the impact of the international organisation inputs from those of other inputs. For instance, the data supplied arising from Met Éireann's participation in EUMETSAT is an important element underpinning many of the forecasts the Forecasting Division prepares, alongside other elements such as Met Éireann's meteorological expertise and experience, local computing facilities, locally designed and calibrated numerical models etc. It is beyond the scope of this assessment to undertake the forensic analysis which would be required to isolate the inputs associated with the international subscriptions in terms of each individual service Met Éireann provides.

A related difficulty is the public good nature of most of the services Met Éireann delivers. The 2014 Strategic and Operational Review of Met Éireann noted that, while it is self-evident that meteorological services have value for the Irish economy, the specific aggregate value thereof is not readily observable. The value of Met Éireann's meteorological services is principally derived from the increased certainty provided to consumers when making decisions in conditions of uncertainty. These decisions are made at the level of the person, the household and the firm. The national value is an aggregate of these individually realised benefits. Due to the public good nature of meteorological services it is somewhat difficult to place a value on most of the activities of Met Éireann. Met Éireann's services are provided, in the main, free of charge so, insofar as price reflects the value a consumer places on a service, we have limited visibility of the value placed by consumers on the general forecast and warnings produced by Met Éireann.

An alternative method to assess the available policy options is therefore required.

A suitable alternative technique to the programme logic model is multi-criteria analysis[12], which is an evaluation technique used to help establish preferences between options by reference to an explicit set of objectives and criteria; a linear additive model of multi-criteria analysis with a simple weighting system has been used. The preparation of a multi-criteria analysis involves the following steps:

(i) The identification of criteria;

[12] Alternative techniques, such as Cost Benefit Analysis and Cost Effectiveness Analysis are not considered to be appropriate techniques for the purposes of this analysis, given the timeframes, the policy area and the methodological complexities of monetising impacts.

(ii) Description of the performance of each option against the criteria;

(iii) Scoring and weighting;

(iv) Examining the results; and,

(v) Sensitivity analysis.

A preceding step will be to establish whether a rationale and continued relevance exist for Met Éireann to concern itself with the benefits associated with memberships of the international meteorological organisations. This step will include, as a calibration exercise, a calculation of the costs associated with the international memberships from 2016 to 2020 and a brief review of the relevant conclusions of the 2012 Audit and 2014 Review.

Design of the Multi-criteria Analysis

A necessary step is to consider and determine the options which will be subject to the multi-criteria analysis, the criteria against which each option will be judged and the weightings of scores. As noted in Chapter Two, given that EUMETSAT, ECMWF, WMO, EUMETNET and HIRLAM collectively constitute the lion's share of the contributions, the analysis will focus on these subscriptions.

The following policy options will be examined:

a. **No policy change:** Met Éireann continues with the current suite of international memberships;

b. **Withdrawal without replacement:** Met Éireann resiles entirely from the international organisations without any measures to replace lost capacity, observations, network access etc.;[13]

c. **Withdrawal with partial replacement:** Met Éireann withdraws entirely from the international organisations and seeks to replace, where available, capacity, observations, network access etc. with available substitutes, such as:

- Freely available data, observations, models etc. such as the American Global Forecast system;
- Internally designed and produced numerical models;
- A strengthened Met Éireann observation network; and,

[13] Given the interrelated nature and purpose of the international organisations, and the extent to which their operations are tied together, it would not be appropriate to consider withdrawal from a subset of the major subscriptions.

- Commercially available satellite data, supercomputer access etc. (presuming such services exist at reasonable cost, which they may not).

Clearly, a cost associated with this policy option would be the overhead associated with negotiating access to third party data and systems. It should also be noted that no alternative or market exists to replace some of the benefits of membership of some of the international meteorological organisations;[14] and,

d. **Withdrawal with full replacement:** Met Éireann withdraws entirely from the international organisations and seeks to entirely replace the services, data etc. gained from participation in the international organisations, including satellite networks, supercomputer access, oceanic observation vessels etc. Note that this option is included for the sake of completeness as the cost would be prohibitive; the establishment of an independent satellite and observations network, supercomputing facilities and independently designed numerical models etc. would likely cost in excess of €1bn.

Having identified the policy options which will be subject to analysis, the second step of a multi-criteria analysis is the selection of criteria that reflect the value associated with the consequences of each option. Each objective must be expressed by a criterion or criteria. Criteria should be complete, should be without redundancy (i.e. all criteria should be necessary), should be capable of being effectively, if subjectively, judged, should be mutually independent, and should be measured without double counting of benefits. Given the objectives and roles which have been defined for Met Éireann, as set out in Chapter One, the following criteria, each scored on a scale from 1 to 10, have been chosen:

1. Capacity of the Policy Option to support accurate, reliable warnings of severe weather and support to emergency management to protect life and property and to promote wider societal and economic wellbeing;
2. Capacity of the Policy Option to support the production and communication of authoritative, accurate and reliable Short Term (0-24 hours) Forecasting, including general, aviation, maritime and other specific forecasts;

[14] For instance, the World Meteorological Organisation oversees and determines the protocols for the Global Telecommunication System, a communications system which allows for the efficient communication of information among national meteorological services.

3. Capacity of the Policy Option to support the production and communication of authoritative, accurate and reliable Medium Term (24-240 hours) Forecasting including general, aviation, maritime and other specific forecasts;
4. Capacity of the Policy Option to support the conduct of research into weather and climate to inform Government policy and decision-making,;
5. Capacity of the Policy Option to support Met Éireann's institutional development and the advancement of Met Éireann's expertise – note that to avoid double counting such institutional development and expertise advancement is separate to that captured by criteria 1 - 4;
6. Impact of the Policy Option on Ireland's standing in international meteorology;
7. Impact of the Policy Option on Ireland's standing in wider international affairs; and,
8. The cost of the Policy Option.

All criteria are important and each criterion is derived from Met Éireann's mission, however, certain criteria have been assigned an additional weighting. Weighted scorings represent the degree to which certain criteria are considered to be more important than other criteria. The following weightings are used:

Criteria 1, 2, 3, 4 and 8:	Each subject to a weighting of 1.4.
Criteria 5, 6 and 7:	Each subject to a weighting of 1.0.

As such, any given Policy Option scored across all 8 criteria could receive an unweighted score from 0 to 80, and a weighted score between 0 and 100.

Chapter Four – The Assessment

Prior to setting out the scores achieved by each of the policy options under the multi-criteria analysis, it seems appropriate to seek to quantify, insofar as possible, the costs associated with membership of the international organisations to help calibrate this assessment.

Net Present Costs

As discussed in Chapter Three, arriving at a robust monetary estimation of the benefits of the international subscriptions is problematic, for several reasons. Therefore it is not possible to conduct a simple investment appraisal exercise. Typically, such exercises involve calculation of Net Present Values, that is, the difference between the present value of the revenue and the present value of the costs. However, the Net Present Benefits are not readily observable. Nor is it possible to calculate Internal Rates of Return. It is, however, possible to calculate the Net Present Costs of each subscription, over 2016 to 2020. There are several elements of the total costs of collective membership of the international organisations, including:

(a) The membership fees paid to the international organisations;
(b) The costs of membership in terms of the staff time and travel required to participate in the organisations; and,
(c) The overheads associated with operational processing of the outputs of each of the subscriptions.

The first two elements are quantified below.[15] The last, that is the costs of processing the inputs have not been quantified, due to the inherent complexity and in recognition that under several of the alternative policy options similar costs would arise.

Table 4.1: Net Present Costs of the Membership Subscriptions, 2011 to 2016[16]

Subscription	Net Present Cost €
EUMETSAT	22,369,340
ECMWF	2,979,635

[15] Note that a small proportion of the travel and accommodation costs, and staff time, are related to relatively minor memberships, in cost terms, of international meteorological organisations (EC-Earth and Met Alliance).
[16] The relevant calculations are set out in Appendix II.

WMO	1,284,122
HIRLAM	365,315
EUMETNET	339,372
Total	27,337,784

Membership and participation in international organisations draws on Met Éireann's managerial and corporate resources. Based on 2015 travel and accommodation costs of €24,000, the Net Present Cost of travel and accommodation 2016 to 2020 is an additional €109,103.[17] Met Éireann has advised that in 2015 63 staff days were required to prepare for, travel to and from, and attend meetings associated with the international meteorological organisations, such as governance, management, financial and other technical committees. 63 days loosely corresponds to 25% of the total annual available working effort of a Principal Officer equivalent; a rough costing equates to €30,000 per annum which has a Net Present Value of €136,379.

The total Net Present Cost, including membership subscriptions, travel and accommodation costs and staff time, of approximately €27.6m sets a benchmark. This benchmark provides a value against which to calibrate expectations of the value of the present and future benefits of membership to Met Éireann and Ireland. Considering only the 2016 to 2020 period, and therefore ignoring any costs or benefits which may arise beyond this period, the investment required by collective participation in the international organisations is justifiable if the benefits exceed €27.6m.

Scoring the Multi-criteria Analysis

As per the criteria set out in Chapter Three, the scores achieved by each of the four policy options under examination are set out in the following pages, with reasoning provided for each of the assigned scores.

[17] The relevant calculations are also set out in Appendix II.

Criterion 1: Capacity of the Policy Option to support accurate, reliable warnings of severe weather and support to emergency management to protect life and property and to promote wider societal and economic wellbeing. [Weighting: 1.4]

Policy Option	Score	Reasoning
a. No policy change	8	Systems[18] currently in use provide demonstrably world class forecast data, providing warnings at 48+ hours in advance of a severe weather event. The WMO provides the institutional structure to support training and policy guidance for severe weather warnings and interactions with emergency management organisations. EUMETNET's Meteoalarm system provides: - Pan-European weather warnings; - Training for weather forecasters in severe weather situations - A forum for exchange of best practise. EUMETNET also contributes to weather warning system research, and coordinates financial support for weather buoys.
b. Withdrawal without replacement	2	Withdrawal without replacement would largely jettison the advances in forecasting severe weather which have been made in last 50 years. Forecasts and warnings would be based on the national observation system. Little to no warnings would be available for the West Coast, approximately 6 hour for the East Coast.
c. Withdrawal with partial replacement	4	Freely available web data, such as the Global Forecast System weather forecast model could be used, however this model is relatively coarse.[19]Access to fine resolution models and satellite data would be severely restricted or unavailable. Model boundary conditions would be unavailable. Met Éireann would have no access to ECMWF supercomputers for research; no national alternative facility is available.
d. Withdrawal with full replacement	7	Due to inherent capacity issues, even if Ireland dedicated a super-abundant level of resources to extreme weather forecasting it would not be possible to replicate the knowledge base found elsewhere.

[18] EUMETSAT, HIRLAM and ECMWF.

[19] The American Global Forecast System is not considered to be world leading, as it incorporates less data points and has a lower resolution than the models currently used by Met Éireann. For instance, the Global Forecast System has a base horizontal resolution of 28km between grid points, as opposed to the ECMWF system which did have a horizontal grid spacing for high-resolution forecasts of 16km, and which has been improved to 9km from March 2016.

Criterion 2: Capacity of the Policy Option to support the production and communication of authoritative, accurate and reliable Short Term (0-24 hours) Forecasting, including general, aviation, maritime and other specific forecasts. [Weighting: 1.4]

Policy Option	Score	Reasoning
a. No policy change	9	Met Éireann's current Short Term forecasting capability is regarded as strong; forecasts are authoritative and demonstrably accurate. Met Éireann operates a high resolution model, which is dependent on EUMETSAT and ECMWF inputs. The WMO contributes by setting forecast standards and protocols which all national meteorological services must comply with. The WMO also oversees and sets standards and training for the communications systems which allows national meteorological services to interact with the aviation and marine commercial communities (e.g. airlines).
b. Withdrawal without replacement	2	This option would result in reversal to a 1950s level of service. Met Éireann would be unable to support the aviation industry to required levels, potentially resulting in the cessation of commercial aviation in Irish airspace. The consequences of the closure of Irish airspace are obvious.
c. Withdrawal with partial replacement	4	Potentially, aviation forecasts could be outsourced to a WMO-affiliated organisation, for example to a foreign national meteorological service. However, such a service would lack the knowledge and experience of 40 years of forecasting which Met Éireann has and therefore would likely yield an inferior short range model for Ireland.
d. Withdrawal with full replacement	7	Full replacement at high cost would provide a short term forecasting service, however it would not be possible to replicate or bypass the WMO and therefore WMO membership would be required to support aviation forecasting.

Criterion 3: Capacity of the Policy Option to support the production and communication of authoritative, accurate and reliable Medium Term (24-240 hours) Forecasting including general, aviation, maritime and other specific forecasts. [Weighting: 1.4]

Policy Option	Score	Reasoning
a. No policy change	9	The ECMWF is the foremost Medium Term forecasting system in the world. The HIRLAM system is regarded as very good out to 54 hours; a particular strength of HIRLAM is its contribution to shipping forecasts. Met Éireann receives world class Medium Term guidance and training as a result of its memberships of international meteorological organisations.
b. Withdrawal without replacement	1	Under this option no knowledge of Medium Range conditions would be available, other than analysis of the historical time series, and therefore there would be little-to-no forecast capability.
c. Withdrawal with partial replacement	4	Freely available web data, such as the Global Forecast System weather forecast model could be used, however this model is relatively coarse, with limited detail for Ireland, and has considerably less authority than ECMWF and HIRLAM. Met Éireann could endeavour to produce a national model, however it would be constrained by a lack of data and a lack of access to specialised computing facilities. In practice, accurate forecasts would be limited to 2 days in advance, with a sizable impact on certain industries, such as farming.
d. Withdrawal with full replacement	7	Even in circumstances in which a sophisticated global model was to be developed, such a model would be limited by a lack of observation data from other parts of the globe.

Criterion 4: Capacity of the Policy Option to support the conduct of research into weather and climate to inform Government policy and decision-making. [Weighting: 1.4]

Policy Option	Score	Reasoning
a. No policy change	8	Met Éireann's technical advice to the Environmental Protection Agency, concerning matters such as climate change, and other State agencies relies heavily on membership of the international meteorological organisations. The WMO coordinates extensive research into weather and climate. Membership of the WMO also provides access to a global database of weather observations. The Intergovernmental Panel on Climate Change (IPCC) was established by the WMO and is closely connected to the WMO. The IPCC helps inform the political agenda, by ensuring the scientific basis of climate change information provided to global policy makers. The output of ECMWF models is used to provide detailed Irish focused research to national policy makers. The ECMWF operates the EU-funded Copernicus Climate Change service. The data arising from EUMETSAT membership is also important for national climate change research.
b. Withdrawal without replacement	2	A national database is available but would be of limited use. Very limited research tailored to national circumstances would be available for policymakers.
c. Withdrawal with partial replacement	4	Access to relatively coarse global models could be secured, however challenges would include limited downscaling[20] expertise and insufficient computing capacity; Met Éireann benefits from ECMWF membership to run downscaling models.
d. Withdrawal with full replacement	6	It would be possible to procure the expertise and computing facilities, however the constraint would be data; past data can't be reproduced even with an Irish-owned global model.

[20] Downscaling is the name for procedures used to apply information known at large scales to make predictions at local scales.

Criterion 5: Capacity of the Policy Option to support Met Éireann's institutional development and the advancement of Met Éireann's expertise. [Weighting: 1.0]

Policy Option	Score	Reasoning
a. No policy change	9	Within existing resource constraints, Met Éireann exploits its memberships of the international meteorological organisations to a considerable extent. WMO membership acts as a spur to all national meteorological services, including Met Éireann, to better their performance and increase expertise. WMO requirements often act as an impetus to upgrade equipment. As a small national meteorological service, Met Éireann relies heavily on international engagement to maintain international standards. Met Éireann receives training and gains expert knowledge from membership of ECMWF and HIRLAM in particular; Met Éireann is integrated with HIRLAM research teams.
b. Withdrawal without replacement	1	Should Met Éireann withdraw from the international meteorological organisations, institutional development and the advancement of Met Éireann's expertise would be considerably retarded.
c. Withdrawal with partial replacement	3	A 'watch and copy' strategy to Met Éireann's development could be adopted, and partnerships with academia could be put in place, however the returns would be limited.
d. Withdrawal with full replacement	7	It would be possible to procure consultants to adopt international best practices, however Met Éireann would be operating, at best, at one remove from core, and would have no input into developing best practice elsewhere.

Criterion 6: Impact of the Policy Option on Ireland's standing in international meteorology. [Weighting: 1.0]

Policy Option	Score	Reasoning
a. No policy change	8	Ireland currently enjoys a position of good standing in the international meteorological community.
b. Withdrawal without replacement	1	Wholesale withdrawal would have severe negative consequences for Ireland's standing in international meteorology.
c. Withdrawal with partial replacement	1	Wholesale withdrawal would have severe negative consequences for Ireland's standing in international meteorology, and partial replacement would not compensate for the withdrawal.
d. Withdrawal with full replacement	3	Wholesale withdrawal would have severe negative consequences for Ireland's standing in international meteorology, however efforts to develop replacement systems would demonstrate a commitment to meteorology. It would be open to Ireland to make observations and other data freely available, which would be counted as a contribution.

Criterion 7: Impact of the Policy Option on Ireland's standing in wider international affairs. [Weighting: 1.0]

Policy Option	Score	Reasoning
a. No policy change	7	Ireland's standing in international relations is certainly not predicated on meteorology alone, however Ireland's memberships of, and contributions to, international meteorological organisations is a signal of a commitment to the wider international institutional architecture.
b. Withdrawal without replacement	4	Withdrawal would send a damaging signal concerning Ireland's relationship with the world, perhaps casting doubt on Ireland's commitment to international cooperation, international organisations and Ireland's place in Europe.
c. Withdrawal with partial replacement	4	Withdrawal would send a damaging signal concerning Ireland's relationship with the world, perhaps casting doubt on Ireland's commitment to international cooperation, international organisations and Ireland's place in Europe.
d. Withdrawal with full replacement	4	Withdrawal would send a damaging signal concerning Ireland's relationship with the world, perhaps casting doubt on Ireland's commitment to international cooperation, international organisations and Ireland's place in Europe.

Criterion 8: The cost[21] of the Policy Option (on a scale of 1 to 10, from highest cost to lowest cost). [Weighting: 1.4]

Policy Option	Score	Reasoning
a. No policy change	9	Estimated costs 2016-2020: Approximately €30m.
b. Withdrawal without replacement	9	Estimated costs 2016-2020: It is generally the case under the relevant membership agreements that members leaving an international meteorological organisation remain liable for commitments made prior to the official notification of its decision to leave. As such, major savings would not arise over the 2016-2020 period. In addition, minor costs associated with executing a withdrawal strategy would arise.
c. Withdrawal with partial replacement	9	Estimated costs 2016-2020: As per option b. In addition, approximately €30 million of further costs would arise, arising from expenses associated with: - The procurement of observation data from third parties; - Additional investment in the national observation network, - Access to commercially available supercomputer facilities; and, - The recruitment of three additional specialist staff.
d. Withdrawal with full replacement	1	Estimated costs 2016-2020: In excess of €1bn.

[21] In nominal terms, as opposed to Net Present.

Table 4.1: Unweighted Total Scores

Policy Option	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6	Criterion 7	Criterion 8	Total
a. No policy change	8	9	9	8	9	8	7	9	67
b. Withdrawal without replacement	2	2	1	2	1	1	4	9	22
c. Withdrawal with partial replacement	4	4	4	4	3	1	4	9	33
d. Withdrawal with full replacement	7	7	7	6	7	3	4	1	42

Table 4.2: Weighted Total Scores

Policy Option	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6	Criterion 7	Criterion 8	Total
a. No policy change	11.2	12.6	12.6	11.2	9	8	7	12.6	84.2
b. Withdrawal without replacement	2.8	2.8	1.4	2.8	1	1	4	12.6	28.4
c. Withdrawal with partial replacement	5.6	5.6	5.6	5.6	3	1	4	12.6	43
d. Withdrawal with full replacement	9.8	9.8	9.8	8.4	7	3	4	1.4	53.2

Additional Considerations

A further set of considerations arise. Firstly, because of prevailing weather patterns and Ireland's location, Met Éireann's observation network is an important component of the European observations system. The withdrawal of Met Éireann, presumably resulting in discontinued access of relevant international meteorological organisation to Met Éireann's weather balloon data, radar facilities and buoy network, would degrade the efficacy of the wider European observation network. Clearly, a general disimprovement in the capacity of European national meteorological services to forecast weather would not be a welcome development, even when viewed solely from a narrow Irish national interest perspective. Secondly, a withdrawal by Met Éireann could result in the loss of access to data and observations, for instance, as international meteorological organisations seek to encourage other national meteorological services to remain within the fold.

A further relevant observation is that the international benchmark is participation in international meteorological organisations. No other peer country has adopted an isolationist approach to meteorological services. The aggregate costs of the suite of international meteorological organisations to the global community of nations is considerable, however the international system as a whole has clearly determined that the investment is worthwhile. Irish withdrawal would be a repudiation of a policy shared by our peer countries at a time when commitments to international collaboration and cooperation should be reinforced.

These considerations have not been encompassed within the multi-criteria assessment, however they resonate with the result of the assessment.

Conclusion

Based on the criteria and assigned scores, the 'no policy change' option is the superior option. As such, this assessment finds that the benefits gained through Met Éireann's memberships of international organisations, in terms of the services Met Éireann delivers and the wider achievement of Met Éireann's goals, are considerable. This assessment therefore recommends that Met Éireann continues its longstanding policy of international engagement and remains a member of the:

- World Meteorological Organisation;
- European Organisation for the Exploitation of Meteorological Satellites;
- European Centre for Medium-Range Weather Forecasts;
- High Resolution Limited Area Model; and

- EUMETNET.

The results of the multi-criteria assessment are in accord with the judgements expressed in the 2012 Audit and of the 2014 Operational and Strategic Review.

As noted in relation to the scoring of policy option "a. No Policy Change" under criterion 5, Met Éireann exploits its memberships of the international meteorological organisations to a considerable extent within existing resource constraints. However, there may be future opportunities to further capitalise on membership of international meteorological organisations, subject to assessments of value for money.

Governance and Accountability

The Terms of Reference of this assessment require a consideration of Met Éireann's adherence to best practice concerning the transfer of subscription and other payments by Met Éireann to the international meteorological organisations. Of relevance is the 2012 Audit, which identified no major concerns at the time. Met Éireann has provided confirmation that the processes in place concerning the making of payments to international meteorological organisations adhere to the requirements of the Public Spending Code and to the Department's budgetary procedures. Met Éireann has further confirmed that its activity and operations in that regard comply with the relevant processes.

As noted in Chapter Two, Met Éireann participates in optional programmes operated by the international meteorological organisations. Some of these programmes, such as those related to satellite networks, involve considerable costs. In respect of those programmes, Met Éireann will ensure that the appropriate authorisation is obtained; for instance, should participation in an optional programme be deemed to be a new 'international agreement' the assent of the Dáil would be required to authorise participation under Article 29 of the Constitution. In other circumstances, a Government or Ministerial decision may be required. In 2015 Met Éireann sought the advice of the Office of the Attorney General in respect of its participation in the HIRLAM-B programme arising from which a Government decision authorised participation and also authorised future participation in other optional programmes which cover the same material scope. Met Éireann is currently exploring the appropriate sanction required to participate in the Jason CS optional programme; the Jason programme is discussed in Chapter Two.

This assessment recommends that Met Éireann continues to obtain the appropriate assents to participate in optional programmes.

Output Indicators

The Terms of Reference of this assessment require consideration of the topic of the development of suitable performance indicators in respect of Met Éireann's memberships of international meteorological organisations. Performance indicators should focus on two general themes:

- That the inputs associated with each of the various international memberships, such as observations data, meet Met Éireann's operational requirements in terms of quality, reliability, regularity etc.; and,
- That, insofar as resources and operational requirements permit, Met Éireann exploits to the fullest the various benefits and opportunities which accrue from the memberships and ensures that benefits of relevance to other State agencies are disseminated.

This assessment therefore recommends that Met Éireann, in the context of the development of its long-term strategic roadmap 2017 to 2026, prepares a short strategy document, by end-Q2 of 2017, setting its goals and expectations in respect of each membership with a view to securing the most advantageous impact and coherence with Met Éireann's wider operational and research agendas. An element of this strategy should include the establishment of performance indicators which should be put in place and reported on internally at regular intervals. A further element should be an articulation of how Met Éireann wishes to contribute and influence the agendas of the various international meteorological organisations, cognisant of Met Éireann's status as one among many other participants.

Appendix I - Terms of Reference

The Focused Policy Assessment will consider and evaluate Met Éireann's membership of International Meteorological Organisations in the following respects:

- The costs and benefits of the memberships, including the direct contribution of the membership to the services Met Éireann delivers and to the wider achievement of Met Éireann's goals;
- The development of suitable performance indicators; and,
- Adherence to best practice concerning the transfer of subscription and other payments by Met Éireann to the international meteorological organisations.

The Assessment will examine Met Éireann's membership of the following organisations:

- World Meteorological Organisation;
- European Organisation for the Exploitation of Meteorological Satellites;
- European Centre for Medium-Range Weather Forecasts;
- High Resolution Limited Area Model; and
- EUMETNET.

Appendix II – Calculating Net Present Costs

As the annual payments in respect of the subscriptions are irregular, that is, in most cases they vary from year to year, the present value of the cost for each year is calculated using the following formula:

$$P = S(1 + \frac{r100}{\quad})^{-t}$$

where

S = future value

P = principal

r = interest rate

t = time[22]

using the official 5% Test Discount Rate for Economic Evaluation and Appraisal Purposes provided by the Department of Public Expenditure and Reform. Note that the 5% rate is intended to be applied when future costs and benefits are presented in real terms, excluding projected inflation.

Table A2.1: Net Present Cost Calculations, 2016 to 2020 Membership Subscriptions

Year	**EUMETSAT**		**ECMWF**		**WMO**	
	€		**€**		**€**	
	Nominal	*Discounted*	*Nominal*	*Discounted*	*Nominal*	*Discounted*
2016	4,153,483.00	4,153,483.00	622,066.00	622,066.00	279,943.00	279,943.00
2017	4,765,735.00	4,538,795.24	638,889.00	608,465.71	279,943.00	266,612.38
2018	5,489,382.00	4,979,031.29	647,666.00	587,452.15	279,943.00	253,916.55
2019	5,467,935.00	4,723,407.84	672,116.00	580,599.07	279,943.00	241,825.29
2020	4,831,179.00	3,974,622.92	706,272.00	581,051.72	293,940.00	241,825.17
Total	24,707,714.00	22,369,340.29	3,287,009.00	*2,979,634.66*	1,413,712.00	*1,284,122.39*

[22] Jacques, I (2003) *Mathematics for Economics and Business*, 4th Edition. London: FT Prentice Hall, Pages 215-6.

Table A2.1 (cont.)

Year	HIRLAM €		EUMETNET €	
	Nominal	*Discounted*	*Nominal*	*Discounted*
2016	75,900.00	75,900.00	67,011.00	67,011.00
2017	78,177.00	74,454.29	72,531.00	69,077.14
2018	80,522.00	73,035.83	74,707.00	67,761.45
2019	82,938.00	71,644.96	78,442.00	67,761.15
2020	85,426.00	70,280.18	82,364.00	67,761.07
Total	402,963.00	*365,315.26*	375,055.00	*339,371.81*

Table A2.2: Net Present Cost Calculations, 2016 to 2020 Travel and Accommodation

Year	Travel and Accommodation Costs €	
	Nominal	*Discounted*
2016	24,000	24,000.00
2017	24,000	22,857.14
2018	24,000	21,768.71
2019	24,000	20,732.10
2020	24,000	19,744.86
Total	120,000	109,102.81

Table A2.2: Net Present Cost Calculations, 2016 to 2020 Staff Time

Year	Travel and Accommodation Costs €	
	Nominal	*Discounted*
2016	30,000	30,000.00
2017	30,000	28,571.43
2018	30,000	27,210.88

2019	30,000	25,915.13
2020	30,000	24,681.07
Total	150,000	136,378.52