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Integrating Climate and Energy Projections in Practice

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Executive Summary

Achieving the objectives of the Paris Agreement and the European Union's climate and energy targets for 2030, in line with the Energy Union strategy, will require fundamental changes in how we use fossil fuels – the primary source of climate changing greenhouse gases (GHGs) – and how we live with more variable energy supply solutions. To lay the foundations for a more sustainable future, we are now poised to make significant investments in new energy infrastructure, systems and supply chains, and to implement measures addressing energy demand. Decisions relative to these investments and to the design and evaluation of these policies and measures must be underpinned by robust analysis and tools, able to provide a range of coherent outputs relevant to several policy objectives.

This paper, developed by experts from the European Topic Centre on Air and Climate Mitigation (ETC/ACM) ([1]) and the European Environment Agency (EEA), outlines the role of integrated climate and energy projections as a tool supporting coherent policy interventions under the Energy Union, and proposes a number of concrete solutions to integrate climate and energy projections in practice. It is based on knowledge gained across two decades of working in support to EU policy on climate change and environment, in particular on reporting issues, and from workshops and interactions with EU Member State representatives.

Key findings

Regularly updated projections are a powerful tool to inform policymakers.

Making informed strategic decisions about the future relies on a number of methods and tools to define and interpret information for comparing alternatives. Among these tools, projections are increasingly used by planners and policymakers as part of a systemic approach for trade-off analysis. As such, they serve to estimate the likely outcomes of a scenario considering existing policies, with or without a planned set of additional interventions.

In the climate area, projections are modelled estimates of future economic, energy and decarbonisation scenarios, which aim to reproduce the effects of our investment in low-carbon, well-adapted, sustainable economies.

Estimating projections involves the use of tools and models to manage the range of assumptions and interactions between the assumptions involved. These models and tools need to be sufficiently comprehensive and transparent enough to provide decision makers with confidence in implementing actions. Modelling of projections needs to build up scenarios iteratively, starting from a historic trend of a number of key economic, energy and climate policy parameters, whilst considering resource availability perspectives and constraints.

Well-developed projections can inform decisions on policy targets and the actions needed to meet them. Regularly updated projections can also support regular assessments of the projected progress towards a defined set of targets or against a trajectory expected to achieve these targets, and of the impact that policies are expected to have on such progress. Whilst it is possible to set and to meet targets with no support from projections, without the information obtained from *regularly updated projections* it is not possible to analyse and anticipate in a timely manner whether those targets are on track to be met.

([1]) The European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM) is a consortium of 14 European institutes under contract of the European Environment Agency (EEA).

Integrating the planning and reporting of energy and climate projections has multiple benefits, but requires overcoming technical and institutional challenges.

> ***Box ES.1. Elements of GHG projections***
> GHG emission projections combine an array of inputs, from historical trends and intensities, to assumptions about future economic activities, technologies, resource availability, prices and the growth or decline of products and services. Modelling of projections starts from informed assumptions on the future economy and economic change. These then feed energy models, which work out how economic change will make use of available energy resources. Specific policy preferences influence the final energy mix through e.g. preferences for domestic supply and/or improved interconnections, or incentives for cleaner fuels. GHG projections therefore build on economic drivers and energy mix assumptions based on market (price) and national and European policy (Energy Union) constraints. Ultimately, GHG projections as reported today, if done properly and transparently, constitute integrated projections, since they rely on and include key energy policy assumptions and their projected impacts on energy and associated GHG emissions.

The Energy Union aims to transform Europe into a low-carbon, energy- and resource-efficient economy, in a socially just manner and based on an integrated European energy market (EC, 2015). To that end, it puts forward several binding targets to be achieved by 2030 – especially concerning GHG emission reductions, renewable energy use and energy efficiency improvements – and introduces new planning, monitoring and reporting obligations for Member States and the EU post-2020 in a new Governance Regulation of the Energy Union (EC, 2016a).

At present, climate (GHG) projections, renewable energy trajectories and energy efficiency objectives (energy consumption targets), designed to provide information relevant for planning how to achieve existing national and EU policy targets for 2020 and for tracking progress towards these targets, are reported in separate streams by Member States, and to different timelines. After 2020, the inclusion of projections in the Governance Regulation proposal (EC, 2016a) builds upon the 15-year experience of reporting on GHG projections by Member States under the Monitoring Mechanism Regulation and the United Nations Framework Convention on Climate Change. This inclusion seeks to provide a coherent decision-support tool for policymakers for integrating planned activities and interventions across the climate and energy domains. In particular, it aims to improve the coherence and synergies of national decision making through dialogue and transparency, and align with the reporting obligations and timelines under the Paris Agreement.

Achieving these objectives through the integration of climate and energy projections requires overcoming a number of challenges, including:

- *Harmonising nomenclature differences* between the national (energy and climate) projection dimensions – to reduce challenges for consistency and transparency;
- Safely *navigating the wide variety of different projections tools* – to safeguard comparability and compatibility of integrated frameworks;
- *Overcoming institutional challenges at the national level* such as inertia due to unclear division of responsibility between different ministries and national and subnational authorities – to improve institutional cooperation, ensure consistent use of projection parameters, assumptions and underlying datasets and methodologies, and reduce the risk of over-burdening experts;
- *Removing possible economic or political hurdles* in the way of integrated projections – to ensure continuity of work programmes and government priorities for research on integrated projections even in times of changes in government.

Further challenges may concern the inherent process of estimating integrated projections, for instance if assumptions are not carefully balanced and take the form of overstated expectations for economic growth or for abatement/technology performances compared to operational use (for example the latter has been experienced regarding road vehicle engines).

Good practices in estimating and reporting climate projections are a valuable input for the development of integrated energy and climate projections.

The practical process of integrating energy and climate projections and overcoming the above challenges has not been defined within the Governance Regulation proposal. To date however, reporting of national GHG projections is an established process, delivered according to specific rules, guidance and practices by a system of institutional, legal and procedural arrangements (EC, 2013). Having been set up in 1999 (EUCO, 1999) and revised and improved in 2004 (EC, 2004), 2013 (EC, 2013) and 2014 (EC, 2014), the set of rules for national GHG projections aims to ensure high relevance of the reported information and meaningful summation to the EU level by ensuring compliance with key quality principles, especially: *transparency, accuracy, consistency, completeness* and *comparability* ([2]). With over a decade of rigorous reporting, Member States' climate experts have built up expertise on reporting systems and projections data which, by definition, include key parameters on energy projections. Where done properly and reported transparently, the GHG projections currently reported under the MMR provide integrated climate and energy projections that may well cover several of the five Energy Union dimensions.

Similar reporting on energy developments under the existing EU energy acquis follows, to date, a less structured approach than that in place for GHG projections.

Enhancing the current projections systems to serve integrated projections requires revisiting national structures, coordination processes and transparency requirements.

When upgrading the current systems to integrated energy and climate projections, there are likely two extreme approaches between which a solution could be found. The first, 'limited reporting', would put the emphasis on Member States proving that they have an integrated national system that sets and meets the needs of national targets, through independent review or audit processes. The second, 'extensive reporting', would put the focus on Member States fully disclosing details of projection scenarios, including transparent methods, data sources and assumptions.

To achieve a sensible balance between the two approaches, this paper suggests three key steps at the national level:

1. A certain level of requirement for the development of an adequate national system for integrated energy and climate projections, starting from the good practices and existing systems on the climate side;
2. Coordination of a regularly updated set of transparent energy and climate projections;
3. Improved information sharing and transparency in energy and climate projections.

Information exchange and capacity building processes can facilitate the development of integrated projections.

To date, Member States' projections are at varying levels of readiness for integration across energy and climate fields. In some cases, a capacity building process – assured at European level – could facilitate successful outcomes. With support from the Commission, the European Environment Agency, the Member States, and other independent organisations, good practices and lessons learned can be shared and improved. Energy and climate projections will remain a key tool for planning policies and assessing progress towards policy targets and long-term decarbonisation, and the further harmonisation of their reporting under the Regulation on the Governance of the Energy Union will aid future evaluation.

([2]) As defined in section 1.4 of the 2006 Intergovernmental Panel on Climate Change *good practice guidance* http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_1_Ch1_Introduction.pdf

1 Introduction

Energy and climate projections are estimates of future economic, energy and decarbonisation developments which are summarised in scenarios (see also Box ES.1. *Elements of GHG projections*). They are used as tools to increase coherence in forward-looking decisions on targets: regularly revised/updated projections help to guide decision makers on whether targets are on track to be met, and what impacts policies will have. Whilst it is possible to agree on targets without support from projections, without the information obtained from regularly updated projections it is not possible to analyse and anticipate whether a target is on track to be met (or not) until it is too late.

The current situation regarding official reporting of national energy and climate projections in the context of the climate and energy targets for 2020 of the European Union (EU) and the Member States can be summarised as follows:

- **Climate projections:** For nearly two decades, EU Member States have been required to regularly compile and report official estimates of their projected (future) greenhouse gas (GHG) emissions under the GHG Monitoring Mechanism Decision (EU, 1999), and, subsequently under the Monitoring Mechanism Decision (EU, 2004) and then the Monitoring Mechanism Regulation (MMR) (EC, 2013). Through these, Member States have trained international climate reporting experts and cultivated long-standing expertise and best practices for reporting systems and projections data.

  In the context of this climate reporting Member States report partial information relating to energy metrics. This includes projected energy-related parameters that underpin the GHG projections under the MMR, such as primary and final energy demand/consumption ([3]). However, projected energy balances are not reported, even though they are typically used in the development of GHG projections. Nevertheless, if done properly and reported completely and transparently, the current GHG projections are ultimately integrated energy and climate projections.

- **Renewable energy projections:** The Renewable Energy Directive (EU, 2009) required Member States to report by 30 June 2010, as part of their National Renewable Energy Action Plans (NREAPs), the projected national trajectories for total gross production from renewable energy sources (by technology and for the energy market sectors *electricity*, *heating and cooling*, and *transport*) together with expected gross national final energy consumption, for each year starting with 2010 and up to 2020. Most Member States have specified two scenarios: a *reference* and an *additional energy efficiency scenario*, but the relationship between the energy efficiency scenario and the national targets for energy efficiency are not clarified in the NREAPs.

- **Energy efficiency projections:** Member States are currently not required to report projections on energy efficiency improvements (i.e. on primary and final energy consumption). The Energy Efficiency Directive (EED) (EU, 2012) requires Member States to set national energy efficiency targets ([4]) for 2020 and expected energy savings from policies and measures reported under Article 7. The EED requires Member States to report National Energy Efficiency Action Plans (NEEAPs) every three years.

([3]) Cf. Article 23 of Commission Implementing Regulation (EU) No 749/2014, according to Annex XII Table 3.
([4]) Based on either primary or final energy consumption, primary or final energy savings, or energy intensity.

In the post-2020 context, the Energy Union, a project created by the Energy Union Framework Strategy (EC, 2015), aims to drive the transformation of the European energy system as it looks to facilitate Europe's transition to a low-carbon, energy- and resource-efficient economy in a socially just manner. The proposal on a Regulation on the Governance of the Energy Union (EC, 2016a) (referred hereafter in this report as the "Governance Regulation") streamlines and builds upon existing reporting systems and data, and, among other elements, integrates reporting requirements across energy and climate fields. The lessons learned by the climate community will be valuable assets for this integration. The Governance Regulation sets out the requirements for developing integrated National Energy and Climate Plans (NECP) that cover the five dimensions of the Energy Union (see Box 1).

Box 1: Dimensions of the Energy Union

D1. Energy security (ES)

D2. Internal energy market (IEM)

D3. Energy efficiency (EE)

D4. Decarbonisation

D4a. GHG emissions & removals

D4b. Renewable energy sources (RES)

D5. Research, innovation and competitiveness (RIC)

The (proposed) Governance Regulation emphasises the importance of meeting the EU's 2030 energy and climate targets. By integrating energy and climate plans and reporting, the proposed legislation aims to reduce administrative burden, redundancy and overlaps ([5]), improve the coherence of national decision making, maximise synergies, and align with the reporting obligations under the Paris Agreement ([6]).

([5]) Overall the Governance Regulation integrates 31 individual planning, reporting or monitoring obligations of the energy and climate fields, and deletes 23.
([6]) Adopted at the 21st Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC) in December 2015.

2 Integrating energy and climate projections

2.1 Why are we integrating?

Projections provide a reliable early indication of the expected future trends, and thus, information on whether the implementation of policies and measures is in line with existing commitments. Energy represents over half of total EU GHG emissions (EEA, 2017a) and is the main source of air pollutants. Therefore, energy and climate decision makers need to be aware of many overlaps and relationships between energy and climate projections. Rightfully, the priorities of the Energy Union include **maximising the synergies and minimising trade-offs** and administrative burdens between energy and climate strategies and actions, as the EU and its Member States prepare for a new governance framework post-2020.

Due to limited time, resources, and administrative silos, decision makers in the energy and climate field have traditionally worked independently of each other and have focused on a few key domains. Increasingly, to make informed decisions, policymakers must be able to understand the positive or negative implications, or co-benefits, of decisions on both climate and energy at once, and indeed also on wider strategies, such as air quality, climate and energy related aspects of agriculture, land use change and forestry (LULUCF), and waste. By integrating energy and climate projections, decision makers and their technical advisors can be equipped with sufficient evidence to spot conflicts and opportunities early on, thus helping them to avoid conflicts and aim for maximising co-benefits.

This is also often true for reporting obligations, where joining of the currently separate reporting streams for the climate and energy domains, and of the often-different institutions responsible for each dimension, can bring out useful synergies in policymaking.

> We cannot hope to **manage** these complex interrelations, and sometimes conflicting priorities, if we cannot adequately **measure** the likely effects of interrelation in an integrated way.

The following three reasons, outlined below, explain why the integration of energy and climate projections is important, and which benefits the process can bring.

Reason 1: Joining up national decision making on actions

Informed decision making is vital in areas such as climate (mitigation) and energy, where there is major interplay. In a world that is increasingly resource- and space-constrained, with accelerating urbanisation trends and increasingly sophisticated infrastructure, developing coherent policies is a necessity. Therefore, the concept of "Integrating energy and climate projections" is tantamount to **improving national and subnational knowledge, awareness and ultimately decision making**:

1) **Climate-related decisions** are the most focussed under the *decarbonisation dimension* (D4) but also come into decision making processes under *energy efficiency* (EE, D3), *research, innovation and competitiveness* (RIC, D5) and spill down to decisions for the Internal Energy Market (IEM, D2) dimensions. Climate-related decisions are focused on GHG emissions/removals ([7]) across all main sectors. Climate mitigation/decarbonisation priorities establish the need to monitor targets and actions for the reduction of GHGs in the atmosphere. Many GHG emissions/removal actions have a direct impact (many positive, but some negative) on *renewable energy sources* (D4b) and on other dimensions of the Energy Union, notably: EE (D3), *energy security* (ES, D1), *integrated energy market* (IEM, D2) and RIC (D5). For example:
    a. Energy efficiency activities (D3) reduce the overall demand for energy (including the reliance on energy from fossil fuels), and improve energy security (D1), making the use of renewables more viable (RES, D4b) through lower demand and less need for energy storage, and

([7]) 'Removals' being understood as climate mitigation activities to remove GHGs from the atmosphere.

reducing overall GHG emissions (D4a). However, uncoordinated energy efficiency measures can weaken the carbon price under the EU ETS cap-and-trade system, making climate goals more difficult to meet (D4a).

  b. The promotion of renewable and low carbon energy sources (D4b) reduces GHG emissions (D4a) and generates positive RIC effects (D5) through technological developments. Renewable energy implementation focussed on national energy sources will improve energy security (D1) and reduce the use of fossil fuels and their associated GHG emissions (D4a). The integration of fluctuating renewable energy sources has important impacts on the electricity and energy transmission infrastructure (D2), especially regarding new technical demands for electricity, gas and distributed heat networks. However, as in the case of poorly integrated energy efficiency activities, uncoordinated RES measures can undermine signals from climate policies and impact mitigation efforts (D4a) and energy security (D1).
  c. Electrification of vehicles offers opportunities for lowering GHG emissions in the transport sector through the elimination of tailpipe emissions and the use of electricity generated from renewable sources (D4b). This improves efficiency in transport but the increase in demand for electricity generation can maintain/create additional demand for fossil fuel and/or renewable fuels, with impacts on energy efficiency (D3) and on energy security (D1). The overall reduction in GHG emissions (D4a) ultimately depends on the interplay of policies applying to the transport and electricity generation sectors, respectively ([8]).
  d. Carbon capture and storage reduces GHG emissions (D4a) and supports energy security (D1) as it increases the diversity of fuel sources without compromising the climate targets, but it reduces energy efficiency (D3).
  e. Phase out of coal-based electricity generation reduces GHG emissions (D4a), improves generation efficiency (D3) and could enhance the role of renewables (D4b) for baseload generation, but it may also affect energy security (D1) if it increases certain fuel imports.

2) **Energy-related decisions** are focused on establishing and monitoring targets and actions for all five dimensions: Renewables (D4b), Energy efficiency (D3), Energy security (D1), Integrated energy market (D2) and Research, innovation and competitiveness (D5). Many energy actions are part of, or have a direct impact (many positive, but some negative) on climate strategies (D4a). For example:
   a. Decisions on different types of energy sources will have an impact on the emissions of GHGs (D4a). Decisions on renewable energy sources will also give rise to climate effects (D4a) beyond the energy sector, through interactions with the land-use sectors regarding e.g. the production of biomass resources.
   b. Decisions important for energy security (D1), such as import/export of electricity and stocks and fuel reserves (e.g. national reserves of oil, gas, coal and/or biomass resources, waste to energy, solar, hydro, wind, nuclear) will impact on GHG emissions (D4a).
   c. Strategies on levels of electricity interconnectivity and objectives for electricity and gas transmission infrastructure have a high relevance for energy security (D1) and for increased future renewable energy deployment and GHG emissions (D4).

3) **Other related priorities**: Many other strategies, such as air quality, waste, agriculture and land management (forestry, peatlands, etc.) have positive and negative impacts on actions within the Energy Union dimensions, such as:

([8]) Road transport GHG emissions are covered by emission limits adopted under the Effort Sharing Decision. GHG emissions from the electricity generating sector are being addressed through the binding, EU-wide cap on emissions from industry under the EU ETS.

a. The choice of road fuels (for example, diesel was generally encouraged as an energy efficient solution and thus a lower carbon energy source, but contributed to Member States' worsening of air quality).
b. The use of biomass resources for energy purposes to tackle decarbonisation targets (D4a, b) and energy security issues (D1), but with potential to increase the pressure on food production systems, biodiversity and air pollution.

Given these complex and cross-cutting interactions between energy and climate domains, policymakers need to adopt a systemic approach that can lead to mutually-reinforcing policy packages in pursuit of all policy targets. Integrated projections that take into account such feedback loops and iterations support the strategic assessment of trade-offs and help finding the best energy–climate compromise.

Many Member States already use projection models and tools for developing energy projections and GHG projections together. Ultimately, a GHG projection (as reported under the MMR) (D4a), if done properly and reported **transparently** provides an **integrated projection since it uses or includes energy projections**. This allows decision-makers to respond to a coherent dataset.

Figure 1 illustrates in a simplified form the relationships between the dimensions of the Energy Union and the other components of the economy that have climate impacts but are less significantly connected to energy (waste, agriculture, LULUCF and industrial processes):

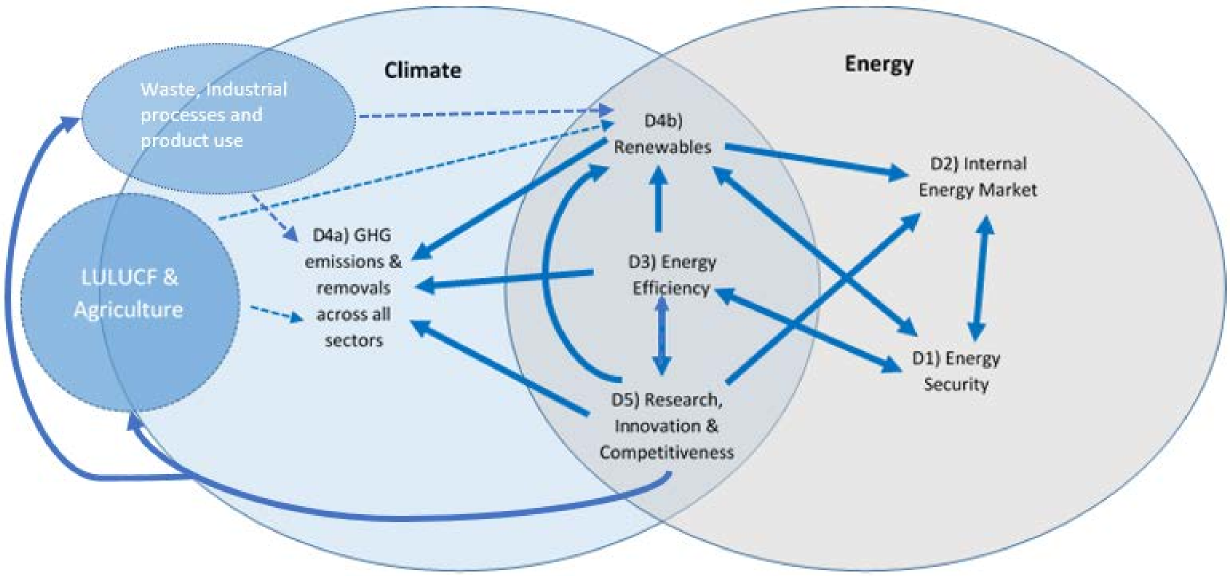


Figure 1: Schematic relationships of the Energy Union dimensions

Note: the direction of arrows indicates the most typical impacts and feedbacks.

Reason 2: Improved awareness, trust and understanding through compliant and transparent reporting
Acting together as an international community to tackle climate change requires trust and understanding. Building stakeholder buy-in and action through education and awareness is a key pillar for well informed and proactive societies. To do this, communities need data they trust, can rely on and can understand. The EU also needs to engage the wider international community in the context of the Paris Agreement (United Framework Convention on Climate Change (UNFCCC), 2015). It needs to convince the world that it is focussed on its goals and making progress. As a committed group of countries, the EU and its citizens will benefit from taking a strong lead. Therefore, the concept of "integrating energy and climate projections" is also relevant to the need for **transparent reporting,**

building understanding and the dissemination of information to a broader public audience. There are at least three key areas where transparent reporting provides value in advancing towards goals of the Energy Union and the transition to a low carbon economy:

1) **Community awareness and trust in decision making:** The collection and aggregation of trusted information is the backbone of good decision making. Clear Member State and EU level information on trends and projections of climate (GHG emissions/removals across all sectors ([9])) and energy (renewables, energy efficiency, energy security, IEM) indicators and metrics is important. This engages the community's stakeholders and informs key EU level decision making processes iteratively over the necessary long periods of time. This is particularly important where there are synergies that will benefit from shared ownership across a wide range of stakeholders, not only in the energy field but also in other relevant sectors, such as agriculture, LULUCF and the air polluting aspect of transport and energy production, linked through the climate dimension. Synergies also take place in investments and where stakeholders might need to address a number of trade-offs (see examples under point 1 above). Providing tangible, transparent, and quantified (where possible) evidence improves the speed with which action can be taken and confident low-risk decisions made. Sharing data compiled to a similar quality standard ([10]) helps Member States identify synergies and conflicts and work towards common goals.
2) **International transparency:** The EU has a commitment for transparent reporting under the UNFCCC and the Paris Agreement (see reporting requirements on GHG mitigation under Article 13). This reporting includes information on projections of GHGs, targets and national action, and includes reporting on non-energy related source-categories in sectors relevant to decarbonisation such as LULUCF, agriculture and industrial processes. Transparent reporting is expected, and the EU is keen to remain a good example in taking the Paris Agreement forward. Being able to transparently show how energy related actions have and will impact future GHG emissions is important. Illustrating the synergies and constraints of energy priorities on GHG projections is also critically important in negotiations.
3) **Regional cooperation:** Transparent reporting helps to inform neighbouring EU Member States on energy and climate related plans, which might be relevant for neighbouring countries both with regard to the construction of grid interconnectors and planned future national capacity expansions/decommissioning potentials and regional energy cooperation.

Reason 3: Reducing the administrative burden of reporting

Aligned with the Commission's agenda for better regulation, the Governance Regulation will significantly reduce the administrative burden for Member States, the Commission, and other institutions. The current planning and reporting requirements in the energy and climate fields are scattered across numerous separate pieces of legislation, which were adopted at different stages – a situation that has led to a certain degree of incoherence, redundancy and overlaps (EC, 2016b; 2016c). These overlaps undermine current national efforts because of apparent inconsistencies, lack of transparency in data, and time wasted with clarifying and justifying differences.

The Governance Regulation will bring together the existing obligations, simplifying and removing duplications and aligning requirements with the 2030 Framework for Energy and Climate (moving on from 2020 targets) and with EU commitments under the Paris Agreement. The current proposal integrates 31 and repeals 23 existing obligations. However, the timing of projections reporting under the Governance Regulation might still mean that underlying data or assumptions are updated between different reporting deadlines, resulting in sets of projections that are inconsistent.

([9]) See Annex 2 for the subsectors covered in the Energy sector of GHG emission inventories.
([10]) Following the timeliness, transparency, accuracy, consistency, comparability and completeness (TTACCC) data quality standard of the MMR (EC, 2013) and used in GHG emissions inventories.

2.2 The role of projections under the Energy Union

The important role of projections cultivated under previous policy frameworks of the EU will continue in the context of the Energy Union. At a technical level, projections (energy and GHG) translate assumptions on external drivers (e.g. population, GDP, transport, production fuel prices etc.) into expectations in terms of energy demand and production and resulting pressures (such as emissions). This will equip Member States with the knowledge to negotiate, design policies and measures, and meet key targets. Projections also enable assessment of the EU and its Member States' collective progress towards the Energy Union's objectives for energy and climate. If a Member State's reports indicate insufficient future progress towards the Energy Union's objectives, the Commission and the Member States may be able to jointly come up with solutions to ensure the overarching EU targets are met in good time. Without projections, it is impossible to tell if EU and its Member States are on track to reach their targets. To meet targets, Member States must work out how growth-related activities can be maintained as well as decreasing demand for energy and products and resulting emissions.

Current good practice on data sharing in the climate domain

GHG data sharing in the current international context

Collectively understanding whether targets are adequate and reachable is important. Within the international UNFCCC GHG inventory field (historic trend reporting), some guiding principles and transparent practices have emerged to ensure that there is enough trust and a strong evidence base for global action. These elements are based around the provision (reporting) of data. Key features include the use of common nomenclatures and common reporting formats, ensuring that datasets are complete (within the defined scope) and not biased (over– or underestimated) and supported with clear explanation of methods, data and assumptions used to derive them (often referred to as a "Methodology Report" or for GHG inventories the "National Inventory Report").

The 2006 Good Practice Guidelines ([11]) developed by the Intergovernmental Panel on Climate Change (IPCC) allow countries to use a simple (Tier 1) approach where there is limited data availability (to avoid null reporting). The Guidelines also support countries in developing more sophisticated Tier 2 and Tier 3 approaches using country specific factors, where appropriate. The progress made with this approach has established *strong centres of excellence in providing detailed analysis of trends in GHGs*. This includes the energy sector along with other economic sectors. Today, these centres perform a key role in supplying the information basis for decision making on future action. This data needs to be *Timely, Transparent, Accurate, Complete, Comparable* and *Consistent* (TTACCC). These TTACCC principles are defined in section 1.4 of the introduction of the Good Practice Guidelines.

GHG projections in the current European context

The biennial mandatory reporting of GHG projections under the MMR already plays a key role in the existing climate policy process. It is designed to provide Member States, the European Commission and other stakeholders with a reliable early indication of the expected trend of future GHG emissions, and thus with information of whether implementation of national and EU-wide policies and measures is helping countries meet their GHG emission commitments.

Biennial, mandatory GHG projections data (together with information on policies and measures) are reported to the European Environment Agency in a standardised Excel/XML data structure.

The latest data on projections, reported by Member States in 2017, include estimates of emissions by gas and sector to 2035 and for three pre-agreed scenarios: 'without measures'; 'with measures'; and 'with additional measures' (see box 2). In addition to the energy sector, the GHG projections also cover projections in the following GHG sectors: land-use, land-use change and forestry (LULUCF); agriculture; waste; industrial processes; and F-gas use. This systemic approach of including energy and non-energy

([11]) http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_1_Ch1_Introduction.pdf related activities ensures an economy-wide assessment of GHG projections, which takes into account important feedback loops to energy from projections of the economy development, industrial processes, transport demand, agriculture, land-use and waste expectations regarding biomass and biofuel availability for electricity, heating and transport, future interlinkage (coupling) of sectors, air pollution, public health goals and agriculture needs.

Strengths of this system include the provision of commonly formatted (i.e. comparable) quantitative data on projected GHGs from all Member States. There are clear guidelines for their compilation (based on a tiered approach, the same as historical GHG data) and a review process of the reported datasets by the European Environment Agency. These technically harmonized projections allow the calculation of an aggregated EU projection as the sum of Member State projections.

Weaknesses include the *varying degrees of linkage to official energy projections* used e.g. to support national efforts towards renewable energy and energy efficiency targets. In some Member States there is a lack of consistent and integrated modelling of future scenarios for energy with other sectors of the economy. There are areas for some Member States where projections are relatively weak and potentially inconsistent across sectors (especially for some sub-sectors of industrial processes, agricultural and land use sectors). Quantitative links between GHG projections and the GHG mitigation policies and measures reported under the MMR are rare, and guidance for the delivery of structured and transparent methodology reports are, to date, informal. Ex-ante quantification of GHG policies and measures reported under the MMR are increasingly common, but it is rare for a GHG projection scenario to be fully attributed to individual GHG policies and measures.

Energy projections in the current European context

The MMR includes biennial reporting of the parameters used to generate the GHG scenarios. For example, energy parameters include national retail fuel prices per fuel type and final energy consumption by economic sector ([12]). For renewables and energy efficiency parameters, reporting is required under the Renewable Energy Directive (28/2009/EC) and The Energy Efficiency Directive (EED, 2012/27/EU), respectively. In 2010, Member States had to report expected national renewable energy targets for 2020, and indicative trajectories for annual (renewable) energy consumption up to 2020, as part of their National Renewable Energy Action Plans (NREAPs). There were no official EU obligations to regularly update those projections after 2010, which is why they are currently seen as being outdated (EEA, 2017b). In addition, there are no official EU obligations for projection scenarios on energy efficiency, as the EED only requires the setting of 2020 targets and savings from policies and measures, and reporting of National Energy Efficiency Action Plans (NEEAPs) every three years.

([12]) Parameters for reporting are established in Table 3 of Annex XII of the Implementing Regulation (EU) No 749/2014.

Box 2: Types of reported GHG projections

Projections are important as a tool to provide information and increase coherence in decision making, and for tracking progress towards policy targets. Especially for longer term evaluation of progress, such as for 2030 or 2050, projections will remain the main guide for policymakers.

The set of projections that Member States will be required to report under the integrated National Energy and Climate Plans (EC, 2016a) is defined as:

- **Projections scenario 'with existing measures' (WEM)**, meaning projections of anthropogenic GHG emissions by sources and removals by sinks that encompass the effects, in terms of GHG emission reductions or developments of the energy system, of currently implemented or adopted policies and measures;

Projections scenarios 'without measures' (WOM) and **'with additional measures' (WAM)**, where available, are required in the biennial reporting of projections under the Governance Regulation in Article 16 (*).

- **WOM** means projections of anthropogenic GHG emissions by sources and removals by sinks that exclude the effects of all policies and measures which are planned, adopted or implemented after the year allocated as the starting point for the relevant projection.
- **WAM** means projections of anthropogenic GHG emissions by sources and removals by sinks or developments of the energy system that encompass the effects, in terms of GHG emissions reductions, of policies and measures which have been adopted and implemented to mitigate climate change or meeting energy objectives, as well as planned policies for that purpose.

(*) Precise requiring to be checked against the final text of the Governance Regulation

(EC, 2016a)

Strengths include the detail of reporting under the Renewable Energy Directive, with expected consumption of renewable energy sources disaggregated per technology, into categories of heating and cooling, electricity and transport. The expected energy consumption was reported for each year in the period 2010 – 2020 (in 2010, under the NREAPs), rather than for every 5 years and with biennial periodicity as GHG projections. In addition, many Member States have specified two scenarios for the reporting under the RED: a *reference scenario* and an *additional energy efficiency scenario*, albeit without indicating the clear link between this *additional energy efficiency scenario* and the national targets for energy efficiency.

Weaknesses include the lack of official, comprehensive and regularly updated energy projections that are easily accessible for analysis. The reporting of energy parameters related to GHG MMR projections are often incomplete. The NREAPs were submitted to the Commission in 2010 and are not regularly updated, so can now be considered out of date (EEA, 2017b). The expected gross final energy consumption reported up to 2020 in the NREAPs are not aligned with the requirements for scenarios under the MMR (see Box 2 below). Expected energy consumption extends only to 2020, not up to 2035 as is the case for GHG projections. Reporting is mostly limited to tables within PDF reports, rather than in a structured electronic data format.

What are we integrating?

Defining "integration"

Definition: Integrating **"To put together parts or elements and combine them into a whole."**

To enable coherent forward-looking decisions on climate and energy, the Governance Regulation ensures integration between the energy and climate fields. This covers different types of parameters, across the five dimensions of the Energy Union. This means integrating climate (GHG emissions/removals as well as, where relevant of emissions of air pollutants in accordance with Directive 2016/2284/EU) and energy (renewables, energy efficiency, energy security, internal energy market) expectations (projections), along with key exogenous parameters influencing the energy system and its associated GHG emissions and air pollutants, such as macroeconomic forecasts and technology cost developments ([13]).

Integrated (and regularly updated) projections in the context of mitigating GHGs in the EU should enable decision makers to see if defined targets are in range and achievable as these target dates approach. Integrated projections will provide:

- A starting point for target setting, by giving decision makers a view of different scenarios of action and underlying economic development.
- Emissions and activity output variables (e.g. projected coal consumption in residential houses or motor fuels in road vehicles) to illustrate possible future trajectories and key target elements for action.
- Transparency for reporting to international bodies e.g. UNFCCC National Communications and Biennial Reports.

In developing integrated energy and climate projections, Member States need to ensure that these comply with reporting requirements under the UNFCCC. This means that integrated projections shall be based on adopted or implemented (WEM) or planned (WAM) policies and measures (see Box 2).

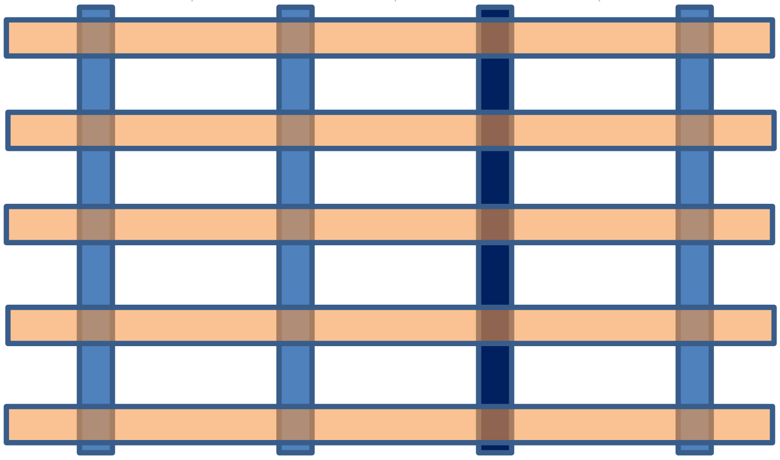
The Energy Union dimensions

The integration of energy and climate fields under the Governance Regulation is applied in the context of the five dimensions of the Energy Union. A simple matrix of the dimensions and some of the key components that will be communicated by Member States, drawn from the annexes of the Governance Regulation, is presented in Table 1. This matrix helps to illustrate that integration should ensure consistency across the common vertical elements (blue pillars) of Objectives and Targets; Progress Tracking; Projections; Climate & Energy Actions (Policies and Measures) across all horizontal dimensions of the Energy Union (green bars). It shows that integrated energy and climate projections (dark-blue bar) should ideally reproduce across all dimensions the likely outcomes of national scenarios with existing policies (WEM) and/or a planned set of interventions (WAM).

([13]) See Annex I Part 1 Section B of COM (2016) 759 for a full list.

Table 1: Matrix of dimensions of the Energy Union and components for integrated reporting

	Key components of Energy and Climate action and transparency			
Energy & Climate Dimensions	**1. Objectives and targets**	**2. Progress Tracking (Historical trends)**	**3. Projections**	**4. Climate & Energy Actions (Policies and Measures)**
D1: Energy Security				
D2: Internal Energy Market				
D3: Energy Efficiency (final demand)				
D4: Decarbonisation **D4a: GHG emissions & removals** **D4b: Renewables**				
D5: Research, innovation and competitiveness				



Further information regarding the Energy Union dimensions and their interactions and use for integrating energy and climate projections is provided in Annex 1 of this paper.

The next chapter focuses on the development of integrated projections and how Member States might approach the new requirements.

3 Implications for Member States

3.1 How could we integrate energy and climate projections?

Several practical suggestions and options for integrating energy and climate projections were discussed at the 2017 Eionet meeting on 'Energy and the environment' ([14]) and the Governance and Effort Sharing Unit of DG Climate Action's 2017 workshop on 'Integrated climate and energy projections' ([15]). These build on international experiences over the last 15 years of projections reporting. Many of the suggestions are for Member States to consider in developing their national integrated projections. Some are also intended for the Commission, in its role of facilitating collaboration and transparent information exchange. There are **two extreme approaches** between which the most appropriate solution could be found.

The first extreme: limited reporting

This would avoid detailed reporting but require Member States to (i) prove through detailed independent review/audit that they have a well-functioning integrated national system that incorporates all relevant energy and climate data and (ii) ensures that they set and meet sufficiently challenging targets. Once this national system is established and has proven it is up to the job, Member States need only report relatively minimal indicators on historical and projected progress and information on their targets. Regular audits would be required to ensure the national system has not degraded and that integration exists and continues to be improved.

The second extreme: extensive reporting

([14]) EEA Energy and Environment Eionet meeting, Copenhagen, 4th May 2017.
([15]) Governance and Effort Sharing Unit of DG Climate Action workshop on integrated climate and energy projections, Brussels, 27th September 2017.

This assumes there is relatively little or no focus on establishing national systems. The focus is solely on Member States providing full disclosure on a series of different projection scenarios. This disclosure would include the reporting of detailed projections with activity data and a fully transparent report of methods, data sources and assumptions, showing integrated policy making. There would still be a need for a thorough review of data to ensure that they meet certain requirements on quality.

Clearly, both of the options above are unrealistic and should be understood only as theoretical margins for more practical work. Three suggestions that navigate a sensible path within these boundaries are presented below. They set a *certain level of requirement for the establishment of national systems* (Suggestion 1), *for good practice in co-ordinated compilation of energy and climate projections* (Suggestion 2) and for *improved information sharing and transparency* (Suggestion 3). Combined, they could provide a pathway to developing integrated national energy and climate projections.

Suggestion 1: Develop national systems for integrated energy and climate projections

Establishment of a strong and co-ordinated **national system** for energy and climate policies and measures and projections is considered a good starting point. Having a co-ordinated, integrated pool of data providers, expertise, tools and working practices will support rapid and well-grounded decision making and awareness raising. This will avoid, as much as possible, any effects of actions arising from one policy domain negatively impacting on a different domain.

The below ideas could help strengthen the national systems for integrated projections:

1) **Overall guidance in developing strong institutional arrangements could be provided by the Commission to Member States** by highlighting good practices and important linkages and encouraging cross-ministerial collaborations. The latter is needed to co-ordinate activities, to plan, assess and report on progress to climate and energy targets and to decide upon additional policies and measures. This overall guidance could build on the strong body of guidance concerning national systems for GHG inventories, developed under the Kyoto Protocol.
2) Member States could define **clear responsibilities and organisational structure** for the overall creation of integrated energy and climate projections. Ideally, Member States should aim to have a national integrated system in place. Assignment of responsibilities for sub-components should follow. The following key findings emerged from the session on *Integrating national energy and climate projections* of the EEA 2017 Energy and environment Eionet meeting:
   - Where the overall responsibility per workflow is insufficiently defined, activities on energy and on climate are likely to run in parallel between departments and/or ministries, leading to insufficient integration.
   - There is an increasing awareness that divisions of responsibilities between ministries for energy and climate can hamper the co-ordination of responses. In these cases, ministries need to develop approaches to work together to identify, push, track and measure important actions on one side (Climate Ministries) and to implement the large-scale key actions on the other (Energy Ministries). Equally, Energy Ministries need to be equipped with the knowledge to challenge climate policy proposals that threaten key energy strategies.
   - National systems need protected resources to establish long-term trusted teams to inform decision makers, as well as investment to arrive at stable capacity levels and independent expertise.
   - At present, Member States that have a single ministry responsible for energy and climate seem to progress better with integrating energy and climate projections (e.g. Netherlands, UK).

   In the light of these, Member States could consider **clearly allocating responsibilities for “implementing” actions** and maximising their beneficial impact across the energy and climate dimensions, and **clearly allocating responsibilities for "monitoring" and championing the cumulative impact of actions** for their dimension.

Member States could work on **raising the profile of** energy and climate projections **to gain public support and stakeholder/political buy-in** on the proposed paths to achieve the targets:

3) Engagement of wider stakeholders through national systems could help gain interest in integrated solutions that meet public interests.
4) Member States need to look to establish a set of **common goals across ministries** focussed on improved decision making through integrated energy and climate projections analysis. This should **ensure integrated approaches even when there are different interests and priorities** to avoid the effects of conflicting priorities and to make better policy.
5) Relevant Member State ministries and co-ordinators could improve the **identification of the driving forces behind climate and energy actions**. This can then improve decision making and be used to make the business case for resources, national data collection and improved engagement with stakeholders.
6) Member States should **design appropriate methods and formats to share relevant data across departments/ministries/institutions** through the development of indicators and accepted metrics.
7) Last but not least, Member States without existing national systems may consider **building up these national systems** to reinforce their capacity for trade-off analysis and long-term strategic decisions. The importance of national systems for projections is highlighted in Article 12 of the MMR and Article 32 of the draft Governance Regulation. No doubt, it will take time to build a national system, but having distinct tasks within a pre-agreed improvement plan would allow for stepwise, manageable improvement.

Suggestion 2: Consolidate/co-ordinate the compilation of GHG and energy projections

The EEA Eionet workshop highlighted a need for Member States to focus on the **co-ordination of a regularly updated set of energy and climate projections**. These should include transparent data on trends and shares of sectors, subsectors, fuels, technologies and practices, such that important indicators of expected GHG emissions/removals, renewable installations, energy efficiency and energy security measures can be understood.

As an example, the compilation of transparent GHG projections requires a sufficient level of detail in its input parameters (see also Box 3). Many of the input parameters identified for activity data and parameters used for indicators are directly related to, and can come from, suitably prepared and detailed energy projections.

The below ideas could help consolidate/co-ordinate the compilation of integrated projections:

1) Agreeing on **standard approaches to defining projections** across GHG and energy reporting **and target setting** (e.g. using those defined for GHG reporting of "WEM" and "WAM", or using a target-based scenario).
2) Reaching consensus on **improving the use of appropriate tools/models**, to facilitate integration. By standardising methodologies and using common approaches and tools, Member States can provide more consistent analysis of future trends. These tools/models would have a more accepted and understood approach to integrating data and providing consistent outputs across the different dimensions.
3) For both climate and energy, reaching a **common agreement on macroeconomic development assumptions** – such as future developments of GDP, population, fuel and CO_2 prices – that underpin the projections. Similarly, an important factor is reaching agreement on the starting point of projections, which ought to be the same for all sectors. In addition, the historical dataset for energy and climate issues should be compiled and shared. For this it is important to agree on the sectoral disaggregation to avoid double counting or gaps in energy demands or sources of

emissions. Usually, energy data is based on energy balances, which do not build upon the same sectoral disaggregation as the key source subsectors of GHG inventories.

4) Reaching **agreement on common sets of policies and measures** and their translation into modelling, across different scenarios. Sufficient time has to be allocated for this process, so that a compromise between different national interests can be found (i.e. economic aspects, energy security (D1), energy efficiency (D3), climate and renewables targets (D4), etc.).
5) Agreeing on **common timelines and workflows for compiling data** for energy and climate projections. This will require the development of co-ordinated workplans, to ensure that work is conducted in the right order and builds in the correct and commonly-agreed assumptions. Outputs from economic analysis (projections) are used in energy analysis (projections). Climate and air pollutant projections require both economic and energy analysis as input: both represent a base to build energy demand, agriculture and waste expectations upon.
6) Ensuring appropriate feedback from the distance-to-climate-target analysis back to energy projections. This can develop the use of integrated energy and climate projection as the base for informed policy activities. Nevertheless, the results of **WEM and WAM projections should not be misunderstood as target-based scenarios.** The latter are designed to show possible/desired pathways to targets. By themselves, they can become a tool subject to integration too, especially with regard to reporting of national trajectories for renewable energy and energy consumption (from 2021 to 2030), and for national long-term low-emission strategies with a 50 years perspective.
7) Establishing clearer compilation requirements for **energy related inputs to GHG projections.** These need to **build on official national assumptions regarding the implementation of policies and target-setting, at least for renewables, energy efficiency and energy security**. These inputs, usually stemming from energy projections, need to be translated into activity data split by the type of fuels consumed by the relevant subsectors, using the available technologies.
8) Assessing and presenting **targets on common metrics across GHGs (D4a), renewables (D4b), energy efficiency (D3), energy security (D1) and interconnectivity (D2),** and using them to inform decision makers. This should include an analysis and description of the interrelation between the trends in GHGs, renewables, energy efficiency and the implementation of energy security measures.

Annex 3 details the parameters required for reporting under the Governance Regulation.

Box 3: Similarity of key variable types in GHG projections and energy projections

1) **Within GHG projections of Member States, projected activity data is required to provide a certain granularity.** Specifically, data on future energy consumption needs to differentiate:
   - **Fuel type** e.g. coal, oil, gas, gas oil, petrol, biomass, biogas, fossil-based wastes, nuclear, biogenic based wastes etc.
   - **Technology** e.g. catalytic converters, carbon capture and storage (CCS) etc.
   - **Sector** based around the UNFCCC/IPCC categorisation, which contains categories such as electricity generation, fuel production, industrial combustion (various categories), residential combustion, commercial combustion, road and other transportation. Decision makers need to understand the economic/activity areas with high emissions intensities and their sectoral location.
2) **Projection of macroeconomic parameters:** estimates of future economic activity and resource (fuel) availability/price and/or the **implementation of** certain mitigation **measures** (e.g. related to renewables and energy efficiency).
3) **Projection of emission factors:** These are the emission rates per unit of activity (energy consumed) by:
   - **Fuel type** (as above)
   - **Sector** (as above)

For each of these variable types, different **Scenarios** have to differentiate between, e.g., the view on the use of specific fuel types and the process implementation of specific mitigation measures, including abatement, new technologies with reduced rates of emission per unit of activity, etc.

There are difficulties in aligning the categories of GHG and energy data. In many cases energy projections use different nomenclatures and levels of detail. Both general sector drivers (e.g. economic growth) and policy-related drivers (e.g. energy efficiency (EE) or measures that affect renewable energy sources (RES)) affect the activity data. It is also currently difficult to explicitly illustrate policy details of RES and EE policies to show emissions savings. These are often interpreted as the implicit change and/or reduction in fossil fuel consumption which can be difficult to disentangle from other economic factors. It would be helpful if integrated projections can highlight where climate change policies impact the activity data – e.g. which fuels are used and how much savings are seen as a result of the measure. This strays into the territory of quantifying policies and measures, but if integrated tools are used they could look jointly at the activity data **and** at the greenhouse gas intensities then illustrating the effect of RES and EE policies on GHG projections would be clearer.

[1] http://unfccc.int/national_reports/annex_i_ghg_inventories/reporting_requirements/items/2759.php

Suggestion 3: Improve information sharing and transparency in energy and climate projections

The EEA Eionet workshop highlighted that elaborated transparency on how projections are compiled would help to drive improvement in the integration of energy and climate action. The increased transparency would enable stakeholders to understand the links between trends in GHGs and energy activities within other Member States. Member States would be able to track and understand their own contribution and expectations in the context of other Member States' efforts. This would help in meeting the Energy Union goals and support the negotiation and successful delivery of the shared EU-level targets. In addition, Member States need to cooperate for the development of their integrated National Energy and Climate Plans (NECP, see Article 11 of the Governance Regulation) and therefore need a common terminology and database to enhance communication and to align national projections for specific issues (e.g. net electricity import/renewable energy sources investment across borders). Specific suggestions for enhanced communication and transparency include:

1) **Improving formal reporting or ad-hoc exchange** of information to generate better dialogue at national and EU level between energy and climate experts. This would include improved consistency in formats, visibility of relevant details across reporting of *GHGs and renewables* (D4), *energy efficiency* (D3), *energy security* (D1), *internal energy market* (D2) and *RIC* (D5), nomenclature, indicators and timing for climate and energy reporting. The nomenclatures defining subsectors, fuels, technologies need attention if they are to support transparent exchange of information. The granularity necessary to understand progress and assess future action across dimensions should be considered carefully. This includes clearly separating data by:
    a. **Sectors** such as industry, residential, service, transport, co-generation as highlighted in the energy efficiency dimension (D3). A deeper split is managed in the GHG emission/removal dimension reporting (D4a).
    b. **Energy/fuel type** such as those used under D1 (Energy security) for the diversification of energy, including: coal, crude oil, natural gas, nuclear energy, electricity, derived heat and different renewable energy sources (which ideally, for the benefit of GHG projection analysis, should be split by technology) and waste. Current GHG reporting does not separate the individual fuels beneath solid, liquid and gaseous fuels, but this could be seen as an opportunity to improve transparency and boost upstream consistency and integration of energy and climate projections. Added detail from the renewables dimension (D4b) would also help transparency in understanding projections and the impact of action. This would break data down by different technologies for the three energy market sectors: heating and cooling; electricity; and transport.
2) **Co-operating and sharing of information within established networks** e.g. EEA-Eionet, Energy Community ([16]) and other networks focussed on energy and climate mitigation in the EU and with its neighbours.
3) **Streamlining reporting,** e.g. the biennial national progress reports under the Governance Regulation proposal (Article 15, COM (2016) 759) could entail a single national submission on energy and climate trends and projections. This submission could contain analysis of trends ([17]) and projections with respect to various targets across the Energy Union dimensions. It could also include a transparent description of the methodologies used to estimate the projections which, together with associated data reporting, would reassure that the integrated approach remains in focus. This means it would be similar to the approach used for GHG inventory reporting with National Inventory Reports (NIR) providing a narrative on the trends and transparency on the methods, data sources and assumptions used and associated Common Reporting Format (CRF) datasets, providing the detailed data that can be aggregated to an EU level dataset. This avoids repetitive and potentially inconsistent reports and incompatible datasets prepared at different times with different levels of quality assurance/quality control (QA/QC) measures applied. A guided electronic reporting system would allow for automated analyses of quantitative data, as is currently done for reporting under the MMR.
4) **Establishing informal peer-to-peer review processes and collaboration across countries.** This suggestion includes the establishment of networks of experts that collaborate to assess and assure themselves on the integrity of different Member States' projections. The formation of an informal or formal group, with unbiased view on the reliability and consistency of projections, could help to improve the credibility of Member State projections. In practice, this would likely be an informal

([16]) https://www.energy-community.org/
([17]) The benefit of having historical trends is that Member States would provide clarity on the transition from the known (in the inventory) to the unknown (in the projections). This is a key consideration for transparent projections reporting.

group, as a formal peer review is not possible without binding guidelines for the preparation of projections. The formal review processes that exist in the GHG inventory community would not transfer easily to projections, as providing objective recommendations while not being overly prescriptive of methods and models is difficult.

3.2 Challenges to integrating energy and climate projections

The following questions and answers assess the key problems and solutions discussed at the EEA Eionet expert workshop of May 2017[14]. These have been further elaborated based on the authors' experience of EU energy and climate projections reporting over the last 15 years.

Challenges concerning the national systems

Many Member States have several ministries in place that manage different aspects of energy and climate related action. There can be a disconnect between those responsible for the **Monitoring Reporting and Verification** (MRV) of action and those responsible for the **implementation** of action. There can also be regular, politically driven, re-arrangement of responsibilities between ministries and changes to ministries. This can disrupt the flow of information and the value seen in MRV activities and even in action itself. It can be difficult for ministries to have a stable distribution of co-ordinated responsibilities that can work progressively to establish a sustained and valued flow of information and support to decision makers. If there is a lack of leadership in the area of MRV, then technical experts cannot dedicate the time to generating good quality projections and will get over-burdened with multiple portfolios to manage.

Without a national system there can be a lack of ownership contributing to departmental inertia, such as the imbalance of responsibility between national and local authorities. Adaptability is a challenge and a necessity. In many cases there are several approaches, developed by different ministries, to bring stability to the national MRV system. These use different projection methods, tools, goals and outcomes. To minimise the incoherence, Member States could:

- Establish **strong national systems** that empower a trusted team to bring data together. The work must give something back to the contributing institutions and ministries in the form of decision making services and tools. The national system must ensure that the **teams work together** or that there is a defined team that can handle the integration of assumptions on GHG (D4a), RES (D4b), EE (D3), ES (D1), IEM (D2) and RIC (D5).
- Identify a **lead co-ordinating organisation/ministry** and define roles and responsibilities for the important contributing organisations. These need to make space for experts to interact in order to enable cooperation and exchange of expertise.
- Clearly define stakeholders that are responsible for **implementing** actions that will deliver the shared goals for energy and climate and those responsible for **monitoring** their success in the different dimensions to strengthen the national systems. For example, an action on renewables (D4b) may well be led by an energy ministry and private stakeholders, but monitoring its success across the different dimensions will fall to leads within those specific dimensions.
- Identify **members of a steering group** to ensure engagement of a broad range of implementing and monitoring stakeholders, and to foster cross-departmental communication and

Member States' national systems should focus on highlighting the **benefits (in lowering risks) to decision making** of integrated energy and climate projections. In doing so, they should explain:

- What data and links can be made to complement decision making with new information that was not available before;
- What policy failures can be avoided in this way;
- How can knowledge of co-benefits be used to help national agendas on decarbonisation targets (D4), energy security (D1), jobs/employment, improved health and other high-profile goals; etc.

collaboration.

Member States can face issues of **lack of political will and agreement to invest** in integrated energy and climate projections. There can be political sensitivities against ex-ante analysis exposing weaknesses. Illustrating the benefits to decision making of integrated energy and climate projections can help address these challenges. Countries should seek to establish co-ordination and technical excellence centres that are protected from political influence and keep the outputs unbiased and credible (e.g. Netherlands' institutions for co-ordinating energy and climate projections have their budget protected by law).

Challenges concerning the development of projections models and tools

Modelling of projections scenarios is a key element. Projections need to bring together a large volume of data and analysis but also **agree on the setting of assumptions on parameters,** which is based on views of future economic (and other) developments. To ensure the generation of a coherent set of projections, a consistent set of underlying assumptions for the creation of modelling parameters is needed. Whilst this is often the result of expert judgement, it needs to capture the multiple cross-cutting links and represent the challenges of interactions between various dimensions.

Member States need to bring data together from different institutions' and ministries' models to get integrated energy and climate projections fit for decision making. This needs to be done carefully to avoid the introduction of different conflicting assumptions, methods and metrics used in different institutions and data sources.

Challenges due to conflicting assumptions, methods and metrics can be avoided by:

- **Developing a modelling approach** that is capable to produce the insights and support needed for decision making. This will require using/developing a model for the **energy system and a combination of sectoral models coupled to it**. The increased importance of low carbon intervention is forcing the need for a convergence of planning and operational decision making in energy systems. Ensuring the integrated assessment of energy and climate action considerations in energy system models requires increasing the levels of details which are reported transparently.
- Integrating subnational stakeholders, who are taking action and collecting data (e.g. cities & regions), into the national systems (as seen in Latvia) to increase coherence of data, awareness of data availability, awareness of the data required for projections, and communication between national and subnational actors.
- **Integrating stakeholders** with responsibilities for **related portfolios** (e.g. industry, agriculture, LULUCF, air quality, water, waste), to increase technical capacity.
- Identifying organisations that can provide **independent analysis** of the official datasets, methods and assumptions used in the integrated projections to enhance credibility.
- Where **multiple models exist,** consider all outputs to provide a range of possible outcomes and give a view on uncertainties (as resources allow).

In accordance with Article 23(1) and Annex XII, Table 4 of Commission Implementing Regulation (EU) No 749/2014, Member States are required to report details regarding the models used for the preparation of GHG emission projections. The information required includes descriptive data of the model, input data required, sectoral and geographic coverage, and validation and evaluation. This reporting will be replaced by reporting formats to be laid down in an implementing act following Article 32(3) of the Governance Regulation.

There are a wide variety of models employed by Member States for GHG projections reporting required under the MMR ([18]). What is relevant for integrated climate and energy projections are models that are:

- **Multi-sectoral**, i.e. covering the whole energy system either with one tool or a combination of tools. For example, The Integrated MARKAL-EFOM System used by Denmark (TIMES-DK), a bottom-up integrated energy system model. Its results on energy use by fuel type feed into the GHG projections for energy supply, industry, transport and households.
- **Interfacing with other models**. For example, the Sustainable Energy Authority of Ireland (SAEI) energy forecast accounting model outputs Ireland's energy demand by fuel by sector. This uses energy demand projections from the COre Structural MOdel of the Irish economy (COSMO), electricity fuel mix and generation by fuel type from PLEXOS, National Energy Efficiency Action plan (NEEAP) energy savings from Ireland's national NEEAP report, renewable heat and transport shares for the WAM scenario which are determined from historical national energy balances and the National Renewable Energy Action Plan. The output of the SAEI energy forecast accounting model feeds into energy GHG projections.

These energy related models have to be linked to models for non-energy sectors, so that the full range of sources and sinks of GHG emissions is covered. In addition, ideally these models need interfaces to tools for the calculation of the development of air pollutants.
Models that interface extensively with other models, and with models from different dimensions of the Energy Union, help to increase the integration and consideration of feedback loops or sector interaction. Expanding the interaction between models of different projection parameters could be a component of Member States' improvement plan for developing integrated projections. For example, in 2017 the UK updated the methodology for modelling projections of Combined Heat and Power (CHP) plants (BEIS, 2018). Previously, CHP had been projected using a separate model, but the modelling has now been incorporated within BEIS's Dynamic Dispatch Model for the power supply sector. This means projections can be made in the context of the electricity market, which ensures that interactions between the wider power sector and CHP plants are taken into consideration. Another possible component of the Member States' improvement plan is the better or even automatized consideration of feedback-loops which often lead to time and resource intensive processes.

Challenges concerning the reporting timeline of NECPs

The first draft integrated national energy and climate plans are proposed to be submitted to the Commission by the 31 December 2018 ([19]), which presents a relatively short timeframe, considering the scale of the exercise. Two pragmatic suggestions were identified at the EEA Eionet workshop of 2017 to help address this:

- The work should start from what already exists, transparently showing any gaps or inconsistencies, and an improvement plan for future development of national systems and reporting should be developed to show how these gaps/inconsistencies will be addressed in the future, potentially for the draft update of NECPs expected by 2023 (Article 13.1 in EC, 2017) ([20]).
- A national system (see above) should be established to formally pick up responsibility for advancing the improvement plan.

([18]) Details of models reported by each Member State under the MMR can be viewed in the Eionet Central Data Repository (CDR) by searching under the Obligation "[Greenhouse gas] Projections (greenhouse gas emissions and removals)".
([19]) EC (2016a) set 1 January 2018 as the deadline but this was revised in Article 9.1 of Revision 7 of the Proposal for a Regulation of the European Parliament and of the Council on the Governance of the Energy Union, December 2017 (EC, 2017).
([20]) The legal date of submission needs to be checked against the final text of the Governance Regulation.

Challenges concerning the consistency with existing reporting

Integrated projections may present **inconsistencies with GHG projections and effects of policies and measures** reported under MMR in 2017 or their updates in 2018 and 2019**.** This is due to different timescales for reporting, different sectoral disaggregation and models used, and the potential for different sets of parameters used. To help address this, experts within the national projections systems should:

- Assess inconsistencies, explain them transparently and include actions to remove them in the improvement plan for energy and climate projections, or to highlight/emphasise uncertainties and a lack of concrete knowledge.
- Incorporate activities related to energy and GHG reporting into the responsibilities of the national system for energy and climate projections.

Challenges concerning the transparency, consistency and communication of results

Fears of new reporting requirements and additional resource requirements can block the investment needed for improved data for decision making. Member States should try to **communicate the results and benefits** of the integrated energy and climate projections. This could involve:

- Acknowledging that if "you can't measure it you can't manage it". A small investment in measuring significantly reduces the risks in managing appropriate actions.
- Ideally, agreed formats, nomenclatures, units and indicators should be established early on. This will facilitate common understanding, the communication of results and the visibility of what investors/decision makers will get to help their work. Member States could agree informally or formally (e.g. via a well elaborated Annex to the Energy Union commitments, recalling the content of Implementing Regulation 749/2014,) to using established data formats for communicating nationally and internationally (ensuring existing reporting requirements are also met). To support this, clear, unambiguous and well-structured reporting templates could be provided by the European Commission, e.g. via implementing acts for the reporting of progress reports (Article 15(3) of the Governance Regulation).
- Member States could consider simple summary communications to key stakeholders, in order to encourage awareness and action. These should be discussed with relevant stakeholder groups to collect views and opinions from a broad range of the public. They could be used to help inform decision makers and engage data providers.
- Member States could consider improved reporting to address poor transparency in key areas of climate and energy action. This could include improving the transparency of the interactions between projected GHGs and projections for renewables, energy efficiency and energy security.

How do we improve the transparency of and consistency between energy and climate projections?

For complete transparency, data should be broken down to a granularity from which it can be aggregated to a useful level for each dimension. The levels of granularity for each dimension are currently different, and not always compatible. For example:

1) Nomenclature and normalisation used for Renewables (D4b) ("gross final energy consumption" by technology, in three energy market sectors: electricity; heating and cooling; and transport) is potentially new and interesting for monitoring decarbonisation and GHG related actions (D4a). However, this level of granularity is not contained in GHG inventory databases (e.g. no split of GHG emissions between energy market sectors or per technology). It has yet to be agreed on the way different weather conditions are accounted for, such as normalisation of wind power and hydroelectricity generation, or the use of heating degree days.
2) Energy efficiency (D3) sectors (industry, residential, service, transport) are broadly similar to the sectors used to report GHG projections. However, some reconciliation/subdivision is needed for industry e.g. high efficiency co-generation is not identified separately in GHG inventories or projections. The same goes generally for the reporting of emissions from electricity and heat

production in public utilities, industries and in the service sector. In addition, the separation into process and energy emissions is difficult and not necessarily consistent between energy balances and GHG inventories.

3) For decarbonisation (D4a), understanding the **fuel types** plays an essential role, as carbon intensity differs across different types of fossil fuels. Energy security (D1) has identified fuel types in Annex 1 to the proposal COM (2016) 759 explicitly (requiring reporting of the "current energy mix" in section 4.4 of Annex I). However, energy efficiency (D3) does not explicitly call for the different fuel types to be specified and is more concerned with a general reduction in energy use. It would be helpful if Energy Efficiency reporting (D3) highlighted reductions in **types of energy usage** for example, providing thereby missing information that links to decarbonisation efforts (D4a).

For integrated national projections it is vital to address these differences between dimensions in ways which ensure that the level of detail and transparency is consistent. These differences might be partly country specific, depending on the definition in the energy balances. Suggestions from the EEA Eionet workshop of 2017 included defining a nomenclature set that enables disaggregation of energy and GHG data to a level from which it could be aggregated to meet existing reporting requirements, while transparently showing the links between the individual Energy Union dimensions. It might also be helpful to further clarify the allocation of energy demand and GHG emissions to end users (to allow a more targeted action by policy makers) and to strengthen the linking between energy balances and UNFCCC sectors.

3.3 Possible technical solutions

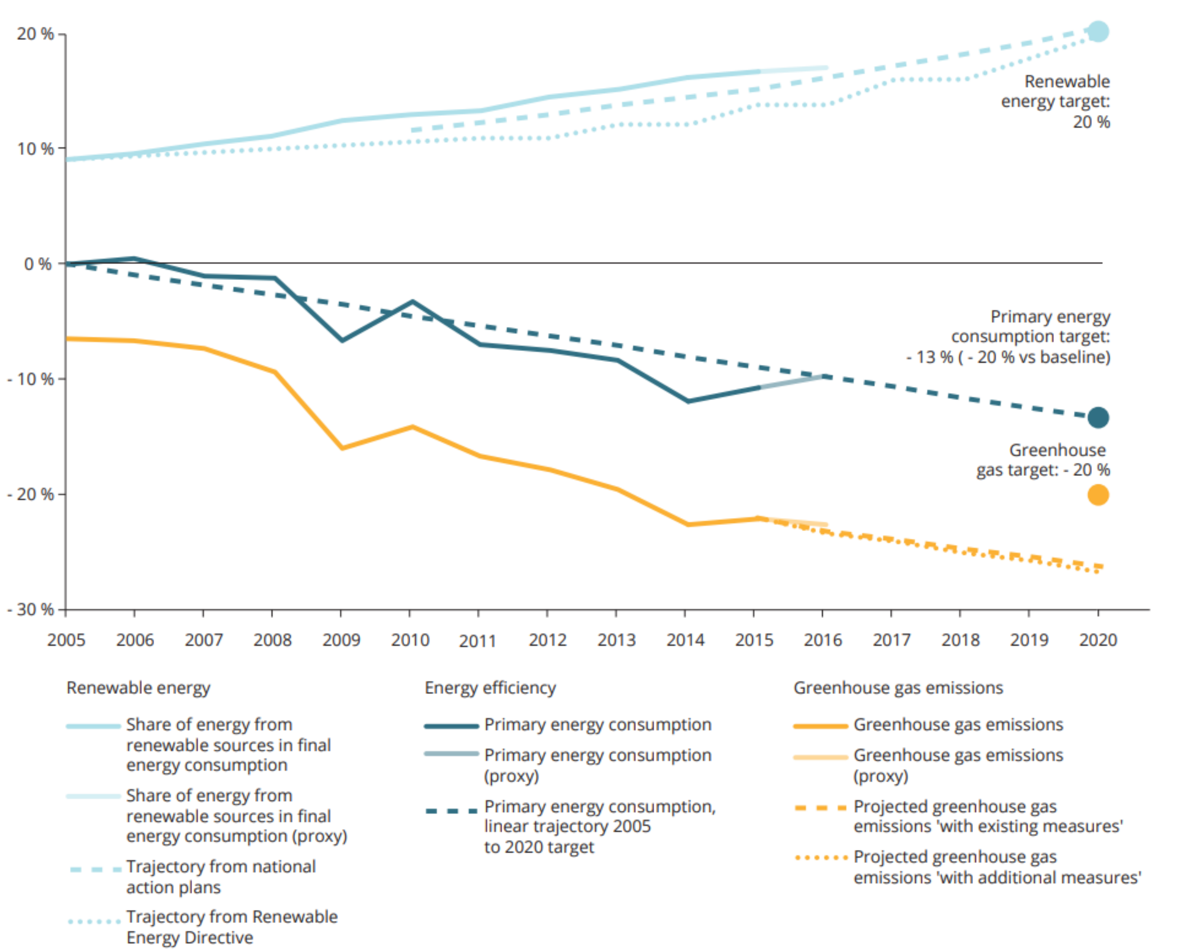
Drawing from the challenges identified in this paper, this section formulates suggestions of technical steps that could be implemented by Member States in the development of their integrated energy and climate projections. These include:

1) **Early engagement of energy experts with GHG experts** to understand the variables needed for GHG projections. These experts need to be able to produce comparable data on a regular basis. Peer-review processes between GHG and energy experts would also support integration.
2) **Provision of a principal electronic format for reporting** of results of integrated projections, according to the Governance Regulation Annex I Part B – similar to GHG projections reporting under the MMR. This allows a targeted and widely unambiguous set of results from national projections, which allows the results across all Member States to be compared. The reporting from Member States should be streamlined so that the analysis and understanding of results is simplified. It also helps Member States to gather a team of data providers and analysis/modelling expertise around a clearly defined set and scope of outputs.
3) Establish procedures, approaches and teams to **ensure consistency, comparability and transparency of climate (GHG) and national energy balance data used for the projections** and the establishment of a **consistent base year** and base year assumptions for projections. This will require cooperation between GHG and energy experts, and may depend on the country-specific energy balances. This will also require the **definition and mapping of links between sectors in national energy balances, UNFCCC source sectors and reporting sectors**. A standardised, publicly available mapping of sectors across the sources will enable consistency of reporting.
4) Establish tools, procedures, approaches and teams to **ensure consistency in projections'** overarching/general pre-set assumptions (interconnectivity, level of net-import for electricity, level of sector coupling, future availability of synthetic gases etc.) and modelling results. Consistency of assumptions and modelling tools across energy and GHG projections will enable a coherent assessment. Ideally this should also include **linking of air pollutants to integrated climate and energy results**. The following considerations could guide national decisions towards improving the consistency in projections:

- Are the **underlying assumptions** consistent across GHG, energy and air pollution projections?
- Are **feedback loops** identified across projections and between scenarios? For example, a measure for increasing the number of electric vehicles to meet a specific policy increases the demand for electricity that needs to be fed back into the assumptions on overall energy demand. Similarly, the increasing energy efficiency (D3) decreases the demand in both the heating and electrical sector, which needs to be fed back on generation capacities**.**

5) **Tracking of targets across all dimensions using metrics/indicators that link dimensions.** For example, showing trends and projections of GHGs and energy on the same graphs. This could be in the manner of Figure 1.1 from EEA (2017b), plotting EU-28 GHG projections (D4a) in relation to the share of renewables (D4b), primary energy consumption in the context of energy efficiency (D3) and GHG mitigation efforts (D4a), or Figure 2.2 from EEA (2017c) (showing ESD, ETS and LULUCF emissions/sinks compared to national ESD targets and LULUCF commitments).

Figure 1.1 EU progress towards 2020 climate and energy targets



Source: EEA, 2017c

6) **Harmonisation of methodologies in order to quantify energy and climate action savings together and integrate results coherently into projections**. If integrative tools or models are used, then this coherent quantification will be greatly facilitated. For a hypothetical example, a renewable measure to develop *X* GWh of wind and solar will:
   A. Realise *A* Gg CO2 eq. of GHG savings, contributing to *e*% of the national GHG target (D4a).
   B. Add another *x*% to the national renewables target (D4b)
   C. Reduce demand for *Y* GWh of coal and *Z* GWh of oil (D3), (of which Y_i and Z_i will be imported, reducing reliance on imports and improving energy security (D1).

D. This measure will cost *B* euros and save *C* euros.
E. This measure will be fully implemented in 201*x*.

4 Conclusions

This paper explains why and how the future Regulation on the Governance of the Energy Union raises the need for the generation and reporting of integrated energy and climate projections in EU Member States. The integration of projections across the energy and climate fields provides superior tools for managing policies. This paper discusses a number of practical steps for Member States in developing integrated projections systems, on the basis of expert discussions held at the EEA Eionet Energy and environment workshop of 2017, the DG Climate Action workshop on integrated climate and energy projections of 2017, and decades-old experience on working with climate projections. Whilst the integration of energy and climate projections brings numerous benefits, the challenges to integration can be considerable. Changes to the roles and responsibilities of contributing organisations may be required to overcome the challenges, together with increased cooperation and communication between stakeholders, and improvement of national systems. Nevertheless, it also illustrates that due to the crucial role of energy variables in the GHG projections the current GHG projections reported biennially under the MMR – where done properly and reported transparently – can provide a form of integrated climate and energy projections that may well cover many of the five Energy Union dimensions. Nevertheless, further reflections could be helpful regarding future interactions between integrated projections, on the one hand, and target-based national scenarios, on the other hand. The latter may become additional tools for illustrating desired national trajectories for renewable energy and energy consumption (up to 2030) and long-term low-emission strategies (with a 50 year perspective).

The first reporting requirement under the proposed Governance Regulation, consists, for each Member State, in submitting a draft integrated National Energy and Climate Plan (NECP) by 31 December 2018. As this reporting deadline is approaching soon, Member States are encouraged to 'do what they can' with an improvement plan in place to build upon the draft NECP. Providing clear electronic reporting methods, of a standard at least that of the prevailing MMR reporting, and following as best as possible the body of guidance, good practices and transparency requirements that was developed under the MMR and international monitoring and reporting requirements (UNFCCC) would help elevate the reporting formats in the energy domain to a higher standard.

For some Member States, the challenges of integration are large, but not unsurmountable. At the same time, the benefits are considerable. Projections will remain a key tool for ensuring the policies and measures of Member States are sufficiently ambitious to achieve the energy and climate targets of the Energy Union. Integrating the fields will increase coherence and simplify the projections and policy evaluation process.

References

BEIS, 2018, Updated energy and emissions projections 2017, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/671187/Updated_energy_and_emissions_projections_2017.pdf accessed 20th April 2018.

EC, 2017, Revision 7 of the Proposal for a Regulation of the European Parliament and of the Council on the Governance of the Energy Union, amending Directive 94/22/EC, Directive 98/70/EC, Directive 2009/31/EC, Regulation (EC) No 663/2009, Regulation (EC) No 715/2009, Directive 2009/73/EC, Council Directive 2009/119/EC, Directive 2010/31/EU, Directive 2012/27/EU, Directive 2013/30/EU and Council Directive (EU) 2015/652 and repealing Regulation (EU) No 525/2013, http://data.consilium.europa.eu/doc/document/ST-7204-2017-REV-7/en/pdf accessed 6th March 2018.

EC, 2016a, Proposal for a Regulation of the European Parliament and of the Council on the Governance of the Energy Union, amending Directive 94/22/EC, Directive 98/70/EC, Directive 2009/31/EC, Regulation (EC) No 663/2009, Regulation (EC) No 715/2009, Directive 2009/73/EC, Council Directive 2009/119/EC, Directive 2010/31/EU, Directive 2012/27/EU, Directive 2013/30/EU and Council Directive (EU) 2015/652 and repealing Regulation (EU) No 525/2013. COM/2016/0759 final/2 - 2016/0375 (COD), https://goo.gl/pNKh3i accessed 11th July 2017.

EC, 2016b, Commission Staff Working Document – Impact Assessment on the Proposal for a Regulation of the European Parliament and the Council on the Governance of the Energy Union. COM(2016) 394 final, http://ec.europa.eu/energy/sites/ener/files/documents/1_en_impact_assessment_part1_v4.pdf accessed 11th August 2017.

EC, 2016c, Possible streamlining of climate and energy reporting requirements in areas with interlinkages, Final report, https://publications.europa.eu/en/publication-detail/-/publication/ce377b17-f4e1-11e6-8a35-01aa75ed71a1/language-en/format-PDF accessed, 18th August 2017.

EC, 2015, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank on A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy. COM/2015/080 final, https://goo.gl/NT1kPk accessed 11th August 2017.

EC, 2014, Commission Implementing Regulation (EU) No 749/2014 of 30 June 2014 on structure, format, submission processes and review of information reported by Member States pursuant to Regulation (EU) No 525/2013 of the European Parliament and of the Council, https://goo.gl/mHV4JY accessed 14th August 2017.

EC, 2013, Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and at Union level relevant to climate change and repealing Decision No 280/2004/EC, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R0525 accessed 23rd March 2018.

EC, 2004, Decision No 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol.

EEA, 2017a, Data viewer on greenhouse gas emissions and removals, sent by countries to UNFCCC and the EU Greenhouse Gas Monitoring Mechanism (EU Member States). http://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer accessed 19th April 2018.

EEA, 2017b, 'Renewable energy in Europe – 2017 Update: Recent growth and knock-on effects', EEA Report No 23/2017 https://www.eea.europa.eu/publications/renewable-energy-in-europe/at_download/file accessed 28th March 2018.

EEA, 2017c, 'Trends and Projections in Europe', EEA Report No 17/2017 https://www.eea.europa.eu/publications/trends-and-projections-in-europe-2017 accessed 12th March 2017

EEA, 2015, 'Projections in hindsight', Technical Report No 4/2015 https://goo.gl/XLWUGA accessed 11th July 2017.

EU, 2004, Monitoring Mechanism Decision (Decision No 280/2004/EC), https://goo.gl/PP9mZW accessed 11th July 2017.

EU, 2012, Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32 https://goo.gl/9ZdHJ7. Accessed 11th August 2017.

EU, 2009, Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, https://goo.gl/AnSvEQ accessed 14th August 2017.

EUCO, 1999, Council Decision of 26 April 1999 amending Decision 93/389/EEC for a monitoring mechanism of Community CO2 and other greenhouse gas emissions.

UNFCCC, 2015, *Adoption of the Paris Agreement,* 21st Conference of the Parties, Paris: United Nations.

Annex 1: Interactions of the Energy Union dimensions

The dimensions of the Energy Union are elaborated below, together with their interactions and their specific importance for the generation of integrated energy and climate projections under the Governance Regulation.

The relevance ratings "HIGH – LOW" indicate the relative importance to the integration of energy and climate **projections**, where "HIGH" indicates the areas where integration will be most important. The key priority aspects can be summarised for the five Energy Union dimensions as follows:

D1) The **Energy Security dimension** has MEDIUM relevance to the integration of energy and climate projections. This is because there should be a HIGH relevance between energy security (D1), renewables (D4b) and energy efficiency (D3) with interlinkages from the latter two dimensions to GHG emissions/removals (D4a). Energy security considerations should already be implicitly included in energy projections used for GHG projections (and, if done comprehensively, could already be considered as integrated projections). Actions in a WAM projections scenario on energy security (D1) may well complement or conflict with decarbonisation and renewable energy actions (D4), as they will tend to favour indigenous, non-fluctuating energy sources irrespective of their type. Integration of energy and climate projections will thus inevitably help to ensure improved sharing of knowledge between targets and actions on energy security (D1) and decarbonisation (D4) that might be included in a WAM projections scenario.

D2) The **Internal Energy Market (IEM) dimension** has a MEDIUM relevance to the integration of energy and climate projections. This dimension will be critically important for modelling energy consumption and supply, and for ensuring consistency between energy modelling assumptions and market assumptions. Energy modelling must take IEM into account, or else there will be inconsistencies within the energy projections and wider assumptions on the energy market. This consideration will drive the interactions between the Internal Energy Market dimension (D2) and renewables (D4b), energy efficiency (D3) and energy security (D1). Especially challenging – and giving room for possible improvements - is the modelling of the links between WAM GHG projections (under D4a) and the synergies and/or conflicts with the Internal Energy Market (D2) strategy for (i) level of electricity interconnectivity, (ii) objectives for electricity and gas transmission infrastructure, (iii) market integration and coupling, (iv) national objectives with regard to ensuring electricity system adequacy, as well as flexibility of the energy system with regard to renewable energy production. Plans for the internal energy market regarding points i-iv may also form the basis for the modelling of energy consumption and supply and therefore impact on GHG projections in the WAM scenario.

D3) The **Energy Efficiency dimension** has HIGH relevance to the integration of energy and climate projections. Energy efficiency is a key measure in the short-term reduction of GHG emissions. Energy efficiency also works towards improving the achievability and viability of renewables by reducing overall energy intensity of an economy. But uncoordinated energy efficiency measures could also weaken signals from the decarbonisation actions, making climate goals more difficult to meet (D4a).

D4) The **Decarbonisation dimension,** containing **GHG emissions and removals (D4a)** and **renewable energy (D4b)** has the HIGHEST relevance to the integration of energy and climate projections. Both of these elements have a strong focus on actions to replace non-renewable energy resources (e.g. fossil fuels) with renewable and low carbon emitting sources of energy. D4a also provides strong links to other key sectors, especially waste, transport, agriculture and related land use sectors. For land-use activities there is a complex interrelation between the use of land to produce biofuels, the use of land for carbon sequestration and the demand for land for food production. Ultimately, a GHG projection (as reported under the MMR) (D4a), if done properly and reported transparently, provides an integrated projection since it uses or includes energy projections.

D5) **The Research, Innovation and Competitiveness (RIC) dimension** has a MEDIUM relevance to the integration of energy and climate projections. This dimension (D5) will be important for consistency between assumptions with energy modelling and innovation assumptions. Objectives and targets for national research and innovation relating to the Energy Union should be coherent with those in the Energy Union Strategy, and can feed into the underlying activity data for energy and GHG projections (D4a). D4a needs to inform D5 (RIC) on GHG emissions and renewable constraints/targets so that D5 is equipped to provide the research and innovation needed to meet D4a needs. WEM GHG projections can indicate to D5 areas that would benefit from additional efforts for research and innovation to reduce potential gaps between WEM scenarios and Energy Union targets.

Annex 2: The Energy sector of GHG emissions inventories

National GHG emissions inventories reported to the UNFCCC, and to the EU under the MMR, are reported in sectors defined in the Common Reporting Format (CRF) tables[21]. Sector 1 of the inventory is Energy. This covers the following subsectors:

1. Energy

A. Fuel combustion

- 1. Energy industries
  - a. Public electricity and heat production
  - b. Petroleum refining
  - c. Manufacture of solid fuels and other energy industries
- 2. Manufacturing industries and construction
  - a. Iron and steel
  - b. Non-ferrous metals
  - c. Chemicals
  - d. Pulp, paper and print
  - e. Food processing, beverages and tobacco
  - f. Non-metallic minerals
  - g. Other
- 3. Transport
  - a. Domestic aviation
  - b. Road transportation
  - c. Railways
  - d. Domestic navigation
  - e. Other transportation
- 4. Other sectors
  - a. Commercial/institutional
  - b. Residential
  - c. Agriculture/forestry/fishing
- 5. Other
  - a. Stationary
  - b. Mobile

B. Fugitive emissions from fuels

- 1. Solid fuels
  - a. Coal mining and handling
  - b. Solid fuel transformation
  - c. Other
- 2. Oil and natural gas and other emissions from energy production
  - a. Oil
  - b. Natural gas
  - c. Venting and flaring
  - d. Other

C. CO_2 Transport and storage

- 1. Transport of CO_2
- 2. Injection and storage
- 3. Other

(21) The CRF tables, as agreed at the 39th meeting of the Subsidiary Body for Scientific and Technological Advice (SBSTA) to the UNFCCC:
http://unfccc.int/files/national_reports/annex_i_ghg_inventories/application/octet-stream/2006_ipcc_guidelines.7z

Annex 3: Typology of Energy Union parameters

The parameters listed in Part B of Annex I of the Governance Regulation (EC, 2016a) are presented below. These are to be reported in Section B of the Integrated National Energy and Climate Plan. The "Projections in hindsight" report (EEA, 2015) highlights that when parameters are not properly reflected in a consistent manner that allows the understanding of the basis of the projections, consistency across scenarios can be difficult to achieve. This has knock-on effects for aggregating projections at an EU-level. The three sections of parameters cover:

- Section 1 covers macroeconomic parameters, and are typically exogenous variables to projection models.
- Section 2 covers energy related parameters, including fuel production, consumption and prices.
- Section 3 covers GHG emissions by policy and IPCC sector, carbon intensity and non-CO_2 parameters.

Table A3.1: Parameters specified for reporting in Part B of Annex I of COM(2016) 759

Parameter
1. General parameters and variables
(1) Population [million]
(2) GDP [euro million]
(3) Sectorial gross value added (incl. main industrial, construction, services, and agriculture sectors) [euro million]
(4) Number of households [thousands]
(5) Household size [inhabitants/households]
(6) Disposable income of households [euro]
(7) Number of passenger-kilometres: all modes [million pkm] Cars Buses Rail Aviation Domestic navigation
(8) Freight transport tonnes-kilometres: all modes excluding international maritime] [million tkm] Road Rail Aviation Domestic navigation (inland waterways and national maritime)
(9) International oil, gas and coal fuel import prices [euro/GJ or euro/toe] – aligned with Commission's recommendations Oil import price Gas import price Coal import price
(10) EU-ETS carbon price [euro/EUA] - aligned with Commission's recommendations
(11) Exchange rates to euro and to US Dollar (if applicable) assumptions [euro/ currency and USD/currency] Exchange rate to euro Exchange rate to US dollar
(12) Number of Heating Degree Days (HDD)
(13) Number of Cooling Degree Days (CDD)
(14) Technology cost assumptions used in modelling for main relevant technologies
2. Energy balances and indicators
2.1. Energy supply
(1) Indigenous Production by fuel type (all energy products: coal, crude oil, natural gas, nuclear energy, renewable energy sources) [ktoe]

Coal Crude oil Natural gas Nuclear energy Renewable energy sources
(2) Net imports by fuel type (including electricity and split into intra- and extra European net imports) [ktoe] Net coal import (intra-Europe) Net coal import (extra-Europe) Net crude oil import (intra-Europe) Net crude oil import (extra-Europe) Net natural gas import (intra-Europe) Net natural gas import (extra-Europe) Net nuclear energy import (intra-Europe) Net nuclear energy import (extra-Europe) Net renewable energy sources import (intra-Europe) Net renewable energy sources import (extra-Europe) Net electricity import (intra-Europe) Net electricity import (extra-Europe)
(3) Import dependency from third countries [%]
(4) Main import sources (countries) for main energy carriers (including gas and electricity) Gas Electricity
(5) Gross Inland Consumption by fuel type source (incl. solids, all energy products: coal, crude oil and petroleum products, natural gas, nuclear energy, electricity, derived heat, renewables, waste) [ktoe] Coal Crude oil Natural gas Nuclear energy Electricity Derived heat Renewable energy sources Waste
2.2. Electricity and heat
(1) Gross electricity generation [GWhe]
(2) Gross electricity generation by fuel (all energy products) [GWhe] Coal Crude oil Natural gas Nuclear energy Renewable energy sources
(3) Share of combined heat and power generation in total electricity and heat generation [percentage]
(4) Capacity electricity generation by source including retirements and new investments (MW)
(5) Heat generation from thermal power generation
(6) Heat generation from combined heat and power plants, including industrial waste heat
(7) Cross-border interconnection capacities for gas and electricity [Definition for electricity in line with outcome of ongoing discussions on basis for 15% interconnection target] and their projected usage rates
2.3. Transformation sector
(1) Fuel inputs to Thermal Power generation (incl. solids, oil, gas) [ktoe]
(2) Fuel inputs to other conversion processes [ktoe]

2.4. Energy consumption
(1) Primary and final energy consumption [ktoe]
(2) Final energy consumption by sector (incl. industry, transport (split between passenger and freight, when available), households, services, agriculture) [ktoe] Industry Passenger transport Freight transport Households Services Agriculture
(3) Final energy consumption by fuel (all energy products) [ktoe] Coal Crude oil Natural gas Nuclear energy Renewable energy sources
(4) Final non-energy consumption [ktoe]
(5) Primary energy intensity of the overall economy (primary energy consumption per GDP [toe/euro]
(6) Final energy intensity by sector (incl. industry, residential, tertiary, passenger transport (incl. split between passenger and freight, when available), freight transport) Industry Residential Tertiary Passenger transport Freight transport
2.5. Prices
(1) Electricity prices by type of using sector (residential, industry, tertiary) Residential Industry Tertiary
(2) National retail fuel prices (including taxes, per source and sector) (euro/ktoe) National retail fuel prices (with taxes included) - Coal, industry National retail fuel prices (with taxes included) - Coal, households National retail fuel prices (with taxes included) - Heating oil, industry National retail fuel prices (with taxes included) - Heating oil, households National retail fuel prices (with taxes included) - Transport, gasoline National retail fuel prices (with taxes included) - Transport, diesel National retail fuel prices (with taxes included) - Natural gas, industry National retail fuel prices (with taxes included) - Natural gas, households
2.6. Investments
Energy-related investment costs compared to GDP (and compared to gross value added for the industry sector)
2.7. Renewables
(1) Gross final consumption of energy from renewable sources and share of renewable energy in gross final energy consumption and by sector (electricity, heating and cooling, transport) and by technology Electricity - technology A Electricity - technology n Heating and cooling - technology A Heating and cooling - technology n Transport - technology A Transport - technology n

(2) Electricity and heat generation from renewable energy in buildings (as defined in Article 2(1) of Directive 2010/31/EU; this shall include disaggregated data on energy produced, consumed and injected into the grid by solar photovoltaic systems, solar thermal systems, biomass, heat pumps, geothermal systems, as well as all other decentralized renewables systems) Solar photovoltaic systems Solar thermal systems Biomass Heat pumps Geothermal systems Other
(3) If applicable, other national trajectories, including long term or sectorial ones (the share of food-based and advanced biofuels, the share of renewable energy in district heating, as well as the renewable energy produced by cities and energy communities as defined by Article 22 of [recast of Directive 2009/28/EC as proposed by COM(2016) 767])
3. GHG emissions and removals related indicators
(1) GHG emissions by policy sector (ETS, Effort Sharing Regulation and LULUCF) ETS ESD LULUCF
(2) GHG emissions by IPCC sector and by gas (where relevant split into ETS and ESD) [tCO2eq] 1. Energy - CO2 1. Energy - N2O 1. Energy - CH4 2. Industrial processes and product use - CO2 2. Industrial processes and product use - N2O 2. Industrial processes and product use - CH4 3. Agriculture - CO2 3. Agriculture - N2O 3. Agriculture - CH4 4. LULUCF - CO2 4. LULUCF - N2O 4. LULUCF - CH4 5. Waste - CO2 5. Waste - N2O 5. Waste - CH4
(3) Carbon Intensity of the overall economy [tCO2eq/GDP]
(4) CO2 emission related indicators
(a) Carbon intensity of electricity and steam production [tCO2eq/MWh]
(b) Carbon intensity of final energy demand by sector (incl. industry, residential, tertiary, passenger transport, freight transport) [tCO2eq/toe] Industry Residential Tertiary Passenger transport Freight transport
(5) Non-CO2 emission related parameters
(a) Livestock: Dairy cattle (1000 heads), Non-dairy cattle (1000 heads), Sheep (1000 heads), Pig (1000 heads), Poultry (1000 heads) Dairy cattle Non-dairy cattle Sheep Pig

Poultry
(b) Nitrogen input from application of synthetic fertilizers (kt nitrogen)
(c) Nitrogen input from application of manure (kt nitrogen)
(d) Nitrogen fixed by N-fixing crops (kt nitrogen)
(e) Nitrogen in crop residues returned to soils (kt nitrogen)
(f) Area of cultivated organic soils (hectares)
(g) Municipal solid waste (MSW) generation
(h) Municipal solid waste (MSW) going to landfills
(i) Share of CH4 recovery in total CH4 generation from landfills (%)

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