Alliance for Internet of Things Innovation

# AIOTI Vision:
# IoT and Edge Computing impact on Green Deal

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## AIOTI Digital for Green Group

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# Executive Summary

This report introduces the AIOTI vision for the impact of IoT and Edge Computing on Green Deal policies and objectives.

The main objective of this report is to discuss the steps to be followed in order to:

(1) identify the high-level objectives of and challenges imposed by the EU Green Deal and key resulting Data policies;

(2) show IoT and Edge Computing business driven scenarios and use cases that can support these objectives and challenges in addressing key EU Green Deal and Data policies;

(3) map the IoT and edge computing activities in vertical industries;

(4) provide IoT and edge computing high level research and standardisation recommendations on addressing these high-level Green Deal challenges and objectives.

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# 1   Introduction

Future technological developments will create a set of strategic choices related to new value networks and ecosystems, influencing how value is created within companies and redistributed among industry players, countries and society. Intelligent connectivity is essential for the achievement of the United Nation's (UN's) Broadband Commission agenda for 17 UN Sustainable Development Goals, having set deployment targets for 2025 to underline the importance of communication systems and networks on addressing economic growth and addressing social challenges. Moreover, IoT and edge computing can be used to support the European Green Deal and Fit for 55 package and decrease energy and carbon footprint of various vertical industries.

For example, Global e-Sustainability Initiative (GeSI) shows that the estimated carbon reduction accomplished in ten different vertical domains is enabled by the use of mechanisms, such as machine-to-machine (M2M) connections and the functionality of smart devices. In particular, GeSI mentions that 70% of the estimated carbon reduction savings currently being made, come from the use of machine-to-machine (M2M) technologies.

In particular, in the IoT and edge computing areas the impact of the Green Deal would be two-fold:

(1) using IoT and Edge Computing technologies to improve the environment impact of other domains and

(2) improving the energy footprint of IoT based systems, including its use and energy consumption, the disposal or refurbishing of obsolete devices, the design and manufacturing of energy and environment-friendly new devices.

The main objective of this report is to present the steps to be followed in order to

(1) identify the high-level Green Deal challenges and objectives imposed by key EU Green Deal and Data policies;

(2) show IoT and Edge Computing business driven scenarios and use cases that can support these objectives and challenges and these key EU Green Deal and Data policies;

(3) map the IoT and edge computing activities in vertical industries;

(4) provide IoT and edge computing high level research and standardisation recommendations on addressing these high-level Green Deal challenges and objectives.

This report provides as well a short overview of the relation between the EU Green Deal policies and other Global Green Deal policies.

The AIOTI approach to creating a vision supporting Green Deal policies using IoT and Edge Computing scenarios and use cases is depicted in Figure 1.

This approach recommends an adjustment to the overall approach, going beyond the Green Deal objectives and concentrating on 'actions' that the EU highlights to meet [EU Green Deal targets](#) and [Fit for 55 package](#) targets:

i) investing in environmentally-friendly technologies;

ii) supporting industry to innovate;

iii) rolling out cleaner, cheaper and healthier forms of private and public transport;

iv) decarbonising the energy sector;

v) ensuring buildings are more energy efficient;

vi) working with international partners to improve global environmental standards.

For each action, it is possible to map a set of implications for IoT and Edge Computing.

The process to be followed will conclude with a set of recommendations and an overall vision for 'Digital for Green'. In particular, the process applied in AIOTI to support the Green Deal policies using IoT and Edge Computing scenarios and use cases is depicted in Figure 1, which are:

| | |
|---|---|
| Step 1: | Study the EU Green Deal and key resulting Data policies, for more details see Section 2; |
| Step 2: | Identify the high-level objectives of and challenges imposed by the EU Green Deal and key resulting Data policies, see Section 3; |
| Step 3: | Collect IoT and edge devices/solutions/services/standards/research to support High Level Objectives, see Section 4; |
| Step 4: | Map the IoT and edge computing activities to AIOTI WGs and AIOTI IGs, see Section 4; |
| Step 5: | Via a report composed by AIOTI Digital for Green IG provide high level research and standardisation recommendations on addressing these high-level Green Deal challenges and objectives, see Section 5. |

If necessary, any step or flow between these steps, shown in Figure 1 can be repeated;
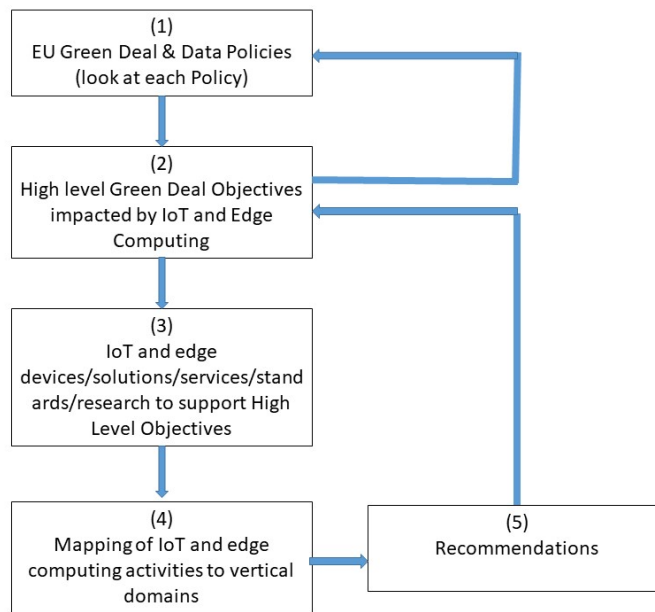
Figure 1: AIOTI approach to supporting Green Deal policies using IoT and Edge Computing scenarios and use cases

# 2 EU Green Deal and Data policies

This section provides the overview of the Green Deal and Data policies in Europe.

## 2.1 Overview of the EU Green Deal policies

This section gives an overview of EU Green Deal policies and regulations.

### 2.1.1 EU Green Deal

On 11 October 2019, the European Commission published the [European Green Deal](#) presenting a list of [policy initiatives](#) aimed at driving Europe to reach net-zero global warming emissions by 2050. The goal of the European Green Deal is to improve the well-being of people by making Europe climate-neutral and protecting Europe's natural habitat for the benefit of people, planet and economy. The European Green Deal targets that the EU needs to fulfil are (see Figure 2):

- reach climate neutrality by 2050;
- protect human life, animals and plants by cutting pollution;
- help become world leaders in clean products and technologies;
- help ensure a just and inclusive transition.

Some of the [motivations](#) behind the European Green Deal are:

93% of Europeans see climate change as a serious problem;

93% of Europeans have taken at least one action to tackle climate change;

79% agree that taking action on climate change will lead to innovation.
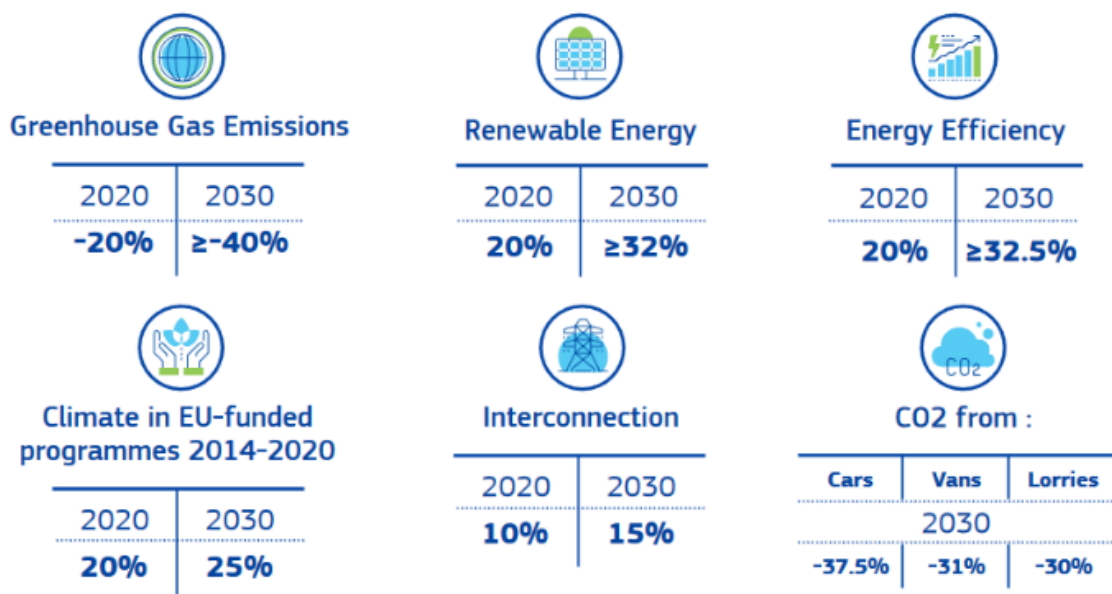


**Figure 2: EU-Energy and Climate 2030 Targets 2018/2019**

One of the key objectives of AIOTI should be to launch activities on realising (a subset of) the Europe's Green Deal objectives described below.

### 2.1.1.1 Climate neutral Europe

The EU aims to reach net-zero greenhouse gas emissions by 2050, an objective that will be endorsed in a "Climate Law" to be presented in March 2020. In particular, the reductions in the GHG (Greenhouse Gas) emissions compared to 1990 are:

-20% in 2020 - 2023: EU member states update their national energy and climate plans to reflect the new climate ambition;

-50 – 55% in 2030;

Zero net emissions of greenhouse gases in 2050.

The proposed objectives to realise these targets are:

- Interconnect energy systems while integrating and increasing share of renewable energy sources into the grid;
- Promote and integrate innovative technologies and modern infrastructure;
- Boost energy efficiency and eco-design of products;
- Decarbonise the gas sector and promote smart integration across sectors;
- Empower consumers and help Member States to tackle energy poverty;
- Increase cross-border and regional cooperation to better share clean energy sources;
- Promote EU energy standards and technologies at global level;
- Promote support for citizen dialogues and support of energy communities.

### 2.1.1.2 Sustainable industry and Circular economy

In March 2020, a new circular economy action plan is launched as part of a broader EU industrial strategy that will include a sustainable product policy with "prescriptions on how we make things" in order to prioritise reducing and reusing materials before recycling them. Moreover, the minimum requirements is set to prevent environmentally harmful products from being placed on the EU market. False green claims will be tackled. The first efforts are targeted to focus first on resource intense sectors such as: textiles, construction, electronics and plastics.

In order to achieve the EU's climate and environmental goals requires a new industrial policy based on the circular economy. Some mentioned figures are:

- From 1970 to 2017, the annual global extraction of materials tripled, and it continues to grow;

- More than 90% of biodiversity loss and water stress come from resource extraction and processing;
- EU's industry accounts for 20% of the EU's emissions;
- Only 12% of the materials used by EU industry come from recycling.

Europe needs a digital sector that puts sustainability and green growth at its heart. In particular, digitalisation presents new opportunities for:

- monitoring of air and water pollution;
- monitoring and optimising how energy and natural resources are consumed.

### 2.1.1.3 Buildings' renovation and retrofitting

The reason of focusing on this objective is due to the fact that 40% of European's energy consumption is by buildings. The main focus will be to renovate buildings, to help people cut their energy bills and energy use.

The proposed objectives to accomplish better energy performance of buildings are:

- Prices of different energy sources should incentivize energy-efficient buildings;
- Design of buildings should be in line with the circular economy;
- Increased digitalization;
- More climate-proofing of buildings;
- Strict enforcement of rules on energy performance of buildings.

### 2.1.1.4 Eliminating pollution

Whether in air, soil or water, the objective is to reach a "pollution-free environment" by 2050.

The following objectives are proposed to reduce pollution:

Clean water:
- Preserve biodiversity in our lakes, rivers and wetlands;
- Reduce pollution from excess nutrients thanks to the Farm to Fork strategy;
- Reduce particularly harmful pollution from micro-plastics and pharmaceuticals.

Clean air:
- Review air quality standards in line with the World Health Organization guidelines.
- Protect citizens against dangerous chemicals with a new chemical strategy for sustainability for a toxic-free environment;

- Combine better health protection with increased global competitiveness;

- Reduce pollution from large industrial installations;

- Provide support to local authorities to achieve cleaner air for our citizens.

Industry:

- Reduce pollution from large industrial installations;

- Improve prevention of industrial accidents.

Chemicals:

- Protect citizens against dangerous chemicals with a new chemical strategy for sustainability for a toxic-free environment;

- Combine better health protection with increased global competitiveness;

- Reduce pollution from large industrial installations;

- Provide support to local authorities to achieve cleaner air for our citizens;

- Develop more sustainable alternatives;

- Improve rules on assessment of substances launched on the market.

## 2.1.1.5 Ecosystems & biodiversity

In March 2020 a new biodiversity strategy was presented in in the run-up to a UN biodiversity summit taking place in China in October.

The EU targets to:

- Lead by example, through the European Green Deal;

- Use diplomacy, trade and development cooperation to advance climate action;

- Set standards for sustainable growth across global value chains.

The uptake of the planned eco-schemes and shift of the focus from compliance to performance towards improved environmental and climate performance, including managing and storing carbon in the soil, and improved nutrient management to improve water quality and reduce emissions is expected to increase the demand for the enabling technologies as well as foster innovation within the sustainable practices, such as precision agriculture, organic farming, agro-ecology, agro-forestry and stricter animal welfare standards  and potentially sustainable seafood as a source of low-carbon food.

### 2.1.1.6  Farm to fork strategy

In the spring 2020, the new farm to fork strategy is launched that aims for a "green and healthier agriculture" system. The target is to make sure that Europeans get:

- affordable and sustainable food;
- tackle climate change;
- protect the environment;
- preserve biodiversity;
- increase organic farming.

The European Commission will work with Member States and stakeholders to realize the following objectives:

- Ensure the transition is fair and just for everyone working in the European agricultural and maritime sector;
- Reduce significantly the dependency, risk and use of chemical pesticides, as well as of fertilizers, antibiotics;
- Develop innovative farming and fishing techniques that protect harvest from pests and diseases;
- Farm to fork will also help combat food fraud by preventing, detecting and fighting it through coordination with Member States and non-EU countries;
- Imported food products from third countries must comply with the EU's environmental standards.

### 2.1.1.7  Sustainable mobility

According to the European Green Deal, Europe must reduce emissions from transport further and faster. Transport accounts for a quarter of the European Union's greenhouse gas emissions and these continue to grow. Therefore, the Green Deal seeks a 90% reduction in these emissions by 2050. Some of the objectives of realising the Sustainable mobility Green Deal targets are:

Go digital:

- Automated mobility and smart traffic management systems will make transport more efficient and cleaner;
- Smart applications and 'Mobility as a Service' solutions will be developed;
- Use different modes of transport:
  - more freight should be transported by rail or water;
  - the Single European Sky should significantly reduce aviation emissions at zero cost to consumers and companies.
- Boost supply of sustainable alternative transport fuels.

By 2025, about 1 million public recharging and refuelling stations will be needed for the 13 million zero- and low-emission vehicles expected on European roads.
Reduce pollution:

- The Green Deal will address emissions, urban congestion, and improve public transport, which can be realized by:
  - stricter standards on pollution by cars;
  - to reduce pollution in EU ports;
  - to improve air quality near airports.

### 2.1.1.8  R&D and innovation

It is considered that the Horizon Europe research and innovation program will also contribute to the Green Deal during the next seven years (2021 - 2027). In particular, it is planned that 35% of the EU's research funding will be set aside for climate-friendly technologies under an agreement struck earlier this year. Moreover, a series of EU research "moon shots" will focus chiefly on environmental objectives.

## 2.2 Overview of additional EU Green Deal regulations Fit for 55 initiative

In the European Commission work programme for 2021, the revisions and initiatives linked to the European Green Deal climate actions and in particular the climate target plan's 55% net reduction target are presented under the Fit for 55 package, published on 14 July 2021.

The factsheets related to this package are:

• Brochure on Delivering the European Green Deal

• Architecture of the package Factsheet

• Socially fair transition Factsheet

• Nature and Forests Factsheet

• Transport Factsheet

• Energy Factsheet

• Buildings Factsheet

• Industry Factsheet

• Hydrogen Factsheet

The updated EU-Energy and Climate Targets based on the Fit for 55 regulation are given in Figure 3.
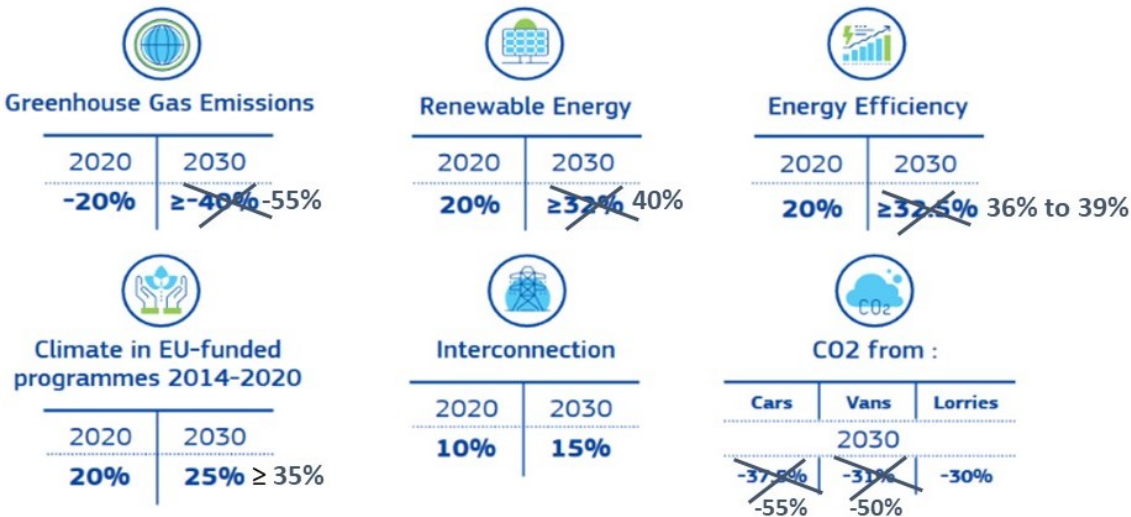


Figure 3: Updated EU-Energy and Climate Targets Fit for 55

## 2.2.1   Fit for 55 package overview

The European Green Deal, presented in the communication (COM(2019)640) of 11 December 2019, see Section 2.1.1 of this report, sets out a detailed vision to make Europe the first climate-neutral continent by 2050, safeguard biodiversity, establish a circular economy and eliminate pollution, while boosting the competitiveness of European industry and ensuring a just transition for the regions and workers affected.

With the announcement of the European Green Deal, the European Commission President Ursula von der Leyen pledged to put forward a comprehensive, responsible plan to increase the European Union's emissions reduction target for 2030. In particular. in her 17 September 2020 State of the Union address, von den Leyen proposed the reduction target to be set at 55%, alongside a revision of the EU's climate and energy legislation by June 2021, a target of spending 37% of the €750 billion NextGenerationEU recovery fund on Green Deal objectives, and the intention to raise 30% of the NextGenerationEU budget through green bonds.

The Commission adopted the communication 'Stepping up Europe's 2030 climate ambition - Investing in a climate-neutral future for the benefit of our people' (commonly known as the 2030 EU Climate target plan), on the same day. It also includes an updated 2030 emissions reduction target of net 55% compared to 1990 levels, from the current 40% emissions reduction target.

The communication builds on an extensive impact assessment and a public consultation during spring 2020. The analysis concludes that the current policy framework is insufficient. Without changes to the current policy framework and legislation, the European Commission communication projects only a 60% emissions reduction by 2050.

While the European Green deal communication referred to legislative processes and initiatives envisioned, the climate target plan gives some concrete examples of possible amendments.

The European Commission argues that delivering on the revised target with a coherent policy framework to support implementation across sectors would make European industry and businesses 'trailblazers'. This is expected to modernise the economy, delivering innovation and a competitive edge, while ensuring security and resilience of energy supply and health benefits. The new 2021-2027 Multiannual Financial Framework and NextGenerationEU provide an opportunity to transition and grow the economy simultaneously. According to the communication, climate action mainstreaming across other funds and programmes and ensuring a just transition through the Just Transition Mechanism is essential.

On 14 July 2021, the European Commission adopted a package of proposals to make the EU's climate, energy, land use, transport and taxation **policies fit for reducing net greenhouse gas emissions by at least 55% by 2030**, compared to 1990 levels. Achieving these emission reductions in the next decade is crucial to Europe becoming the world's first climate-neutral continent by 2050 and making the European Green Deal a reality. With these proposals, the Commission is presenting the legislative tools to **deliver on the targets agreed in the European Climate Law** and fundamentally transform our economy and society for a fair, green and prosperous future.

These proposals will enable the necessary acceleration of greenhouse gas emission reductions in the next decade.

They combine: application of emissions trading to new sectors and a tightening of the existing EU Emissions Trading System; increased use of renewable energy; greater energy efficiency; a faster roll-out of low emission transport modes and the infrastructure and fuels to support them; an alignment of taxation policies with the European Green Deal objectives; measures to prevent carbon leakage; and tools to preserve and grow our natural carbon sinks.

The following initiatives were announced on 14 July 2021:

- Revision of the EU Emissions Trading System (ETS), including maritime, aviation and CORSIA as well as a proposal for ETS as own resource:

  - o The EU Emissions Trading System (ETS) puts a price on carbon and lowers the cap on emissions from certain economic sectors every year. It has successfully brought down emissions from power generation and energy-intensive industries by 42.8% in the past 16 years. On 14 July 2021, the Commission is proposing to lower the overall emission cap even further and increase its annual rate of reduction. The Commission is also proposing to phase out free emission allowances for aviation and align with the global Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) and to include shipping emissions for the first time in the EU ETS. To address the lack of emissions reductions in road transport and buildings, a separate new emissions trading system is set up for fuel distribution for road transport and buildings. The Commission also proposes to increase the size of the Innovation and Modernisation Funds;

  - o To complement the substantial spending on climate in the EU budget, Member States should spend the entirety of their emissions trading revenues on climate and energy-related projects. A dedicated part of the revenues from the new system for road transport and buildings should address the possible social impact on vulnerable households, micro-enterprises and transport users.

- Carbon Border Adjustment Mechanism (CBAM) and a proposal for CBAM as own resource:

  - o The new Carbon Border Adjustment Mechanism will put a carbon price on imports of a targeted selection of products to ensure that ambitious climate action in Europe does not lead to 'carbon leakage'. This will ensure that European emission reductions contribute to a global emissions decline, instead of pushing carbon-intensive production outside Europe. It also aims to encourage industry outside the EU and our international partners to take steps in the same direction.

- Effort Sharing Regulation (ESR):

The Effort Sharing Regulation assigns strengthened emissions reduction targets to each Member State for buildings, road and domestic maritime transport, agriculture, waste and small industries. Recognising the different starting points and capacities of each Member State, these targets are based on their GDP per capita, with adjustments made to take cost efficiency into account.

- Revision of the [Energy Tax Directive:](#)
  - The tax system for energy products must safeguard and improve the Single Market and support the green transition by setting the right incentives. A [revision of the Energy Taxation Directive](#) proposes to **align the taxation of energy products with EU energy and climate policies**, promoting clean technologies and removing outdated exemptions and reduced rates that currently encourage the use of fossil fuels. The new rules aim at reducing the harmful effects of energy tax competition, helping secure revenues for Member States from green taxes, which are less detrimental to growth than taxes on labour.

- Amendment to the [Renewable Energy Directive](#) to implement the ambition of the new 2030 climate target (RED):
  - Energy production and use accounts for 75% of EU emissions, so accelerating the transition to a greener energy system is crucial. The [Renewable Energy Directive](#) will set an **increased target to produce 40% of our energy from renewable sources** by 2030. All Member States will contribute to this goal, and specific targets are proposed for renewable energy use in transport, heating and cooling, buildings and industry. To meet both our climate and environmental goals, **sustainability criteria for the use of bioenergy are strengthened** and Member States must design any support schemes for bioenergy in a way that respects the cascading principle of uses for woody biomass.

- Amendment of the [Energy Efficiency Directive](#) to implement the ambition of the new 2030 climate target (EED):
  - To reduce overall energy use, cut emissions and tackle energy poverty, the [Energy Efficiency Directive](#) will set a **more ambitious binding annual target for reducing energy use** at EU level. It will guide how national contributions are established and almost double the annual energy saving obligation for Member States. The **public sector will be required to renovate 3% of its buildings** each year to drive the renovation wave, create jobs and bring down energy use and costs to the taxpayer.

- [Reducing methane emissions in the energy sector](#)

- Revision of the Regulation on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry ([LULUCF](#)):

Member States also share responsibility for removing carbon from the atmosphere, so the [Regulation on Land Use, Forestry and Agriculture](#) **sets an overall EU target for carbon removals** by natural sinks, equivalent to 310 million tons of CO2 emissions by 2030. National targets will require Member States to care for and expand their carbon sinks to meet this target. By 2035, the EU should aim to reach climate neutrality in the land use, forestry and agriculture sectors, including also agricultural non-CO2 emissions, such as those from fertiliser use and livestock. The **EU Forest Strategy** aims to improve the quality, quantity and resilience of EU forests. It supports foresters and the forest-based bioeconomy while keeping harvesting and biomass use sustainable, preserving biodiversity, and setting out **a plan to plant three billion trees** across Europe by 2030.

- Revision of the Directive on deployment of alternative fuels infrastructure:
  - to ensure that drivers are able to charge or fuel their vehicles at a reliable network across Europe, the revised Alternative Fuels Infrastructure Regulation will **require Member States to expand charging capacity in line with zero-emission car sales**, and to install charging and fuelling points at regular intervals on major highways: every 60 kilometres for electric charging and every 150 kilometres for hydrogen refuelling.

- Revision of the Regulation setting CO₂ emission performance standards for new passenger cars and for new light commercial vehicles:
  - A combination of measures is required to tackle rising emissions in road transport to complement emissions trading. Stronger CO2 emissions standards for cars and vans will accelerate the transition to zero-emission mobility by **requiring average emissions of new cars to come down by 55% from 2030 and 100% from 2035** compared to 2021 levels. As a result, all new cars registered as of 2035 will be zero-emission;
  - Aviation and maritime fuels cause significant pollution and also require dedicated action to complement emissions trading. The Alternative Fuels Infrastructure Regulation requires that aircraft and ships have access to **clean electricity supply in major ports and airports**. The ReFuelEU Aviation Initiative will oblige fuel suppliers to blend **increasing levels of sustainable aviation fuels** in jet fuel taken on-board at EU airports, including synthetic low carbon fuels, known as e-fuels. Similarly, the FuelEU Maritime Initiative will stimulate the uptake of sustainable maritime fuels and zero-emission technologies by setting a maximum **limit on the greenhouse gas content of energy used by ships** calling at European ports.

The following initiatives are announced for fourth quarter of 2021:

- Revision of the energy performance of Buildings Directive (EPBD);
- Revision of the Third Energy Package for gas (Directive 2009/73/EU and Regulation 715/2009/EU) to regulate competitive decarbonised gas markets.

**These proposals are all connected and complementary**. This balanced package and the revenues it generates are needed, to ensure a transition which makes Europe fair, green and competitive, sharing responsibility evenly across different sectors and Member States, and providing additional support where appropriate.

## 2.2.2   A Socially Fair Transition

While in the medium- to long-term, the benefits of EU climate policies clearly outweigh the costs of this transition, climate policies risk putting extra pressure on vulnerable households, micro-enterprises and transport users in the short run. The design of the policies in the fit for 55 package therefore fairly spreads the costs of tackling and adapting to climate change.

In addition, carbon pricing instruments raise revenues that can be reinvested to spur innovation, economic growth, and investments in clean technologies. A **new Social Climate Fund, see** Socially fair transition Factsheet, is proposed to provide dedicated funding to Member States to help citizens finance investments in energy efficiency, new heating and cooling systems, and cleaner mobility.

The Social Climate Fund would be financed by the EU budget, using an amount equivalent to 25% of the expected revenues of emissions trading for building and road transport fuels. It will provide €72.2 billion of funding to Member States, for the period 2025-2032, based on a targeted amendment to the multiannual financial framework. With a proposal to draw on matching Member State funding, the Fund would mobilise €144.4 billion for a socially fair transition.

The benefits of acting now to protect people and the planet are clear: cleaner air, cooler and greener towns and cities, healthier citizens, lower energy use and bills, European jobs, technologies and industrial opportunities, more space for nature, and a healthier planet to hand over to future generations.

The challenge at the heart of Europe's green transition is to make sure the benefits and opportunities that come with it are available to all, as quickly and as fairly as possible. By using the different policy tools available at EU level, we can make sure that the pace of change is sufficient, but not overly disruptive.

### 2.2.2.1  Background

The European Green Deal, presented by the Commission on 11 December 2019, sets the goal of making Europe the first climate-neutral continent by 2050. The European Climate Law, which entered into force in July 2021, enshrines in binding legislation the EU's commitment to climate neutrality and the intermediate target of reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels. The EU's commitment to reduce its net greenhouse gas emissions by at least 55% by 2030 was communicated to the UNFCCC in December 2020 as the EU's contribution to meeting the goals of the Paris Agreement.

As a result of the EU's existing climate and energy legislation, the EU's greenhouse gas emissions have already fallen by 24% compared to 1990, while the EU economy has grown by around 60% in the same period, decoupling growth from emissions. This tested and proven legislative framework forms the basis of this package of legislation.

The EU's long-term budget for the next seven years will provide support to the green transition. 30% of programmes under the €2 trillion 2021-2027 Multiannual Financial Framework and NextGenerationEU are dedicated to supporting climate action; 37% of the €723.8 billion (in current prices) Recovery and Resilience Facility, which will finance Member States' national recovery programmes under NextGenerationEU, is allocated to climate action.

The Public Sector Loan Facility is a pillar of the Just Transition Mechanism, which also comprises the setting up of the Just Transition Fund and a specific component under InvestEU. The overall objective is to achieve EU climate-neutrality in an effective and fair manner, leaving no one behind. More concretely it must contribute to reaching the Union's 2030 climate targets and the objective of EU climate neutrality economy of the Union by 2050.

### 2.2.3 Climate change: EU Parliament stimulates renewable hydrogen, integration of energy systems

EU Parliament sets out measures to help Europe decarbonise its energy system, industry and transport sectors in two reports adopted on 19 May 2021.

The reports are Parliament's response to the European Commission's [hydrogen](#) and [energy system integration](#) strategies, which aim to pave the way towards a more efficient and interconnected energy sector, driven by the twin goals of a cleaner planet and a stronger economy.

Hydrogen produced from renewable sources is key to Europe's energy transition as only renewable hydrogen can sustainably contribute to achieving climate neutrality in the long term. Hydrogen is however not yet competitive and the European Commission and Member States should incentivise the value chain and market uptake of the fuel, when produced from renewable energy sources, they say.

They welcome the Commissions' consideration of various incentives at the demand side. The focus of hydrogen demand should be on sectors for which its use is close to being competitive or that cannot be decarbonised by other technological solutions, namely industry, air, maritime and heavy-duty transports, they add.

#### 2.2.3.1 Background

The [European Green Deal](#), published on 11 December 2019, sets a goal for Europe to become climate-neutral by 2050 and one of the pillars of achieving this is through being able to support and push for the supply of clean, affordable and secure energy. One challenge ahead is intrinsically related to the production and consumption of energy, which in 2018 accounted for 75% of the EU's emissions of greenhouse gases (GHG) while the EU's energy needs relied on the importation of 58%, mainly oil and gas.

In order to address this challenge, the energy system should be transformed in such a manner that it becomes green, sustainable, affordable, efficient and circular. The change should come in the form of the usage of waste and products to produce energy; an increase in the use of electricity from renewable sources; and usage of low carbon fuels - such as hydrogen - where electricity is not a solution.

Currently, Hydrogen represents around 2% of the Union's energy mix, of which 95% is produced by fossil fuels, releasing 70 - 100 million tons of $CO_2$ annually, while at the global level being responsible for 2.5% of greenhouse gas emissions, with less than 1% of the current hydrogen production being used as an energy carrier. Research shows that renewable energies could supply up to 100% of the European energy mix in 2050, of which hydrogen could account for a share of up to 20%, between 20% and 50% of energy demand in transport and between 5% and 20% in industry.

Demand for hydrogen is almost entirely supplied from fossil fuels, with 6% of global natural gas and 2% of global coal going to hydrogen production, while less than 0.1% of global dedicated hydrogen production today comes from water electrolysis.

### 2.2.4    A €17.5 bn *Just Transition Fund* fund to ensure no one is left behind on the road to a greener economy

The [Just Transition Fund](#) will help EU countries address the social and economic impact of the transition to climate neutrality.

The package comprises €7.5 bn from the [2021-2027 Multiannual Financial Framework](#) and an additional €10 bn from the [EU Recovery Instrument.](#) To be eligible, projects must focus on economic diversification, reconversion or job creation, or they must contribute to a transition to a sustainable, climate-neutral and circular European economy.

The Just Transition Fund (JTF) will finance job seeking assistance, up-skilling and reskilling, as well as the active inclusion of workers and jobseekers as Europe's economy shifts towards becoming climate neutral. It will also support micro-enterprises, business incubators, universities and public research institutions, as well as investments in new energy technologies, energy efficiency, and sustainable local mobility.

Waste incineration will not receive support through the JTF. Neither will the decommissioning nor construction of nuclear power stations, activities linked to tobacco products and investments related to fossil fuels.

In their just transition plans, EU Member States have to identify their territories worst affected by the energy transition, and concentrate the JTF resources they receive there. Particular attention should be given to the specificities of islands, insular areas and outermost regions.

At the initiative of Parliament, a "Green Rewarding Mechanism" will be introduced to the JTF if the fund's resources are increased after 31 December 2024. These additional resources would be distributed among member states, with those that succeed in reducing industrial greenhouse gas emissions receiving more funding.

Other key aspects of the regulation

- Access to the JTF for member states will be conditional on their adoption of national-level commitments to achieve climate neutrality by 2050. Before the adoption of this target, member states will be entitled to only 50% of their national allocation;

- Businesses in financial difficulty may receive support in compliance with temporary EU state aid rules established to address exceptional circumstances;

- Resources may be transferred from other cohesion funds on a voluntary basis;

- The proportion of the investments provided by EU funding (co-financing) is set at a maximum of 85% for less developed regions, 70% for transitional regions and 50% for more developed regions.

### 2.2.4.1  Background

The Just Transition Fund (JTF) is the first pillar of the [Just Transition Mechanism,](#) a key tool to support regions, industries and workers expected to face the greatest challenges from implementing the [European Green Deal](#). Legislators reached a provisional political agreement on the JTF on 9 December 2020.

## 2.2.5   EU Environment Action Programme (2021-2030)

The European Commission published its [proposal for a General Union Environment Action Programme to 2030 (8th EAP)](#) in 2020, a year that was marked by a global health and environment emergency in the form of a devastating pandemic and a deepening ecological crisis.

The proposed Decision (on 8 July 2021) sets out a general action programme in the field of the environment for the period up to 31 December 2030 (8th Environment Action Programme). It lays down its priority objectives, identifies enabling conditions as well as actions necessary for the achievement of the enabling conditions. It sets a monitoring framework to measure and evaluate progress of the Union and its Member States towards the achievement of the priority objectives. It also establishes a governance mechanism to ensure full achievement of the priority objectives.

The 8th EAP aims at accelerating the transition to a climate-neutral, sustainable, non-toxic, resource-efficient, renewable energy-based, resilient and competitive circular economy in a just, equitable and inclusive way, and at protecting, restoring and improving the quality of the environment, including air, water and soil, as well as protecting and restoring biodiversity and ecosystems. It builds on and promotes the achievement of the objectives of the European Green Deal and its initiatives.

### 2.2.5.1   Thematic priority objectives

It is proposed that the 8th EAP should have the following six interlinked thematic priority objectives, to be achieved by 2030 at the latest:

1) swift and predictable reduction of greenhouse gas emissions and, at the same time, enhancement of removals by natural sinks in the Union, to attain the 2030 greenhouse gas emission reduction target, in line with its climate and environment objectives whilst ensuring a just transition that leaves no one behind;

2) continuous progress in enhancing and mainstreaming adaptive capacity, including on the basis of ecosystem approaches, strengthening resilience and adaptation and reducing vulnerability of the environment and of society as well as all sectors of the economy to climate change, while improving prevention of, and preparedness for, natural disasters;

3) advancing towards a sustainable well-being economy that gives back to the planet more than it takes, and ensuring the transition to a non-toxic circular economy where growth is regenerative and resources are used efficiently in line with the waste hierarchy;

4) pursuing zero-pollution in order to achieve a toxic-free environment, including for air, water, soil as well as in relation to light and noise pollution, and protecting the health and well-being of people, animals and ecosystems from environment-related risks and impacts, including by applying and promoting the 'One Health' approach;

5) protecting, preserving and restoring biodiversity, including by halting and reversing its loss both inside and outside protected areas, and improving the health of the environment, notably air, water and soil, as well as tackling the degradation of marine and terrestrial ecosystems, in particular by implementing the targets outlined in the EU Biodiversity Strategy for 2030 as well as those laid down in relevant Union legislation;

6) ensuring environmental sustainability, and significantly reducing key environmental and climate pressures related to the Union's production and consumption footprint, including Union-driven global deforestation, in particular in the areas of energy, industrial development, buildings and infrastructure, mobility, tourism, international trade and food chains, including agriculture, fisheries and aquaculture, while internalising climate and environmental externalities.

### 2.2.5.2  Indicators, monitoring framework and governance

Members proposed establishing an overarching EU framework to measure and establish progress towards a sustainable wellbeing economy that is in line with the UN Sustainable Development Goals (SDG)s, the Paris Agreement and the UN Convention on Biological Diversity, without prejudice to the European Semester. They also called on the Commission to ensure that the information resulting from the monitoring, assessment and reporting is publicly available and easily accessible, thereby ensuring effective monitoring of progress made.

Following a consultation process with all relevant stakeholders, the Commission should, by 31 December 2021, present a streamlined framework in the form of a single scoreboard, including headline indicators, to monitor and track progress towards the achievement of the priority objectives.

The European Parliament, the Council and the Commission should exchange views annually on the assessment and should identify, as part of the Union's annual programming, additional legislative and non-legislative measures and actions when progress towards the achievement of the priority objectives is considered to be insufficient or in order to overcome barriers which are identified.

### 2.2.5.3  Evaluation and ensuring continuity of the European Green Deal 2030

In order to ensure that the next Commission takes ownership of the 8th EAP, Members proposed a mid-term review by 31 Match 2024 to take stock of the progress made so far.

### 2.2.6  EU plan puts spotlight on carbon sinks to tackle climate change

Europe will need to increase the amount of carbon stored by its forests and wetlands to meet a new, more ambitious target for carbon removals in Europe. The capacity of European forests to absorb $CO_2$ "has been shrinking" over the years, warned EU climate leader and EC vice-president Frans Timmermans as he presented the bloc's 2030 climate goals in September 2020.  "The sink has to go back to its previous levels" if Europe wants to reach climate neutrality and preserve biodiversity at the same time, he said.

To achieve this, the European Commission is placing its hopes on the land use, land use change and forestry (LULUCF) regulation, which tackles emissions from agriculture and forestry.

It is expected that the European Commission wants to build up the amount of carbon stored to 310 million tonnes by 2030. That is up from the 263 million tonnes in 2018, according to the Commission.

The number is the net total once the amount of carbon captured is balanced against the carbon released by land use practices. The increase was part of a political agreement made during the negotiations on Europe's climate law. A push to sequester 310 million tonnes of CO2 could see Europe's net emissions reduce by around 57% by 2030 – just shy of the 60% reduction the European Parliament was calling for.

## 2.2.7    New EU Forest Strategy for 2030

The European Commission adopted on 16 July the New EU Forest Strategy for 2030, a flagship initiative of the European Green Deal that builds on the EU Biodiversity Strategy for 2030. The strategy contributes to the package of measures proposed to achieve greenhouse gas emission reductions of at least 55% by 2030 and climate neutrality in 2050 in the EU. It also helps the EU deliver on its commitment to enhance carbon removals by natural sinks as per the Climate Law. By addressing the social, economic and environmental aspects all together, the Forest Strategy aims at ensuring the multifunctionality of EU forests and highlights the pivotal role played by foresters.

Forests are an essential ally in the fight against climate change and biodiversity loss. They function as carbon sinks and help us reduce the impacts of climate change, for example by cooling down cities, protecting us from heavy flooding, and reducing drought impact. Unfortunately, Europe's forests suffer from many different pressures, including climate change.

### 2.2.7.1   Protection, restoration and sustainable management of forests

The Forest Strategy sets a vision and concrete actions for increasing the quantity and quality of forests in the EU and strengthening their protection, restoration and resilience. The proposed actions will increase carbon sequestration through enhanced sinks and stocks thus contributing to climate change mitigation. The Strategy commits to strictly protecting primary and old-growth forests, restoring degraded forests, and ensuring they are managed sustainably – in a way that preserves the vital ecosystem services that forests provide and on which society depends.

The Strategy promotes the most climate and biodiversity friendly forest management practices, emphasises the need to keep the use of woody biomass within sustainability boundaries, and encourages resource-efficient wood use in line with the cascade principle.

### 2.2.7.2   Ensuring the multifunctionality of EU forests

The Strategy also foresees the development of payment schemes to forest owners and managers for providing alternative ecosystems services, e.g. through keeping parts of their forests intact. The new Common Agricultural Policy (CAP), amongst others, will be an opportunity for more targeted support to foresters and to the sustainable development of forests. The new governance structure for forests will create a more inclusive space for Member States, forest owners and managers, industry, academia and civil society to discuss about the future of forests in the EU and help maintain these valuable assets for the generations to come.

Finally, the Forest Strategy announces a legal proposal to step up forest monitoring, reporting and data collection in the EU. Harmonised EU data collection, combined with strategic planning at Members States' level, will provide a comprehensive picture of the state, the evolution and the envisaged future developments of forests in the EU. This is paramount to making sure that forests can deliver on their multiple functions for climate, biodiversity and economy.

The strategy is accompanied by a [Roadmap](#) for planting three billion additional trees across Europe by 2030 in full respect of ecological principles – the right tree in the right place for the right purpose.

### 2.2.7.3  Background

Forests are an essential ally in the fight against climate change and biodiversity loss thanks to their function as carbon sinks as well as their ability to reduce the impacts of climate change, for example by cooling down cities, protecting us from heavy flooding, and reducing drought impact. They are also valuable ecosystems, home to a major part of Europe's biodiversity. Their ecosystem services contribute to our health and well-being through water regulation, food, medicines and materials provision, disaster risk reduction and control, soil stabilisation and erosion control, air and water purification. Forests are a place for recreation, relaxation and learning, as well as part of livelihoods.

## 2.3 Overview of Data Policies

This section briefly describes the Data policies that can be applied in combination with the Green Deal Policies.

This section briefly describes the Data policies and their connection to the [European Green Deal](#) policies. "I want Europe to become the first climate neutral continent in the world by 2050" - [Ursula Von Der Leyen, 2019](#). The European Commission plans a healthier atmosphere for all the current and future European citizens. As such, to optimise the digital transformation of Europe, an interaction between Data Policies and the European Green Deal Policies is one of the objectives to accomplish. The following sections describe in detail each of the data policies comprised within the [Digital Decade](#).

### 2.3.1 Digital Decade

On 9 March 2021, the European Commission presented a vision and avenues for Europe's digital transformation by 2030. This vision for the [EU's digital decade](#) evolves around four points:

- Skills;

- Digital transformation of businesses;

- Secure and sustainable digital infrastructures;

- Digitalisation of public services.

Every aspect of the relationship between the EC and data management is developed under the umbrella of initiatives of the Digital Decade.

### 2.3.2 Data Governance Act

Following the need for better data management, the EC has published a [Data Governance Act](#) at the end of 2020. The Data Governance Act is currently being debated in the European Parliament, to create a framework that will allow Europe to become a leading data economy, especially for industrial data.

The Data Governance Act sets the ground for re-use of public sector data and the sharing of personal and non-personal data. Here, the proposal aims at lowering transaction costs linked to business to business (B2B) and business to customer (B2C) data sharing by implementing a framework for data intermediaries. Furthermore, it introduces and promotes the notion of "Data altruism", allowing data use by individuals or companies for the common good. The Act also plans for the creation of an expert group, the 'European Data Innovation Board', which will work on best practices by Member States' authorities. Among other tasks, this Board will advise the EC on the governance of cross-sectoral standardisation.

### 2.3.3 Cloud and Edge Computing

The global data volume is growing very fast. Whereas cloud computing happens mostly in large data-centres today, by 2025 this trend will reverse: 80% of all data is expected to be processed in smart devices closer to the user, known as edge computing.

The availability of both edge and cloud computing is essential in a computing continuum to ensure that data is processed in the most efficient manner. Energy-efficient and trustworthy edge and cloud infrastructures will be fundamental for the sustainable use of edge and cloud computing technologies.

Cloud computing is a key objective to increase Europe's data sovereignty as outlined in the European Commission's Data Strategy, Digital Strategy, Industrial Strategy and the EU recovery plan.

The European Commission has launched a European Alliance on Industrial Data, Edge and Cloud, which will feature the development of several work streams, related to key EU policy goals:

- **Joint Investment in cross-border cloud infrastructures and services** to build the next generation cloud supply, including to enable **Common European Data Spaces**

- **EU Cloud Rulebook** for cloud services, which will provide a single European framework of rules, transparency on their compliance and best practices for cloud use in Europe

- **A European marketplace for cloud services,** where users will have a single portal to cloud services meeting key EU standards and rules

EU countries have signed a joint declaration on cloud where they expressed their will to collaborate towards the creation of a European cloud.

Other initiatives related to cloud computing are:

- The **Regulation on the** free flow of non-personal data, which, together with the General Data Protection Regulation, raises legal certainty for cloud users by ensuring the free movement of all data in the EU.

- **Data portability:** the free flow of non-personal data Regulation also builds trust through facilitating a self-regulatory work on cloud switching and cloud security. This self-regulatory work was addressed by the Cloud Stakeholder Groups. It resulted in the recently finalised SWIPO data portability Codes of Conduct and the CSPCERT Recommendations for a candidate European cloud security certification scheme.

- **Cybersecurity:** at the request of the Commission, the European cybersecurity agency ENISA is working on a single European cybersecurity certification scheme for cloud services. The scheme will provide increased assurance to businesses, public administrations and citizens that their data is secure wherever they are stored or processed.

- **Data protection in the cloud:** the Commission has facilitated a platform for industry to develop Codes of Conduct for data protection in the cloud. This has resulted in two Codes of Conduct that are currently reviewed by the European Data Protection Board. More information about the processing of personal and non-personal data in the cloud can be found in the Commission's [Guidance on mixed datasets](#).

- **Standardised Cloud Service Level Agreements (SLA)** that guarantee the quality of cloud services in the European market.

- **Cloud use by the financial sector:** financial service providers increasingly use cloud services to remain competitive. There must be clear requirements in place for outsourcing agreements between financial entities and cloud service providers. As announced in the [Fintech Action Plan](#), the European Commission is currently working together with stakeholders, supervisors and regulators to define standard contractual clauses for such outsourcing agreements.

- **A European mapping of data flows** that will allow to assess the value of [data flows](#) to the European digital economy.

In parallel, cloud computing and edge computing will be among those digital technologies that will contribute to achieving the sustainability goals of the [European Green Deal](#) in areas such as farming, mobility, buildings and manufacturing.

The European Union also supports the development of cloud computing in Europe with research and innovation actions under the Horizon 2020 programme.

EU-funded projects will work on novel solutions for federating cloud infrastructures. New cloud-based services will have to respond to high-standard requirements with regard to data protection, performance, resilience and energy-efficiency. The services and infrastructures will have to meet the future digitisation needs of industry and the public sector. Addressing these challenges will also be part of and contribute to the technological ambitions of the [Next Generation Internet](#) (NGI).

In addition, the EU intends to invest €2bn via the [European Data Strategy](#) in a European High Impact Project that will federate energy-efficient and trustworthy cloud infrastructures and related services. Cloud technologies that have been developed within Horizon 2020-funded research and by market actors will be deployed via the Connecting Europe Facility 2 (for cloud infrastructures interconnection) and Digital Europe (for cloud-to-edge services and cloud marketplaces) Programme.

### 2.3.4    General data protection regulation (GDPR)

[GDPR](#) was adopted in May 2016 aims at making Europe fit for the digital age. More than 90% of Europeans say they want the same data protection rights across the EU regardless of where their data is processed.

The regulation is an essential step to strengthening individuals' fundamental rights in the digital age and facilitate business by clarifying rules for companies and public bodies in the

digital single market. A single law will also do away with the current fragmentation in different national systems and unnecessary administrative burdens.

### 2.3.5    European strategy for data

Overall, and having in mind all previously described data policies, the  aims at creating a single market for data that will ensure Europe's global competitiveness and data sovereignty. Common European data spaces will ensure that more data becomes available for use in the economy and society, while keeping the companies and individuals who generate the data in control. The EC has proposed a Regulation for European data governance as part of its data strategy which plays a vital role in ensuring the EU's leadership in the global data economy. This  European strategy for data intends to:

- Adopt legislative measures on data governance, access and reuse;

- Make data more widely available by opening up high-value publicly held datasets across the EU and allowing their reuse for free;

- €2 billion investment in an European High Impact Project;

- Enable access to secure, fair and competitive cloud services by facilitating the set-up of a procurement marketplace for data processing services and creating clarity about the applicable regulatory framework for the cloud.

### 2.3.6    Ethics guidelines for trustworthy Artificial Intelligence (AI) and EU regulation

On 8 April 2019, the Ethics guidelines for trustworthy Artificial Intelligence (AI) has been published. This followed the publication of the guidelines' first draft in December 2018 on which more than 500 comments were received through an open consultation.

According to the Guidelines, trustworthy AI should be:

- Lawful - respecting all applicable laws and regulations;

- Ethical - respecting ethical principles and values;

- Robust - both from a technical perspective while taking into account its social environment.

On 21 April 2021, the European Commission has published the Harmonised rules on artificial intelligence (artificial intelligence act) legislative proposal.

The AI Regulation proposes to introduce a comprehensive regulatory framework for Artificial Intelligence ("AI") in the EU. The aim is to establish a legal framework that provides the legal certainty necessary to facilitate innovation and investment in AI, while also safeguarding fundamental rights and ensuring that AI applications are used safely. The main provisions of the AI Regulation are the introduction of:

- Binding rules for AI systems that apply to providers, users, importers, and distributors of AI systems in the EU, irrespective of where they are based.

- A list of certain prohibited AI systems.

- Extensive compliance obligations for high-risk AI systems.

- Fines of up to EUR 30 million or up to 6% of annual turnover, whichever is higher.

- The Commission proposes a risk–based approach based on the level of risk presented by the AI system, with different levels of risk attracting corresponding compliance requirements. The risk categories include (i) unacceptable risk (these AI systems are prohibited); (ii) high-risk; (iii) limited risk; and (iv) minimal risk.

### 2.3.6.1  Scope of the AI Regulation

#### Application to Providers and Users

The AI Regulation proposes a broad regulatory scope, covering all aspects of the lifecycle of the development, sale and use of AI systems. The AI Regulation will apply to:

- providers that place AI systems on the market or put AI systems into service, regardless of whether those providers are established in the EU or in a third country;

- users of AI systems in the EU; and

- providers and users of AI systems that are located in a third country where the output produced by the system is used in the EU.

Therefore, the AI Regulation will apply to actors both inside and outside the EU as long as the AI system is placed on the market in the EU or its use affects people located in the EU.

#### Definition of AI system

The AI Regulation defines "AI systems" broadly as software that is developed with machine learning, logic, and knowledge-based or statistical approaches, and that "can, for a given set of human-defined objectives, generate outputs such as content, predictions, recommendations, or decisions influencing the environments they interact with".

#### Prohibited AI Systems

The AI Regulation lists a number of AI systems which the Commission believe bear an unacceptable risk as they contravene EU values and violate fundamental rights, and therefore are explicitly prohibited. These AI systems include:

- AI systems that deploy subliminal techniques to exploit vulnerabilities of a specific group of persons to materially distort the behaviour of a person belonging to the group in a manner that causes physical or psychological harm;

- The use of AI systems by public authorities or on their behalf for the evaluation or classification of the trustworthiness of natural persons based on their social behaviour or characteristics where the social score generated leads to the detrimental or unfavourable treatment of certain groups of persons;

- AI systems used for real-time remote biometric identification in publicly accessible spaces for the purposes of law enforcement, unless it is strictly necessary for a targeted crime

search or the prevention of substantial threats. This particular prohibition has likely been introduced to address concerns raised by both the European Parliament and the Commission in 2020 in connection with a facial recognition app developed by Clearview to allow clients such as US law enforcement authorities to match photos of unknown people to images of them found online. This technology would now fall within the definition of AI which poses an unacceptable risk under the AI Regulation and will therefore be prohibited.

## High Risk AI Systems

The AI Regulation contains specific requirements for so-called "high-risk" AI systems.

The term "high-risk AI" is not defined, but Articles 6 and 7 of the AI Regulation indicate the criteria used to determine whether a system should be considered high risk.

Article 6 refers to AI systems intended to be used as a safety component of products (or which are themselves a product). This includes products or components that are covered by existing EU product safety legislation that are listed in Annex II to the AI Regulation.

Article 7 refers to stand-alone AI systems whose use may have an impact on the fundamental rights of natural persons. These systems are listed in Annex III and include, for example, real-time and "post" biometric identification systems, education and vocational training, employment, law enforcement, migration, asylum and border control, and administration of justice and democratic processes. The list currently included in Annex III may be expanded in the future to cover other AI systems which the Commission considers to present similarly high risks of harm.

## General requirements applicable to high-risk AI systems

The AI Regulation imposes the following general requirements on high-risk AI systems:

- Transparency: High-risk AI systems must be designed and developed to ensure that the system is sufficiently transparent to enable users to interpret its output and use it appropriately;
- Human oversight: High-risk AI systems must be designed and developed in such a way that there is human oversight of the system, aimed at minimising risks to health, safety and fundamental rights;
- Risk management system: A risk management system must be established and maintained throughout the lifetime of the system to identify and analyse risks and adopt suitable risk management measures;
- Training and testing: Data sets used to support training, validation and testing must be subject to appropriate data governance and management practices and must be relevant, representative, accurate and complete;
- Technical documentation: Complete technical documentation that demonstrates compliance with the AI Regulation must be in place before the AI system is placed on the market and must be maintained throughout the lifecycle of the system; and
- Security: A high level of accuracy, robustness and security must consistently be ensured throughout the lifecycle of the high-risk AI system.

## Requirements applicable to providers of high-risk AI

The AI Regulation imposes the following specific requirements on the provider of a high-risk AI system:

- Compliance: Ensure compliance with the requirements for high-risk AI systems (outlined above);

- Conformity assessment: Ensure the system undergoes the relevant conformity assessment procedure (prior to the placing the system on the market/putting the system into service);

- Corrective action and notification: Immediately take corrective action to address any suspected non-conformity and notify relevant authorities of such non-conformity;

- Quality management system: Implement a quality management system, including a strategy for regulatory compliance, and procedures for design, testing, validation, data management, and recordkeeping;

- Registration: Register the AI system in the AI database before placing a high-risk AI system on the market; and

- Post-market monitoring: Implement and maintain a post-market monitoring system, by collecting and analysing data about the performance of high-risk AI system throughout the system's lifetime. This includes obligations to report any serious incident or any malfunctioning of the AI system, which would constitute a breach of obligations under EU laws intended to protect fundamental rights.

## Requirements applicable to users of high-risk AI

The AI Regulation imposes more limited but notable obligations on users of high-risk AI systems, including:

- to use the systems in accordance with the instructions of the provider and implement all technical and organisational measures stipulated by the provider to address the risks of using the high-risk AI system;

- ensure all input data is relevant to the intended purpose;

- monitor operation of the system and notify the provider about serious incidents and malfunctioning; and

- maintain logs automatically generated by the high-risk AI system, where those logs are within the control of the user.

## All Other AI Systems

Other AI systems which do not qualify as prohibited or high-risk AI systems are not subject to any specific requirements. In order to facilitate the development of "trustworthy AI", the Commission has stated that providers of "non-high-risk" AI systems should be encouraged to develop codes of conduct intended to foster the voluntary application of the mandatory requirements applicable to high-risk AI systems.

For certain AI systems which pose a limited risk, transparency requirements are imposed. For example, AI systems which are intended to interact with natural persons must be designed and developed in such a way that users are informed they are interacting with an AI system, unless it is "obvious from the circumstances and the context of use." This transparency obligation would for example, apply in the context of the use of chatbots.

All other "minimal risk" AI systems can be developed and used subject to existing legislation without additional legal obligations. The vast majority of AI systems currently used in the EU fall into this category. Voluntarily, providers of those systems may choose to apply the requirements for trustworthy AI and adhere to voluntary codes of conduct.

## Enforcement

European Artificial Intelligence Board ("EAIB"): The AI Regulation provides for the establishment the EAIB, to advise and assist the Commission in connection with the AI Regulation. The EAIB facilitate effective cooperation between the national supervisory authorities and the Commission, coordinate and contribute to guidance by the Commission and assist the national supervisory authorities and the Commission to ensure consistent application of the Regulation.

National competent authorities: Member States must designate national competent authorities and a national supervisory authority responsible for providing guidance and advice on the AI Regulation.

Enforcement: Member State authorities are required to conduct market surveillance of AI systems. If an authority believes that an AI system presents a risk to health, safety or fundamental rights, the authority must carry out an evaluation of the AI system and where necessary, impose corrective action.

Sanctions: Infringement of the AI Regulation is subject to financial sanctions of up to €10m – €30m or 2% – 6% of the global annual turnover, whichever is higher. The level of fine imposed depends on the nature of the infringement.

The AI Regulation will be enforced by supervisory authorities and does not provide for a complaint system or direct enforcement rights for individuals. It is unclear whether Member States will appoint data protection supervisory authorities, national standards agencies or other agencies to perform the "competent authority" role. Notably the AI Regulation does not replicate the "one stop shop" system under GDPR which may lead to concerns about consistency and cooperation across the 27 Member States.

## 2.3.7   European Sustainability Product Initiative

Under the European Green Deal, the European Commission presented in March 2020 a New Circular Economy Action Plan, in which it announced a sustainable product policy legislative initiative to make products fit for a climate neutral, resource efficient and circular economy, reduce waste and ensure that the performance of frontrunners in sustainability progressively becomes the norm.

A [roadmap](#) was published on 14 September 2020. It was open for feedback until 16 November 2020. The legislative initiative will entail a revision of the Ecodesign Directive, widening its scope beyond energy-related products, and propose additional legislative measures as appropriate. It will also address the presence of harmful chemicals in products, such as electronics & ICT equipment; textiles; furniture; steel, cement and chemicals.

In her speech on the State of the Union from 16 September 2020, and the Letter of Intent sent to the President of the European Parliament and the German Presidency of the Council, European Commission President Ursula von der Leyen confirmed that the legislative proposal would be one of the key initiatives to be presented in 2021.

In its resolution from 10 February 2021 on the New Circular Economy Action Plan, the European Parliament underlined, among other things, that sustainable, circular, safe and non-toxic products and materials should become the norm in the EU market and not the exception, and should be seen as the default choice, which is attractive, affordable and accessible for all consumers. It therefore welcomed the Commission's plan to propose a legislative initiative on sustainable products to set horizontal principles for product policy and binding requirements on products placed on the EU market. It also stressed the importance of providing market incentives for the most sustainable companies and sustainable products and materials, in parallel to legal minimum standards for product design.

This initiative, which will revise the Ecodesign Directive and propose additional legislative measures as appropriate, aims to make products placed on the EU market more sustainable.

Consumers, the environment and the climate will benefit from products that are more durable, reusable, repairable, recyclable, and energy-efficient. The initiative will also address the presence of harmful chemicals in products such as:

- electronics & ICT equipment;
- textiles;
- furniture;
- steel, cement & chemicals.

According to the Commission work programme for 2021, published on 19 October 2020, the initiative would be put forward in the fourth quarter of the year.

## 2.3.8    Digital and Green Twin transition

The European Commission states that "Europe must leverage the potential of digital transformation, which is a key enabler for reaching the Green Deal objectives."

This idea is reinforced in the New [Industrial Strategy](#) for Europe, where it is underlined that the twin ecological and digital transitions will affect every part of our economy, society, and industry.

New green technologies are already here to help tackle the biggest challenge of our time: climate change. The European Commission has long promoted digital transformation to enhance economic competitiveness, while also recognising that digitisation can contribute to sustainability goals and enable the changes needed for a just green transition. The Commission's twin green and digital goals are seen to complement each other well.

The Fit for 55 packages will drive the transition to achieve the 2030 goal of reducing carbon emissions by 55%, and all sectors will play an important role in helping achieve this objective. Digital technology such as artificial intelligence, cloud computing, IoT can enable speed and scale in delivering the EU's decarbonisation goals. However, while ICT technologies can help most sectors of the economy to become greener, the ICT sector itself must accept its responsibility to meet high ecological standards.

### 2.3.8.1 Digital and Green Twin transition examples

The Green Deal wants to decouple economic growth from resource use by 2050, and transform 'linear' take-make-discard industrial value chains into virtuous models that design waste and pollution out of the process, keeping products and materials in use for longer and helping to regenerate ecosystems.

The growing problem of waste from consumer electronics (e-waste) is a prime example of where robotic intervention makes sense. Less than 40% of the 9 million tonnes ([2017](#)) of e-waste in the EU is currently recycled. As a complex mixture of materials and components, many of which are hazardous and hard to manage, e-waste can cause major environmental and health problems. Addressing this, the EU introduced its pioneering Waste Electrical and Electronic Equipment ([WEEE](#)) Directive.

It also doubled down on the [Strategy for Plastics in the Circular Economy](#) by introducing a new levy on plastic waste as part of its €750 billion Covid-19 recovery package. Svenja Schulze, Germany's Federal Environment Minister, is quoted as saying ([Packaging Gateway](#)) that this demonstrates EU willingness to act: "There has never been so much climate protection in an EU budget. Europe will emerge from [Covid-19] stronger and more climate-friendly than when it came in."

For instance, the [ReCircE project](#) wants to improve plastic waste-sorting using artificial intelligence (AI) and then issuing a Digital Product Passport to build transparency into the recycled materials chain, making it simpler to re-use plastic granulates from complex products like electric kettles and toys.

While these are good signs, broadly consumer waste sorting remains a huge challenge. Further advances are needed to deal with such diverse waste streams. Yet here, Covid-19 may have delivered a much-needed reality check to consumers whose growing demand for eco-friendly products is spurring further progress in industry.

Researchers in the K-Project have studied how digitalisation in industry (Industry 4.0) is quickly evolving to meet consumer and government demands in the field of waste management, what they call ReWaste4.0. Robotic systems that sort mixed waste are highly prized, they note on [Science Direct](#).

Prevention is always better than a cure, so the first priority is to cut back on waste full stop. The key is to reduce, reuse and recycle materials to prevent waste from entering landfill. This calls for complex sorting processes. As K-Project reports, technology like 'smart bins' with sensors for detecting materials, new digital imaging techniques and innovative business models have already been developed, and K-Project predicts data will be a critical factor in determining waste management facilities' "digital readiness".

Europe is clearly making headway (Eurostat), but Europe's Waste Directive and CE Action Plan are more ambitious than that. Households in the EU-27 currently generate some 8.2% of total waste, while construction (36%), mining/quarrying (26.2%) and manufacturing (10.6%) make up of vast majority.

According to the Ellen Macarthur Foundation, data-rich artificial intelligence will boost the CE transition by informing efforts to design out waste and pollution, optimising business models, and streamlining the infrastructure needed to keep products and materials in use.

Norway's TOMRA Recycling is an early AI adopter using mathematical models, based on information gathered from large-scale material sampling.

Finland's ZenRobotics sees machine learning and robotics as "fast becoming a new industrial standard". Its AI-powered recovery facility sorts valuable materials from the waste stream and intensifies recycling rates. The robots create a more structured and predictable sorting environment which helps to mitigate the health and safety risks associated with manual sorting, and thereby create safer working conditions through increased social distancing possibilities," notes ZenRobotics.

But digital innovation like this is not cheap, and comes with complications. The traditional waste industry is often a patchwork of smaller and larger businesses, many of which struggle to justify investing today in advanced 'green' technologies for the sake of tomorrow. The capital costs (CAPEX) need to be offset by gains in efficiency which reduce typical operational costs (OPEX) such as labour. And when they don't, this "favours bigger players that can raise the required money", which according to a recent Eionet Digital Waste Management report, "can be a problem for public companies where large investment costs can [also] be a political issue".

The OECD weighs into this and other challenges with its RE-CIRCLE project to help member countries and emerging markets identify and quantify their CE effectiveness in diverse areas, from digital innovation, plastic waste and food security to international trade and labour markets.

# 3   High level Green Deal challenges and objectives

This section provides the key high level Green Deal challenges and objectives derived from the Green Deal and Data policies

## 3.1    Overview of IoT and Edge computing (Digital Transformation)

IoT, Edge computing and Digital Transformation are all terms which are currently overused and often misunderstood. By way of introduction and clarity, we consider here the relevant technologies which are today contributing to the commonly shared vision of a 'digitally transformed society' and are the underlying technologies which are expected to contribute to the Green Deals initiative.
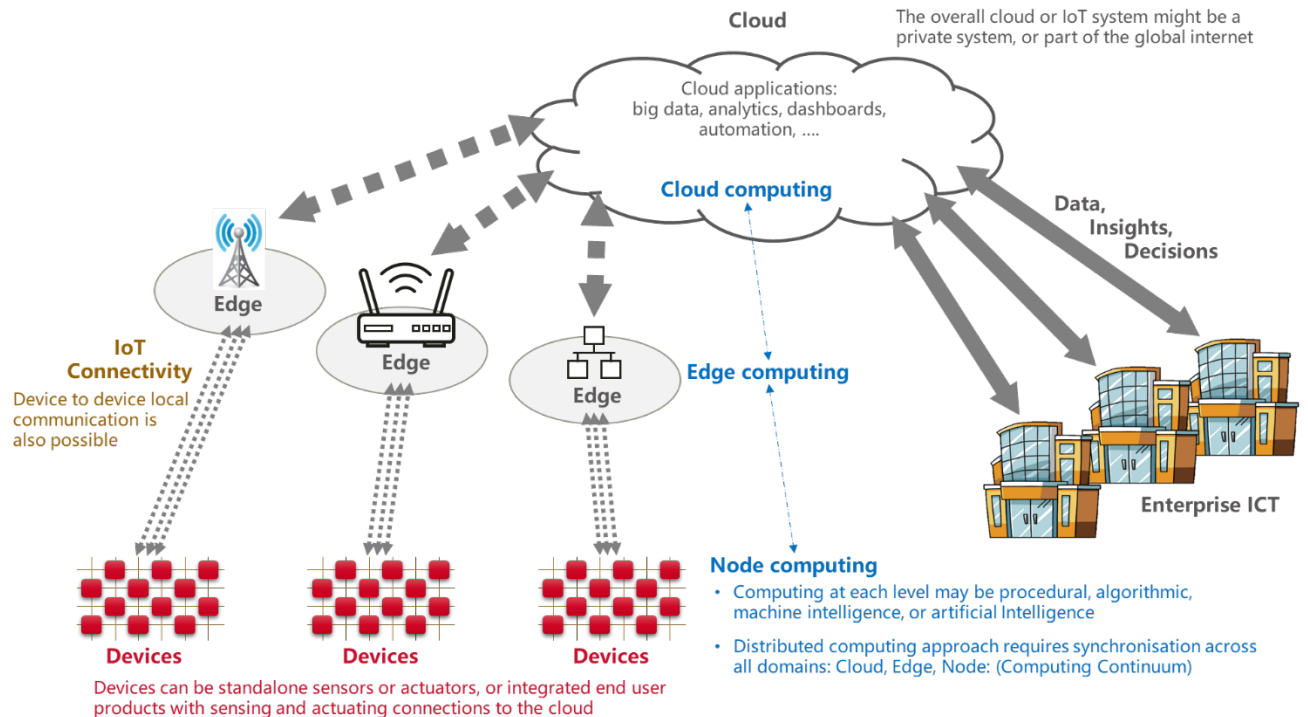


**Figure 4 The overall technology landscape**

Through the EU's Digital Market Act (currently focused on consumer data), there is an intention to build a more sustainable, future data economy that builds on the concepts of data sharing and fairer allocations of the value of data. This definition of IoT systems should reflect the capabilities involved in data sharing through standards that promote a) vendor interoperability b) sharing of data and resources across silo IoT-applications c) standards for data and information models that facilitate semantic interoperability. Such requirements have implications for data licensing, privacy and security in Edge/Cloud scenarios.

National strategies are complementing activities at the EU level. For example, Finnish Climate Strategy for ICT Sector lists six objectives and measures to achieve them in pursuit of ecologically sustainable digitalisation:

1.  Improving ICT infrastructure energy efficiency and introducing zero carbon sources of electric power

The design, construction and operation of communication networks must aim for energy efficiency.

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Much greater use can be made of the surplus heat generated by data centres, thereby reducing the energy generating requirement for heating and its accompanying carbon dioxide emissions. Investments in zero carbon electricity generating will also reduce emissions from the ICT sector.

2. Seeking a climate friendly data economy

Data traffic and electricity consumption increase with the rising number of services. The volume of data transmitted on Finland's mobile networks per head of population has grown by well over an order of magnitude in the last decade. The design of software and services must give greater consideration to minimising their energy consumption. There is a need for research, training of specialists, and guidance in service procurement. Cheaper software can require more processing power and hardware capacity, ultimately both wasting resources and becoming more costly over its life span.

3. Longer hardware life and recycling of precious metals

The service life of hardware can be extended at the design stage. Consumers must also be advised as to product warranties, software upgrades and recycling. Rare metals are required in the batteries and displays of smartphones and computers. Recycling could be made more efficient, for example by paying a refund when old hardware is returned. The strategy seeks to influence the sustainability of primary material production and the traceability of materials in Finland and the European Union.

4. An overview of the environmental impacts of digitalisation

The lack of transparent, centralised and available data on the climate and environmental impacts of the ICT sector is a challenge both nationally and internationally. Comparable data is needed on the carbon footprint of the ICT sector and on how information and communication technologies can help to reduce emissions in other sectors.

While the Energy transition progress, Grid operators will be further incentivised to provide real-time information of the electricity mix provided through the European electricity system which should be used as reference information to assess the 24-7 carbon footprint performance of IoT & Cloud assets (similarly to what is currently envisaged for Building Energy performance).

The proposals made by the Commission to amend the Renewable Energy Directive as part of the 'Fit for 55' package require Grid Operators to make digitally available to any market participant & consumer the share of renewables and the greenhouse gas content of the electricity they supply in each grid bidding zone. It also requires that this information is streamed down to edge IoT & communication devices such as smart metering, EV recharging points, Heating & Cooling systems and Datacenter Energy Management Systems and that it should be as accurate and as close to real time as possible, in time interval of no more than one hour, with forecasting available.

Such 24/7 renewable and carbon accounting from system operators should be used to increase transparency and give more accurate benchmarking information to IoT end-users on the carbon footprint which their service generate through the whole electricity system. This also has the potential to lead to a location marginal emission indicator that should incentivise batch processing during period of high renewable Infeeds to the system, thus further supporting demand-side flexibility business models through IoT infrastructures while contributing to the broad energy system efficiency.

5. Making consumers aware of environmental impacts

Consumer behaviour substantially affects the environmental impact of the ICT sector. Consumers are interested in the carbon footprint of the services that they use, and in their opportunities to influence this footprint. Access to information must be improved through various channels, ranging from school education to consumer campaigns.

6. Use of emerging technologies in climate work and environmental protection

Artificial intelligence, robotics, automated systems and other new technologies are raising hopes that they will provide solutions to climate and environmental problems. For example, artificial intelligence has already begun helping to reduce the energy and material consumption of various processes. Attention must also be paid to the energy and material consumption that is involved in developing new technologies.

There are many definitions of IoT, but here we consider that IoT is the extension of internet connectivity into towards physical devices, sensors, machines and everyday objects, to enable the following possibilities:

1. to allow gathering of data from all connected objects, to facilitate services and applications running within or cross-IoT domains;

2. analysis, in order to gain insight and (often) create actions transmissible back to those objects.

However, this is worth noting that not necessarily the internet connectivity has to be provisioned from device level, but maybe instead enabled from a gateway/edge onwards. IoT applies to all verticals and industries and is able to deliver enhanced visibility of operations, increased efficiency, innovation and (often) new business models. Often this is referred to as 'Smart', e.g. Smart City, Smart Transport, etc.

In particular, the combination of real-world sensing and distributed computing enables so called 'Digital Twins' to be built where a virtual model of a real-world system enables complex simulations and predictive analysis to be deployed, facilitating automated optimisation of operation and detection of anomalies.

The ability to compute (process) gathered data and transform it into valuable insight and / or actions can occur within the device (node) at the edge of the network, or in the cloud, or through a combination of computing at all three levels.

Connectivity is key to this vision, but it is important to recognise there might be several different forms of connectivity involved; e.g. short range low power (between devices - RFID, BLE, UWB, ZigBee), wide area ad-hoc (such as WiFi), wide area cellular (LoRaWAN, Sigfox, Cellular-IoT for small data, LTE and 5G for broadband),wired / optical solutions, and specialized solutions (e.g., C-V2X for ITS or FRMCS for railroads) or satellite IoT as an alternative/complementary form of connectivity for the cases and zones where terrestrial networks are not available. The key performance indicators (e.g., latency/throughput), limitations (e.g., maximum payload) and implied data transfer architectures and functionalities (e.g., unicast, broadcast, peer-to-peer, simplex/duplex operation) for these technologies also differ substantially.

## 3.2    IoT and edge computing research challenges and objectives

This section provides a brief description of the high level IoT and edge computing research challenges and objectives related to the European Green Deal.

IoT and Edge Computing are two elements in a larger family of technologies to deliver effective and sustainable systems. Currently many enabling technologies, like IoT, smart connectivity, AR/VR, AI/ML and distributed ledger technologies are being deployed and used in many facets of the economy and vertical domains. The use of those enabling technologies can support sustainable solutions that will be able to achieve the objectives of the European Green Deal. Those technologies, such as IoT and smart connectivity can function as enablers of such solutions and at the same time their use will enable energy networks and consumers to become more energy efficient in general, thereby reducing energy consumption at a time when the future of our environment depends on it. These enabling technologies are supported by an evolved ICT infrastructure addressing the connectivity and computing horizontal features. Examples of these ICT infrastructures are edge and cloud computing, 5G, WiFi-6, low power-wide range IoT network, High Performance Computing.

In particular, the development of low-price and at the same time intelligent sensors are enabling more effective ways to monitor and actively collect and manage information using real-time data. Moreover, advances in Artificial intelligence & machine learning are giving different stakeholders (depending on the vertical sector) greater insight about issues to be solved, e.g., urban-related problems; Moreover, the metadata generated by these technologies enable these stakeholders to make more immediate and well-informed decisions. In addition to that developments in cloud and edge data centers have decreased cost of storing the large amount of information generated, while at the same time by using effective big data mechanisms, make the data more readily and available for analysis.

It is recognised that the transition to climate neutrality necessitate ICT infrastructures, supported by cross-border, regional cooperation to ensure resources optimisation and affordability of the transition towards the objectives of reaching carbon neutrality (see Figure 3).

A brief summary below shows the challenges that need to be overcome the European Green Deal objectives. Moreover, the goal towards the Energy and Carbon footprint reduction is two-fold:

(1)  Reducing the Energy and Carbon footprint of the ICT infrastructures and enabling technologies, like IoT, according to the prediction described in Setting Climate Targets, GSMA:

- According to GSMA, the Subsector GHG percentage reduction between 2020-2030, should be for:

  o  Mobile Network Operators: 45%;

  o  Fixed Network Operators 62%;

  o  Data Center Operators 53%.

- The per year GHG percentage reduction can follow the guidelines provided in the GSMA SBTi initiative [Guidance for ICT Companies Setting Science Based Targets](#) and [GSMA Climate Action Handbook](#). Another possible way to follow, is to assume that the per year GHG percentage reduction during 2020-2030 follows a linear curve.

  - Moreover, an important challenge to be investigated is to how to increase the Energy Efficiency, compared to 1990 level, in each sector, including the ICT sector, from a level of 20% in 2020 to a level equal or higher than (36% to 39%) in 2030, see Figure 3 and [Energy Factsheet](#) and [Fit for 55 package](#). A possible way to follow, to calculate the per year energy efficiency increase, compared to the 1990 level, from a level of 20% in 2020 to a level equal or higher than (36% to 39%) in 2030, is to assume that this increase follows a linear curve.

- Furthermore, it is important to focus on reducing energy and carbon footprint of ICT infrastructures and technologies, as boosting their energy efficiency without impact on their performances. For example efficient power management concepts, (massive) reduction of the dataflow to be transmitted through local data processing and (distributed) AI algorithms. Even if the impact of the reduction of the CO2 footprint of ICT components is low compared to their impacts by use in vertical domains – about 1,8 Gt CO2eq ([GeSI: SMARTer2030 – ICT solutions for the 21st Century report](#)), the digitalization of the society push extremely their development in all verticals. Consequently their impact will grow with the deployment of new ICT infrastructures. The eco-design of future generation of ICT products should be also part of future development with more research and innovation activities needed:

  - on standards or guidelines are required to define the CO2 footprint of ICT installations – in use but also incl. material production, assembling, recycling (LCA);

  - on "green AI", developing strategies and implementation concepts;

  - for reference designs and benchmark platforms;

  - on sustainable power supplies, employing alternative energy sources for small devices (energy harvesting) and energy storage devices (batteries, capacitors) with low carbon footprint;

  - on energy-efficient wireless protocols targeting massive IoT applications (MIoT, NB-IoT, 5G/6G).

(2) Reducing Energy and Carbon footprint, while increasing the Energy Efficiency within the vertical domains using enabling technologies can be achieved following the prediction shown in Figure 3. A study that provides more insights on these footprints is described in [Global Energy Perspective 2019: Reference Case, Energy Insights, McKinsey](#) and [Global Warming of 1.5° C. IPCC Intergovernmental panel on climate change, October 2018](#)

- According to [Global Energy Perspective 2019: Reference Case, Energy Insights, McKinsey](#), Carbon emissions are projected to decline due to decreasing coal demand. However, in order to achieve a 1.5° C temperature rise limitation by 2050, as specified by IPCC [Global Warming of 1.5° C. IPCC Intergovernmental panel on climate change, October 2018](#), more far-reaching decarbonisation initiatives are needed across all sectors, including the vertical domains. Furthermore, [ref8] shows the estimated carbon reduction accomplished in ten different vertical domains, which is enabled by the use of mechanisms, such as machine-to-machine (M2M) connections and the functionality of smart devices. In particular, [GeSI: SMARTer2030 – ICT solutions for the 21st Century report](#) mentions that 70% of the estimated carbon reduction savings currently being made, come from the use of machine-to-machine (M2M) technologies. An [Ericsson study](#) is suggesting that the ICT infrastructures and IoT technologies could reduce carbon emissions by around 15% by 2030.
- More research and innovation activities are needed, in order to develop IoT solutions that can realise the reduction of the GHG emission in vertical domains. This reduction, compared to 1990 levels, need to be accomplished from a level of 20% in 2020 to a level equal or higher than 55% in 2030, see Figure 3. The per year GHG percentage reduction could follow the projections shown in [ref10]. Another possible way to follow, is to assume that the per year GHG percentage reduction during 2020-2030 follows a linear curve.

Regarding the European Green Deal, it is important to as well take into account the 17 UN SDGs. Table 1 shows how ICT infrastructure and enabling technologies can be used to support these 17 [UN Sustainable Development Goals (SDG)](#)s:

1) No Poverty: Financial inclusion: Mobile Access to financial services for the world's two billion unbanked;

2) Zero Hunger: e-Agriculture: Access to market updates and weather forecasts increases rural business productivity;

3) Good Health and Well-being: Be Healthy be mobile: Direct patient interaction, health informatics and telemedicine;

4) Quality education: e-Learning: Access to knowledge to all people no matter where they live or how much they earn;

5) Gender equality: ICTS are essential pathway to gender equality and empowerment;

6) Clean water and sanitation: Smart water management systems, sanitation and hygiene;

7) Affordable and clean energy: Energy efficiency, smart grids, green standards and technology for sustainable energy;

8) Decent network and economic growth: Promoting the digital economy, e-commerce, tech-SMEs, entrepreneurship and cyber trust;

9) Industry Innovation and Infrastructure: Provide universal and affordable access to the Internet. ICTs are essential for a resilient 21st century infrastructure and access to services and application;

10) Reduced Inequalities: Narrow the digital and empower communities;

11) Sustainable cities and communities: Smart sustainable cities, intelligent transport systems, 5G and the Internet of things;

12) Responsible consumption and production: ICTs enable sustainable production and consumption through smart grids, smart metering and cloud computing;

13) Climate Action: ICTSs support greener lifestyles, climate monitoring, forecasting and warning systems;

14) Life below water: Satellite oceanic observations and monitoring increases scientific knowledge of the ocean;

15) Life on Land: Satellite observations of terrestrial ecosystems to protect biodiversity

16) Peace, justice and strong institutions: Open data increases transparency, empowers citizens and drives economic growth;

17) Partnerships for the Goals: ICTs integrate and facilitate all SDGs through innovative collaboration and scaled up capacity building.



**Figure 5 ITU-R view in Sustainable Development goals (Source: United Nations)**

**Table 2 EU Green Deal call areas and ICT infrastructure and IoT & edge computing impact and challenges**

| EU Green Deal area | ICT infrastructure and IoT & edge computing impact and challenges |
|---|---|
| Climate action | • See UN SDG 13: Climate Action: ICTSs, including IoT support greener lifestyles, climate monitoring, forecasting and warning systems<br>• Reducing the Energy and Carbon footprint of the ICT infrastructure and enabling technologies, like IoT and edge computing<br>• Reducing Energy and Carbon footprint, while increasing the Energy Efficiency within the vertical domains using enabling technologies, like IoT and edge computing |
| Clean energy | • Support for energy demand management ICT infrastructure and IoT & edge computing solutions to realise reduction of the GHG emission and improve energy efficiency in vertical domains. |
| Sustainable industry | • Support of monitoring of the pollution of air and water.<br>• Optimize the consumption of energy and natural resources.<br>• See UN SDG 14: Life below water: Observations and monitoring increases scientific knowledge of the ocean<br>• Reducing the Energy footprint of the ICT infrastructures and enabling technologies, like IoT and edge computing<br>• Reducing Energy, while increasing the Energy Efficiency within the vertical domains using enabling technologies, like IoT and edge computing<br>• Monitor and optimize the process of recycling goods, collecting  and processing metadata information |
| Building and renovating | • Usage data driven energy consumption with building<br>• Monitor and control (1) the use of energy and (2)  the air pollution in buildings using technologies like IoT and edge computing |
| Sustainable mobility | • Automated mobility and smart traffic management systems will make transport more efficient and cleaner<br>• Use IoT in combination with smart traffic management systems and apps can reduce road traffic congestion road congestion and at the same time decrease the air pollution. When electrical vehicles are used then this combination of IoT & edge computing solutions with smart traffic management systems and apps can decrease the battery usage of the cars. This reduces the energy that needs to be generated in order to recharge the batteries of the electrical car. |
| Biodiversity | • See UN SDG 15: Life on Land: Satellite observations of terrestrial ecosystems in combination with IoT and edge computing solutions to protect biodiversity |
| From farm to fork | • Optimize usage of resources by applying smart irrigation methods<br>• Monitoring the food supply and have means to influence the flow of the food supply chain<br>• Monitor and control the processes and operations, using IoT & edge computing solutions, in farms (agricultural areas) in order to improve the quality and quantities of agricultural products, such as: agricultural crops, livestock such as poultry and poultry products, dairy and dairy products, fishery and fishery products, forestry and forestry products, horticulture and horticultural products. |
| Eliminating pollution | • Support of monitoring of the pollution of air and water.<br>• Optimize the consumption of energy and natural resources.<br>• Reducing the Carbon footprint of the ICT infrastructures and enabling technologies, like IoT and edge computing<br>• Reducing Carbon footprint, within the vertical domains using enabling technologies, like IoT and edge computing<br>• Monitor and optimize the process of recycling goods, collecting  and processing metadata information, using ICT infrastructures and enabling technologies, like IoT and edge computing |

## 3.3 IoT and edge computing standardisation challenges and objectives

The growing proliferation of IoT and edge computing technologies serves as a fundamental building block and enabler for meeting the sustainability goals being defined by various entities such as the UN and the EU. For example, these technologies enable more precise and accurate monitoring of indicators such as air quality, soil moisture and water usage, which are important metrics to track progress towards achieving sustainability goals. However these technologies themselves have their own energy and carbon footprints that also need to be carefully considered. Therefore, stakeholders involved in the deployment of IoT and edge computing technologies must carefully consider responsible deployment practices. In doing so, the carbon footprints of IoT and edge computing technologies can be minimized while maximizing their positive impact on achieving sustainability goals.

Examples of responsible deployment practices include interoperability, scalability, modularity, and re-use. Interoperability makes it possible for designers to interchange components from different suppliers, connect different deployments to one another, and to exchange data across application and operational silos. This ties into the principle of scalability and the potential to benefit from economies of scale from a large and dynamic supplier base. Modularity in system and software design helps designers to combine sub-systems. As a design principle, this helps developers to build IoT systems that combine new capabilities with legacy systems. This preserves some value of deployed systems without foreshortening their useful service lives. This also contributes to the principle of 're-use'. Here, the aim is to make solutions and sub-systems available to developers which can save time and improve their productivity.

Standardisation is key enabler for interoperability, scalability, modularity, and re-use in IoT and edge deployments. IoT and edge technology stacks consist of several layers of protocols and services that interface to one another as shown in the following diagram.



Figure 6 Standards and technologies (author: Dale Seed)

In addition, IoT and edge typically consist of large numbers of distributed devices, edge nodes and servers that all must interwork with one another at scale.
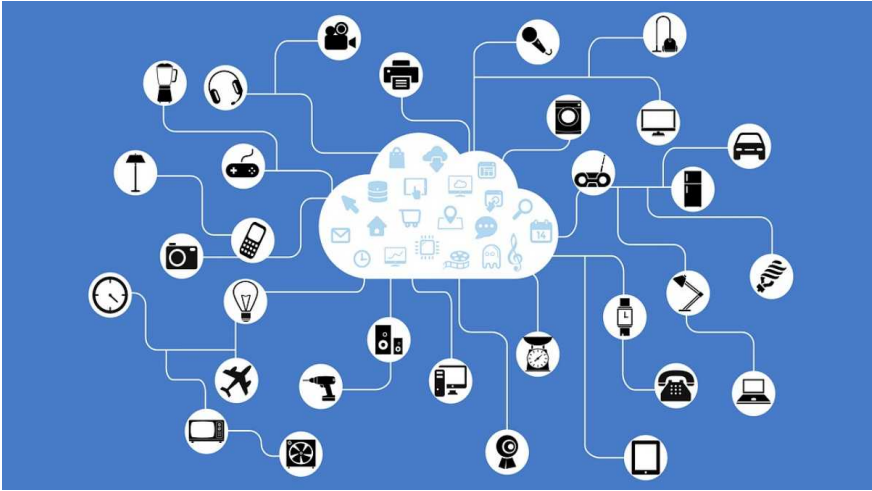


**Figure 7 Distributed devices (source: https://pixabay.com/vectors/network-iot-internet-of-things-782707/)**

Standards define a common set of protocols and services that can be used across these different technology layers and between the various network nodes in a system. This results in increased levels of interoperability, modularity, re-use and scalability of deployments. Finally, standards create a pathway to scalability through economies of scale from a large and dynamic supplier base.

# 4 Scenarios and Best Cases

This section provides possible IoT and edge computing business driven scenarios, examples and best cases that can be applied to address the IoT and edge computing high level challenges and objectives;

## 4.1 IoT and Edge computing business driven Scenarios

This section provides a brief description of business driven scenarios in vertical industries that can be used to address the IoT and edge computing high level challenges and objectives.

### 4.1.1 Energy System Decarbonistion and Cross Sectorial Flexibility integration

Grids play a crucial role in ensuring a secure, and economically fair energy transition for societies. While the EU energy transition has significantly accelerated over the past 12 months, it pushes new constraints and opportunities to TSOs in fast changing environments.

The electrical system needs on one hand to integrate further horizontal cross border energy flow exchanges to maximize the integration of intermittent renewable sources throughout Europe while requiring on the other hand further vertical interactions across TSO and DSOs to enable active interactions from distributed flexibilities spread across Transmission and Distribution Systems. Both TSO & DSO Grid operators are in this new context providing the central physical and operational backbone infrastructures of future decarbonized energy systems.

These changes will require new approaches to properly balance trade-off between acting too early and potentially over investing or investing in wrong technologies or acting too late and so potentially hindering the speed of transitions related to further integration of renewables and electrification of transportation.

It will require TSO to not only invest in physical asset developments but also into new skills and capability required to facilitate energy system integration across sectors. Internally TSOs will need to invest in cross sectorial modelling and forecasting tools and platforms to account for the increased volatility of renewables and properly activate demand side flexibility to ensure the system security of supply. It will also require the use of much larger volumes of data, applying more modern digital architectures as well as attracting new digital talents. Externally these new approaches require to build up new partner ecosystems with Grid users as well as relevant technology ecosystems as innovation and inventions will largely emerge from other adjacent sectors.

The impact of renewables, distributed energy resources, electricity demand growth due to the increased sector electrification as has major implications for future grid capacity and operation. Moving towards further sectorial integration – whether for green hydrogen production, deployment of decarbonized heat networks in cities and heat pumps in residential environments as well as Vehicle to Grid charging infrastructures is key to ensure the overall energy system decarbonisation is managed at lowest cost to end users.

Storage is confirmed to form a significant piece of the solution emerging across various sectors of the energy value chain. Furthermore interconnectivity of grids and smart integration will be key for TSO & DSO Grid Operators in delivering the capacity and flexibility that is needed to reach the next complex miles of the European energy transition.

Such new approaches indirectly question the methods used for infrastructure planning – going towards cross sectorial cost benefit analysis as initiated with Power & Hydrogen – as well as tools used for System operation where Grid flexibilities will have to be searched across sectors hence requiring a proper definition of critical cross sectorial interfaces and interoperability principles.

## 4.1.2 New Prosumer & community multi sided platforms for the integrated planning and operation of Decarbonised Energy Systems

Prosumers – whether residential, community, city, or industrial scale - will end up forming the central focal point of such cross sectorial integration investigating best financial options to decarbonize their process and operation and so minimize their growing exposure to Emission Trading Schemes which progressively get expanded beyond energy intensive sectors. Overall, we should expect all sectors to develop appropriate metrics and KPIs to define their carbon footprint efficiency indirectly linking with the source of energy being distributed to them, whether electrons or green molecules. The importance to track the carbon origin of these different energy value chains will grow, indirectly supporting the need to define auditable carbon baselines and carbon balancing mechanisms across sectors.

No doubt the future energy system will consist in one coordinated system of interconnected systems working seamlessly together. Each sectorial system will have to manage its operation through the boundaries of its own set of operational requirements however opening new "market coupling interfaces". So the digital infrastructure required will evolve from central monolithic closed environments as historically observed in SCADA control rooms into new Platform of orchestrated IoT platform architectures where data interoperability and Open Application Programmable Interfaces will become key technology components to develop to the interest of prosumers particularly.

With the accelerate development of EVs and the further electrification of the heat sector particularly, demand side dynamics have a growing impact on the grid through the accelerated adoption of virtual power plant and demand side response. This means a lot more resources will soon become available to potentially balance the system on one side, but much more dispersed on the other hand hence requiring to develop real-time digital connectivity to the lowest voltage levels of the electrical system. Over the coming years we should expect a progressive shift on how the market operates from a market having interactions with a limited number of large power plant entities – where manual operator interactions are still possible - into a future with a multiplicity of flexibility resources at the edge of the system with potentially several service provider present in a single prosumer environment (as suggested by Elia in their recent Customer Centric Market design recommendations).

This change indirectly poses new questions on the extent of the role of DSOs into future market facilitation processes as the majority of future flexibility will actually be physically connected to Distribution system Medium and Low voltage and so creating new congestion management and voltage control challenges particularly.

There is no doubt several of the System Operator functions will in the future evolve into coordinated process across TSO and DSO, raising new questions in term of Control Room connectivity and integration strategies as well as interoperability.

To avoid the fragmentation of marketplaces and data exchange platforms across Europe and to ensure the best usage of flexibilities available across sectors, the key is to ensure interoperability, transparent and a level playing access to all electricity market participants across the value chain.

Interoperability must therefore be enforced across Europe while the number of market participant increases:

- Horizontally between Power exchanges & TSO marketplaces across Europe, as largely initiated through the integration of Pan European market processes such as Flow Based Market coupling on day ahead and intraday as well as coupling of European balancing platforms;
- Vertically between TSO and local DSO marketplaces to ensure the coordinated operation of flexibility from highest voltages down to residential prosumers on lower voltage. Such coordination should cover all aspects of DER flexibility registration and qualification processes as well as baselining and real-time activations for fast acting flexibilities such as for storage resources;
- Between Grid operators, market participant and stakeholders, to ensure that DER integration is made with minimal entry costs into the system while ensuring level playing interactions between wholesale and distributed flexibility at Gridedge which is today still not the case of a majority of Grid service rules.

As highlighted by SmartEn through its digital taskforce, exchanging with market stakeholders, future marketplace design need consider such interoperability as a base requirement, e.g. by having a published API, and work towards open standards to further promote open competition. Considering the large usage of [CIM IEC62325](#) based APIs across the market platforms recently deployed such as Xbid as well as the new electricity balancing platforms, TSO & DSO should cooperate to guide a progressive transition of this interface towards harmonized APIs across Europe leveraging CIM IEC62325 message profiles and formats (as successfully initiated by ENTSO-E through its transparency platform). New generation open data exchange platforms are progressively developed by some System Operators, like the Green Energy Hub[1], allowing all metered non-sensitive data used for settlement purposes to be shared and accessed by all parties, including market players and regulated entities. Such new approach requires to further standardize the APIs used by Grid operators to publish their data – TSOs, DSOs and Market Operators – and evolve towards open data standards easing market access to new entrants and innovation-driven business models.

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[1] For more information: [https://en.energinet.dk/About-our-news/News/2021/04/19/Energinet-shares-recipe-for-new-DataHub-with-the-world](https://en.energinet.dk/About-our-news/News/2021/04/19/Energinet-shares-recipe-for-new-DataHub-with-the-world)

### 4.1.3 Enhanced Grid Control Room situational awareness technologies for Grid Operators

Digitalization of the grid infrastructure has already become a key priority for many TSOs over the past 3 years and several of them are reaching further by accelerating digital transformation of their whole organizations and developing new business models accordingly. Over the coming years, TSO should expect a complete shift in the way the system will be operated through digitalization. The growing complexity of the Power system will soon prevent TSOs from relying on human know how in control rooms and progressively shifting to automation, machine learning, drones and robotics where Control Room operators will turn into trainers and analyst of machine intelligence.

TSO's have historically developed a very strong and undisputed expertise in managing grid security of supply while progressively developing partnerships with relevant grid users and national authorities to prevent and manage national electricity crisis.

Most national risk preparedness plans focus on the containment of historic hazards ranging from typical natural hazards for their region to assess security of supply risks. The growing consequences of Climate change as recently observe increases the impact of Natural hazards onto Grid infrastructures as well as the growth cybersecurity and terrorism risks due to the growing deployment of digital technologies.

Heatwaves for instance put pressure on electricity systems in multiple ways. They increase demand as people turn up air-conditioning and as some appliances have to work harder to maintain cool temperatures. At the same time, higher temperatures can also squeeze electricity supplies by reducing the efficiency and capacity of traditional thermal power plants, such as coal, natural gas and nuclear. Extreme heat can reduce the availability of water for cooling plants or transporting fuel, forcing operators to reduce their output. In some cases, it can result in power plants having to shut down, increasing the risk of outages. If the heat wave is spread over a wide geographic area, it also reduces the scope for one region to draw on spare capacity from its neighbours, since they have to devote their available resources to meeting the national demand.

### 4.1.4 System wide Carbon performance & analytics

One of the next EU Green Deal energy challenges is to further accelerate renewable integration which complexifies the management of renewable intermittency throughout the system. The next challenge will consist in decarbonizing the end-to-end energy value chain through its day to day operation instead of considering average yearly estimates, hence requiring to provide more signals to prosumers to not only adjust their load profile but also to be able to provide new carbon metrics and accounting from "wells to use".

On the side of prosumers coins early adopters in the ecosystem have started to evolve towards new 24/7 carbon accounting methodologies bringing further transparency on their asset carbon footprint taking into account the real electricity mix of the electricity delivered from the Grid while considering the real-time profile of their asset electricity consumption. As TSOs are central to the real-time measurement of the energy mix – and so indirectly to the carbon footprint of the electrons delivered through their systems – they should support this movement through their digital strategy and develop clear 24/7 measurements of the carbon footprint of the energy delivered through their system as well as of their grid balancing. Beyond traditional price signal information, it will offer an implicit incentive to shift prosumer behaviours through the period of high renewables as well as minimize renewable curtailments

Besides these system benefits, such new digital approaches will support the tightening of carbon accounting methods and favour deployment of artificial intelligence over prosumer energy usages to best position their flexibility into the system.

Beyond the publication of real-time carbon footprint indications, TSOs should also consider new approaches properly taking into account the growing amount of bilateral renewable PPAs developed throughout their system and avoid double accounting benefits across market-based and location-based accounting methods.

This method is proposed to be used to benchmark the overall carbon footprint efficiency of IoT infrastructures as mentioned in the previous chapter.

## 4.2    IoT and Edge computing Best Cases

This section provides a brief description of best cases in vertical industries that can be used to address the IoT and edge computing high level challenges and objectives.

### 4.2.1    New Prosumer multi sided IoT platforms for Energy System Orchestration

New generation IoT platforms have started to be deployed in Prosumer environments offering new sensors to complement DSO smart metering with detailed sub-metering information which can be used to accurately monitor behind the meter flexibility activation and performance. Such sensors are becoming increasingly important to replace baselining and settle distributed flexibility according to their measured performance instead of theoretical estimates. These new approaches are notably key for explicit demand response flexibility managed by flexibility service providers positioning into fast acting grid frequency reserves.

In the context of the forthcoming Implementing Act on demand response data access, TSOs & ENTSO-e should work at expanding interoperability requirements beyond simple electricity smart meters, opening new options to consider "virtual metering channels" from relevant sensors for the settlement of explicit demand response and grid services (considering for example submetering from EV chargers or residential heat pumps in residential environments). This will ensure a more comprehensive coverage of both price-driven (implicit) and incentives-driven (explicit) demand response schemes, while ensuring a fair and level playing remuneration of all flexibility resource throughout the system.

Digital platforms will also evolve towards multisided approaches: on one side seamlessly incorporating relevant open non-sensitive data from grid infrastructures while on the other side, in line with GDPR requirements and associated data governance, integrating necessary data controls and portability to guarantee prosumer data protection and managing the sharing of relevant information with market parties with Prosumer consent.

As identified by the Digital Working Group 4 of ETIPSnet through its Big Idea Use case, new platforms should be developed to enable data exchange and contributions across key actors of the energy value chains, such as:

1. Prosumers  and energy communities to gather all necessary energy and carbon footprint data to make most appropriate investment decisions while benefitting from all new regulations related to customer data protection (in term of data ownership, interoperability, and portability). This environment should particularly allow

    a. to harmonize APIs for Prosumer energy & carbon data exchange across domains;

    b. to be able to compare and benchmark consumer energy costs and associated carbon footprint according to historical baselines as well as through consumer communities (while maintaining the necessary level of anonymization);

   c. to plug & play connect with relevant Home IoT devices (Smart Heating, Smart Charging, Demand response IoT) to enable the automation of energy optimization strategies at Gridedge;

2. For energy system infrastructure planners (TSOs & DSOs) to access more granular bottom-up data per customer segments refining associated energy profiles taking into account consumer investment decisions / technology adoption rates (as individuals or through energy communities facilitating their investment decisions). The associated interface should particularly allow to properly plan needed connection capacity of all electricity, heat and gas energy networks on several year time horizon as well as define relevant consumption & energy efficiency baselines taking into account the adoption of new energy efficiency programs as well as DER technologies. It should also allow the optimization of flexibility use for cost efficient planning and in longer run to optimized infrastructures investments;

3. For energy system infrastructure operators and service providers (TSOs, DSO, retailers, aggregator, IT service providers ) to offer most relevant energy supply contracts and DER program management strategies according to specific Prosumer profiles. The interface should be designed:

   a. To facilitate customer Opt-in/Opt-out;

   b. To offer transparent benchmarks of the cost implications taking into account reference baselines for energy consumption, self-generation as well as EV/V2H/V2B;

   c. Once a contract is opted in to allow real-time energy data exchange (as required for both implicit and explicit demand response types of contract) with relevant IoT devices;

4. For cities to provide data and geospatial analytics to anticipate and coordinate the parallel deployments of energy (Gas, Heat & electricity) and transport infrastructures (EV charging or Hydrogen fuelling stations). The platform should provide aggregated energy maps for energy efficiency, renewable penetration as well as progress on carbon footprint improvements.

The following diagram offers a high level view of the platform interactions as well as the main System functions associated to the proposed Business Use case.
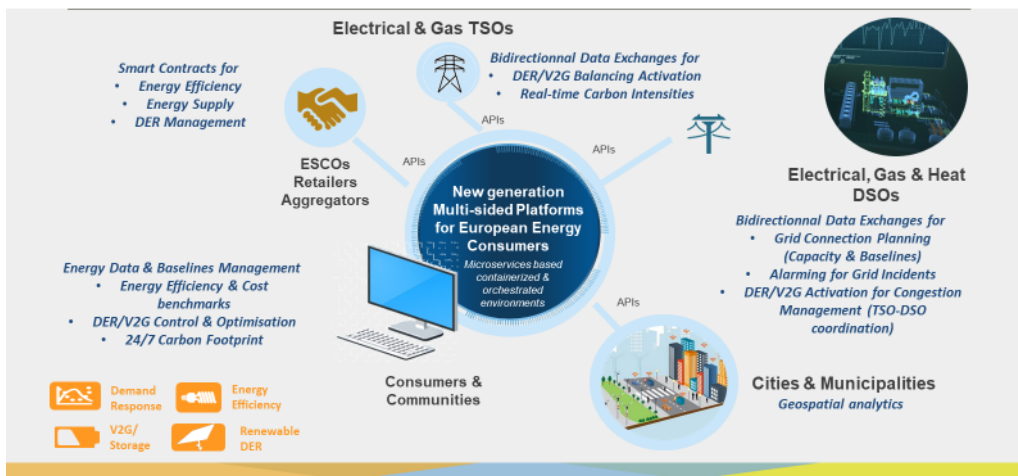
**Figure 8 High level view of the platform interactions, (source: ETIP SNET)**

## 4.2.2 Future Grid Control Room architectures

Market deregulation has significantly increased the number of market participants having to interact throughout the systems, which is expected to continue to grow exponentially with the emergence of new prosumer centric market designs. This requires rethinking the architecture of control room environments to open up traditional SCADA environments to larger volumes of data streaming incorporating lower granularity timeseries evolving from minutes down to second while the system inertia reduces. New control room developments need to incorporate data processing through critical event streaming to enhance Grid operator situational awareness and further automate critical decision making.

The new EU Green Deal objective further accelerates the integration of intermittent renewables into the Grid on all voltage levels growing the complexity to forecast and observe renewable injections across the end to end T&D system.

Classical renewable and load forecasts therefore require to be adapted to reach higher granularity for timing as well as locations. The closer forecasts get to real-time the smaller can be the amount of grid security margins required to manage security of supply hence releasing more capacity to market participants.

Beyond improvements into compound forecasting methods it is becoming essential to enlarge observability across the entire system. The high volatility of renewables infeed and prosumer net consumptions in the future will need to be observed through real-time requiring to develop new data exchange interfaces throughout the electricity system.

Ultimately, future control rooms will evolve towards newer generation situational awareness environments providing Control Room operators several digital twins of the Grid state – through steady state and dynamic transient calculations while incorporating all relevant data related to new threats appearing throughout the system.
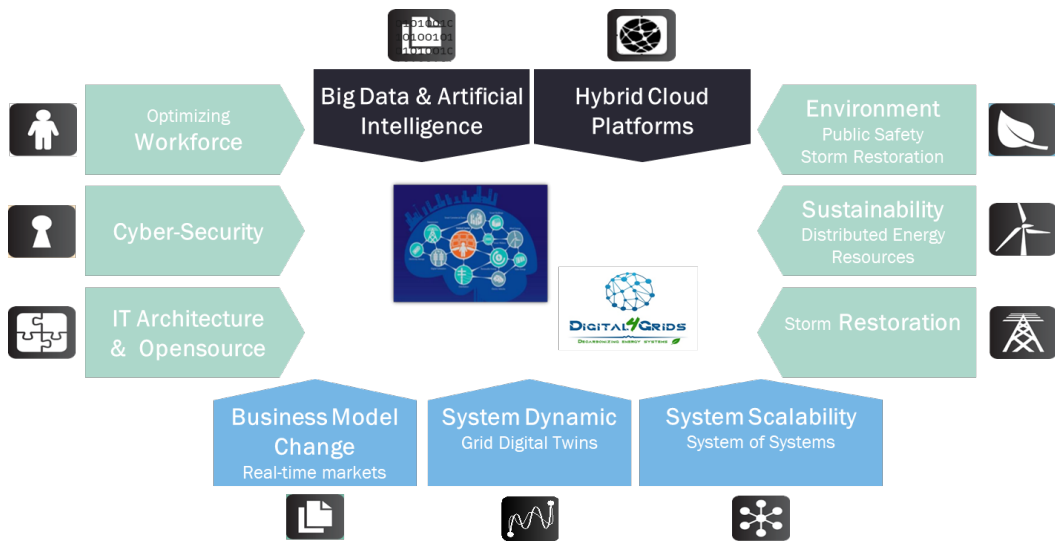
**Figure 9 Future Grid Control Room architectures, (source: Digital4Grids)**

# 5 Recommendations

This section first descries the high level research, standardisation, business and policy recommendations derived from the analysis of the scenarios and best cases and on how they can address the IoT and edge computing high level challenge and objectives.

## 5.1    Research high level recommendations

The future technological developments will set several strategic choices related to new value networks and ecosystems, how value is created within companies and redistributed among industry players, countries and society. Intelligent connectivity is essential for the achievement of the EU Green Deal and the United Nation's (UN's) Broadband Commission agenda for 17 UN Sustainable Development Goals, having set deployment targets for 2025 to underline the importance of communication systems and networks on addressing economic growth and addressing social challenges. Moreover, IoT and edge computing can be used to support the European Green Deal and decrease energy and carbon footprint of various vertical industries. In particular, in the IoT domain the impact of the Green Deal would be two-fold:

(1) using IoT and Edge Computing technologies to improve the environment impact of other domains and

(2) improving the energy footprint of IoT based systems, including its use and energy consumption, the disposal or refurbishing of obsolete devices, the design and manufacturing of energy and environment-friendly new devices.

The high level recommendations on research are as follows:

1.  Define and evaluate (e.g. simulation and/or prototype experiments) approaches on increasing energy efficiency in communication infrastructures applied in IoT and edge computing solutions:

    *   Climate action;
    *   Clean energy;
    *   Sustainable industry;
    *   Building and renovating;
    *   Sustainable mobility;
    *   Biodiversity;
    *   From farm to fork;
    *   Eliminating pollution.

2.  Develop and evaluate (e.g. simulation and/or prototype experiments) security and privacy by design approaches required to secure the IoT and edge computing solutions applied to monitor and control energy and carbon footprint usage in EU Green Deal areas and which are as well able to protect any personal data lifecycle used by these solutions;

3.  Develop (or reuse) and evaluate (e.g. simulation and/or prototype experiments) interfaces, data models and ontologies required by IoT and edge computing solutions that support monitoring and controlling energy and carbon footprint usage in EU Green Deal areas;

4. More research and innovation activities on standards or guidelines are required to define the $CO_2$ footprint of ICT installations – in use but also incl. material production, assembling, recycling (LCA);

5. More research and innovation activities on "green AI", developing strategies and implementation concepts;

6. More research and innovation activities for reference designs and benchmark platforms;

7. More research and innovation activities on sustainable power supplies, employing alternative energy sources for small devices (energy harvesting) and energy storage devices (batteries, capacitors) with low carbon footprint;

8. More research and innovation activities on energy-efficient wireless protocols targeting massive IoT applications (MIoT, NB-IoT, 5G/6G).

## 5.2    Standardisation high level recommendations

Although a fair amount of standardisation of IoT and edge technologies has taken place in various standardisation organisations, the following are some recommendations on further standardisation opportunities to support EU Green Deal sustainability goals.

1. Specify (or modify existing) interfaces that help monitor and control of the energy usage in communication protocol layer stacks applied in IoT and edge computing solutions;

2. Specify (or modify existing) IoT and edge computing related standards, interfaces, data models and ontologies to reduce the energy and carbon footprint (by e.g., monitoring and controlling energy and carbon footprint) in EU Green Deal areas:

   - Climate action;

   - Clean energy;

   - Sustainable industry;

   - Building and renovating;

   - Sustainable mobility;

   - Biodiversity;

   - From farm to fork;

   - Eliminating pollution;

3. Specify (or modify existing)  security and privacy by design standards required to secure the IoT and edge computing solutions applied to monitor and control energy and carbon footprint usage in EU Green Deal areas and which are as well able to protect any personal data lifecycle used by these solutions;

4. Align the legacy ontologies historically developed across section in consistent energy data spaces, namely CIM ontologies for Energy Systems, ontologies derived from Open Charge Point Protocols in the new electrical Transportation sectors as well as the recently developed SAREF ontology in the Prosumer environment with new ontology.

## 5.3    Business driven high level recommendations

The green and digital transition will generate new business in particular in the area of using IoT and edge computing as enablers to reduce the energy and carbon footprint in vertical industries, such as:

1. Monitoring and control of energy and carbon  usage in vertical domains, such as for example energy, manufacturing, buildings and homes, agriculture, smart city, automotive, mobility, supply chains and transportation;

2. Strengthen circular economy by recycling and reusing IoT and edge computing equipment;

3. Develop platform for benchmarking and methodology to assess ICT energy efficiency and certification for business deployment;

4. Facilitating deployment of innovative enabling technologies such as IoT, edge computing and AI in critical sectors, in particular grids, aggregators and energy suppliers.

## 5.4    Policy driven high level recommendations

The green and digital transition related regulations can be strengthen by new amendments such as:

1. Establish lab environment where IoT equipment interoperability can be type tested and validated for pre-defined test use cases;

2. Develop new IoT Efficiency benchmarking rules labelling the efficiency of IoT infrastructures / Attach the associated real-time carbon footprint hourly measures to the services delivered to citizens and offer new possibility to benchmark cloud based services according to their measured carbon footprint throughout the day (indirectly favouring IoT consumption during lower carbon intensity periods);

3. Favour Cross sectorial technology demonstration projects that support the green and digital transition, joined with regulatory sandboxes demonstrating interoperability across technology platforms as well as the needed minimum regulatory changes - whether for new mandates on data interoperability (such as for the interoperability network code of the clean energy package) as well as for the definition of new roles and responsibility throughout the energy market (such as for the new flexibility network code of the clean energy package);

4. Develop demonstration projects favouring the adopting of IoT architecture into key energy domains, particularly the domain related to the launch of multi sided market places enabling peer to peer flexibility exchanges across the value chain and through prosumer energy community.

# 6 Relations of EU Green Deal policies to other Global Green Deal Policies

This section provides a brief overview of the Green Deal policies in other regions such as the USA, China, India and their comparison to the European Green Deal policies.

## 6.1    USA Green Deal policies

### 6.1.1    The Green New Deal

The Green New Deal has motivated those who want the United States to undertake unprecedented climate action, but it has also drawn backlash.

The Green New Deal, a broad and sometimes vague aspiration to rapidly mobilize American government, society, and industry to create a sustainable, low-carbon future, has become hotly contested among policymakers. For supporters, such an effort represents a last chance to avoid the worst consequences of catastrophic climate change. For detractors, it's a financially profligate proposal concerned more with traditional left-wing economic policies than environmental necessity.

A congressional resolution on the Green New Deal both motivated and divided Democrats during the 2020 presidential campaign, and it ultimately influenced President Joe Biden's climate plan. Biden issued a broad slate of executive actions addressing climate change in his first days in office.

Such a proposal, affecting all aspects of the U.S. economy and society, is unprecedented. However, major world economies, including China, India, and the European Union, have begun implementing some of the policies envisioned by the Green New Deal, shedding light on the complexities and costs involved.

The Green New Deal is a contested concept, but all of its various versions, center on a common vision of a government-led, society-wide effort to dramatically reduce U.S. greenhouse gas emissions and quickly shift the U.S. economy to be less carbon intensive. The term might have originated in a 2007 New York Times column by Thomas Friedman, and by 2018 the concept had become a rallying cry in Democratic Party politics. In February 2019, Representative Alexandria Ocasio-Cortez (D-NY) and Senator Ed Markey (D-MA) introduced a nonbinding resolution in support of the idea.

Their version is essentially a statement of principles backing a ten-year "national mobilization." The resolution is notable for going far beyond climate change, aspiring to a broad-based industrial policy that would reshape the U.S. economy. It aims for a sweeping social transformation reminiscent of President Franklin D. Roosevelt's New Deal, which was an unprecedented application of the power of the federal government to dig the United States out of the Great Depression in the 1930s.

The goals of the Green New Deal involve:

1.    Emissions: cutting net greenhouse gas emissions to zero over ten years;

2.    Manufacturing: spurring "massive growth in clean manufacturing.";

3. Power use: meeting all U.S. power demand "through clean, renewable, and zero-emission energy sources.";

4. Agriculture: sharply reducing emissions and other pollution from agriculture;

5. Infrastructure: upgrading infrastructure, including transportation and housing, and ensuring all infrastructure bills considered by Congress address climate change;

6. Jobs: guaranteeing a job with a "family-sustaining wage" for everyone;

7. Welfare and social justice: providing everyone in the United States with high-quality health care, affordable housing, economic security, clean water, clean air, and healthy food, while addressing systemic social exclusion and injustice;

The specific means to carry all this out are left open, but the resolution stresses that it should be a duty of the federal government and should include public financing, technical expertise, public investment in research and development, stronger enforcement of trade rules relating to the environment, antitrust enforcement, and the expansion of workers' rights.

### 6.1.1.1  The Debate

The Green New Deal grew out of an increasing urgency regarding climate change, which the resolution calls a "direct threat to the national security of the United States."

But critics argue that the expense of such a mobilization would be astronomical, and some leading Democrats in Congress have been sceptical of what they see as an overly broad approach. Jerry Taylor of the Niskanen Center, a free-market think tank, writes that proponents of the Green New Deal have attached to the plan too many issues unrelated to climate change, and ended up with an inflated price tag that is easy for opponents to attack on fiscal grounds. Economist Noah Smith writes that the plan's "enormous new entitlements paid for by unlimited deficit spending" could mean that nearly three-quarters of all U.S. economic activity would eventually come from government spending.
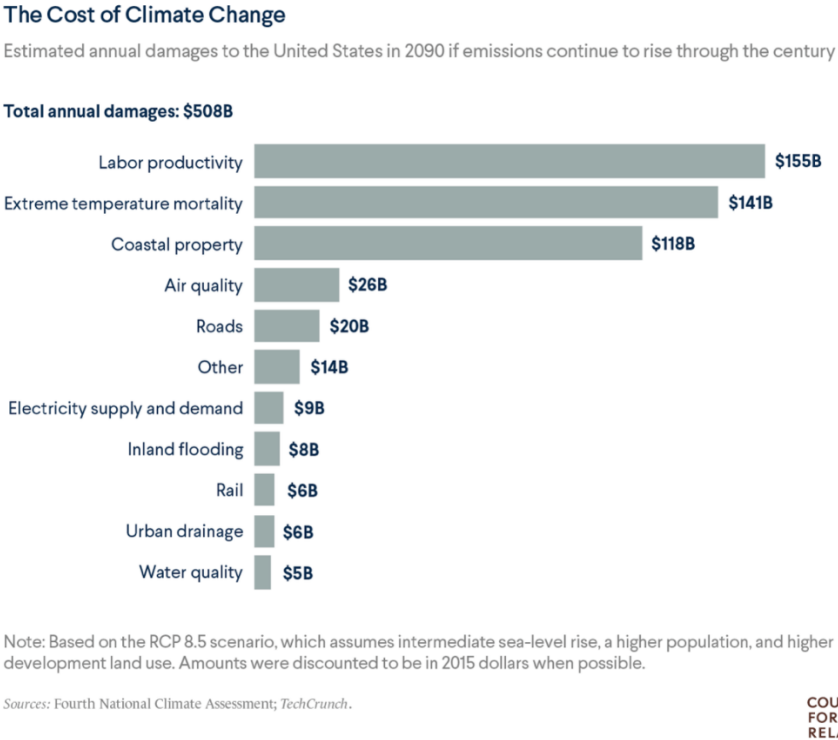
Many experts say concerns over costs are highly speculative given the plan's lack of details. The Congressional Budget Office, which provides cost estimates for all proposed legislation, has been unable to do so in this case because there are not yet concrete policy proposals. Many on the left, such as the progressive think tank Data For Progress, argue that dealing with climate change will be expensive either way, and that inaction will be much worse: they point to the National Climate Assessment's prediction that the effects of global warming could cost the United States upward of $500 billion per year by the end of the century.

Indeed, a near-universal consensus has emerged that dramatic action to fight climate change is necessary. A 2018 special report by the United Nations' Intergovernmental Panel on Climate Change (IPCC) warned that the most harmful effects of global warming could occur by 2040 and suggested there only remained twelve years to cut emissions enough to limit global temperature rises to 1.5°C or 2°C over preindustrial levels and avoid the worst outcomes.

The [U.S. National Climate Assessment](#), also released in 2018, raised alarm over the spread of deadly diseases, such as West Nile virus and Zika virus, to new parts of the United States. At the same time, floods, hurricanes, and [wildfires](#) that experts say are worsened by climate change have devastated swaths of the country in recent years. Likewise, the U.S. military [has warned](#) about the rising threat of climate-driven conflicts.

At the same time, growing civil society movements are seeking to force action on climate, from Friday school strikes in Sweden and elsewhere to the Sunrise Movement in the United States to the Extinction Rebellion in the United Kingdom.

The Green New Deal calls for major investments in transportation; Americans rely on cars much more than Europeans. This is largely due to the higher density of European cities, which makes public transport more viable. But even in the EU, steps to reduce car use remain fraught: in France, the Yellow Vests protests broke out in late 2018 over a planned fuel tax increase. Vehicle gas there is about twice as expensive as in the United States, in large part due to higher taxes.



**The Cost of Climate Change**

Estimated annual damages to the United States in 2090 if emissions continue to rise through the century

**Total annual damages: $508B**

| Category | Damages |
|---|---|
| Labor productivity | $155B |
| Extreme temperature mortality | $141B |
| Coastal property | $118B |
| Air quality | $26B |
| Roads | $20B |
| Other | $14B |
| Electricity supply and demand | $9B |
| Inland flooding | $8B |
| Rail | $6B |
| Urban drainage | $6B |
| Water quality | $5B |

Note: Based on the RCP 8.5 scenario, which assumes intermediate sea-level rise, a higher population, and higher development land use. Amounts were discounted to be in 2015 dollars when possible.

*Sources:* Fourth National Climate Assessment; *TechCrunch*.

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**Figure 10 Estimated annual damages to USA in 2090 if emissions continue to rise (source: Council of Foreign Relations)**

## 6.2    China Green Deal policies

China produces roughly 28% of all emissions in 2018, compared to 15% in the United States, while India is responsible for much of the global rise in emissions in recent years. The Green Deal regulation in China have taken steps to scale back emissions, cut pollution, and employ renewable energy resources, even as they continue to seek faster economic growth to lift their people out of poverty.

Due to among others, the large population in China, i.e. 1/6 of World's population, it is estimated that China produces more than a quarter of global greenhouse gases, emitting nearly as much as Canada, Europe, and the United States combined. This is Beijing's buy-in was central to the Paris Agreement, in which China promised that its carbon dioxide emissions would peak by 2030. The country appears on track to keep its commitment, although emissions have again increased in recent year. China's government has pushed several green initiatives. These include efforts to transition from coal to renewable energy, investments in new technologies, and mechanisms to put a price on carbon. In 2020, China's President Xi announced a goal to achieve carbon neutrality by 2060.

But China's climate policy has a coal problem: its power sector runs on it, and the country accounts for over half of global coal consumption, producing worrisome levels of air pollution. Though new coal plants are still being built, China has successfully combated air pollution: it cut fine particulates by more than 30% from 2014 to 2017. This has raised hopes it could similarly attack greenhouse gas emissions. "Already, 40% of the world's new renewable power plants are in China, and in 2016 China invested $78.3 billion in renewable energy—exceeding both Europe ($59.8 billion) and the United States ($46.5 billion)," CFR's Elizabeth C. Economy writes in her book The Third Revolution. The USA Green New Deal's commitment to zero-emission power would rule out the use of coal. At the UN General Assembly on 22 September, Chinese President highlighted the need to accelerate transition to a green and low-carbon economy while achieving green recovery and development. "China will strive to peak carbon dioxide emissions before 2030 and achieve carbon neutrality before 2060," he pledged. He added that China would increase support for other developing countries in developing green and low-carbon energy, and not to build new coal-fired power projects abroad.

China's "Made in China 2025" policy, a state-led high-tech manufacturing strategy, has started developing industries including electric cars and rail transport. Beijing has already spent some $60 billion to create an electric car industry, and more electric vehicles were sold in China in 2019 than in the rest of the world combined. However, it is important to as well focus on using renewables and green energy for the underlying power sector that charges all these new modes of transport.

Like the European Union and several other countries, China is trying a national emissions trading scheme (ETS). Emissions trading programs, often known as cap and trade, allow the government to issue permits for emissions. The number of these permits is then capped, and firms that wish to emit must buy permits on an open market, forcing polluters to pay an economic price for their environmental harm.

However, since China represents more than 1/6 of the global population, any climate neutrality measures by the US and Europe alone, without China's confirmation and support, would not be sufficient to reach the global climate neutrality targets.

## 6.3    Other Green Deal policies

This section provides a short overview of other Global Green Deal policies.

### 6.3.1    India

In 2018, India was the world's third-biggest national emitter, at 7% of the total, behind only China and the United States. New Delhi has set a renewable energy target for 2022 that would require an investment four times the size of its national defence budget. Despite an expansion of solar power, coal still supplies more than half of India's energy consumption. The latest forecasts predict India will fall short of its 2022 goal, and it remains unclear how disruptions from the COVID-19 pandemic will affect India's energy transition.

For many observers, India is a bellwether for determining whether global greenhouse gas emissions reductions can be successful. The country's population will soon surpass China's, and its economy is already growing faster. While emissions have at times levelled off or even dipped for China, the European Union, Japan, Russia, and the United States, India's have steadily risen.

Dozens of smaller countries, regions, and even cities have pushed the envelope on emissions reduction goals and other climate policies. Indeed, their strategies are often closer to the ambitions of the Green New Deal than those of larger economies.

### 6.3.2    Norway and other countries

Norway, which is not an EU member, has been particularly aggressive on energy policy. Norway aims for all new cars to have zero emissions by 2025, and it has exempted electric vehicles from many taxes, tolls, and parking fees. The incentives have had an effect: despite a population of about five million, Norway is the third-largest market in the world for electric cars, after China and the United States. The Netherlands and several other countries have set similar targets.

In March 2019, Norway announced its $1 trillion sovereign wealth fund—the world's largest— would divest from oil and gas firms. However, some analysts question Norway's green ambitions, given that crude oil and natural gas make up half its exports.

Chile became the first South American country to implement a carbon tax in 2014. Mexico launched its own such tax in 2018. Kazakhstan, New Zealand, and South Korea have followed, either taxing carbon or implementing their own ETS. Costa Rica has launched a national program to completely decarbonize its economy by 2050.

## Carbon Pricing Initiatives

Fifty-seven carbon pricing initiatives are being implemented around the world. Initiatives can take the form of carbon taxes or emissions trading schemes and vary in scope and impact. "Tons of emissions covered" is measured in metric tons of $CO_2$ equivalent.

### Carbon Taxes

| Jurisdiction | Tons of emissions covered | Percent of jurisdiction's emissions |
|---|---|---|
| **National** | | |
| Argentina | 79 | 20 |
| Canada | N/A | TBD |
| Chile | 47 | 39 |
| Colombia | 42 | 24 |
| Denmark | 22 | 40 |
| Estonia | 1 | 3 |
| Finland | 25 | 36 |
| France | 176 | 35 |
| Iceland | 2 | 29 |
| Ireland | 31 | 49 |
| Japan | 999 | 68 |
| Latvia | 2 | 15 |
| Liechtenstein | 0 | 26 |
| Mexico | 307 | 46 |
| Norway | 40 | 62 |
| Poland | 16 | 4 |
| Portugal | 21 | 29 |
| Singapore | 42 | 80 |
| Slovenia | 5 | 24 |
| South Africa* | 360 | 80 |
| Spain | 9 | 3 |
| Sweden | 26 | 40 |
| Switzerland | 18 | 33 |
| Ukraine | 287 | 71 |
| United Kingdom | 136 | 23 |
| **Subnational** | | |
| Alberta | 109 | 42 |
| British Columbia | 42 | 70 |
| Newfoundland and Labrador | 5 | 47 |
| Prince Edward Island* | N/A | TBD |

### Emissions Trading Schemes

| Jurisdiction | Tons of emissions covered | Percent of jurisdiction's emissions |
|---|---|---|
| **National** | | |
| Australia | 381 | 50 |
| Canada | N/A | TBD |
| China* | 3232 | 25–30 |
| European Union[a] | 2132 | 45 |
| Kazakhstan | 183 | 50 |
| New Zealand | 40 | 51 |
| South Korea | 468 | 70 |
| Switzerland | 6 | 11 |
| **Subnational** | | |
| Alberta | 120 | 48 |
| Beijing | 85 | 45 |
| British Columbia | 0 | 0 |
| California | 378 | 85 |
| Chongqing | 97 | 40 |
| Fujian | 200 | 60 |
| Guangdong[b] | 366 | 60 |
| Hubei | 162 | 35 |
| Massachusetts | 14 | 20 |
| Newfoundland and Labrador | 4 | 43 |
| Nova Scotia | 15 | 80 |
| Quebec | 67 | 85 |
| RGGI[c] | 80 | 18 |
| Saitama | 8 | 18 |
| Saskatchewan | 8 | 11 |
| Shanghai | 170 | 57 |
| Shenzhen | 61 | 40 |
| Tianjin | 118 | 55 |
| Tokyo | 14 | 20 |
| Washington | 58 | 67 |

\* Scheduled

a. Also includes Iceland, Liechtenstein, Norway
b. Does not include Shenzhen
c. Regional Greenhouse Gas Initiative, includes CT, DE, ME, MD, MA, NH, NY, RI, and VT

*Source:* World Bank.

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**Figure 11 Carbon pricing initiatives (source: Council of Foreign Relations)**

### 6.3.3   Cities, states, and regions

These smaller communities are often willing to go further than national politics allow. Copenhagen has announced plans to be carbon neutral by 2025. Dozens of cities around the world have banded together to try to influence climate policy. In the Powering Past Coal Alliance, for instance, eighty cities, states, regions, and national governments have committed to phasing out coal use. States such as California, provinces such as Quebec, and metropolises such as Tokyo have all pledged to start their own emissions trading schemes.

California, on its own the world's fifth-largest economy, has rallied local climate efforts. In 2018 the state mandated that by 2045 it would transition to 100% clean electricity. Two years later, Governor Gavin Newsom signed an executive order that by 2035, all new vehicles sold must be zero-emission. Climate experts say that such subnational efforts can serve as laboratories for best practices, and in some cases—such as California's development of auto emissions standards in the 1960s—regions with enough market power can force national governments to follow their lead.

### 6.3.4   Inter-Governmental Panel on Climate Change (IPCC) Report

An IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.

# Annex I.    Editor and Contributors to this Report

The document was written by several participants of the AIOTI Digital for Green Group.

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# Acknowledgements

# About AIOTI

AIOTI is the multi-stakeholder platform for stimulating IoT Innovation in Europe, bringing together small and large companies, start-ups and scale-ups, academia, policy makers and end-users and representatives of society in an end-to-end approach. We work with partners in a global context. We strive to leverage, share and promote best practices in the IoT ecosystems, be a one-stop point of information on all relevant aspects of IoT Innovation to its members while proactively addressing key issues and roadblocks for economic growth, acceptance and adoption of IoT Innovation in society.

AIOTI's contribution goes beyond technology and addresses horizontal elements across application domains, such as matchmaking and stimulating cooperation in IoT ecosystems, creating joint research roadmaps, driving convergence of standards and interoperability and defining policies. We also put them in practice in vertical application domains with societal and economic relevance.