Supporting the implementation by NRAs of renewable energy technologies in the road infrastructure

Deliverable 3.3

Contractor Report with country specific conclusions and recommendations

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1 INTRODUCTORY REMARKS

1.1 Purpose of the report

This report aims to identify the National and EU regulations, potentially applicable to NRA's in the area of renewable energy production. By setting out and summarising the work done to identify the applicable regulations, the report can act as a reference resource for the project team to help the NRA's answer the following two questions:

- Based on the research undertaken by the ENROAD project, what is the current relevant European and national regulatory framework dictating what can be done in terms of decentralised renewable energies in the target countries?
- What opportunities and challenges arise from the research and the country specific stakeholder integration workshops?

1.2 Methodology

The methodology adopted was to carry out research and analysis at an EU level and then to do the same exercise in each of the target countries of existing and foreseen regulation that conditions the generation and commercialization of electricity, both for self-consumption as well for distributed generation.

The analysis intends to identify if, how and where the countries have defined and regulated figures that could be used in the business models to be proposed for the NRAs in their aims such as:

- Demand Aggregators
- Closed distribution networks
- Renewable energy communities
- Charging infrastructure
- PPAs
- Others

The research was carried out in the WP3 and presented in the deliverables 3.1 and 3.2 as well as Milestones 3.1 and 3.2

The results of the desktop based research was complemented by the outcomes of the stakeholder integration workshops held together with the NRAs and the stakeholder selected and invited by them. The outcomes of these workshops were:

- Key identified opportunities
- Key identified challenges

Lastly, recommendation were made on changes that would help overcome the identified challenges and materlialize the identified opportunities.

2 THE EU FRAMEWORK

All countries studied under the ENROAD project, with the exception of the UK, are subject to European regulation setting the direction and timings for the decarbonization agenda in line with the commitments made in Paris in 2015. The main European regulation affecting the electricity sector and markets that will/can have an influence in the viability of the renewable energy projects for the road infrastructure to be valuated under ENROAD are described at high level as follows:

2.1 Clean energy for all europeans

In 2015, the EU, along with 194 other signatories, agreed to maintain global warming well below 2ºC and pursue efforts to limit it to 1.5ºC. Achieving carbon-neutrality by mid-century is essential in order to accomplish this objective and avoid the most catastrophic consequences of climate change.
In 2016, the Winter Package `Clean energy for all Europeans', put forth 8 proposals to facilitate the transition to a clean energy economy and reform the design and operation of the European Union's electricity market.
Between May 2018 and May 2019, political agreement was reached on eight proposals and they were enacted into law. Of the eight, **the following directives and regulations are relevant because they propose/define figures and targets which are relevant to the goals of the ENROAD project**, these are to be transposed into national regulation by the member states :

Renewable Energy Directive (EU) 2018/2001
Regulation on the Governance of the Energy Union and Climate Action (EU) 2018/1999
Internal Electricity Market Directive 2019/944

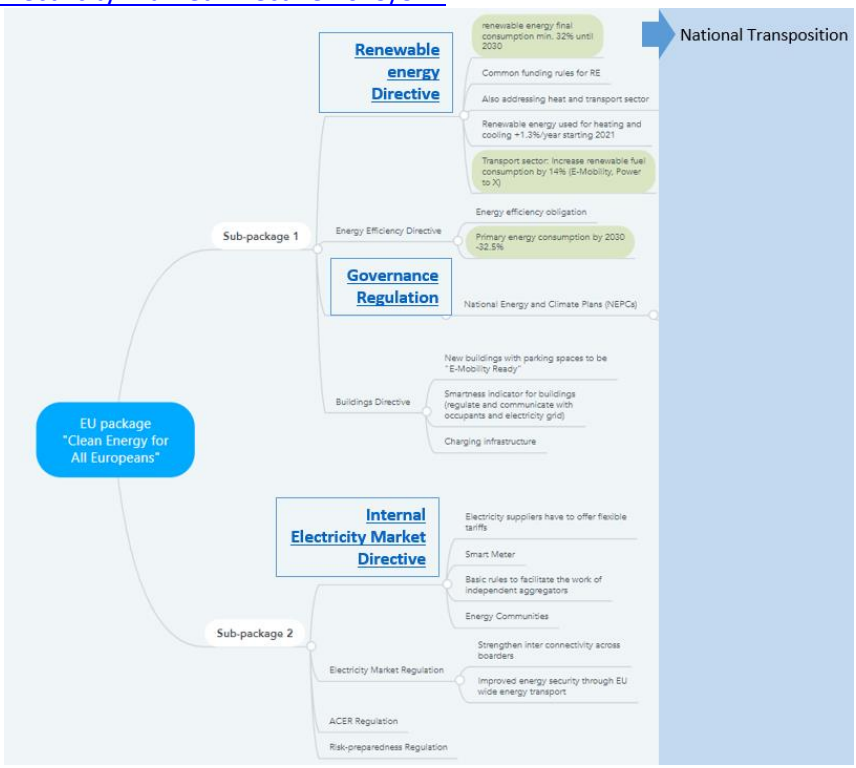

Figure 1.- Relevant EU regulation and requirements to member countries related to renewables

Soon after, the flagship plan for a climate neutral Europe, the European Green Deal, was presented in December 2019, following the Parliament's declaration of a climate emergency.
As part of a broader package of ambitious actions announced in the Commission's European Green Deal Communication, the Commission adopted its proposal for a European Climate Law, establishing the framework for achieving climate neutrality and amending Regulation **with the legally binding target of net zero greenhouse gas (GHG) emissions by 2050 in March 2020**. The proposal for a European Climate Law was later amended in September of the same year, in line with the 2030 Climate Target Plan, **to increase the emission reduction objective to 55% by 2030.**
As shown in the 2030 Climate Target Plan, this more ambitious target implies **increased greenhouse gas emission reduction efforts by all sectors**, and enhancement of renewables, which need to be enabled by various policies.
The three directives and regulations highlighted above, have been updated as a consequence of the European Green Deal and the Russian invasion of the Ukraine which have resulted in measures increasing the ambition of the emissions reductions objectives as well as the energetic independence of Europe.

2.2 European Green Deal, Fit for 55 and RePowerEU

The EU Green Deal is a policy framework and package with the overarching goal for the EU to become the first climate-neutral continent by 2050 and increasing the ambitions of existing emission reduction targets. The plan focuses on policies and strategies to ensure the supply of cleaner & affordable energy, establish a circular economy, cleaner the environment, eliminate pollution, safeguard biodiversity, create sustainable food and smart transport system, create new jobs, and overall better quality of life.

The main elements of the EU Green Deal are related to the goal of the EU to be climate neutral by 2050 and the intermediate objective of 55 % greenhouse gas emissions (GGE) reduction by 2030 compared to 1990. The European Climate Law requires that all EU policies contribute to achieving the EU Green Deal objective. The aspects of the European green deal most applicable to the aims of the Enroad project are:

Fit for 55 package:
This package is made up of proposals aimed at reducing emissions in the sectors already regulated and new sectors within the emissions trading system, a revision of the Effort Sharing Regulation for diffuse sectors, a modification of the regulation of sinks and, in a complementary way, it proposes modifications in the areas of energy, more sustainable fuels and transport.

The EU Commission are reviewing every EU law to ensure its alignment with the EU emission reduction targets. Intended to be effective by the time Member States begin updating their national energy and climate plans in 2023, the plan includes revisions on:

- **Renewable Energy Directive:** the package has proposed measures to attain the increased objective of 40% renewable energies in the final energy consumption by 2030 (up from 32% originally intended). For this purpose, it has proposed binding targets such as 28% of renewable energies in the transport sector and creates a mechanism of credits to increase electromobility where the electricity suppliers providing charging infrastructure can use this credits to comply with their obligations in the ETS.

- **Union guidelines for the development of the trans-European transport network (TEN-T):** The modifications here include the requirements for EV charging stations every 60km as well as Hydrogen refueling stations every 150km

RePowerEU

In may 2022, the European Commission presented the REPowerEU Plan, its response to the hardships and global energy market disruption caused by Russia's invasion of Ukraine. There is a double urgency to transform Europe's energy system: ending the EU's dependence on Russian fossil fuels and tackling the climate crisis. The measures in the REPowerEU Plan can respond to this ambition, through energy savings, diversification of energy supplies, and accelerated roll-out of renewable energy to replace fossil fuels in homes, industry, transport and power generation.

Some of the key measures proposed by the RePowerEU that would have a possitive effect in the objectives of the ENROAD project are:

- Increase the European renewables target for 2030 from 40% to 45%
- New legislation and recommendations for faster permitting of renewables especially in dedicated 'go–to areas' with low environmental risk
- Regulatory measures to increase energy efficiency in the transport sector

2.3 Summary

All of the European regulation briefly described above has and will further dictate the direction of travel of the national regulation through the transposition in national laws and plans that are expected to facilitate the objectives of the NRA's of implementing renewable energy projects along/within its road infrastructure. The countries within this study have implemented the European regulation at different levels defining the following structures and figures which are considered to be key in rendering possible the objectives of this study:

- Self consumption
- Demand Aggregators
- Closed distribution networks and Renewable energy communities
- Charging infrastructure
- PPAs
- Others

How these figures and structures have, or haven't yet, been defined in each country and what opportunities and challenges have been identified is presented in the following country specific sections.

3 BELGIUM-FLANDERS

As an EU Member State, Belgium has implemented EU energy legislation on electricity and natural gas. Electricity and natural gas markets have been unbundled: a single grid operator is appointed for a designated area. Within this area, the grid operator is responsible for the operation, maintenance and development of the grid. The grid operator has to grant non-discriminatory third-party access to producers, suppliers and off-takers against regulated tariffs. The regulatory authority oversees market functioning and compliance by market actors[1].

Belgium's National Energy and Climate Plan sets a 2030 target to reduce greenhouse gas emissions from the energy sector by 35% from 2005 levels, to reach 17.5% renewables in gross final energy consumption, and significantly reduce energy demand. Belgium has made progress on these goals. Coal-fired generation was phased out in 2016 and Belgium is a global leader in offshore wind, with 2.23 GW in 2020 and plans for 5.7 GW or more by 2030[2].

Belgium remains reliant on fossil fuels and is facing energy security challenges. Nuclear energy covers over half of electricity demand, while the federal government plans to phase out most nuclear generation by 2025. Almost half of Belgium's gas imports come from the Netherlands with most delivered through a dedicated network connected to the Groningen gas field, which will stop production in mid-2022. Belgium is working to address energy security issues and has one of the most interconnected electricity grids in Europe[3].

3.1 National transposition – Regulatory framework

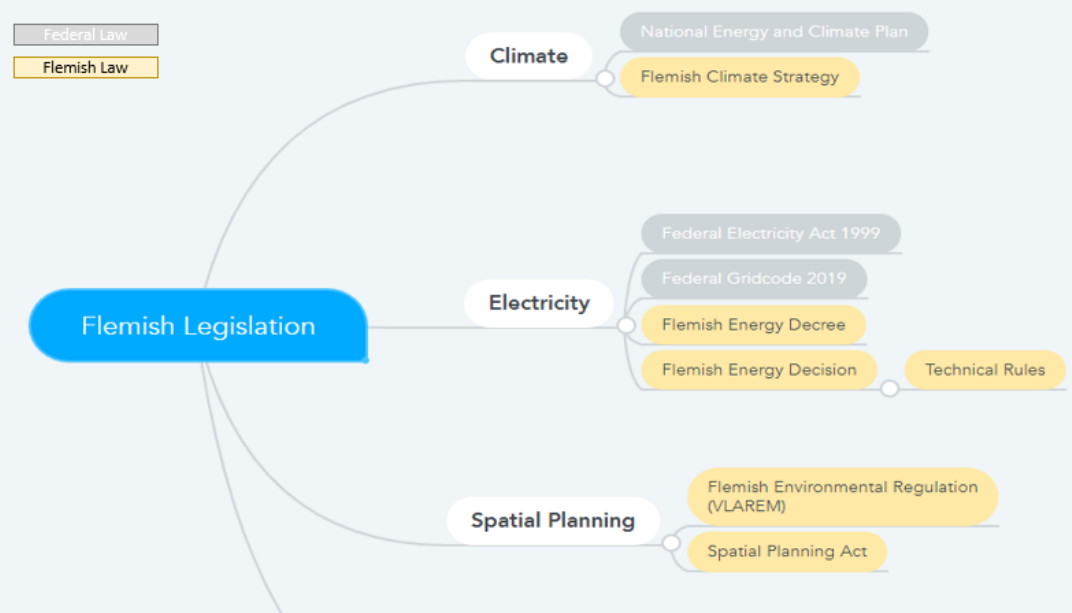

Figure 2.- Relevant national and regional transposition of the requirements from the Clean energy package

[1] The Energy Regulation and Markets Review: Belgium, The Law Reviews, 2022
[2] Belgium 2022, IEA, 2022
[3] Belgium 2022, IEA, 2022

European legislation is integrated in federal (Belgian) legislation and by the Flemish Government in Flemish legislation. The most relevant laws in Flanders legislation are the Climate Act and Energy Act in addition to the Flemish energy and climate plan (Analogue to the NECPs).

3.1.1 National and Regional Climate and Energy plans

Climate Act

The Belgium federal government has together with the districts of Flanders, Walloon and Brussels agreed the **Belgian Integrated National Energy and Climate Plan** ("NEKP"). The Plan captures the Energy and Climate policy of the European Union which includes security of supply, competitiveness and sustainability. On that basis, the Flemish government has on 19 December 2019 agreed its **Flemish Climate strategy 2050** ("Vlaamse Klimaatstrategie 2050") which will be integrated and notified to the European Commission as part of the Belgian Climate Strategy 2050. Additional to the Belgian NECP there is a Flemish specific energy and climate plan (Vlaams Energie en Klimaatplan) 2021-2030

Electricity Act

In Flanders, both the region and the federal government are responsible for the electricity and natural gas markets. The federal government sets regulation for transmission, high voltage grid and non-renewable energy production. Federal energy law is captured in the **Electricity Act 1999** ("Wet Elektriciteit") and **Direction common rules internal electricity market** ("Richtlijn 96/92/EG van 19 december 1996 betreffende gemeenschappelijke regels voor de interne markt voor elektriciteit (art. 20)")

Energy decree

Decree of 8 May 2009 ("het Energiedecreet") laying down general provisions on energy policy (Energy Decree), which sets out the basis of the energy policy in Flanders and has been updates several times to include new obligations for example the ones arising from the Renewable energy directive REDII

3.1.2 Other applicable regulation

The **VREG** (Vlaamse Regulator van de Elektriciteits- en Gasmarkt) is the Flemish regulator which is supervised by the Flemish Parliament that regulates the electricity and gas markets in the Flemish Region and is responsible for Green energy regulation. The energy law and regulations of Flanders are captured by the **Energy Decree and Energy Decision** ("Energiedecreet" and "Energiebesluit") and the **technical rules** ("Technische Reglementen").

Acts on environment and spatial planning

Different laws cover rules and regulations for spatial planning, environmental impact and permitting for sustainable development: **Flemish Environmental Regulation** (VLAREM) and **Spatial Planning Act** (Decreet tot aanpassing en aanvulling van het ruimtelijke plannings-, vergunningen- en handhavingsbeleid).

3.2 Current landscape

3.2.1 Overview of regulatory bodies

Belgium is a federal state, where the decision-making power is shared between a Federal government, three Regions (Wallonia, Flanders and the Brussels Capital Region) and three Communities (the Flemish, the French and the German-speaking Community).
One federal regulator, CREG oversees the high voltage electricity transmission and import/export of electricity. Three regional regulators oversee suppliers and generators at the regional level:

Table 1.- Regulators and operators at federal and regional levels.

Region	Regulator	Operator
Federal	CREG	Elia
Flanders	VREG	Fluvius
Wallonia	CWaPE	ORES / RESA
Brussels	BRUGEL	Sibelga

The Flemish Energy and Climate Agency (VEKA) is a relevant internally autonomous agency with the following objectives:

- ensures policy implementation and support for energy and climate policy in Flanders
- encourages the rational use of energy and environmentally friendly energy production
- provides advice and attestations on the rational use of energy and renewable energy sources in the context of tax deductions and other subsidies for companies
- ensures and evaluates the action plans on rational use of energy and use of renewable energy sources of the energy sector and other target groups
- represents the Flemish Government in Enover, the consultation forum between the regions and the federal level in which energy matters are discussed
- deals with dossiers on the Energy Performance Regulations (EPB) and Energy Performance Certificates (EPC).

3.2.2 Definition of relevant figures and structures

With respect to the relevant figures and structures to be defined, the respective legislation has been identified as follows:

- **Self consumption:** Self consumption is allowed in Belgium and has been in place for several years under the name of "Prosumer or active consumers", these are allowed to generate energy for self consumption and injection to the grid with the installation of a reversible meter that posibilizes the concept of **net-metering**. Recently, a so called "prosumer tariff " has been introduced to "to eliminate an injustice in the charging of the costs for the use of the electricity distribution network". The simple scheme is limited to 10kW, bigger installations are considered "large installations" and need to go through a network study and a permitting process explained later in this report. No supply licence is needed for "behind-the-meter supply" or supply through a direct line, for Flanders, a notification to the VREG suffices, except where the line crosses the limits of its own property, in which case an authorisation from the VREG is required.

- **Demand Aggregators** In Flanders, the concept of aggregation is included under the simplified figure of "**energy sharing**" this posibilitizes the net-metering of consumptions in different supply points for the generation of a single installation and the energy can be either shared for free or sold at a mutually agreed price under the scheme of "**peer to peer trading**". Normally, for the supply of electricity, a regional supply licence is required for the supply of electricity via the public grid to end consumers at a distribution level. According to VREG, from July 2022 everyone - from citizens to local authorities and companies - can become a green electricity supplier. Buyers of such sales only need to notify Fluvius. Fluvius then takes over the practical arrangements and ensures that the information is passed on to the suppliers so that the electricity bill is adjusted automatically. The types of energy sharing are distinguished bewtween: (i) energy sharing in a communal building, (ii) energy community, (iii) energy sharing with yourself, (iv) peer-to-peer sales.

- **Closed distribution networks & renewable energy communities** From 2023, energy sharing will be extended to create energy communities (differences exist between a citizens' energy community or a renewable energy community) and thus comply with the requirements of te European regulation. Anyone who joins an energy community can then invest in a renewable energy installation, a battery system, shared charging stations for EVs, etc. The cost of the investment and the resulting benefits are then shared among the members of the energy community or are spent on other ecological or social projects. To keep the new activities manageable and feasible, a phased approach is foreseen. A community can also act as a flexibility service provider or a participant in flexibility or aggregation. The regulations regarding flexibility on the distribution network are still being developed. In the initial phase, a number of conditions and restrictions will apply which will gradually disappear so that from 2024 onwards, these activities will be possible almost without limit according to VREG. The Flemish Energy and Climate Agency (VEKA), VREG and Fluvius are preparing the technical regulations and practical matters so that mutual energy exchanges can take place correctly and automatically. **The protocols are still under construction,** current information can be found under the dedicated VREG website.

- **Charging infrastructure** In Flanders, investments are being made to develop a network of charging points for electric vehicles. The network operators, in this case Fluvius, have been given a legal obligation ("**openbaredienstverplichtingen aan de elektriciteits-distributienetbeheerders ter stimulering van de infrastructuur voor elektrische voertuigen")** to install a certain number of charging points. Additionally, as discussed before, in 2023 the installation of charging points by third parties will be possible as part of the energy communities figure.

- **Power Purchase Agreements (PPAs)** or Bilateral off-exchange transactions. These transactions take place between known partners, such as a producer selling to a supplier. They form a substantial part of the whole market and Long-term Power Purchase Agreements (PPAs) are often used. Since 2019, various corporate PPAs (CPPAs) have been signed between generators and off-takers in Belgium, which still imposes requirements for Balance Responsible Parties and suppliers.

The detailed definitions according to the Energy decree can be found in the following links:

- Active customer Article 4.4.2 Energy Decree
- Energy community of citizens Article 4.8.1 Energy Decree , Article 4.8.4 Energy Decree
- Renewable energy community Article 4.8.2 Energy Decree , Article 4.8.4 Energy Decree
- Energy parts Article 7.2.1 Energy Decree
- Person-to-person sales (peer-to-peer trade of green energy) Article 7.2.2, §2 Energy Decree

3.2.3 Support schemes

Electricity generation from renewable energy in Belgium and specifically the Flemish Region is promoted primarily through green certificate programmes, as well as other support mechanisms in place to foster the addition of renewable energy capacity, the main applicable mechanisms are:

- **Tradeable Green certificates** to fulfil the suppliers mandatory quotas, these are issued by the regulator and can provide an income source additional to the energy sale prices. Prices for certificates have been adjusted numerous times to reduce the level of subsidies, in line with falling technology and deployment costs and so that certificate prices vary in line with electricity market prices. For medium to large-sized PV-installations and wind turbines, this system is planned to be modified to a tendering system supporting renewable energy installations.
- **Encouragement of small- and medium-sized PV installations and wind turbines** through calls for investment aid and grants, these calls include floating PV installations, PV installations on marginal land and small and medium-sized wind turbines as well as other PV installations. An application can be submitted by public and private companies in Flanders looking for funding for medium-sized solar energy installations and small and medium-sized wind turbines. The latest call (3rd) with a budget of 9,5M€ is due on the 30th of November 2022, nevertheless it is expected for more of these calls to follow.

3.2.4 Permitting, conditions and requirements

For **self consumption**, in plants smaller than 10kW there is only an obligation to register the installation with Fluvius, this size limitation is considered too small for the potential applications within the ENROAD project. For installations larger than 10kW, a Grid connection study is necessary and needs to be requested with Fluvius. For large installations, Environmental permits are required for solar and wind installations. Since 2017, environmental and land use/building permits have been merged into an integrated environmental permit (omgevingsvergunning). Individual permits for projects greater than 25 MW capacity are required from the Federal Minister for Energy.

- Applications should be addressed to the FOD Economie, which submits the file to the CREG for advice.
- The Federal Minister for Energy makes the final decision

For **energy sharing**, the project needs to be registered with Fluvius and the following conditions must be met:

- All relevant off-take points must have a digital meter .
- Anyone who wants to share must request 'metering regime 3' from their electricity supplier so that the digital meter can read quarter -hour values.

- The energy sharer must register via the Fluvius online customer portal, where the system and the steps to be taken are also explained.
- For the time being , the parties involved must have the same electricity supplier. From 2023 this is expected to no longer be necessary.

For **Energy Communities,** which will be possible as of 2023, the protocols and checklists are still under construction**,** current information can be found under the dedicated VREG website. The commnunities must be **registered legal entities** such as a company (e.g. cooperative company, private company, etc.) or an association (e.g. non-profit organization).

Currently it has already been defined who can take part and who can control energy communities. According to VREG and following the EU directives, a citizens' energy community or a renewable energy community are very similar but the main differences are in who can participate in and have control over the community and in the existence or not of geographical or technical proximity requirements. For the aims of the ENROAD project, have been identified to be more viable for the NRA as they allow entities such as the NRA to participate and do not require a geographical nor technical boundary.

3.2.5 Other Conditions

Additional conditions can apply depending on the municipality, for example in the case of Antwerp. Relevant documents would be the zoningplan, which refers to the spatial implications and elevations of buildings.

3.3 Identified Key Opportunities

Under the current and foreseeable regulation, several opportunities have been identified and discussed in the stakeholder workshops held in October 2022. The concepts of Energy sharing and Energy communities were discussed and some specific examples were proposed.

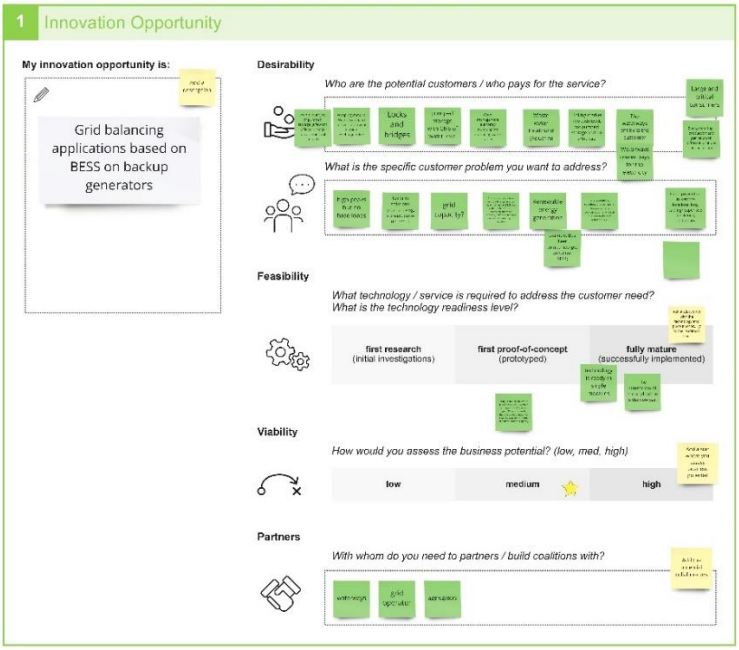

Figure 3.- Sample innovation worksheet from workshop held in October 2022

The figures of Energy sharing and Energy communities present several opportunities for linear infrastrucutres with decentralized consumptions and potential injection points such as the ones owned and opertated by the Flemish NRA, for example:

- The volumes of energy generated by independent and decentralized installations such as PV on noise barriers or small scale Wind turbines can be aggregated under the Energy sharing figure and associated/matched with the consumption of the NRA in other locations within Flanders such as offices, briges and locks and do not need to be connected directly. While there are current limitations to the energy volumes that can be shared under this mechanism to be agreed with Fluvius, these are expected to be loosened in the foreseeable future. The upcoming Energy communities will allow the NRA to extend the pool of potential offtakers for the decentrally generated energy to include charging stations and or other consumption installations owned by third parties such as resting stations provided a legal entity is formed to constitute the Energy community.

- In addition to the generic applications of the possibilities presented by Energy sharing and Energy communities described above, some applications specific to the Flemish case were discussed. These are related to the Flemish NRA also owning and operating waterways, locks and bridges, some of wich are located in remote locations and operate during a couple of minutes at once and accumulating only few operational hours in total per year.

- The possibility of installing battery storage systems next to some of this consumers to make a better use of their grid connection, wich is not utilized during most hours of the year, by storing the energy generated by the decentral installations and injecting it back to the grid in periods of un-matched energy consumption by the NRA.

- These bateries could also be charged by using the positive water level differences in the locks when moving from a higher to a lower level as well as when managing water levels due to precipitation for which there are reliable forecasts. While the technology needed to implement this concepts has been readily available for several year, without the extended offtake opportunities, and potentially also grid balancing opportunities, presented by the energy sharing and energy communities these were not economically viable.

- Lastly, for remote critical applications which currently use back up diesel generators, battery storage systems powered by on- and off site renewables can be deployed more viably through the opportunities presented by the described schemes.

3.4 Identified Key Challenges

In order to implement the opportunities described above, some current challenges have been identified that need to be overcome, mainly:

- The size limit for self consumption renewable installations without the need of network studies is considered too low(10kW). As a point of comparison, other EU countries have limits as high as 500kW.
- For self consumption and energy sharing, some costs such as the grid fees, taxes and the so called "prosumer tariff" are applied to the self consumed/shared energy. This makes the business cases less attractive.
- For large installations, Environmental permits are required for solar and wind installations. Additionally, individual permits for projects greater than 25 MW capacity are required from the Federal Minister for Energy. The permitting process has historically been the bottleneck for utility scale installations in Belgium.
- While not officially published, there are limits to the volumes of energy allowed under the energy sharing schemes to be agreed with Fluvius, these are expected to be partially lifted with the introduction of the Energy communities in 2023 but the details are still unknown.
- While expected to be open for all participants, for the consolidation of energy communities a legal entity needs to be formed and internal legal/organizational barriers may prevent the Flemish NRA from doing so. This needs to be investigated at legal level within the organisation.

3.5 Key Recommendations

The recommendations arising form this analysis are in line with the identified challenges to the implementation of renewable energy projects, these are summarized as follows:

- To increase the size limit for self consumption renewable installations without the need of network studies.
- To free the shared energy from taxes and levies and the self consumed energy on site and with direct connections from the network charges such as the "prosumer tariff"
- To mainstream, standardize and facilitate the environmental and zoning/special permitting process for large installations, Environmental permits are required for solar and wind installations.
- To lift or define generous limits to the volumes of energy allowed under the energy sharing schemes and energy communities.
- To conduct a legal review at organization level to evaluate the potential issues preventing the Flemish NRA to form or take part on legal entities necessary for the consolidation of Energy communities.

4 UNITED KINGDOM

As of 31 January 2020, the UK has left the EU, and therefore will not contribute to EU targets or be bound by the Effort Share Regulation after the Transition Period ends. However, UK has its own objectives. In the UK's British Energy Security Strategy and the Nationally Determined Contribution stated that all regions have high ambitions and works hard to reduce the GHG emissions along every sector with a global target of reducing UK GHG emissions around 68% by 2030, compared to 1990 and net zero by 2050.

Additionally, Climate change policy is devolved to Wales, Scotland and Northern Ireland, although the UK government retains control over many policy areas as defined in the UK's British Energy Security Strategy. The Environment (Wales) Act 201651 requires Welsh Ministers to reduce emissions in Wales by at least 80% in 2050. Wales has targets to produce 70% of the electricity used from renewable sources by 2030, and of 1GW of locally owned renewable energy capacity by 2030. Scotland's climate change legislation requires Scottish Ministers to reduce emissions in Scotland to net-zero by 2045, with interim targets of 56% reduction (from a 1990 baseline) by 2020, 75% reduction by 2030, 90% reduction by 2045 and annual targets for each other year to net-zero.

4.1 National Regulatory framework

Energy policy in the UK is the responsibility of the Department for Energy Security and Net Zero (DESNZ). Although there are numerous regulators for specific parts of the energy sector, much of the energy market is regulated by Ofgem. Historically, parts of energy generation, transportation, and supply were run by the public sector. Most of the market is now privatised; generation and supply are competitive, and transportation through networks is regulated as the operators are monopolies.

The Government and Ofgem continue to regulate the market for customers, and deliver policy to meet the Government's aims on energy. The energy policy of successive Governments has centred around three objectives of security, affordability, and decarbonisation. This is sometimes referred to as the energy 'trilemma'.

Electricity Act 1989 and Energy Act 2013 provide a complete framework for development of renewable energy technologies in the UK, with a range of measures to support the sector and incentivize investment.

Additionally, Electricity Market Reform (EMR) is intended to provide a stable and predictable framework for investment in lowcarbon energy sources, while also ensuring that there is sufficient capacity to meet electricity demand. By providing financial incentives and support for renewable energy projects. The EMR made two significant changes to how the electricity market works, the capacity market and the Contracts for Difference scheme.

The Review of Electricity Market Arrangements (REMA) consultation, conducted between July and October 2022, analysed various aspects of the UK energy market, aiming to balance the need for low-carbon electricity production with the need for reliable and affordable energy for consumers. A second consultation is planned for 2023 to deepen outstanding issues.

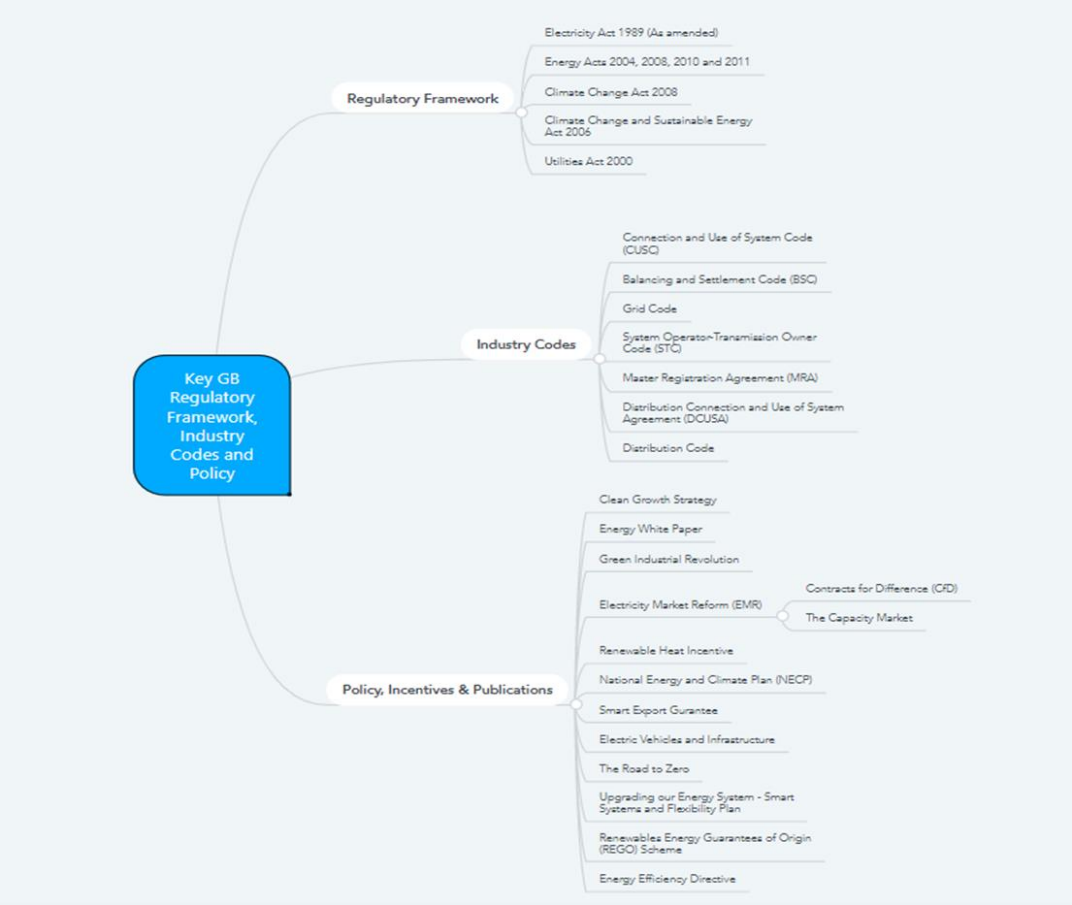

Figure 4.- U.K. Specific Relevant Regulatory Diagram

4.1.1 National and Regional Climate and Energy plans

British energy security strategy: although the UK has now left the EU, the government remains committed to building on the policies set out in the UK's compormisses relating to renewables and energy efficiency. (Secretary of State for Business, Energy, and Industrial Strategy, April 2022)

In December 2020, the UK Government launched its **Energy White Paper** building on the Prime Minister's Ten Point Plan for a Green Industrial Revolution by outlining plans for transformation of transport, energy and infrastructure in order to delivery significant decarbonization of power in the 2030s and net-zero by 2050. The publication provides a lot of detail for stakeholders in terms of how energy and electricity will be transformed in the UK over the next 30 years.

The **Road to Zero:** Sets out the UK's strategy for cleaner road transport in order to delivery zero-emission transport by 2030 and the development of the required charging infrastructure and manufacturing capability.

The **Energy Digitalisation Strategy**, developed by the government, Ofgem and Innovate UK in coordination with the energy sector, sets out a vision and suite of policies to digitalise the energy system. Digitalisation will enable millions of low carbon assets, including solar PV, electric vehicles and heat pumps, to be optimised across our energy system.

4.2 Current landscape

4.2.1 Overview of regulatory bodies

Figure 5.- Overview of main market players. Source: Arup.

- **Transmission Grid:** managed by the Transmission Network Operator (TNO), it comprises all the transmission lines and substations by means of which energy is distributed across the country. Transmission voltage is 275kV or 400kV. In Scotland, 132kV is also used. The transmission owners for the different regions are: National Grid Electricity Transmission (NGET) for England and Wales, Scottish Hydro Electric Transmission Plc for northern Scotland, and SP Transmission Plc. for southern Scotland. The System Operator in England, Wales and Scotland is the National Grid Electricity System Operator (NGESO).

- **Distribution Grid**: managed by energy Distribution Network Operators (DNOs), there are six DNOs in GB and are responsible for the regional/local distribution of electricity (Electricity North West, Northern Powergrid, Scottish and Southern Energy, SP Energy Networks, UK Power Networks and Western Power Distribtuion). Distribution voltage is 132kV in lower in England and Wales, and less than 132kV in Scotland.

- **Suppliers/Retailers (liberalized):** licensed companies that supply electricity to retail customers, may have own generation or acquire in the wholesale markets.

- **Market operator:** the wholesale market is operated by Elexon, who administer the Balancing Settlement Code (BSC) in Great Britain.

- **Regulatory body:** Ofgem (Office of Gas and Electricity Markets), the government regulator for the electricity and downstream natural gas markets in Great Britain.

4.2.2 Definition of relevant figures and structures

With respect to the relevant figures and structures to be defined, the respective legislation has been identified as follows:

- **Self consumption:** Self consumption is allowed in UK and has been in place for several years, this allows entities with their own generator source to self consume and inject to the grid. The self-consumption installation has an electricity supply contract either through a supplier or aggregator. The simple scheme is limited to 11.04kW if connected to 400V and 3.68kW if connected at 230V. Bigger installations are considered "large installations" and need to go through a network study and a permitting process.

- **Demand Aggregators:** Aggregation contracts are currently possible in the UK and commonly used by consumers with supply points spread. Demand aggregator can deliver Demand response services by either reducing their demand or taking advantage of onsite generation.

- **Renewable energy communities:** According to Community Energy England, by 2020 there were 424 community energy organisations across the UK, with 319 MW of installed capacity. The Government has policies to support energy, including at the local level. These include the Smart Export Guarantee, the Renewable Heat Incentive, and the Local Energy Programme.

- **Closed distribution networks:** A distribution exemption holder may apply to Ofgem for classification as a Closed Distribution System (CDS). Ofgem must agree to classify the distribution exemption holder if it considers that it meets the criteria laid down in regulations. Broadly, these criteria include that: The distribution system is not used for the purpose of supplying electricity/gas to household customers (or supplies fewer than 50 employees of the exemption holder supplied from embedded generation); The distribution system is used for distributing electricity/gas within a geographically self-contained industrial, commercial or shared services site and is not integrated into the national transmission or distribution network; The distribution system is wholly or mainly used to supply integrated system users or the distribution exemption holder.

- **Charging infrastructure:** The market for EVs is immature yet growing. The latest data for Q3, 2022 shows that 14% of new car registrations in the UK were battery electric vehicles (BEV) with a further 5% being plug-in hybrid electric vehicles (PHEV). The Government has a variety of schemes to support the provision of charging infrastructure, including in people's homes and workplaces. The electric vehicle infrastructure strategy was published in March 2022 setting out the vision to charging infrastructure as both a perceived and real barrier to the adoption of electric vehicles. The provision of charging infrastructure was also included in amendments to the Building Regulations 2010 in June 2022.

- **Power Purchase Agreements (PPAs)**: They form a substantial part of the whole market and long-term PPAs are often used. The UK has a relatively healthy short-term PPA market or renewables which a number of policies have facilitated. Similarly, the Contracts for Difference scheme, being based on wholesale market price, prompts PPAs to be signed which will provide revenues corresponding to market reference price for the CfD.

4.2.3 Support schemes

There are several government policies and initiatives that encourage the adoption of renewable energy and self-consumption in the UK, such as:

- **Smart Export Guarantee (SEG)**
  Smart Export Guarantees (SEGs) are a financial incentive to support distributed and small-scale renewable energy generation, up to a capacity of 5 MW. The SEG scheme for generators opened on the 1st January 2020.

  The SEG scheme replaces the Feed-in Tariff (FIT) scheme that closed on the 31st March 2019 but works differently to FITs. The SEG scheme obliges electricity suppliers to offer an export tariff rate to an eligible generating unit.

  The main financial benefit from a generation project under the SEG scheme is the export tariff, which is a guaranteed price for each unit of electricity exported to the grid. It is an obligation for licensed energy suppliers to offer eligible generation projects an export tariff rate. The electricity suppliers decide the SEG export tariff details i.e. the rate and the length of the contract. However, although wholesale electricity prices can fall below zero due to changes in demand, electricity suppliers must always offer a tariff which is greater than zero.

- **Contracts for difference (CFD)**
  This is the main financial incentive mechanism for larger schemes of low carbon generation, installed capacity of at least 1MW. It has replaced the Renewables Obligation (RO), which closed to new applications in March 2017. The application process for a CFD is much more complex than for the SEG scheme.

  A Contract for Difference is a bilateral contract between a generator and the Low Carbon Contracts Company (LCCC, the CFD counterparty), which is government owned. A generator with a CFD is paid the difference between the "strike price" and the "reference price" over a 15-year period. The strike price is an agreed price for electricity reflecting the cost of investing in low carbon generation. The reference price is a measure of the GB market price for electricity.

  CFDs require generators to sell electricity into the market as usual. But to reduce their exposure to market prices, the CFD provides a variable "top up" payment. When the strike price is higher than the reference (market) price, the generator receives a payment. At times when the market price exceeds the strike price, the generator is required to pay back the difference, thus protecting consumers from over-payment.

4.2.4 Permitting, conditions and requirements

For **self consumption**, for capacities lower than 30MW, it is recommended to connect via a distribution network, as it may be more economical and efficient. All DNOs provide information on the feasibility of the connection and associated cost, such as capacity network capacity maps, dedicated generation 'surgeries' or 'drop in' sessions, For capacities bigger than 30MW National Grid offers ConnectNow Research Assistant tool, created to help with the connection research. It shows the potential locations that could meet the needs and an estimated cost of the connection. As of April 2023, all new connection applications should be submitted via the Electricity System Operator portal. This replaces the previous connection application form process.

In the future, there is likely to be **a new requirement for Electricity Storage devices** operating in import mode to switch to export mode if the grid frequency falls below a defined threshold. The details surrounding these requirements are being considered by an industry working group and are not yet mandatory. (Energy Networks Association)

4.2.5 Other Conditions

Additional conditions can apply depending on each region within UK.

4.3 Identified Key Opportunities

Under the current and foreseeable regulation, several opportunities have been identified and discussed in the stakeholder workshops held in April 2023. The concepts of Energy sharing and integration of storage technlogies were discussed and some specific examples were proposed.

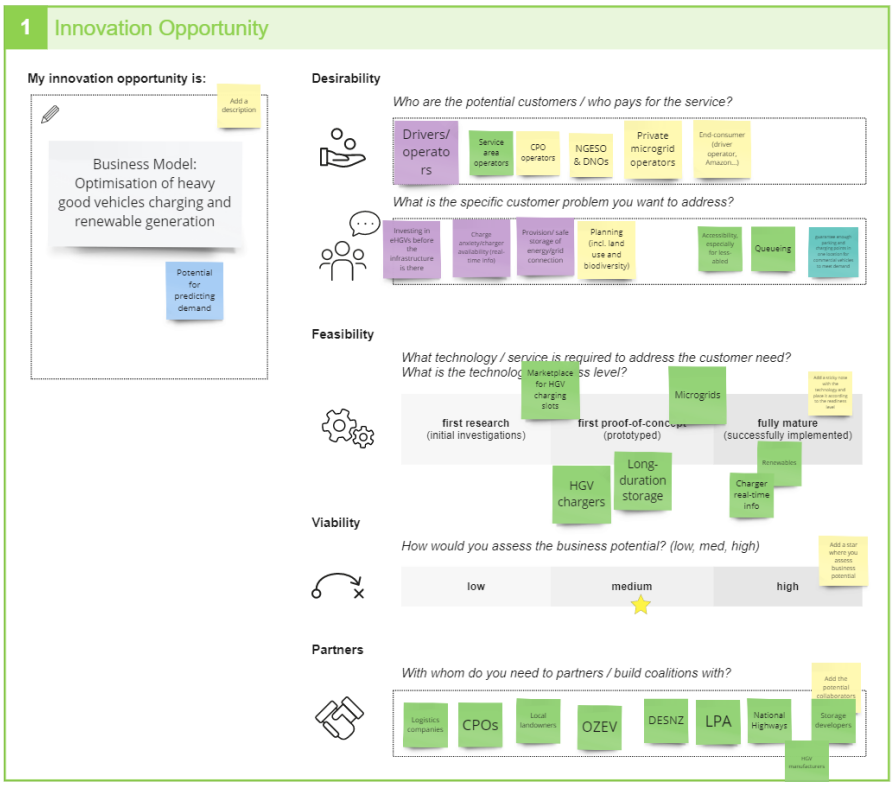

Figure 6.- Sample innovation worksheet from workshop held in April 2023. Source: Arup.

Some trends and factors that will drive the development of solar self-consumption in United Kingdom:

- Cost reduction: The costs of renewable technology and energy storage systems have decreased significantly in recent years and it is expected to keep dropping, which will make distributed energy generation even more accessible and cost-effective. Recently, supply change constrains have stopped the price drop.

- Regulatory changes: although the regulation has evolved positively, there are still some changes required, specially those related to procedures and grid connection. A second REMA consultation is planned for 2023. Government plans to deepen consultation related to electricity market reform across several market dimensions.

- Environmental awareness: consumers are concerned about the environmental impact of their actions and are looking for ways to reduce their carbon footprint. Solar self-consumption is an effective way to reduce carbon emissions and contribute to the fight against climate change.

- BESS integration or flexible technologies: the entry of storage systems, mainly batteries, will take place in the next few years and allow a more efficient management of surpluses, displacement of consumption peaks and a greater penetration of renewables.

- Surplus management: new products to compensate the surplus are available in the market as the virtual batteries, and others, as the PPAs, onsite and offsite are becoming available for all the scales.

- Technological advances: The technology behind renewables and energy storage systems is constantly evolving, that will lead to better prices and to improve the grid stability. In UK, Ofgem provides funding mechanisms for electricity and gas distribution and transmission companies through the Network Innovation Allowance (for small scale innovations projects) and Network Innovation Competition (for larger-scale).

- Decentralised energy: self-consumption allows consumers to generate their own energy and reduce their dependence on electricity companies. As a more decentralised electricity grid develops, solar self-consumption could become an even more important part of the UK energy system.

- Integration of the electrical vehicles: EV charger are becoming more present with a high requirement of energy; ENA Low Carbon Technology Working Group has been looking at a way to simplify the V2G connection application, including considering a single process that combines the aspects of EV as demand and generation.

- "Call for inputs" and consultations from Ofgem have been recenltly launched in several topics around energy market and distributed energy being od special relevance Call for Input: The Future of Distributed Flexibility, Consultation: Future of local energy institutions and governance.

4.4 Identified Key Challenges

- Administrative and bureaucratic barriers: Although some administrative barriers have been removed, there are still formalities and procedures that hinder the installation of self-consumption systems. The complexity of the process can discourage consumers and delay the development of solar self-consumption.

- Access to the grid: Grid connectivity in the United Kingdom results in long delays for renewable energy projects. Investment in grid infrastructure is critical to address these challenges and improve throughput capacity for integrating renewable projects. However, the swift progress of solar energy technology has not kept pace with requisite infrastructure construction, which requires significant investments and multiple permit approvals to install kilometres of transmission circuits.

- Complex stakeholders: the administrative procedures and project requirements involve a wide network of stakeholders. Moreover, if Energy Communities or other alternatives are considered, it significantly increases the number of stakeholders involved who have to be aligned.

- Renewable energy communities and self-consumers are possible under regulation, however, support from the government is limited and the strategy for this segment is unclear.

- Low level of reward via the SEG.

- In the future, there is likely to be a new requirement for Electricity Storage devices operating in import mode to switch to export mode if the grid frequency falls below a defined threshold. The details surrounding these requirements are being considered by an industry working group and are not yet mandatory.

4.5 Key Recommendations

The recommendations arising form this analysis are in line with the identified challenges to the implementation of renewable energy projects, these are summarized as follows:

- Establish likely hurdles and associated costs related to planning permission and grid connection, which as highlighted, are common barriers to developing renewable projects.

- Explore the level of savings and revenues a project could generate through the various routes-to-market available to understand the strength of the business case.

- Engage with key stakeholders early on in project development and maintain regular communication throughout to ensure project success.

- To increase the size limit for self consumption renewable installations with simplified connection procedures.

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