IANOS

SUSTAINABLE SOLUTIONS
for islands' decarbonisation

D3.7

Decision Support Toolset Pre-Validation/Assessment of LH & Fellow Islands Plans

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Executive Summary

The assessment of investment activities is a pillar in strategic management at any level. When investment activities involve the deployment of projects, project evaluation aims at determining the effects caused to foster the best allocation of scarce resources. In project evaluation, laws of economics are pivotal to determine the profitability of an initiative. However, projects that have also a social interest have to be assessed considering a broader range of impacts. Assessment shall be performed before project deployment to forecast the effects expected (ex-ante), during project deployment to check the performance level to identify corrective measures (in medias res) or after the time horizon of the project to verify the actual impacts generated (ex-post). Cost-benefit analysis (CBA) is the most acknowledged tool for financial viability assessment. A wider project assessment is obtained where soft effects, and intangible and non-monetizable impacts are included in the project assessment.

Therefore, the decision-makers across the energy value chain need a tool that is able to provide quantifiable insights supporting their potential investments decisions in clean and smart energy interventions. Towards that direction, the activities of WP3 aim at proposing an IANOS Energy Planning and Transition (IEPT) suite that supports the investments of the different stakeholders providing a holistic approach that quantifies both the costs and benefits of the IANOS interventions in the demonstration sites, i.e., Lighthouse and fellow islands of IANOS, as well as providing a tool that facilitates the fundraising campaigns.

The main objective of Task 3.4 is to conduct a pre-validation of the IEPT suite, in order to justify its applicability and fitness level to the interventions activities that take place in the IANOS demonstrators. The work of this task is consolidated and presented in this deliverable (D3.7), which is the first version (followed by a second version in month 30).

To fulfil the objectives of Task 4.3, D3.7 briefly presents the components and functionalities of the IEPT suite. Afterwards, a literature review analysis is carried out, so as to assess the existing regulatory framework being in place in the Lighthouse and Fellow islands of the IANOS project. The long-term planning procedures regarding the innovative smart grid interventions are also presented. In addition, in order to validate and test the functionalities of the IEPT tool, a thorough investigation and description is provided for each country, for both the electricity and gas networks. Specific information about the transmission and distribution operators in both of the energy networks is included. That information will be used not only as an input in the IEPT tool and particularly in its CBA component, but also as an additional explanatory element which reflects the current conditions/dimensions used in the investment practices of the Operators.

Following the literature review, this deliverable presents an initial dimensioning of the used assets and the scenarios that will be tested by each demonstrator. The input of the information reported in this deliverable describes the progress of the project up to M18. In the second version of this deliverable the content included in this section will be updated and finalized according to the progress at that point. In addition, the information describing the power system topology that those assets will be installed is going to be provided the following months of the project and will be also documented in the next version of this deliverable. Finally, for each Use Case, the benefits, along with the defined KPIs those that are linked to the IEPT tool are presented. A screening process takes places, where from those KPIs that are linked to the IEPT tool, the ones that can be monetized through the KPI component are presented. These KPIs provide fine-grained quantified opportunities for the decision-makers, in order to assess the smart grid interventions.

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List of abbreviations and acronyms

Abbreviation	Description
CBA	Cost Benefit Analysis
CEC	Citizens Energy Communities
DER	Distributed Energy Resources
DLT	Distributed Ledger Technology
DSO	Distribution System Operator
FI	Fellow Islands
FiP	Feed-in-Premium
FiT	Feed-In-Tariff
HV	High Voltage
ICT	Information Communication Technology
IEPT	IANOS Energy Planning Transition
KPI	Key Performance Indicators
LCA	Life Cycle Analysis
LCC	Life Cycle Cost
LH	Lighthouse islands
LV	Low Voltage
ML	Machine Learning
MV	Medium Voltage
NDP	Network Development Plan
OHL	Overhead lines
RES	Renewable Energy Sources
TSO	Transmission System Operator
UC	Use Case
WACC	Weighted Average Cost of Capital
WP	Work Package

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1. Introduction

1.1 Objectives and Scope

The overall objective of WP3 is to develop a concrete energy planning and decision-making toolkit to assist the energy transition of geographical islands, integrating a dedicated web platform for Life Cost Analysis (LCA)/ Life Cycle Cost (LCC) studies, an equity crowdfunding tool blended with power system modelling and simulation tools and a Cost-Benefit Analysis (CBA) tool. The main objective of Task 3.4 is to produce practical feedback to finetune the efficiency of the toolset regarding calculations and functionalities, by examining holistically the smart grids solutions in the Lighthouse (LH) and Fellow Islands (FI), using the developed toolset. Within the scope of Task 2.3, the regulation set in the geographical area, incentivizing and reimbursing innovation, as well as the operators' long-term planning procedures were considered. In addition, an assessment of the IANOS Use Cases (UCs) was performed and a pre-validation of the decision support toolset was conducted.

1.2 Relation to other IANOS activities

As shown in Figure 1, Task 3.4 is closely interrelated with the rest of the tasks of Work Package (WP) 3, as well as with WP2, WP7 and WP9 activities. More specifically, the results of Task 2.3 will be an input for:

- WP2: This WP will integrate the market design concepts developed within this particular WP with the findings of Task 2.3 and the results coming from the demo clusters.
- WP7: This WP will use the initial assessment of LH and FI plans as a starting point for performing the technical, social and impact assessment of IANOS solutions.
- WP9: Based on the Task 3.4 output, WP9 will assess the scalability and replicability potential of IANOS UCs in the LH and FI.

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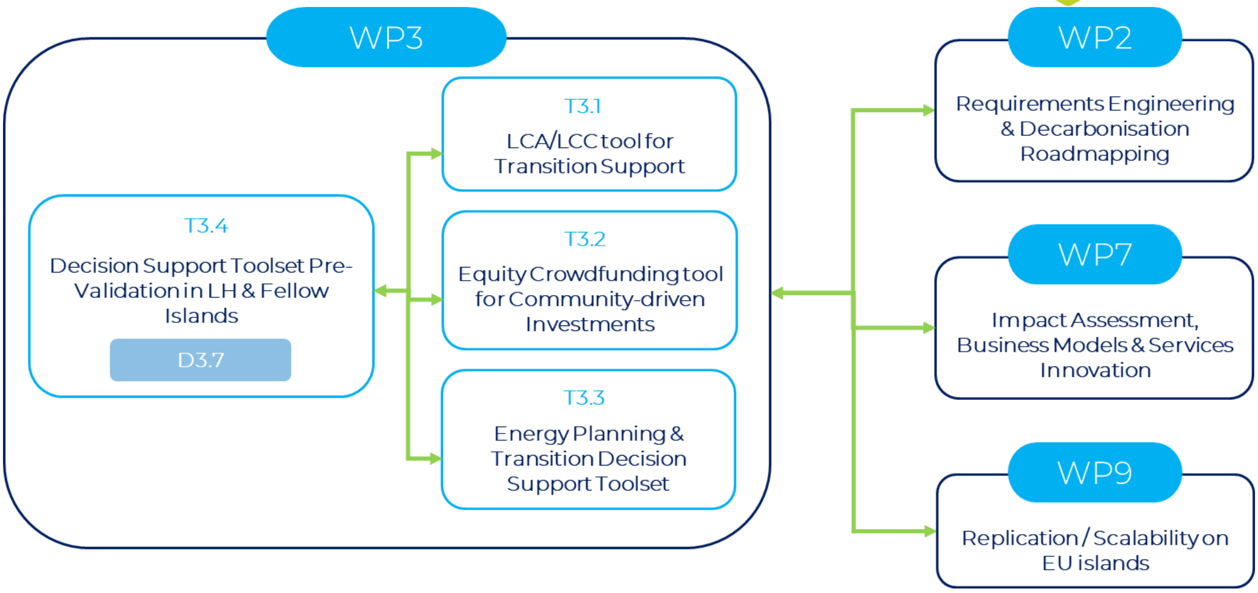

Figure 1: Interactions between Task 3.4 and other WPs in the IANOS project.

1.3 Deliverable outline

This deliverable aims to present the respective work carried out in Task 3.4, including the pre-validation of the decision support toolkit in the LH and FI. First, Chapter 2 provides an overview of the decision support toolkit and its main functionalities. Chapter 3 presents the existing regulatory barriers to innovation that IANOS islands face and the long-term planning processes of system operators.

Then, Chapter 4 describes the IANOS UCs in detail and performs an initial assessment, while Chapter 5 presents a relation among the KPIs calculated for each UC, their calculation engine and an initial assessment for their utilization in the IEPT suite. Finally, in Chapter 6 the work of Task 3.4 is concluded, while also including a description of the information that the next version of this deliverable will contain.

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2. Overview of Decision Support Toolset

During the WP3 activities, a concrete IANOS Energy Planning and decision-making Toolkit (IEPT suite) will be developed to assist the energy transition of the Lighthouse (LH) and Fellow (FL) islands. IEPT constitutes as a holistic tool able to evaluate the overall benefits expected from clean energy/smart grid interventions, from various perspectives, based on the viewpoint from each stakeholder (Municipality, Distribution System Operator (DSO), community representatives, etc.). This will be pre-validated in this deliverable[1], where the LH and FL UCs will be evaluated holistically for their sustainability, scalability, and replicability potential.

The different components that will be integrated under a unified concept are the following:

a) **VERIFY District Platform (VERIFY-D):** A dedicated web platform for Life Cycle Analysis (LCA)/Life Cost Cycle (LCC) studies. Environmental and economic analyses are expected through the computation of emissions extracted (life cycle environmental footprint), which depend on the technology applied in the grid and type of fuel mixture used to generate energy in the LH islands. Also, this tool will compute the life cycle costing based on the energy components that appear in the energy grid. Finally, the comparison between baseline and target scenario in terms of the environmental gains and economic profits,

b) **An equity crowdfunding tool (CrowdEq):** This tool will create a crowd-equity (or crowdfunding) platform, where actors (i.e., project investors, islanders, other key stakeholders) will be able to register their foreseen projects and set a funding goal in return for equity, creating a fundraising campaign. The platform would ultimately enable fractional ownership of RE assets, supporting projects' fundraising and transactions either via normal FIAT currency or tokenized energy over Distributed Ledger Technology (DLT),

[1] And also, in its second version with a due date the M30.

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c) **Energy System Simulator (ESSIM):** This tool simulates network balancing and the effects thereof, in an interconnected hybrid energy system over a period of time. It takes as inputs the energy system defined in ESDL and calculates optimal schedule of flexible producers and the effect of this schedule in terms of emissions, costs, load on the network, etc.,

d) **INTegrated Energy Management Simulator (INTEMA.grid):** It is an energy system modelling and simulation platform. It is based on open-source non-proprietary tools. It is composed by the following main components: (a) Power System Simulations–Based on the acausal, object-oriented, equation based Modelica language to conveniently model complex physical systems, (b) Power Optimization–Ability to construct optimization problems using Python optimization tools pyomo along with the neos-server that provides the required solvers., and (c) Power Forecasting–Utilizing open-source Machine Learning (ML) frameworks in Python, i.e., scikit-learn and Keras,

e) **A Cost-Benefit analysis tool (CBA):** The CBA tool will be based on the JRC's and ENTSO-E's CBA methodologies. To do that and depending on the activities and vision of the various stakeholders, the factors of interest will be selected and respective KPIs will be calculated to assist them in setting strategic priorities, aligning horizontally in all cases with the priorities set by the Green Deal. The CBA tool offers an analytical approach for the stakeholders/ investors that provides a quantifiable insight regarding whether a smart grid intervention exceeds the existing baseline scenario in terms of cost and benefits. This task is considered as the cornerstone of the IEPT suite and will assist the activities in several tasks across the WPs of IANOS, such as the CBA of WP7 and the scalability and replicability studies activities that will be conducted in WP9.

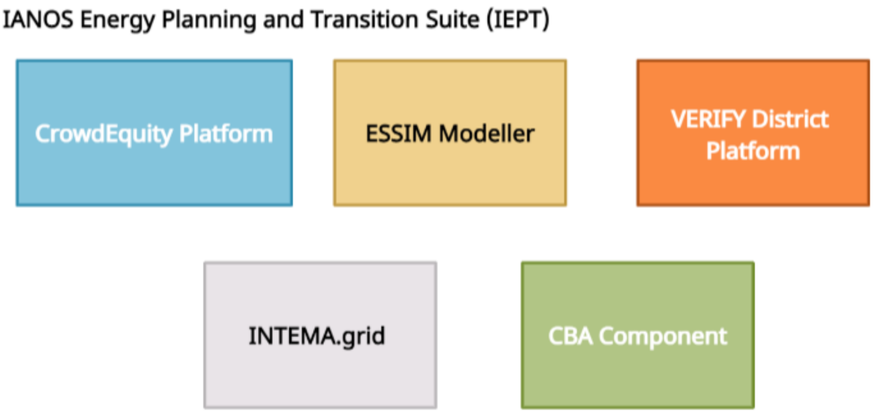

Figure 2: Conceptual Model of the IEPT suite.

3. Regulatory barriers landscape & planning procedures in IANOS islands

A brief overview of the existing regulatory barriers to innovation that IANOS Lighthouse (LH) and Fellow islands (FI) face, and a description of the existing long-term planning processes and the regulatory framework for investment of the system operators.

3.1 Regulatory barriers to innovation

Island territories that are not connected to the mainland grid have some peculiarities derived from their high level of isolation like higher cost of energy, grid instability and high energy dependence. For these reasons, they are the subject of specific regulation under the EU, national and local legislation. In this context of the deliverable D2.4, entitled as “Report on regulatory/legal and financial aspects presents an overview of EU policies”, a questionnaire was circulated aiming at collecting this information directly from the islands’ authorities. This contribution can be considered as an integration of the future questionnaire output with other external literatures, aiming at collecting relevant regulation for the different locations in the IANOS islands on a national and local level, underlying potential challenges in this area.

Regarding Portugal, Greece and French territories, a work published in [1] offers a good review of all regulatory challenges for the implementation of renewable energy system on isolated islands, identifying some domain of action.

- **Remuneration scheme**

Greece: Feed-in-Premium (FiP) scheme in 2014, that adds a premium to price received by renewable generators in the wholesale electricity market. The FiP Contracts of renewable energy projects participate in the wholesale electricity market (either directly or through aggregators) and enter with zero price energy offers on an hourly basis. Regarding renewable energy from hybrid stations there was still not a clear remuneration mechanism, as a special tariff only of hybrid stations is currently under consideration. The pricing issue

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is a main barrier for the project as the framework mainly refers to pumping systems rather than battery-powered hybrid station.

Azores: The Regional Legislative Decree No. 26/2006/A [2], subsequently updated by Regional Legislative Decree No. 14/2019/A [3], defines an additional remuneration mechanism known as PROENERGIA or "System of Incentives for the production of energy from renewable sources." For investment projects on the islands of Santa Maria, São Jorge, Graciosa, Flores and Corvo, the rate increases to 35% [4].

French territories: In France, renewable energy is also promoted through feed in laws and competitive tenders. More concretely, a combination of Feed-In-Tariffs (FiTs) for installations below 500 kW and FiPs for installations above 500 kW is in place since 2015. The overseas departments are subject to this special remuneration, which defines a guaranteed purchase price over a period of 15-20 years. In order to deal with the problems of energy security during load peaks in extreme weather events, the maximum share of intermittent generation is legally limited to 30% within the island's electricity grid [5].

- **Unified price electricity systems**

Insular systems have also higher investment and operating costs, which normally should have been translated on the electricity prices the consumers pay monthly. All the examined cases have unified price systems, which want to play down the differences in the prices between islands and the mainland that can lead to discrimination.

However, the unified price systems although aim to ensure fair prices and to avoid discrimination between the habitants of mainland and the islands does not allow for a pricing structure that reflects the cost of energy production and thus, promote the renewable energy [6]. This creates various issues, such as the costly and underperforming hybrid station in the island of Tilos in Greece, but also in cases of resistance from the local population, which does not recognize to have any direct economic benefit from the deployment of Renewable Energy Sources (RES). Other issues include the rising costs for the governments that can lead to deficits, and economic disincentives for the electrical utilities which are forced to sell power on these islands at the same price.

- **Energy storage systems**

This is a crucial point as until the various barriers in storage technology are overcome it will be difficult to achieve 100% self-sufficiency. Greece was the first European country to adopt specific regulation regarding the installation of hybrid systems [7]. According to this framework, there are two different tariffs, one for the electricity that is fed to the grid and one for the electricity that comes from storage units. Additionally, there is a limited amount of energy from the grid that can be used to store, and only be used when RES is not available. There is the need for improvements in the legal framework for hybrid systems, in particular in the regulation "dealing with battery technology". Regarding Portugal and French territories there was a lack of coherent regulation regarding energy storage systems, at list up to 2020.

In this regard, very recently in Ireland the "Renewable Energy Regulations 2022" was published, which also cover energy storage systems [8]. In particular, the regulation declares the rights of **active costumers which own an energy storage facility**: they shall be offered the transmission or distribution system within a reasonable time since their application, should not be subject to any double charges, for stored electricity remaining within their premises or when providing flexibility services to system operators, object to disproportionate licensing requirements or fees, and they may provide several services simultaneously, if is technically feasible. Regarding RES **self-consumers** (individually or through aggregators), they can generate renewable energy for their own usage, and also store and sell their excess production of renewable electricity, through the Power Purchase agreements (PPAs), electricity suppliers/retailers and Peer-to-Peer (P2P) trading arrangements, without being subject to any discriminatory or disproportionate policies and fees. They may install electricity storage systems combined with installations generating renewable electricity for self-consumption , without any double fees. We could expect that this regulation will formulate the regional ones.

Regarding the **Lampedusa** case, according to [9], the main regulation barriers to a massive penetration of RES in Sicily's islands are:

- Economic: Since the early years after the World War II, to lower the electricity bill paid by the inhabitants of Italy's remote island, the Italian government paid a subsidy to the local utilities burning diesel fuel transported at high cost with ships. This could lead to a disincentive to the implementation of RES.

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- Environmental and landscape constraints: old regional regulation which demand every building's owner willing to install solar modules to undergo a tedious authorization route with authorities in the Sicily's mainland.

  Fortunately, this is rapidly changing and Sicily "Piano Energetico Ambientale della Regione SICILIA" (PEARS) [10] has been just updated and will also shape future regulations. To meet the plan objectives, it is of vital importance the 'Programma Isole Minori (DM 14/02/2017)' [11]. According to this program, the remuneration of the producers (electricity network operators and third parties) will be commensurate with the cost of the fuel saved due to the lower consumption of the efficiently produced electricity, i.e., the cost of fuel avoided (cost avoided efficient) due to the replacement of the production of electricity from fossil sources through Best Available Technology with a similar amount of electricity from RES. Regarding landscape constraints, Presidential Decree n. 31/2017 identified the interventions excluded from the landscape authorization and those subjected to a simplified authorization procedure. Thanks to the multiple incentive possibilities of these plants, it is possible to foresee a consistent development of RES plants on the Sicilian Minor islands. Moreover, Lampedusa and Favignana islands have adopted the Action Plans for Sustainable Energy (PAES) [12], thanks to an agreement of Mayors program, coordinated and financed by the Regional Energy Department.

3.2 Long-term planning procedures

Transmission and Distribution on electricity grids, are activities subject to unbundling (Electricity Directive, 2009 hereafter E-Directive) [13]. The concept of unbundling requires 'vertically integrated' companies (a firm which performs activities ranging from production to distribution) to be 'unbundled' into a distribution and production and/or supply company. Today in Europe there are 44 Transmission System Operators (TSOs) and around 2400 Distribution System Operators (DSOs), of which only 13% are subject to unbundling. More in-depth considerations on the different realities of European DSOs show a very fragmented landscape. The E-Directive does not require the separation of the assets' ownership; therefore, DSOs are required to be at least legally independent from vertically integrated undertakings (art. 26 E-Directive) to avoid any possible conflict of interest between system operation, and production and supply. In the Netherlands, unbundling goes beyond the minimum requirements of the E-Directive: the E-Act requires DSOs to be ownership

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unbundled. In other words, DSOs should be fully separated from production and supply companies (art. 10b E-Act).

More recently, in 2019, the European Commission proposed a new directive for the electricity markets, Directive 2019/944, also defining the role of the DSO in the market and setting the requirements for its independence. The required regulatory framework shall be provided by Member States in order to incentivise DSOs to procure flexibility services in the areas under their supervision. All customers should have access to electricity markets, where they can trade their self-generated electricity and potential flexibility [14].
Art. 32 of the Directive states that:

- the development of a distribution system shall be based on a transparent network development plan that the DSO shall publish at least every two years and shall submit to the regulatory authority,
- the network development plan shall provide transparency on the medium and long-term flexibility services needed and shall set out the planned investments for the next five-to-ten years, with particular emphasis on the main distribution infrastructure, which is required in order to connect new generation capacity and new loads, including recharging points for electric vehicles,
- the network development plan (NDP) shall also include the use of demand response, energy efficiency, energy storage facilities or other resources that the DSO will use as an alternative to system expansion.

The following topics from the European Commission's report in 2019 focus on the innovative services and roles that DSOs can play in the future transition towards carbon neutrality:

- collaboration with small legal entities (CECs - Citizen Energy Communities) which can undertake electricity generation or provide any other type of energy-related service,
- appropriately manage flexibility sources in the grid integrating RES, Electric Vehicles, and Distributed Energy Resources (DERs),
- DSOs investment plans should carefully reflect on the grid expansion and/or upgrade, in order to deliver the transition towards carbon neutrality.
- DSOs should ensure neutrality by no owning energy storage facilities and shall cooperate with TSOs sharing balancing services across their grids.

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After briefly presenting the European framework, we analysed the national framework of the two LH islands.

Starting with the Netherlands, where the government considers as the overarching objective the low carbon dioxide energy supply system. In their 2015 Energy Report, the Dutch Ministry of Economic Affairs stated that for the energy system to be sustainable over time, it is expected to simultaneously serve public values availability, affordability and safety. However, a discrepancy between the Dutch legislator's objectives and the Dutch DSO's daily practice exists.

The DSO's primary task is the safeguarding of public values (such as availability, affordability and other qualities) which are inherent to the power system. Over the past two decades, the energy industry has radically changed through concentration, liberalisation, unbundling, privatisation and internationalisation. Energy transition is now a potentially more fundamental change which is affecting the energy sector. This phenomenon consists of a simultaneous decarbonisation, decentralisation and digitalisation. The change driver is the need to reduce the energy production and consumption impact on the planet. Achieving this transition also affects the DSO, which is steadily changing from a passive network operator to an active manager of a smart distribution system.

The provisions of the current Electricity Act (E-Act) and Gas Act (G-Act) contain a public value balance, determined by the government, which reflects the government's priorities for the energy sector prior to the roll-out of the energy transition. This balance has been translated into a number of DSOs obligations- such as:

- DSOs are legally obliged to invest in network upgrading, despite lower social cost alternatives sometimes being available.
- DSOs are legally obliged to keep creating gas networks and implementing gas connections, despite gas losing its importance as a consequence of electrification and the switching to heat.
- DSOs are legally obliged to charge all small consumers the same fixed connection fee, despite some consumers causing congestion which then triggers network upgrading.

DSOs acting in accordance with these dictated preferences for a long time contributed to the public value balance the government aimed for. Lately, this balance has come under

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pressure. The current E-Act and G-Act dictate DSOs to take decisions that disregard the technological changes brought about by the energy transition. Consequently, the public value trade-off, imposed by this legislation, is no longer perceived as resulting in a socially acceptable balance between public values.

On the other side, in Portugal, the Directive 2019/944 has been transposed into the National legal framework and according to Art. 40 DL 76/2019, the electricity HV and MV distribution networks operator must prepare, every two years in even years, a five-year development and investment plan (NDP) for its networks, based on the technical characterization of the current and planned network and supply & demand [15]. Similar process is done for the natural gas distribution networks (11 network operators plans) and, during odd years, for the electricity transmission network and the natural gas transmission network, storage facility and LNG terminal planning.

Relevant content of the development and investment plan are for instance objectives and planning strategy, main strategic vectors (security and quality of supply, network efficiency and access to new services), renewal and/or refurbishments of existing network assets, network resilience, e.g., moving existing overhead lines (OHLs) to underground cables, vegetation management, Information Communication Technology (ICT) & Cybersecurity, smart grids, risk analysis and investment costs and network tariffs impact assessment.

Both the HV and MV distribution networks in Portuguese mainland are a national concession operated by one network operator that presents the referred NDP. On the other hand, the LV distribution network is divided into 278 municipal concessions with their specific investments not being considered at the NDP approval process. However, as the supply points of MV distribution network are the interconnection points between MV and LV networks, major aspect of the LV planning is already included during the preparation of the MV network development at the NDP. In addition, as the HV and MV network operator is responsible for data collection and treatment from all the “smart” and “traditional” meters in all the HV, MV and LV networks, this facilitates the inclusion in the NDP of the strategic investment topic of smart grids, optimised distribution grid dispatch and local flexible markets.

A first challenge for Portugal resulting from the Directive (EU) 2019/944 is to assure a better integration of the HV and MV network, along with the LV network development planning.

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This will allow to assume that the NDP represents an integrated distribution networks development and investment plan, recasting the national law in line with the recent European legislative developments. Major consequences to the distribution network are expected from the challenges resulting from the impact that technological developments, related to decarbonisation, digitalisation and decentralisation, will impose on available electrical distributed resources, i.e., PV and other RES generation, self-generation, storage, electric vehicles, etc.

3.3 Existing investment regulatory framework for operators and the relevance with Decision Support Toolset

In order to validate and test the functionalities of the IEPT tool, it is essential to investigate the regulatory framework of each country of interest. Hence, a detailed description is provided in the tables below for each country, for both the electricity and gas networks [16]. Specific information about the transmission and distribution operators in both of the energy networks is included. Those information will be used not only as an input in the IEPT tool and particularly in the CBA component, but also as an additional explanatory element which reflects the current conditions/dimensions used in the investment practices of the Operators. The information included in the tables below includes the following:

- General: Incentive regulation is the use of rewards and penalties to induce the utility to achieve desired goals where the utility is afforded some discretion in achieving goals. Most countries use a mixture of a cap regulation (revenue or price) and a guaranteed Rate of Return (RoR). Revenue cap regulation can thereby be seen as an indirect form of price cap regulation, where the revenue is the result of price multiplied by the quantity. Nowadays, cost-plus regulation is used in a small amount of counties.
- Rate of Return (RoR): Most regulatory systems allow for an RoR on investments. There are various possible methods to calculate the RoR. Mostly the WACC factor is used. The WACC can be expressed in a simplified manner by the given formula:

$$WACC = \frac{equity}{(equity + debt)} * cost\ of\ equity + \frac{debt}{(equity + debt)} * cost\ of\ debt$$

The National Regulatory Authorities can make a distinction between nominal or real and before and after taxation, as well as “vanilla” WACC, i.e., the weighted average cost of capital using a pre-tax cost of debt and a post-tax cost of equity.

- Regulatory Asset Base (RAB): In general, the RAB serves as an important parameter in utility regulation to determine the allowed profit. The structure of individual components included in the RAB and their valuation differ significantly among countries and even among the regulated sectors. The RAB value is usually also linked with depreciation, depending on an individual NRA’s approach. In general, the RAB provides for remuneration of both historic and new investment. The RAB should be formed by the assets necessary for the provision of the regulated service in their residual (depreciated) value. The RAB can be comprised of several components such as fixed assets, working capital or construction in progress. Other elements such as capital contributions of customers, government (e.g., subsidies) and third parties are, on the contrary, usually excluded. The RAB may be valued according to different methods (e.g., historical costs, indexed historical costs or actual re-purchasing costs), which will have an influence on the determination of CAPEX. A RAB based on indexed historical costs would, therefore, require the use of a “real” instead of a “nominal” WACC. As a result, it is important to understand the relation between the RAB definition and the WACC structure.
- Depreciation: Depreciation decreases the asset value through use and the shortening of theoretical asset life and should also allow a firm to cover replacement investment costs during the economic lifetime of an asset. Concerning the duration of depreciation, the economic lifetime of the asset should be taken into account in a forward looking, long-run approach. The two most common approaches towards depreciation are straight line and accelerated depreciation. The straight-line depreciation method spreads the cost evenly over the life of an asset. On the other hand, a method of accelerated depreciation such as the double declining balance, allows the company to deduct a much higher share in the first years after purchase.

Table 1: Existing regulatory framework for the investment decisions of the operators in the Netherlands.

Netherlands					
		Gas Network		**Electricity Network**	
		TSO	DSO	TSO	DSO

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General	**System regulation**	Incentive regulation / revenue cap			
Rate of return	**Type of WACC**	Real, pre-tax			
	Determination of rate of return on equity	Sum of risk-free rate and equity risk premium * beta. Equity risk premium is based on data in individual Eurozone countries over the period 1900-2015 (Dimson, Marsh and Staunton database). An average of both the geometric and arithmetic average is taken. Multiplied by beta based on comparator group			
	Rate of return on equity before taxes	6.7% in 2021 (based on 5.02% after taxes and 25% tax rate)			
Regulatory asset base	**Components of RAB**	Fixed assets and certain intangible assets (such as software) are included (no working capital)			
	Regulatory asset value	Indexed historical costs			
	RAB adjustments	Annual indexation for inflation and adjustment for certain specific (expansionary) investments	Annual indexation for inflation and adjustment for certain specific (replacement) investment	Annual indexation for inflation and adjustment for certain specific (expansionary) investments	Annual indexation for inflation
Depreciations	**Method**	Straight=line depreciation, corrected for inflation each year			
	Depreciation ratio	Most assets are depreciated over a period of 35-55 years			
	Consideration	Depreciation is part of the total costs, which are subject to an X-factor over the course of the Regulatory period			

Table 2: Existing regulatory framework for the investment decisions of the operators in Portugal.

Portugal			
		Gas Network	**Electricity Network**

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		TSO	DSO	TSO	DSO
General	System regulation	Price-cap (OPEX) and rate-of-return (CAPEX)	Price-cap (OPEX) and rate-of-return (CAPEX)	Price-cap (OPEX) and standard costs/rate-of-return (CAPEX)	Price-cap and rate-of-return (HV/MV) and TOTEX (LV)
Rate of return	**Type of WACC**	Nominal, pre-tax The WACC (pre-tax) is indexed to the Portuguese ten-year bond benchmark and depends, in each year, on its evolution, with a cap and a floor Tax rate= 31.5%			
	Determination of rate of return on equity	CAPM: $Market\ risk\ premium = risk\ premium\ for\ mature\ market + country\ risk\ spread$, where: The risk premium for mature market is the spread between S&P 500 and USA ten-year treasury bond yields since 1961; and The country risk spread is the spread between Portuguese ten-year bond yields and ten-year bond yields of Germany, Finland, Austria, the Netherlands and France.			
	Rate of return on equity before taxes	6.7%	7.1%	7.9%	8.5%
Regulatory asset base	**Components of RAB**	Fixed assets deducted from third parties' contributions			
	Regulatory asset value	RAB is based on historical and re-evaluated costs	RAB is based on historical and re-evaluated costs	RAB is based on historical costs and standard costs	RAB is based on historical costs
	RAB adjustments	Each year the RAB is adjusted to consider new investments, write-offs and depreciation			
De	**Method**	Straight line depreciation			

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	Depreciation ratio	Five-45 years	Five-40 years	15-30 years	Five-40 years
	Consideration	Part of CAPEX			

Table 3: Existing regulatory framework for the investment decisions of the operators in Greece.

Greece					
		Gas Network		**Electricity Network**	
		TSO	DSO	TSO	DSO
General	**System regulation**	Cost-plus	Revenue cap	Revenue cap	Cost-plus
Rate of return	**Type of WACC**	Nominal, pre-tax	Nominal, pre-tax	Real, pre-tax	Nominal, pre-tax
	Determination of rate of return on equity	WACC: a) CAPM and additional country risk premium for cost of equity, and b) cost of debt based on operators’ proposal and actual figures of base year			
	Rate of return on equity before taxes	8.23%	8.01%	8.20%	8.16% (2020)
Regulatory asset base	**Components of RAB**	Fixed assets, working capital, assets under construction			
	Regulatory asset value	Historical costs		Historical costs since 2009	
	RAB adjustments	No adjustments, historical values			
Depreciations	**Method**	Straight line			
	Depreciation ratio	Most assets are depreciated over a period of 25-50 years			
	Consideration	Depreciation ratio depends on asset type and is integrated directly into the revenues			

Table 4: Existing regulatory framework for the investment decisions of the operators in Italy.

Italy

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement Nº 957810

		Gas Network		Electricity Network	
		TSO	DSO	TSO	DSO
General	System regulation	Cost-plus for CAPEX. Price cap for OPEX Price cap for OPEX.	Cost-plus for CAPEX. Price cap for OPEX. Standard cost approach for centralised costs	Cost-plus for CAPEX. Price cap for OPEX Cost-plus for CAPEX.	Standard cost approach for smaller DSOs
Rate of return	Type of WACC	Pre-tax, real			
	Determination of rate of return on equity	Sum of real risk-free rate (with a floor of 0.5%), a country risk premium, and a beta risk factor multiplied by an equity risk premium (determined as the difference between total market return and the risk-free rate)			
	Rate of return on equity before taxes	5.4%	5.8%	5.3%	5.7%
Regulatory asset base	Components of RAB	Fixed assets, working capital, assets under construction			
	Regulatory asset value	Historical cost re-valued for inflation, net of depreciation and grants	Both historical cost and standard unit cost (sectoral average) depending on type (central vs local assets). Both are revalued for inflation and are net of depreciation and grants	Historical cost re-valued for inflation, net of depreciation and grants. Investments prior to 2004 are considered as lump-sum with standard net value	Historical cost for bigger companies. Standard unit cost (sectoral average) for smaller companies. Both are revalued for inflation and are net of depreciation and grants

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				evolution and depreciation	
	RAB adjustments	New investments, depreciation, grants	New investments, depreciation, grants. For standard costs, changes in the driver	New investments, depreciation, grants. For investment prior to 2004, standard evolution	New investments, depreciation, grants. For standard costs, changes in the driver
Depreciations	**Method**	Straight line			
	Depreciation ratio	Buildings 3%, pipelines 2%, stations 5%, metering 5%-7%, other 10%-20%	Buildings 2%-3%, pipelines 2%, city gates 5%, metering 5%-7%, other 14%	Buildings 3%, lines 2%, stations 3%, metering 7%, other 5%-20%	
	Consideration	Deducted from gross RAB to form net RAB			

Table 5: Existing regulatory framework for the investment decisions of the operators in France.

Portugal					
		Gas Network		**Electricity Network**	
		TSO	DSO	TSO	DSO
General	**System regulation**	System regulation			
Rate of return	**Type of WACC**	Pre-tax, real		Pre-tax, nominal	N/A
	Determination of rate of return on equity	Sum of a nominal risk-free rate and a risk premium (market risk premium multiplied by a beta risk factor) multiplied by a		Sum of a nominal risk-free rate and a risk premium	N/A

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		corporate tax factor, and expressed in real terms		(market risk premium multiplied by a beta risk factor) multiplied by a corporate tax factor	
	Rate of return on equity before taxes	8.6%	8.4%	7.8%	N/A
Regulatory asset base	**Components of RAB**	Fixed assets			
	Regulatory asset value	Historical revaluated costs (considering inflation and depreciation)			
	RAB adjustments	Subsidies and grants are removed from the value of assets before entering the RAB			
Depreciations	**Method**	Straight line			
	Depreciation ratio	Depends on asset type. Ratio between 2% and 4% for network assets (lines, pipes, etc.)			
	Consideration	Integrated directly and with 100% (except assets that were funded through subsidies or grants)			

3.4 Financial support mechanism for RES integration in IANOS demonstration islands

The main financial support mechanisms available in member states throughout the EU include [17]:

1. **Net metering (NM):** NM is suitable for residential and business users. It represents a profitable investment, achieving the offsetting between the energy generated by the photovoltaic panels and the energy that the user consumes. This enables the direct supply of the energy required and thus the electricity bill is reduced to zero.

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2. **Feed-in tariffs (FITs)**: A contract between RES producers and authorized buyers allows the former to sell the electricity they actually produce at a predetermined price to the latter. This kind of contract usually lasts a number of years coherent with the economic lifespan of the generation assets (15-25 years). In many countries, FITs do not include balancing responsibilities. At the same time, in some other countries (e.g., Finland), FITs are called “feed-in-premium support” and do include balancing responsibilities.
3. **Feed-in premiums (FIPs)**: RES producers sell their expected generation in the wholesale market and are subjected to balancing responsibilities. In addition to this source of revenue, they receive an amount of money, usually for each MWh they actually produce, over a period usually coherent with the lifespan of their assets. This money can be predetermined and fixed for the whole contract duration (ex-ante premium) or adjusted periodically (ex post premium). The premium can be either fixed (i.e., independent of market prices) or variable (i.e., depending on the evolution of market prices, like for Contract for Differences) and complemented with caps or floors.
4. **Green Certificates (GCs)**: RES producers sell their expected production in the wholesale market and are subjected to balancing responsibilities. In addition to this source of revenue, they receive a certificate for each MWh they produce that they can sell to market participants (often suppliers). The latter have to buy a predetermined number of certificates, typically each year; the total obligation corresponds to the (increasing) RES target set up legally. Scarcity of the certificates creates a positive price that remunerates RES producers on top of their revenues from the wholesale electricity market.
5. **Investment subsidies**: In addition to other sources of revenues from the wholesale market and/or from another support scheme, RES producers receive money either upfront (possibly in the form of tax reductions) or yearly for a predetermined duration, typically proportional to the installed capacity.

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The amount of money granted through a price-based support scheme can be set administratively, but alternatively, the administration can choose a quantitative target and set up a call for tender to allocate the support. In this case, respondents bid on the level of support (typically the price in a FIT or the premium level in a FIP), and the support is granted on a merit order basis.

An overview of the financial support mechanisms as they take place in the countries, where the IANOS lighthouse and fellow islands are located, is provided below.

1) Netherlands

Overview of Dutch national support schemes in place by RES technologies in 2016 and 2017 [18]:

Type of support	Process determining the level of support or the quota	PV	On-shore wind	Off-shore wind	Bioenergy	Hydropower	Duration of support (years)
Feed-in Premium	Tendering procedures	x	x	x	x	x	8 to 15

The Stimulation of Sustainable Energy Production (SDE+) support scheme is the main policy measure encouraging the deployment of renewables. SDE+ was established in 2011 and supports renewable electricity, gases and heat. In 2020, SDE+ was expanded into the Sustainable Energy Transition Incentive Scheme (SDE++), which supports renewables and a wider range of technologies that reduce CO2 and other GHG emissions, including methane. SDE+ includes sustainability requirements for biomass, which will be maintained in the transition to SDE++. Since in 2019, renewable electricity projects require confirmation from the relevant network operator showing that sufficient grid capacity is available to support the project before they can be awarded SDE+ funding; this requirement will be maintained under SDE++.

Funding under SDE+ and SDE++ is awarded via competitive technology neutral auctions, which are open to bids from private companies, institutions and non-profit organisations. Under SDE+, projects including biomass and biogas, geothermal, hydropower, onshore wind, and solar PV compete with each other. The final SDE+ auction was held in the first half of 2020. Starting in the second half of 2020, SDE++ auctions will allow bids from renewable technologies along with carbon capture and storage (CCS), waste heat, heat pumps, and low-carbon hydrogen. The technologies eligible to participate in SDE++ auctions will be reviewed annually. It is currently planned that SDE++ auctions will be held once a year (SDE+ auctions were held twice a year).

SDE+ and SDE++ auctions are conducted in phases with the lowest level of financial support offered in the first phase. Once the first phase is closed, if there is still money remaining, additional phases are opened with increased levels of support for each successive phase (up to a limited maximum subsidy) until the total budget for the auction is awarded. If the number or quality of project bids is too low for all funding to be awarded, then this budget is rolled over for use in the next auction. This approach gives priority to the most cost-effective project bids. Winning bids that pass a project viability assessment conducted by the RVO are eligible to receive financial support once they start production.

Under SDE+, the level of support was determined via a sliding feed-in premium mechanism designed to cover the difference between the cost of renewable energy production and the relevant corresponding market price for electricity, gas or heat. The level of support under SDE++ covers the difference between the base tariff awarded per tonne of CO2 equivalent avoided and an estimated market remuneration. Conversion factors determine the CO2 reduction level for various technologies, with emissions reductions for renewable electricity based on displacement of the expected marginal generation source in 2030.

A project awarded support under SDE+ or SDE++ is required to start operating within a certain number of years after being selected through the auction process. The time limit is based on normal project lead times for the eligible technologies. The period over which a project receives support payments is technology dependent and ranges from 8 to 15 years from the commissioning of the project [19].

2) Portugal

Overview of Portuguese national support schemes in place by RES technologies in 2016 and 2017 [18]:

Type of support	Process determining the level of support or the quota	PV	On-shore wind	Off-shore wind	Bioenergy	Hydropower	Duration of support (years)
Feed-in Tariff	Administrative procedures	x	x	x	x	x	15 to 25

In Portugal, a FIT scheme drove strong deployment of wind generation from 2004 to 2012. As a result of the financial crisis, Portugal eliminated the FIT for renewable energy projects commissioned after November 2012. Qualifying projects commissioned before this date continue to receive FIT payments of EUR 74 – 270 per megawatt hour (MWh) for 12 - 25 years from the project's commissioning, with payment level and period of eligibility depending on the technology applied. Following the economic recovery, the government reintroduced a limited FIT in 2014, supporting small – scale PV, biogas, biomass and hydro projects. The updated FIT is only available for small production units (UPP), with a maximum capacity of 250 kilowatts (kW). In 2018, the government increased this FIT to EUR 95 per MWh. PV and hydropower generation receive the full FIT rate, while biomass and biogas systems receive 90% of the full rate . The government is also supporting small-scale distributed generation by encouraging the development of energy communities and self-consumption of renewable electricity [20].

3) Greece

Overview of Greek national support schemes in place by RES technologies in 2016 and 2017 [18]:

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Type of support	Process determining the level of support or the quota	PV	On-shore wind	Off-shore wind	Bioenergy	Hydropower	Duration of support (years)
Feed-in Tariff	Tendering procedures	x	x				20 to 25
Feed-in Premium	Tendering procedures	x	x				
Feed-in Tariff	Administrative procedures	x	x	x	x	x	
Feed-in Premium	Administrative procedures	x	x	x	x	x	

RES and HECHP projects up to a certain threshold of installed capacity (i.e., 500kW and 3MW for wind parks) are supported by operating aid on the basis of a feed-in-tariff (FIT). The RES and HECHP units with an installed capacity over the aforementioned thresholds are supported on the basis of a sliding Feed in Premium (FIP). Tendering procedures as basis either for FIP or FIT are organized only for PV and wind stations, with the exception of wind stations of installed capacity less than 3MW. For these stations the level of FIT is being determined administratively. Finally, for the rest RES technologies (other than PV and wind) the level of the applied FIP is being determined administratively.

4) Italy

Overview of Italian national support schemes in place by RES technologies in 2016 and 2017 [18]:

Type of support	Process determining the level of support or the quota	PV	On-shore wind	Off-shore wind	Bioenergy	Hydropower	Duration of support (years)
Feed-in Premium	Tendering procedures		x	x	x	x	15 to 25
Feed-in Tariff	Administrative procedures	x	x	x	x	x	
Feed-in Premium	Administrative procedures	x	x	x	x	x	

- Feed in premium: It replaced Green Certificates since 2016. It is applied to energy produced by power plants that have been enabled to Green Certificates mechanism

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and it is no longer in force for new projects. The premium, different for each source, is granted for 12 years for power plants that started operation between April 1999 and December 2007, for 15 years for power plants started operation after January 1st 2008.

- Feed in premium for PV plants: It is applied to energy produced by PV in operation before August 27th 2012. Different values, depending on the power plant size, are granted for 20 years.
- Premium tariffs for PV plants: they are applied for PV plants in operation between August 27th 2012 and July 6th 2013, as described below, and are granted for 20 years.
  - ➢ PV plants with capacities up to 1 MW: FIT for electrical energy injected to the grid, plus a feed in premium for self-consumption [11]. Member Nature of the support PV Onshore wind Offshore wind Bioenergy Hydropower Explanation energy; in case of PV plants with capacity higher than 1 MW: feed in premium, computed on hourly basis as the difference between a total tariff and the zonal energy price, for electric energy injected to the grid, plus a feed in premium for self-consumption energy.
- Premium tariffs for RES – E plants except for PV plants: These were defined by the Ministerial Decree July 6th 2012 and they are applied as described below. They are also granted for different time periods, depending on the source (from 15 up to 25 years).
  - ➢ Plants with capacities up to 1 MW: FIT (different for each source) for injected energy;
  - ➢ Plants with capacities over 1 MW: FIP (different for each source) for injected energy. The premium is calculated, on an hourly basis, as the difference between a total tariff, different for each source, and the hourly zonal energy

price. Furthermore, the premium value is determined through auctions for largest plant (capacity over 5 MW, augmented to 10 MW for hydro plants and to 20 MW for geothermal plants). It is no longer in force for new projects.

- Updated Premium tariffs, defined by the Ministerial Decree June 23rd 2016, for RES – E plants except for PV plants: They are applied as described below, and are granted for different time periods, depending on the source (from 15 up to 25 years):
  - Plants with capacity up to 500 kW: FIT (different for each source) for THE injected energy;
  - Plants with capacity over 500 kW: Feed – in – premium (different for each source) for the injected energy. The premium is calculated, on an hourly basis, as the difference between a total tariff, different for each source, and the hourly zonal energy price. Furthermore, the premium value is determined through auctions for largest plant (capacity over 5 MW).

5) French Polynesia

There is no policy in force regarding support schemes for RES.[2]

[2] https://climatepolicydatabase.org/countries/french-polynesia

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4. Assessment of LH & Fellow Islands Plans

In this chapter, each use case is described in detail. This description includes an initial dimensioning of the used assets and the scenarios that will be tested by each demonstrator. The input of the information reported in this chapter describes the progress of the project up to M18. In the second version of this deliverable (D3.8 with a due date the M30), the content included in this section will be updated and finalized according to the progress at that point. In addition, the information describing the power system topology that those assets will be installed is going to be provided the following months of the project and will be also documented in the next version of this deliverable.

4.1 Use Case #1

The dimensioning of the Ameland demonstrator is almost completed. The definition of the exact list of assets in the Terceira LH island is still under progress.

Table 6: Dimensioning of assets in the LH islands for UC#1.

	Terceira		Ameland	
	Components	**Specs**	**Components**	**Specs**
Behind-the-Meter Assets	Smart home appliances	TBD	Hybrid-heat pumps	20kWth (boiler) /1.1kWe/5kWth (hp)
	Electric Water heaters	TBD	Suwotec Battery	120kWh
	Batteries	TBD		
Production side-assets	PV panels	TBD	Solar Farm	6MW
			Residential PV	1MW
			Wind turbine	15kW

As reported in D2.1, in the context of UC1 two different scenarios will be demonstrated:

1) Self-consumption maximization through optimization of behind-the-meter assets,

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2) Self-consumption maximization through P2P energy trading based on DLT.

For both of those scenarios, exact information needs to be defined, providing a fine-grained description able to be tested in the actual pilot sites. This action will take place the following months.

4.2 Use Case #2

The dimensioning of the Ameland demonstrator is almost completed. The definition of the exact list of assets in the Terceira LH island is still under progress.

Table 7: Dimensioning of assets in the LH islands for UC#2.

	Terceira		Ameland	
	Components	**Specs**	**Components**	**Specs**
Production-side assets	Wind Farm	TBD	Solar Farm	6MW
	Fossil-fuel generators	TBD	DC Solar Farm	3MW
	Geothermal Power Plant	TBD		
Power to Hydrogen device			Electrolyser	TBD
Large-scale storage systems	Battery	15MWh	Battery	3MWh

As reported in D2.1, in the context of UC2 a scenario will be demonstrated:

1) Supply-side optimal dispatch.

The exact information of this scenario needs to be defined, providing a fine-grained description able to be tested in the actual pilot sites. This action will take place the following months.

4.3 Use Case #3

The dimensioning of the Ameland demonstrator is almost completed. The definition of the exact list of assets in the Terceira LH island is still under progress.

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Table 8: Dimensioning of assets in the LH islands for UC#3.

	Terceira		Ameland	
	Components	**Specs**	**Components**	**Specs**
Large-scale storage systems	Flywheel	TBD	Battery	3MWh
	BESS	15MWh	Fuel Cell	500kWe
	Distributed Electrochemical Batteries	TBD		
Combined Heat & Electricity production			CHP	75kWe/110kWth
Flywheel				

As reported in D2.1, in the context of UC3 a scenario will be demonstrated:

1) Provision of fast ancillary services through storage systems of any-scale.

The exact information of this scenario needs to be defined, providing a fine-grained description able to be tested in the actual pilot sites. This action will take place the following months.

4.4 Use Case #4

The dimensioning of the Ameland demonstrator is almost completed. The definition of the exact list of assets in the Terceira LH island is still under progress.

Table 9: Dimensioning of assets in LH islands for UC#4.

	Terceira		Ameland	
	Components	**Specs**	**Components**	**Specs**
Large-scale storage systems	Cold storage Facilities	TBD	Battery	3MWh
			Fuel cell	500kWe
Combined Heat & Power production			CHP	75kWe/110kWth
Behind-the-Meter Assets	HVACs	TBD	Hybrid Heat Pumps	20kWth (boiler)

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				/1.1kWe/5kWth (hp)
			Suwotec Battery	120kWh
Operators' assets	Hybrid transformer	TBD		

As reported in D2.1, in the context of UC4 three different scenarios will be demonstrated:

1) Demand-side management capable of providing slow ancillary services,
2) Voltage control to support power quality optimisation and congestion management services,
3) Localized energy routing management capable of providing ancillary services.

For those scenarios, the exact information/ dimensions need to be defined, providing a fine-grained description able to be tested in the actual pilot sites. This action will take place the following months.

4.5 Use Case #5

The dimensioning of both of the LH islands for UC#5 is still under progress.

Table 10: Dimensioning of assets in the LH islands for UC#5.

	Terceira		Ameland	
	Components	**Specs**	**Components**	**Specs**
Electricity devices	Electric charging stations	TBD	Electric charging stations	10, specs are still TBD
Power to Hydrogen device			Electrolyser	TBD
Transportation	EVs	TBD	Electric cars & bikes	TBD
Electrolyser				

As reported in D2.1, in the context of UC5 three different scenarios will be demonstrated:

1) The use of V2G for power system stabilization,
2) The use of smart charging for power system stabilization,

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3) The use of hydrogen for mobility in order to decarbonize the transport sector.

For those scenarios, the exact information/ dimensions need to be defined, providing a fine-grained description able to be tested in the actual pilot sites. This action will take place the following months.

4.6 Use Case #6

The dimensioning of the Ameland demonstrator is completed.

Table 11: Dimensioning of assets in the LH island for UC#6.

	Ameland	
	Components	**Specs**
Large-scale storage	Fuel cell	23 CH_4 fuel cells with rated power 2kW each.
Production-side assets	Wind farm turbine	12kW
	Solar farm	6MW
	Tidal Kite	500kW

As reported in D2.1, in the context of UC6 a scenario will be demonstrated:

1) Electrification of natural gas platform.

The exact information of this scenario needs to be defined, providing a fine-grained description able to be tested in the actual pilot sites. This action will take place the following months.

4.7 Use Case #7

The definition of the exact list of assets in the Ameland LH island is still under progress.

Table 12: Dimensioning of assets in the LH island for UC#7.

	Ameland	
	Components	**Specs**
Hydrogen demanding assets	Water taxis	TBD
Power to Hydrogen assets	Electrolyser	TBD
Battery Storage Systems	Private Fuel Cells	TBD

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	Large Storage Systems	TBD
Generation	Micro CHP	TBD
	Auto generative High-Pressure Digester	TBD

As reported in D2.1, in the context of UC7 two different scenarios will be demonstrated:

1) Green natural gas production from waste streams,
2) Research on biomass processing technologies.

For both of those scenarios, exact information needs to be defined, providing a fine-grained description able to be tested in the actual pilot site. This action will take place the following months.

4.8 Use Case #8

The definition of the exact list of assets in the Ameland LH island is still under progress.

Table 13: Dimensioning of assets in the LH islands for UC#8.

	Ameland	
	Components	**Specs**
Large scale storage	Fuel Cells	500kW
Behind-the-Meter Assets	Suwotec Battery	120kWh

As reported in D2.1, in the context of UC8 one scenario will be demonstrated:

1) Decarbonization of heating network.

For this scenario, the exact information needs to be defined, providing a fine-grained description able to be tested in the actual pilot site. This action will take place the following months.

4.9 Use Case #9

The amount of engaged citizens in almost completed in the case of Ameland. On the other side for the case of Terceira, the engagement process is still under progress. For this UC there are not explicit scenarios defined as in the previous ones. However, in order to conduct

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a quantifiable CBA approach, the IEPT suite will need to collect data that quantify the local communities and citizens engagement to the IANOS activities. This indicators are thoroughly presented in the next chapter.

Table 14: Dimensioning of assets in the LH islands for UC#9.

	Terceira		Ameland	
	Amount	**Type**	**Amount**	**Type**
Engaging citizens	TBD	TBD	5	TBD

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5. Decision Support Toolset Pre-Validation

For each UC, the benefits, along with the defined KPIs those that are linked to the IEPT tool are presented. In addition, a screening process takes places, where from those KPIs that are linked to the IEPT tool, the ones that can be monetized through the KPI component are presented. These KPIs provide fine-grained quantified opportunities for the decision-makers, in order to assess the smart grid interventions.

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5.1 Use Case #1

Benefits[3]	**Maximize self-consumption from renewable energy sources to allow the users (Terceira) or community (Ameland) level better exploit their assets, to avoid future grid transport costs to the mainland and to alleviate the grid in periods of excess of renewable generation**
	Reduce energy curtailment by achieving a maximum renewable penetration possible
	Avoid grid challenges such as congestion and voltage variations
Identified KPIs[4]	T-1, T-2, T-8, T-9, EN-1, EC-1, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8, EN-2, I-4
IEPT module responsible for KPIs calculation[5]	**VERIFY-D->** EN-1, EN-2, EC-1, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8 **INTEMA.grid (for Terceira) ->** T1, T2, T8, T9, I-4 **ESSIM (for Ameland) ->** T1, T2, T9, EN-1, EN-2
Benefit Monetization[6]	T8, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8
Pre-validation comments	All the defined KPIs will be calculated for this UC by the IEPT suite modules. Most of them are able to be converted into monetary benefits, providing quantifiable decision-making capabilities for the stakeholders.

[3] The related to each KPI benefits are directly emerge from the objectives of each UC, as documented in D2.1. The extensive list of KPIs is also included in Appendix A.
[4] This is a list of KPIs directly linked to the particular UC (D2.1) and is also documented in D2.7.
[5] The direct link between a particular KPI and its calculation engine is reported in D3.5.
[6] This is linked to the CBA module of the IEPT toolkit, whether the particular benefit through the corresponding KPIs can be monetized or not. In case that monetization is not applicable, then the plain technical/ environmental benefits are used in the CBA process as an auxiliary input to the decision-makers.

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5.2 Use Case #2

Benefits	**Provide flexibility on the generation-side**
	Reduce Energy curtailment
	Avoid grid challenges
Identified KPIs	T-1, T-2, T-5, T-8, T-11, T-12, EC-1, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8, EN-2, I-1, I-4, I-5, P-1, P-2
IEPT module responsible for KPIs calculation	**VERIFY-D->** EN-2, EC-1, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8 **INTEMA.grid (for Terceira) ->** T1, T2, T5, T8, I-4, I-1 **ESSIM (for Ameland) ->** T1, T2, T9, EN-2
Benefit Monetization	T8, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8
Pre-validation comments	Most of the KPIs will be calculated by the IEPT suite modules. From the calculated benefits, except the those directly linked to economic indicators, the cost savings through the reduction in energy curtailments can be computed.

5.3 Use Case #3

Benefits	**Improve power quality and continuity of power supply**
	Reduce energy curtailment
	Avoid grid challenges such as congestion and voltage variations
Identified KPIs	T-7, T-8, T-9, T-11, EC-1, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8, P-1, P-2, P-3
IEPT module responsible for KPIs calculation	**VERIFY-D->** EC-1, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8 **INTEMA.grid (for Terceira)->** T-7, T-8, T-9 **ESSIM (for Ameland)->**T-7, T-9
Benefit Monetization	EC-1, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8
Pre-validation comments	Most of the defined KPIs can be calculated through the components of IEPT suite. In addition, the benefits that can be converted into monetary

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	gains are those linked to the reduction in energy curtailment and the peak reduction.

5.4 Use Case #4

Benefits	**Ensure stability of the power system**
	Minimize energy curtailment
	Support congestion management services by utilizing demand flexibility as a mean to provide slow ancillary services to the grid
Identified KPIs	T-3, T-4, T-8, T-9, T-11, EC-1, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8, EC-11, I-1, I-2, I-5, S-1, P-1, P-2, P-3
IEPT module responsible for KPIs calculation	**VERIFY-D->** EC-1, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8 **INTEMA.grid (for Terceira)->** T-8, T-9 **ESSIM (for Ameland)->** T-9
Benefit Monetization	EC-1, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8, T8, T9
Pre-validation comments	Most of the defined KPIs can be calculated through the components of IEPT suite. In addition, the benefits that can be converted into monetary gains are those linked to the reduction in energy curtailment and the peak reduction

5.5 Use Case #5

Benefits	**Present a clear roadmap to decarbonize the transport sector**
	Study the potential of electric chargers, hydrogen taxis, V2G and smart charging schemes to reach decarbonization targets
	Offer flexibility in the electricity grid
Identified KPIs	T-2, T-7, T-8, T-11, EN-1, EN-2, EN-4, EC-1, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8, I-1, I-3, I-4, I-5, P-1, P-2, P-3
IEPT module responsible for KPIs calculation	**VERIFY-D->** T-2, EN-1, EN-2, EN-4, EC-1, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8 **INTEMA.grid->** T-2, T-7, T-8, I-4 **ESSIM->** T-2, T-7, EN-1, EN-2
Benefit	EN-1, T-2, T-8, I-4, EC-1, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8

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Monetization	
Pre-validation comments	Most of the defined KPIs can be calculated through the components of IEPT suite. In addition, the benefits that can be converted into monetary gains are those linked to the reduction in energy curtailment, the increase of the RES hosting capacity, the reduction in fossil fuel consumption, and the energy savings.

5.6 Use Case #6

Benefits	**Maximize consumption from local RES**
	Decarbonize the industrial sector
Identified KPIs	T-1, T-2, T-5, T-8, EC-1, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8, EN-1, EN-2, EN-4, P-1, P-2, P-3
IEPT module responsible for KPIs calculation	**VERIFY-D->** T-1, EN-1, EN-2, EC-1, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8, T-5 **INTEMA.grid (for TERCEIRA)->** T-1, T-2, T-5, T-8 **ESSIM (for AMELAND)->** T-1, T-2, T-5, EN-1, EN-2
Benefit Monetization	EN-1, T-2, T-8, T-5, EC-1, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8
Pre-validation comments	Most of the defined KPIs can be calculated through the components of IEPT suite. In addition, the benefits that can be converted into monetary gains are those linked to the reduction in energy curtailment, the increase of energetic self-supply by RES, the reduction in fossil fuel consumption, and the energy savings.

5.7 Use Case #7

Benefits	**Reduce the negative impact of waste streams produced on island by reusing them to produce green energy**
	Foster gas and electricity grid decarbonization
Identified KPIs	T-1, EC-1, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8, EN-1, EN-2, EN-3, EN-4, EN-5, I-4, S-1, S-3, P-1, P-2, P-3
IEPT module responsible for	**VERIFY-D->** T-1, EC-1, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8, EN-1, EN-2, EN-3 **INTEMA.grid->** T-1, I-4

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KPIs calculation	**ESSIM->** T-1, EN-1, EN-2
Benefit Monetization	I-4, EC-1, EC-2, EC-3, EC-4, EC-5, EC-6, EC-7, EC-8
Pre-validation comments	Most of the defined KPIs can be calculated through the components of IEPT suite. In addition, the benefits that can be converted into monetary gains are those linked to the reduction in fossil fuel consumption, and the increase in RES hosting capacity.

5.8 Use Case #8

Benefits	**To decarbonize the existent heating grid in Ameland which currently uses mainly natural gas as fuel**
Identified KPIs	T-5, EN-1, EN-2, EN-4, EC-6, EC-11, I-1, S-1, S-2, G-1, P-1, P-2, P-3
IEPT module responsible for KPIs calculation	**VERIFY-D->** T-5, EN-1, EN-2, EN-4, EC-6 **INTEMA.grid->** T-5, **ESSIM->** T-5, EN-1, EN-2
Benefit Monetization	EN-2, T-5 EC-6
Pre-validation comments	An important amount of the KPIs will be calculated through the modules of the IEPT suite. The benefits that can be converted into monetary gains are those linked to the increase of self-consumed RES energy and the reduction in fossil fuel consumption.

5.9 Use Case #9

Benefits	**Promoting the engagement of the local community in island's energy transition**
	Raising customer's environmental and energy efficiency awareness.
	Support local generation
	Promote DSM programs
Identified KPIs	T-12, I-2, S-1, S-6, P-1
IEPT module responsible for	**VERIFY-D-> -** **INTEMA.grid->** T-12

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KPIs calculation	**ESSIM->** T-12
Benefit Monetization	T-12
Pre-validation comments	Only the T-12 KPI can be calculated for this UC, which can also be monetized. The rest KPIs, which are not technical, can be calculated without the use of any module, and thus can be introduced in the CBA module directly.

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6. Conclusions

This deliverable is the first version of the deliverable linked to Task 3.4. Important information was documented, providing the initial environment that the IEPT suite will be running. Hence, two dimensions were investigated: the regulatory and the level of fitness to the project's demonstrators. The next version of this deliverable will cover the following topics:

- Provision of the exact dimension of the demonstration areas and direct validation of the tool functionalities for real-pilot data,
- Validation of the interoperability of the tool based on the defined components. Initial tests will be conducted before the integration of the IEPT suite to the pilot areas. It is essential for the functionality of tool the interoperability of its internal components. Thus, a validation and verification analysis will be conducted in order to test the functionality of the IEPT suite under different operational scenarios (operational from the software point of view), and
- Validation of the GUI functionalities and users' satisfaction. It is essential the under-development tool to facilitate the decision-making capabilities of the stakeholders. Thus, the GUI functionalities of the IEPT suite shall be capable of providing high quality analytics, satisfying the suite's end-users requirements.

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Appendix A – IANOS KPI list

Table 15: IANOS KPIs final list.

Categories in D2.7	*KPI Name*
T-1	*RES Generation*
T-2	*Energy Savings*
T-3	*SAIFI*
T-4	*SAIDI*
T-5	*Increase of degree of energetic self-supply by RES*
T-6	*Percentage of total amount of waste that is used to generate energy*
T-7	*Storage capacity of the energy grid per total island energy consumption*
T-8	*Reduced energy curtailment of RES and DER*
T-9	*Peak load reduction*
T-10	*Accuracy of energy supply and demand prediction*
T-11	*Unbalance of the three-phase voltage system*
T-12	*kWp photovoltaic installed per 100 inhabitants*
EN-1	*Reduced Greenhouse Gas Emissions*
EN-2	*Reduced Fossil Fuels consumption*
EN-3	*Electrical and thermal energy (GJ) produced from solid waste or other liquid waste treatment per capita per year*
EN-4	*Air quality index (Air pollution)*
EN-5	*Reduction in the amount of waste collected*
EN-6	*Primary Energy Demand and Consumption*
EC-1	*Total investments*
EC-2	*ROI*
EC-3	*Total annual cost*
EC-4	*Payback period*
EC-5	*Total annual revenues*
EC-6	*Financial benefit for the end- user*
EC-7	*Average electricity price for companies and consumers*
EC-8	*Internal Rate of Return (IRR)*
EC-9	*Fossil Fuel purchasing from mainland*
EC-10	*Load purchasing from mainland*
EC-11	*Energy poverty*
I-1	*Increase system flexibility for energy players*
I-2	*Data privacy - Data Safety & Level of Improvement (Improved Data Privacy)*
I-3	*ICT Response time*
I-4	*Increased hosting capacity for RES, electric vehicles and other new loads*
I-5	*Increased reliability*
I-6	*Number of sensors integrated/devices connected*
I-7	*Improved cyber security*
I-8	*Integrated Building Management Systems in Buildings*

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S-1	*People reached*
S-2	*Increase of Thermal Comfort*
S-3	*Increase of Local job creation*
S-4	*Percentage of citizens' participation in decision making*
S-5	*Number of interactive social media initiatives*
S-6	*Increased citizen awareness of the potential of smart islands projects*
G-1	*Involvement of the island administration*
G-2	*Smart island policy*
G-3	*Micro-grids legal framework*
G-4	*Suitable Energy Storage Regulation*
P-1	*Social compatibility*
P-2	*Technical compatibility*
P-3	*Ease of use for end users of the solution*

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