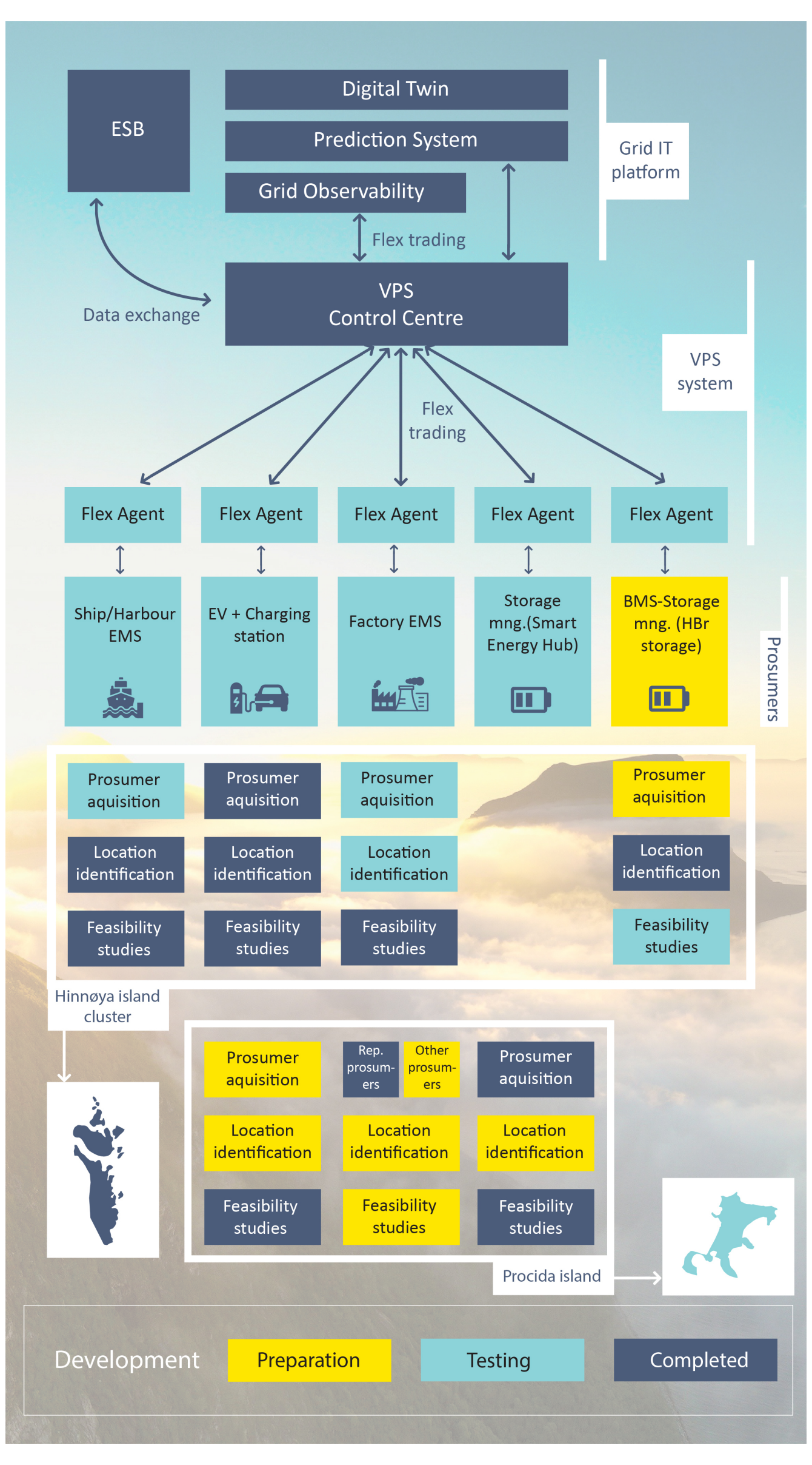
GIFT

Geographical Islands Flexibility

NEWSLETTER

The first two years of the project have been very busy for the GIFT consortium. We have been hard at work on the developments for the (1) grid IT platform, (2) VPS system, (3) prosumers, (4) system integration, and (5) implementation on the demonstration islands. This first newsletter provides you with an overview of our first achievements in these fields.



1. Grid IT platform

a. ESB and KPI visualization

A significant development during the recent months relates to the design and implementation of a web-based dashboard where different Key Performance Indicators (KPIs) associated with the project will be presented. The aim of this dashboard, developed by ICOM, is to present meaningful insights around the performance of individual technological solutions as well as the overall impact of different actions of the project. In particular, the solution presents performance metrics for project solutions that contribute to the different categories of objectives: Achieve highly integrated and digitalized smart grids; Develop RES-based systems cheaper than diesel generation; Reduce significantly fossil fuel consumption; Large scale replication on the same island and others with similar conditions; Enhance autonomy for islands that are grid connected with the mainland. The web-based dashboard application is integrated to the rest of the components of GIFT via the Enterprise Service Bus (ESB) and retrieves from them either raw data or the calculated KPI values.

Finally, the Enterprise Service Bus (ESB), the solution integrating the different software artefacts of the GIFT's project technical solution and legacy/external applications and services through standard interfaces at the level of the control centre was released. The solution utilizes a canonical data model based on the CIM family of standards aiming at increased interoperability. ICOM's team elaborated the implementation and testing of the software interfaces of the ESB with the various GIFT components achieving a significant level of integration among them.

b. Digital Twin

To ensure visualization of the geographic area of the demonstration islands, a Digital Twin has been developed. The visualization includes maps of the area with all relevant infrastructure, in particular the grid, location of prosumers and equipment. The Digital Twin has access to the ESB and can show various details of sensors in the grid and at prosumer sites. Together with other GIFT components, the Digital Twin will act as a monitoring and decision support system. The Digital Twin is developed as a web-based system, with flexible configuration options. This way the system is prepared for transfer to new geographic areas, like the follower islands.

c. Grid Observability

The Grid Observability System developed by Odit-e is a monitoring and control system for the management of low voltage networks. It embeds three different functionalities: "Grid Analysis", "Grid observability" and "Flexibility management". The first one provides statistical analysis over the collected data from both Meter Data Management System and field sensors. The second computes a near real time state estimation of the Low Voltage Grid based on a reduced number of field measurements and machine learning techniques to broaden their scope. The third connects with the VPS to manage flexibility according to observed grid constraints. It serves the grid's quality of supply and brings another solution to expensive grid reinforcements. The system is fully specified and an early prototype is currently running with 576 values being estimated every 10 minutes in the Norwegian demo site.

d. Prospective modelling and long-term assessment

To ensure the large integration of renewable energy in territories, thereby contributing to their decarbonization, a reliable power system for the long-term should be designed. At this aim a proper energy plan has to be assessed, defining the type of technologies to install or remove, their capacities and location over time still considering constraints of different nature, such as technological, environmental, social and political ones. This can be made by considering different evolution scenarios showing possible future pathways of the power system. In order to discuss these technical choices and their subsequent policy and technological impacts on the demonstration island's system on the long-term, prospective modelling allows decision-makers to evaluate possible trajectories that ensure the increase of the share of renewable energy sources and a better management of their resources. Two bottom-up optimization models have been developed at this aim: one dedicated to the long-term analysis of Procida and one of Hinnøya (a first version of the latter was developed by NTNU and updated by ARMINES with flexibility solutions).

So, to assure the quality and reliability of electricity supply, the power grid has to increase its flexibility, notably with the innovative solutions developed by the GIFT Project. This requirement can be much more relevant when dealing with islands, as they have limited (or no) interconnections to the continent and thus have to rely more on flexibility options to ensure the secure and cost-efficient operation of their energy system. Different local policies are studied to evaluate the possible long-term benefits in terms of decarbonisation coming from the use of renewable energy sources in these territories and recommendations will be produced in some months.

2. VPS System

a. VPS

Developed by INEA, the VPS is a decentralised automatic demand response trading platform, connecting DR providers (consumers, producers, prosumers), intermediaries (Aggregators, VPPs) and DR users (BRPs, DSOs, TSOs) that is coupled with Flex Agents, installed at DR providers. VPS will address several energy vectors, such as heating, cooling, transports, with electricity being the main optimisation criterion. Core functionality of VPS is actual trading of energy flexibilities, described in time, energy and price, as well as several other technical and economic parameters. In the following months, each demonstration site will receive its own instance of the VPS to which all prosumers will be connected during deployment phase.

GIFT aims to deliver to the prosumers day-ahead information about where and when flexibility is most needed, with an indication of the its value. The day-ahead flexibility and DR sizing information is given as time-series of active and reactive power curves needed to resolve grid constraints for each location of the network, together with the associated flexibility value for the corresponding location and type of flexibility needed. That is, active power and reactive power are valued according to how useful each of them is to the grid at each moment and at each location. This VPS service to the prosumers promotes their engagement by enabling the prosumers' process to be planned ahead of time in order to have available flexibility to be automatically extracted by the VPS when it is most need and most valuable.

b. FlexAgent

Flex Agent is a way of ensuring common communication protocols, as well as providing toolset for extraction, trading and executing the flexibilities. Using Flex Agents will enable all solutions to be generalised in order for their flexible energy to be traded on VPS platform. Partners (solution providers) have finished xEMS communication protocol specifications and implemented protocol in their solutions, that is explicit and virtual storage solutions. In the next step we have tested interfaces between FA and solution providers EMS systems. With that we have come to point, where partners are ready to proceed with work and testing (WP6).

3. Prosumers

a. Factory EMS (FEMS)

Factories tend to have energy intensive processes and loads. Using Factory EMS, their production can be efficiently optimised, based also on energy consumption. Prototype specifications and required deployment procedures were successfully defined and prepared for the FEMS systems. This work was followed with FEMS prototype preparation, which is finished and is being tested in the components testing phase (WP6). We are in the final stage of representative FEMS systems. Gathered requirements at prosumers sites might result in minor adaptation of FEMS prototype, which is normal procedure in the FEMS implementation process. It is one of the main drivers for the preparation of separate project installation documentation for each FEMS, where these specifics are properly technically addressed.

b. Electric vehicle charging EMS (EVC-EMS)

The EVC-EMS aims for exploitation of electric vehicle charging load flexibility by offering it, via the FlexAgent, to the VPS. The functional specification of EVC-EMS covers two scenarios to cope with different user stories: private charging (at home, with one charging station installed at prosumer) and public charging with several charging stations installed in one location. The system for private charging scenario was developed by Etrel, while the solution for public charging scenario is subject of cooperation between Trialog and Etrel.

The developed EVC-EMS exploits advanced technologies for acquisition of electric vehicle's technical characteristics and of users' requirements related to charging, which enables an enhanced integration of electric vehicle charging with flexibility markets and brings benefits to both, electric vehicle users and electricity grid and market actors.

The EVC-EMS functionalities for both scenarios are already fully developed and are currently in laboratory testing phase. Testing of individual components (modules) including the interfaces between Etrel and Trialog solutions and towards FlexAgent is already finished; the developed EVC-EMS is thus ready for integration testing planned within the next months.

c. Harbour/ferry EMS

The Energy consumption of an electric ferry is affected by many external and internal influences. In the GIFT project. Hafenstrom develop services that address these challenges, and has partnered with NTNU in identifying parameters and developing algorithms for prognosis of battery capacity at any given position of the ferry – both in the future and in the past. Part of the result is the Ship/Harbour EMS service which implement these models. The service also provides an interface to shoreside installations, and will be demonstrated in a model of a ferry crossing between Stornes and Bjørnerå near Harstad in Norway.

The new ferry that is planned to replace the current ship, will according to updated information be fully electric. The original calculations were based on a hybrid configuration with 60% electricity, and the rest using a biofuel aggregate to recharge the battery while portside. Thanks to the modular approach Hafenstrom use, this information was integrated with just minor adjustments in the system configuration. The strategy used allows for a quick way to scale up and reassign the location, vessel and control system profiles.

Hafenstrom plans on running internal test on values generated by the calculations and compare the results with the digital twin implementations provided by NTNU.

d. Multi-vector storage

HBr battery

GIFT aims to implement an electricity storage system based on the Hydrogenbromide Flow Battery principle - an HBr battery developed by Elestor- on the demonstration islands. This battery uses a simple chemical commodity (48w% HBr) as its active material. Using HBr, the lifecycle storage costs per unit of electricity are expected to become considerably lower than those of Lithium batteries and a cost target below €8/kWh is applicable instead of €160/kWh. The technology is particularly well suited for large scale, non-automotive, long duration storage of electricity. The core of this battery, the stacks, have been completely redesigned to enable required quality during series production. Various smaller stacks of this type have already been tested and do show results in alignment with design objectives. Elestor is now working to upscale these stacks to reach a minimum of the 10kW level per stack. To get the stacks operational in a suitable fashion, a surrounding system is required. Elestor moved into a complete redesign of this surrounding system, to secure that total system operation, safety, efficiency and cost are able to meet the future targets. With this redesign, the system shall be ready for further scale ups. The first scale up will be deployed within the GIFT project.

Smart Energy Hub

The Smart Energy Hub, based on a modular design adapted to cover a wide spectrum of power range, include an innovative reversible electrolysis & fuel cell technology, the rSOC technology (40 kW/module in electrolysis mode, 10 kW/module in fuel cell cogeneration mode), designed and manufactured by Sylfen, a "off-the-shelf" hydrogen compression and storage chain (enabling multi-MWh storage capacity) and Li-ion batteries (50 kWh/module). It allows both storing excess energy generated by solar panels (or other renewable power source) for several days to months, and covering local electricity and heating needs even in periods of high demand or low renewable energy production.

For GIFT, the Smart Energy Hub will be installed in the Procida island in Italy, nearby the municipality building. It will be used as an energy storage solution, and also for energy flexibility and management purpose. The Smart Energy Hub being a new technology, the prototype, which is a copy of the one for GIFT, is currently passing through a series of tests and experiments.

The outcomes of Sylfen for GIFT project, is to implement a fully operational system, which is a solution for energy storage and supply, in accordance with the expected power ranges, and allow the flexibility of the energy management into Procida island and being a service for the municipality building.

4. System integration

Testing and system integration in laboratory environment represents the intermediate stage between the development of technical solutions and their deployment to demonstration sites. The process is executed in three steps: component testing (verification of proper operation of individual GIFT system components without interaction with other GIFT components), interoperability testing (testing of interfaces between individual components of GIFT system), and finally the integration testing, where all components are operating in a closed-loop control mode that enables verification of integrated GIFT system's operation as defined by system's functional and technical specifications.

Component tests are currently in final stage, while interoperability tests are beginning. Test plans and procedures for integration testing are in elaboration; execution of integration tests is planned for the coming months.

5. Implementation on the demonstration islands

a. Hinnøya island cluster

On the Norwegian demonstration site, also known as the Hinnøya island cluster, there has been progress on the prosumer acquisition for all GIFT solutions: EV charger, FEMS, e-ferry and HBr battery.

Regarding the FEMS prosumers, the best solution for each of them are being assessed. 11 FEMS prosumers have been selected based on their activity, device, electricity consumption, profile and the five main GIFT specific objectives. These prosumers include fish farm, public buildings, farmers, tourism, horticulture and wholesaler.

Two locations have been selected for EV chargers. Two EV chargers will be placed outside the school on Grytøya, and there will also be installed one home charger. These chargers will be operated by Polar Kraft, which the former HLK Kunde now is a part of.

Regarding the HBr battery, different locations for the battery to be installed on are being assessed. There are also local, regional, and national regulations that has to be taken into account and are being evaluated.

The last type of prosumer is the electric ferry between Stornes on Hinnøya and Bjørnerå on Grytøya. Different stakeholders like the county and ferry operators have been identified and are being contacted regarding the implementation of the e-ferry. The flexibility potential of an e-ferry is also being simulated. More information about the Hinnøya island cluster can be found in deliverable 7.1 published on the GIFT website.

b. Procida island

On Procida island, potential prosumers for the GIFT solutions have been identified and two representative prosumers have been confirmed for the FEMS' prototype. Preliminary analysis, including a feasibility study, a market investigation and the identification of private potential prosumers, has been carried out for the installation of the EV charging system. The procedures to supply the city hall with methan gas for the operation of the Smart Energy Hub have started, as well as the site preparation as of today.

On Jan 18th, 2021, the island of Procida won the title of Italian Capital of Culture 2022, after fighting off competition from nine other finalist cities. The proposal that earned the island the award and one million euros includes 44 projects concerning art, urban regeneration, environmental sustainability and more, involving 240 artists and 40 original works. As the minister of culture Dario Franceschini said, Procida island has presented an "excellent project capable of representing a model for sustainable development based on the island's culture and coastline, as well as transmitting a poetic message, a vision of culture". The GIFT project therefore finds its place within this big program and will surely benefit from the great media and social impact that the island is already experiencing since the proclamation. "An island always pleases my imagination, even the smallest, as a small continent and integral portion of the globe*"- Henry David Thoreau*

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