Strategic energy management plan

Table of Contents

Introduction

Welcome to the guidebook on how to build a port energy management plan! Before we proceed, let us, first of all, define what a strategic energy management plan means. Usually, it stands for a long-term organizational plan to improve energy performance through making better use of energy-intensive assets of the organization. When we mention “long-term”, we mean 10-15 years perspective at most. By “improving energy performance” the following organization-relevant benefits are mainly thought of: maximizing the use of energy sources as well as decreasing its consumption and costs. As a side effect of those, carbon footprint reduction, enhanced reputation and improved market competitiveness follow. This publication aims at helping Finnish port authorities to establish a port energy strategy and draft measures to proceed towards innovation, decarbonisation and efficiency of their energy system. Due to the complexity of the task, it is beneficial to have personnel with both, knowledge about daily operations as well as management skills, working on it. Below is a scheme of step-by-step process on how to formulate the port plan.

EVISA
ENERGIAVIISAS SATAMA

Programme for Sustainable Growth and Jobs

Leverage from the EU 2014–2020

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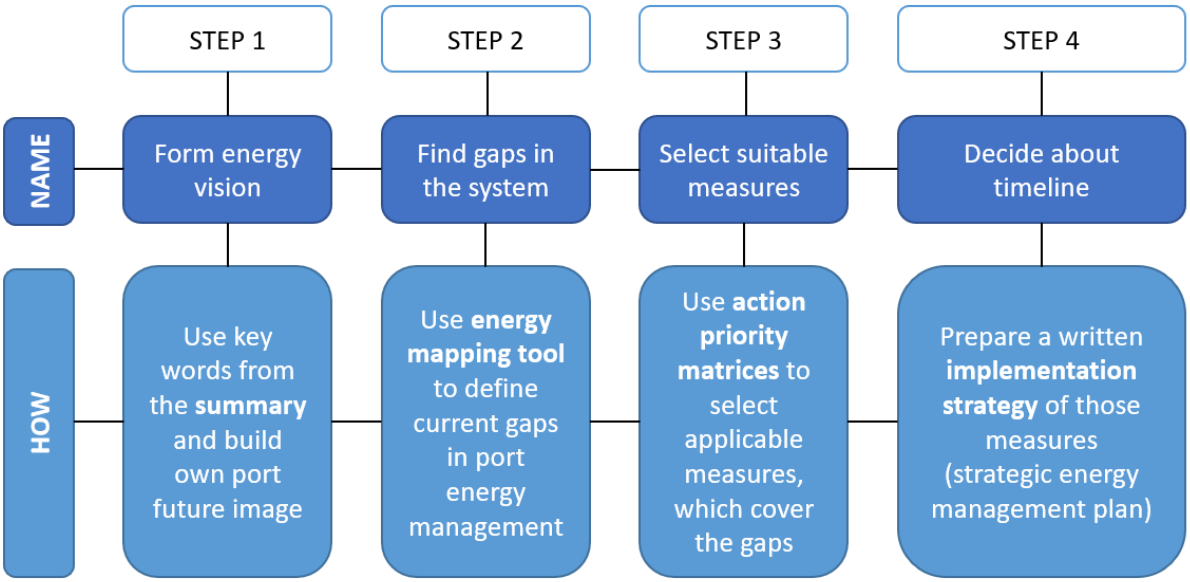

Figure 1. Scheme of building a strategic energy management plan.

Under each step, there is an answer to the question "how?": "*How this can be achieved?*". In this relation, what does the publication include? It is:

- **summary** of the future vision of European port authorities
- guided manual for finding **gaps** in existing port energy management
- list of possible **measures** to cover those gaps and a description of their benefits
- evaluation of their fast **applicability** in port: positive impacts versus required efforts
- **criteria** for choosing measures for the port energy management plan
- and tentative **timeline** for implementation of the selected measures

A recommendation before we go into each detail of the guidelines, please make sure such EVISA tools as ***pre-survey***, ***energy mapping survey, renewable energy potential assessment*** *and* ***carbon footprint calculator*** are approached and completed. Once they are addressed, drafting a port energy management plan will be a smooth and easy task. Best of luck and wish you to take the most out of this publication!

A short-term future vision of the port

The last three years have been fruitful for new EU regulations and frameworks, which will affect the port's day-to-day activities and especially its energy and environmental profile. There are already many hopes and visions describing the port image of the future in such documents as the EU Green Deal, EU's Fit for 55 package and ESPO Green Guide 2021. Altogether there are about 99 pages of reading material. However, to save you time and energy, here are our 12 bullet points with keywords from those publications: answering the following three questions in bold print.

What is the port authority of the near future?

- it is a logistical hub, a centre of the industrial supply chain (production, distribution), which plays important role in avoiding unnecessary transport;
- it has a green image:
  - monitors noise, is silent at night, switches to electric equipment and machinery, applies differentiated dues to reward quitter vessels;
  - manages own wastes and receives waste from vessels, applies indirect waste fee paid by vessels;
  - ready for upcoming changes in climate, resilient to flooding and storms with its structures,
  - carbon-free, monitors and has an inventory of emissions by port and port actors, knows its carbon footprint, aims at no emissions and no pollution concepts;
  - addresses unfamiliar and novel issues as part of the transition to a greener future, the front-runner of Europe's sustainable transition, supports a blue economy (preserves sea and land for food, energy, raw materials and tourism use; carbon capture and storage) as well as the circular economy (waste to resources, recycling, reusing);
- a hub of clean renewable energy (offshore wind and wave energy as well as onshore solar, wind, and bioenergy), provides onshore power supply to vessels and bunkering of LNG as an alternative fuel (to avoid emissions), produces hydrogen and/or hydrogen derived fuels (ammonia), applies Power-to-X solutions to use electricity for the production of hydrogen, methane and ammonia;
- a hub of innovative and digital technologies: sensors, meters, intelligent traffic lights, efficient buildings, and operational and environmental efficiency achieved via digitalization.

What does port authority do with/for port actors and other ports?

- it acts as a coordinator, catalyst and promoter of decarbonisation and greening for port actors;
- provides green discounts, differentiated port fees and advantageous treatment in ports,
- introduces port norms/rules for (sustainable) infrastructure investments, gives prizes for environmental performance, organizing/hosting webinars and conferences;
- collaborates with other ports and stakeholders on sustainability matters.

How does the port authority build its communication with locals?

- it actively takes part in projects, cooperates on strategic green investment decisions and promotes innovations in port;
- provides opportunities for green businesses, provides areas/locations for them, supplies energy for them, is involved in synergies between industries and port, and there is a growing port ecosystem;
- builds green areas and parks for citizens in the port area, cleans coastlines and preserves sea and land nature as well as encourages repopulation of endangered

species (biodiversity) – e.g. building underwater infra where fish, mussels and plants thrive;

- transparent with its activities and green policies (shows how you deliver goods for internet shoppers, produce energy, disseminate good environmental practices, port's policy available on the website), active on social media and offline (reaching out to youth at schools, and families - open port days), target groups: general public, port workers, potential port workers, local community; themes for improvement: find it on Page 40 in ESPO Green Guide.

Out of those 12 bullet points, please choose the most applicable and desirable keywords. Mark them, highlight them right here in the text or underline them with a red pen on a printed version. Use the final collection of the selected keywords to write your own port vision. Decide on an approximate timeline and describe what port authority will be, do and how it will act with the outer world. This will be your supporting document or compass to become more sustainable and form a port energy management strategy. For more inspiration and deeper understanding, please refer to EU Green Deal, EU's Fit for 55 package and ESPO Green Guide 2021. You can also check examples for short or long port visions from ports of Helsinki, Bergen (Norway) or Gothenburg (Sweden).

How to find gaps in the current port energy management?

It is common sense that getting to geographical point B always requires knowing the current location point A. Defining port baseline or starting point A is as important as knowing the final destination point B. As there is already enough material on present energy management practices documented in the port energy map, let us refer to it. Out of 11 pages with valid port information, we would need only 7 to assess existing gaps in the system.

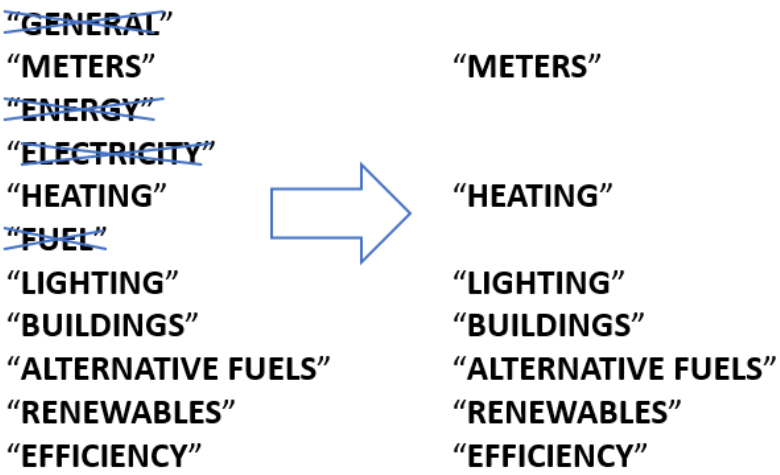

Figure 2. Applicable components of the port energy map.

The page “general” can be crossed out since it has only general port data. Sectors “energy”, “electricity” and partly “fuel” are united with the “meters” page. The remaining part of section “fuel” is linked with “alternative fuels”. The result of all the crossings can be seen in Figure 2. Those seven sections are our main focus.
Since EVISA offers a self-assessment tool, it is only the port authority that can see and write down the current gaps in port energy management. To make it easier for you, below are examples of possible gaps for each individual section. Option “other” represents additional space for your own use to add extra gaps under each category:

● **“METERS”:**

☐ lack of electricity data for areas/buildings
☐ lack of separate data: heating / cold and hot water / lighting / ventilation / fuel / gas
☐ lack of real-time data
Other: Click or tap here to enter text.

● **“HEATING”:**

☐ lack of room temperature regulators
☐ malfunction of heater(s)
☐ insufficiency of the current heater(s)
☐ aged/obsolete heating equipment
☐ inadequate heating technology
☐ high energy bills
Other: Click or tap here to enter text.

● **“LIGHTING”:**

☐ low energy efficiency
☐ heat generation
☐ mercury content in light bulbs
☐ lack of intensity controller
☐ excessive electricity bill
☐ low service life
☐ flickering lights
☐ long time to warm up for full lighting capacity
☐ old-fashioned design
Other: Click or tap here to enter text.

● "**BUILDINGS**":

☐ low energy class
☐ high monthly energy use
☐ excessive energy (heating, electricity) bills
☐ low indoor air quality
☐ regular heat leakages on infrared images
☐ occasional heat losses due to other factors
☐ obsolete materials: walls, windows, roof
☐ local defects: walls, windows, roof

Other: Click or tap here to enter text.

● **"ALTERNATIVE FUELS":**

☐ lack of chargers for plug-in vehicles
☐ lack of parking for bikes, when cycling is allowed
☐ lack of LNG bunkering infrastructure
☐ lack of onshore power supply for vessels at berth
☐ lack of fuel alternatives for current traditional fuel use for heating or vehicle fuel: for instance, cleaner liquid (e.g. biodiesel, bioethanol), solid (e.g. wood pellets) and gaseous (e.g. biogas, LNG, synthetic gas) fuels

Other: Click or tap here to enter text.

● **"RENEWABLES":**

☐ lack of green energy solutions in port: own or contracted
☐ unutilized potential: solar / wind / biomass / wave / geothermal energy

Other: Click or tap here to enter text.

● **"EFFICIENCY":**

☐ low level of energy-saving practices among personnel
☐ lack of energy audit on an annual basis
☐ lack of adaptive and smart lighting systems
☐ lack of thermoregulators for heating
☐ lack of thermal infrared images for port buildings
☐ lack of hybrid engines in port vehicles

☐ existing leakages in pipes or other systems
☐ lack of modern digital solutions for efficient energy management
☐ lack of energy policies and strategies
☐ lack of environmental policies and strategies

Other: Click or tap here to enter text.

If there are any suitable options for port gaps, you are welcome to highlight them directly in the text or underline them with a red pen on the printed version. You can also add your own gaps in the field "other" under each category. If needed, a separate document with a gap assessment survey is available in EVISA attachments.

What are possible measures to cover the highlighted gaps?

For all already defined and listed gaps there are available solutions, which can improve the port's *status quo* and make it a frontrunner in Europe's sustainable transition. All measures are elaborated in the upcoming section right after the presented list:

● "**METERS**":

☐ ship environmental monitoring system
☐ additional meters by port area and building
☐ meters by port consumption: heating (electric and other) / water (hot and cold) / lighting / electric ventilation / fuel (benzine, diesel, gas)
☐ installation of an online metering system

Own option: Click or tap here to enter text.

● "**HEATING**":

☐ district heating/cooling
☐ seawater source heat pumps

Own option: Click or tap here to enter text.

● "**LIGHTING**":

☐ LED lighting
☐ adaptive lighting system
☐ LED floodlights and walkway lights

Own option: Click or tap here to enter text.

● “**BUILDINGS**”:

☐ painting walls white / add windows and skylights
☐ installation of an air curtain
☐ optimization of HVAC system
☐ insulation
☐ nearly zero energy building
☐ demand-controlled ventilation (DCV) system
☐ adjusting air temperature
☐ green roof

Own option: Click or tap here to enter text.

● “**ALTERNATIVE FUELS**”:

☐ onshore power supply (OPS)
☐ LNG PowerPac
☐ mobile LNG barge
☐ LNG bunkering: truck-to-ship (TTS)
☐ LNG bunkering: shore to ship
☐ LNG bunkering: ship-to-ship (STS)
☐ LNG bunkering: local liquefaction plant
☐ alternative fuels
☐ automated mooring systems
☐ hybrid power train
☐ hybrid power train (plug-in-hybrid)
☐ electrification of power train (battery or fuel cell)

Own option: Click or tap here to enter text.

● “**RENEWABLES**”:

☐ obtain “green” energy
☐ solar photovoltaics (PV)
☐ wind power
☐ hydropower
☐ biogas
☐ geothermal
☐ microturbine

Own option: Click or tap here to enter text.

● "**EFFICIENCY**":

☐ energy / emission target
☐ energy management system (EMS)
☐ energy audits
☐ smart grid applications
☐ employee suggestion system
☐ employee environment training
☐ employee bus shuttle services
☐ provision of bikes for commuting
☐ bundling of power
☐ cross-company use of waste heat
☐ heavy duty vehicle (HDV) emission control zone
☐ alternative HDV cooling: Dearman Transport Refrigeration Unit
☐ alternative HDV cooling: grid connection
☐ green port fees
☐ slow steaming
☐ electrification of power train
☐ energy-saving tires
☐ tire pressure control
☐ regenerative drives
☐ emission control technologies
☐ eco-driving lessons

Own option: Click or tap here to enter text.

Please note that this list serves as an introductory demonstration. Further explanation of each of the 50+ measures is available below as well as their assessment in action priority matrices. Feel free to mark a suitable measure for your use at any point of this guideline materials.

Description of the measures

In case you are unaware of what each stated measure is about, here is a description of each out of all 50+ solutions separately: case by case. You can tick the box with those that you are interested to implement right after having read about it. By the way, some measures – where applicable – are assessed in terms of their contribution to carbon footprint reduction in the port. Those numbers are meant as supportive material for further action.

● "**METERS**":

☐ **ship environmental monitoring system:** It is a port system with available data on the most important environmental parameters: e.g. fuel consumption and air emissions of

individual ships. The system helps to centralize environmental data collection and define energy or emission reduction objectives for vessels in the port area and track progress around those objectives. This system can also be used to estimate the environmental impact of the port: e.g. carbon footprint assessment. The data could additionally be used for port benchmarking and certification programs as well as give good grounds for organizing green discounts for visiting vessels.

- ☐ **additional meters by port area and building:** This measure is about the installation of additional meters which specify certain consumption flows (electricity, hot water, other energy sources) for separate port areas and/or individual buildings. This is mostly about improving the availability and precision of data on energy. The generated data are important and serve as input for further improvements in port energy management.
- ☐ **meters by port consumption, heating (electric and other) / water (hot and cold) / lighting / electric ventilation / fuel (benzine, diesel, gas):** This measure is also about installation of meters, but the focus is on specific energy streams: heating (electric and other) / water (hot and cold) / lighting / electric ventilation / fuel (benzine, diesel, gas). If the previous measure was about getting energy data for port locations, this improvement is rather about separate energy flows. This can also be used for further advancement in port energy management. For instance, if there is overconsumption in port lighting and it is possible to see it on a separate meter, betterment can be done here. If old light bulbs consume a lot in comparison with LED technology, precise numbers can support decision-making and justification of change. The same could be used for the addition of an adaptive lighting system when it is possible to predict the difference in certain numbers of consumed electricity.
- ☐ **installation of an online metering system:** This measure can improve the quality of available data due to its properties. It is an online system that shows real-time and archived measurements of electricity consumption by port area and building as well as by separate electricity streams such as lighting, heating and other electricity uses. An existing example is already in operation in the Port of Oulu, Finland.

- "**HEATING**":

- ☐ **district heating/cooling:** It is built on the well-utilized idea that instead of each building having its own heating or cooling system, the energy can be delivered to several buildings in a larger area from a central plant. A change of the heating system from its own fossil fuel-based system to district heating can reduce carbon footprint significantly. Usually, district heating is more energy efficient, due to the simultaneous production of heat and electricity in combined heat and power generation plants. Options for district heating (and cooling) are gas, biomass, central solar heating, heat pumps and geothermal heating. In the Port of Stockholm, for example, the CO2 emissions could be

decreased from 5,500 to 0.7 tons, mainly because of the switch from an oil-based generator to district heat. *Carbon footprint reduction potential, %: from 5 to 16.*

- ☐ **seawater source heat pumps:** The idea is about heating and cooling the port premises with seawater heat pumps. The system is very efficient; however, high investments must be made and they are much higher compared to district heating and cooling solutions. *Carbon footprint reduction potential, %: from 7 to 20.*

● "**LIGHTING**":

- ☐ **LED lighting:** This solution is mostly about replacing conventional light bulbs with LED lights. While the initial cost of installing LEDs is typically higher than conventional lighting options, energy savings and reduced maintenance can result in a fast return on investments. Real case studies suggest that energy savings can amount to between 55-60%. Ports that have introduced newer lighting technologies often report other operational benefits. For example, improved lighting tends to improve safety and result in reduced operator fatigue. New lighting technologies also allow operators to have greater control over how light sources affect the surrounding environment in terms of light pollution, light spill, and glare. Finally, LED lights can be programmed and dimmed to reduce energy consumption and light pollution. It is a common solution in Finnish ports. *Carbon footprint reduction potential, %: less than 1.*
- ☐ **adaptive lighting system:** It has to do with the installation of a lighting system that automatically adjusts its light output and operation. The adjustment is done to provide targeted light levels based on environmental conditions, user schedules, or other application-specific criteria. Such a system may include various types of products: e.g. dimmable lamps and luminaires, occupancy sensors, photocontrols, time clocks, communication panels, and wireless communication nodes.
- ☐ **LED floodlights and walkway lights:** This measure is about local lighting solutions for walkways and similar purposes. Such lights can, for instance, be installed on port cranes. This can reduce energy usage, reduce crane maintenance costs and increase operator safety. Due to fewer moving parts in LED technology, there will be a significant decrease in service costs. Plus it adds to port safety, sustainability and profitability.

● "**BUILDINGS**":

- ☐ **painting walls white / adding windows and skylights:** It has to do with the inclusion of natural lighting. Painting walls in white helps to reflect the light. It is a simple and cost-effective measure to brighten up the port warehouse and/or workshop. Adding windows on the walls or the roof (skylights) enables penetration of natural light in the room and provides the best use of daylight. The most energy-intensive parts in warehouses and workshops are lighting, heating and cooling. Adoption of a more efficient lighting system where a photo-controlled energy-efficient lighting system (e.g. auto-adjusting LED

technology according to the daylight intensity) is coupled with natural light can lead to energy savings of up to 80%. *Carbon footprint reduction potential, %: less than 1.*

- ☐ **install air curtain:** This measure includes the installation of well-insulated, high-speed doors to prevent energy escape. Usually, open doors provide the largest portal for energy loss in port warehouses. The same idea applies to cold storage which consumes considerable amounts of energy. Studies have shown that a large part of the cooling is generally lost each time the doors of the cooling section are opened. This increases the energy consumption and operational costs of the refrigeration unit. As a simple measure, the doors are fitted with transparent PVC curtains strips; this decreases the average energy consumption by nearly 20%, while all other factors (number, time and duration of door openings) have remained the same.
- ☐ **optimization of HVAC system:** It deals with indoor air temperature, which is regulated by heating, ventilation, and air conditioning (HVAC) systems. The components of HVAC systems can degrade over time and drop their energy performance by 30 to 60 %. A well-maintained HVAC system can significantly cut energy costs and extend equipment life. Maintenance can keep the system's original efficiency at 95%. Retrofitting old HVAC systems with thermostats can lead to further energy savings of up to 10 % for heating and cooling. *Carbon footprint reduction potential, %: up to 2.*
- ☐ **insulation:** The building envelope is the thermal and mass barrier between the interior and outdoor environment and is one of the primary determinants of how much energy the building consumes and how comfort and indoor air quality are maintained. Approximately 35% of the energy consumed in commercial and residential buildings is used to maintain a comfortable and safe interior environment. Improving insulation is a proven way to reduce both heating and cooling costs. Proper sealants are also a good way to improve the energy efficiency of a warehouse.
- ☐ **nearly zero energy building:** It is a building that is constructed under the best possible building practices: with a focus on energy efficiency and renewable energy. It has to do with control over indoor climate, heating of household water and utilization of appliances and other electrical equipment. Due to high energy savings in such buildings typically payback time is rather short. *Carbon footprint reduction potential, %: up to 21.*
- ☐ **demand-controlled ventilation (DCV) system:** It has to do with the division of buildings into thermal zones. The zones are controlled separately based on space functions. For example, the radiant heaters should be controlled by timers or occupancy sensors to minimize their operation when areas are unoccupied.
- ☐ **adjusting air temperature:** It deals with adjusting the desired air temperature closer to the ambient air temperature. This measure will save significant amounts of energy consumption. For instance, reducing the indoor temperature in summer from 26° to 22° had been shown to reduce energy consumption by up to 40% on average. This can

easily be achieved by retrofitting the heating system with thermostats and outdoor sensors. *Carbon footprint reduction potential, %: up to 8.*

- ☐ **green roof:** It is about installing a special layer on the rooftop. The layer consists of a specialized growing medium and specifically selected plants. Green roofs can be installed on flat roofs as well as on porch roofs. The advantages include a high degree of insulation, dust prevention, cleaning of the air, CO2-sink and O2-generation by photosynthesis, increased biodiversity in the area, improved aesthetic views for neighbours, improved worker productivity and creativity, extended durability of the roof energy efficiency and minimization of heat loss in winter. Furthermore, they reduce the "urban heat island effect" by absorption (not reflection) of UV radiation. In addition, stormwater run-off is cleaned by the roof and the water amount is reduced to up to 50%.

- "**ALTERNATIVE FUELS**":

- ☐ **onshore power supply (OPS):** This solution helps to avoid air emissions as well as noise pollution from a vessel located at berth. Instead, vessels rely on shore power rather than electricity generated by their auxiliary engines that emit greenhouse gas emissions, reducing local air quality and ultimately the health of people in and around the port. OPS can eliminate generated emissions in port but the carbon footprint of the technology highly depends on the type of electricity supplied to the grid: if it is renewable energy based or not. Expected noise reduction in the port ranges from 0 to 10 dB. Each OPS installation includes transformer stations, frequency converters, cable management systems and grid extension – hence, its substantial initial investment. Additionally, visiting ships have to have a suitable connection to such a system. However, there are visible trends and expectations from ports to apply the OPS system already in the 2030s. *Carbon footprint reduction potential, %: from 30 to 70.*
- ☐ **LNG PowerPac:** Similar to the onshore power supply (OPS) system, this measure also deals with electricity supply for visiting vessels at berth. The idea is to produce electricity from LNG using a generator placed in a mobile container. Same as with the OPS system, the main advantage is the reduction of the ship's emissions and noise from working auxiliary engines. The container or LNG PowerPac can be located on the ship or onshore. The expected power supply is up to 30 MW.
- ☐ **mobile LNG barge:** It represents one more solution that is closely related to onshore power supply or LNG PowerPac alternatives. Mobile LNG barges look like floating power plants that produce electricity for vessels at berth. The power is generated by burning LNG. The mobile barge can provide power to more than one ship at a time. The noise levels of the LNG generator are lower than in the case of a diesel-based generator. Carbon emissions from the barge are 20% lower than when the ship uses the auxiliary engines.

☐ **LNG bunkering, truck-to-ship (TTS):** This measure is about LNG supply for vessels as fuel. This usually requires building a certain infrastructure around it. But one of the simplest approaches is just to fuel ships directly from LNG carrying trucks. The truck connects to the vessel via special hoses. The trucks can also be used for LNG distribution for other purposes. The main disadvantage of TTS LNG bunkering is limited gas carrying capacity – which is important for large consumers. The speed of gas flow is also relatively small. On the other hand, the cost of such a solution would be at a level of 200 000 euros per truck. **NOTE**: According to often shared EU Parliament representatives' opinion, LNG is considered an unsustainable fuel for vessels but rather a transition fuel towards synthetic fuels – which recommends avoiding planning long-term investments (10-15 years) in developing such port infrastructures.

☐ **LNG bunkering, shore to ship:** This measure is about LNG supply for vessels as fuel. This usually requires building a certain infrastructure around it. But this rather local solution allows doing it from a small LNG station in port. Few fixed hoses and cranes are used to handle the operation. The main advantages of the approach are available large bunkering capacity and large speed of gas flow. The mobile station can be customized for automatic fuelling and is ready for shore-to-ship bunkering when required. The solution needs high investments (e.g. tanks and bunker stations) and some port space. **NOTE**: According to often shared EU Parliament representatives' opinion, LNG is considered an unsustainable fuel for vessels but rather a transition fuel towards synthetic fuels – which recommends avoiding planning long-term investments (10-15 years) in developing such port infrastructures.

☐ **LNG bunkering, ship-to-ship (STS):** Similar to the previously mentioned truck-to-ship and shore-to-ship alternatives, this measure is also about LNG supply for vessels as fuel. Bunkering usually requires building certain infrastructure around it. However, in the case of ship-to-ship bunkering, there is only a need for offshore space in port to accommodate the bunkering vessel. The advantages are availability and flexibility of gas fuelling in different port locations and outside of it, large bunkering capacity and high flow rates. The disadvantages are in turn required space in the port water area and high initial costs. **NOTE**: According to often shared EU Parliament representatives' opinion, LNG is considered an unsustainable fuel for vessels but rather a transition fuel towards synthetic fuels – which recommends avoiding planning long-term investments (10-15 years) in developing such port infrastructures.

☐ **LNG bunkering, local liquefaction plant:** This measure is also about LNG supply for vessels as fuel. This requires building a certain infrastructure around it. In this case, the LNG production plant is considered on port premises. The advantages are the security of supply, reduced space for gas storage tanks and certain value on the market with respectful additional revenue channels for the port. The disadvantage is the high investment needed for building the plant. **NOTE**: According to often shared EU Parliament representatives' opinion, LNG is considered an unsustainable fuel for

vessels but rather a transition fuel towards synthetic fuels – which recommends avoiding planning long-term investments (10-15 years) in developing such port infrastructures.

- ☐ **alternative fuels:** It is about substituting traditional fuels (e.g. diesel) for cargo handling equipment with alternative and low-emission fuels. The carbon load levels are lower than for normal diesel but the disadvantages of alternative fuels are that they are more expensive and their organization (e.g. LNG, LPG, CNG) require special infrastructure within the port area.
- ☐ **automated mooring systems:** This measure or system helps to moor quicker and with fewer operators involved. The air emissions are reduced due to the shortness of mooring operation time. Besides, engines are shut off much earlier. Usually, ocean-going vessels represent the largest contribution to the port's carbon footprint calculation. However, the carbon footprint of the port is reduced only slightly with this measure because air emissions from manoeuvring have just a small share of vessel total air emissions in ports.
- ☐ **hybrid power train:** This solution is about the substitution of the main engine power of port vehicles for a newer version – a hybrid with the possibility to operate on electricity together with traditional fossil fuels. The battery is charged during vehicle operation. The advantage is the reduction of air emissions due to the inclusion, for example, of the "stop & go" mode in engine operation. This can be seen in port forklifts. In addition, there is a fuel economy of up to 15%. The disadvantage at the moment is that not all types of port vehicles can yet be available on the market.
- ☐ **hybrid power train (plug-in-hybrid):** It is similar to a hybrid power train solution but the difference is in the charging system. If the power train vehicle is charged during operation, the plug-in hybrid is charged with a cable connection to the power grid. The vehicle can still operate both on electricity and diesel. The advantage is the reduction of air emissions due to less use of diesel as well as fuel economy. The disadvantage at the moment is that not all types of port vehicles can yet be available on the market.
- ☐ **electrification of power train (battery or fuel cell):** It has to do with the full substitution of diesel motors in port vehicles for electric ones. Full electrification is achieved either with the use of a battery or fuel cell. Battery-based electric vehicles require charging: via electricity generation during operation or via a plug-in connection to the electric grid. In turn, fuel cell vehicles have their own inbuilt power plant that supplies electric energy to the motor. No battery is required here. Fuel – normally hydrogen – is transferred to electric energy. If we compare the two types, by far battery electric vehicles seem to perform better: having higher energy efficiency. Fuel cell-based vehicles can consume two times more energy than battery-driven vehicles. The advantages are carbon and noise reduction as well as the additional possibility to operate indoors. The drawback is a higher cost in comparison with common port vehicles, possible short driving distances and the need to be charged (battery case, plug-in hybrid) – it affects both, the practical

use of vehicles as well as requires having a charging station. In the case of a fuel cell, which is based on hydrogen, enhanced safety is required for operation. *Carbon footprint reduction potential, %: from 11 to 20.*

● "**RENEWABLES**":

☐ **obtain "green" energy:** This measure does not require any installation of wind turbines or solar panels in the port area. Instead, it is only about purchasing renewable energy from a local energy company. This is a simple and fast way to reduce carbon footprint in ports (under 5%). It is a comfortable solution for small ports. *Carbon footprint reduction potential, %: from 0,8 to 3,5.*

☐ **solar photovoltaics (PV):** This measure has to do with solar energy production in the port area. Many such projects have already been implemented in Finnish ports. EVISA offers an easy-to-use tool to estimate local solar energy potential and assess how fast a solar energy project can pay back the initial investments. After several tests in real-life conditions, feasible projects usually return the investment in under 5 years. Usual places for solar panel installations are rooftops and walls: e.g. warehouses. *Carbon footprint reduction potential, %: under 1.*

☐ **wind power:** This solution is about the conversion of available local windy conditions into a useful renewable energy source. The traditional way to do it is via the installation of a wind turbine in an offshore or onshore port area. Usually, wind-rich places are located in coastal or highland areas. The disadvantage is the required space for placing the turbine or several of them. In addition, the usual downsides of wind energy use are noise pollution and danger for seabird migration routes. On the other side, the benefit of using wind power is its zero air emissions. This can lower the carbon footprint to some degree (up to 5%). *Carbon footprint reduction potential, %: under 1.*

☐ **hydropower:** This solution, if possible locally, enables utilization of available flowing water potential with subsequent production of electricity. Examples of flowing water can be river flow, tides and wave power. The last two may be troublesome since they require a large area for implementation, which can disturb port operations. The obvious advantage is emission-free energy production and betterment of port image in terms of its sustainability and energy management. *Carbon footprint reduction potential, %: up to 4.*

☐ **biogas:** This measure utilizes biogas for renewable energy production. If there are prerequisites in terms of available feedstock (wastewater, food waste or other organic waste), this solution can be included in the port energy system. The energy is produced by the fermentation of organic material in a closed environment. The disadvantages are specific disagreeable odour, space and temperature requirements. Fermentation requires keeping the temperature at about 37°C all year round. This might be energy intensive in winter. In addition, fermentation leftovers have to be transported at the end

of the process. The advantage is the utilization of existing potential into yearly available sustainable energy. *Carbon footprint reduction potential, %: up to 4.*

- ☐ **geothermal:** It deals with the transformation of available thermal energy under the port into electricity. In addition to electric power supply, geothermal energy can be used for heating. The advantage compared to other renewable energy sources is the permanent access to the energy source. The Swedish port of Stockholm, for instance, partly uses geothermal energy. *Carbon footprint reduction potential, %: from 7 to 20.*
- ☐ **microturbine:** This has to do with the utilization of produced biogas (also natural gas) in energy-generating turbines or microturbines. They look like containers and can be of different sizes: from 30 kW to 10 MW of electric power. Microturbines are a type of combustion turbine, therefore in addition to electricity, they can also produce heat. The advantages are secure power, energy efficiency, fewer air emissions, compact size and mobility. The disadvantage is the availability of certain types of gas (biogas, landfill gas or similar) to be able to place this solution in the renewable energy category. *Carbon footprint reduction potential, %: under 1.*

● "**EFFICIENCY**":

- ☐ **energy/emission target:** This little measure is done as part of the port's energy strategy. EVISA offers an energy mapping as well as a carbon footprint calculator, which both help to define the baseline of how energy is used in port and what carbon emissions are behind it. Once these are completed, the port target on emission reduction or energy improvement is set. Both are usually related to the baseline conditions. Achievement of emission target is assessed in percentage from it: e.g., several per cents from baseline carbon load.
- ☐ **energy management system (EMS):** This holistic measure is about organizing, controlling and managing different energy flows in a port (electricity, lighting, heating). It all starts by making a port energy map, for which the EVISA project developed a tool. Once an energy map is created, there are several steps towards a successful energy management system in the port. Step 1 is building a port energy vision. Step 2 is defining gaps in current energy management using the energy map. Step 3 is choosing measures to implement in order to cover those existing gaps. Step 4 is to put those measures on the timeline: when each of those selected measures is going to be implemented in port. Having an EMS helps to control overall energy consumption, reduce it and at the same time decrease the port's carbon footprint.
- ☐ **energy audits:** It has to do with the assessment of current energy consumption in the port. EVISA suggests using the energy mapping tool to complete this measure. The tool lists the full spectrum of energy flows to consider: annual port consumption of electricity, heating, fuel and water; incoming and outgoing electricity flows; heating budget: incoming and outgoing flows; port vehicles and their fuel consumption; indoor and

outdoor lighting inventory; energy performance of buildings; use of biofuels and other types of alternative fuels; utilized renewable energy sources; and applied energy efficiency measures. Knowing and having the data available will help to define the existing gaps in energy management and formulate energy goals as well as the port's long-term energy strategy.

- ☐ **smart grid applications:** This measure is about a thorough rethinking of port energy distribution infrastructure and management: instead of one-way energy communication from energy producer to consumer towards two-way dialogue when all energy system components communicate with each other. Usually, a smart grid system includes the following parts: energy production site (e.g. solar panels or wind turbine), electricity usage management systems (e.g. smart meters, communication devices, automation algorithms) and onsite energy storage batteries (including plug-in hybrid vehicles). The normal grid connection is still in operation – for the case when renewables cannot supply enough energy for port use. The advantage of a smart grid system is the efficiency, reliability and security of the energy grid. The disadvantage is the requirement of large resources to implement such a system.
- ☐ **employee suggestion system:** It deals with the involvement of employees in the process of striving towards energy sustainability. Examples can be the introduction of voluntary local green initiatives coming from employees and encouragement for those workers who participate in and support those green projects or practices. In other words, this measure is about adding a practice or system through which employees can bring in their ideas.
- ☐ **employee environment training:** This solution includes small seminars or training sessions with invited guests (if the administration does have the resources to organize it by itself), where there is a proper environment for learning about new green or sustainable port practices. It helps employees to start thinking more green. This may result in savings: electricity, fuel, or other resources.
- ☐ **employee bus shuttle services:** This measure suits better for large-scale or industrial ports, where the area of operation is too large to move around. Staff shuttle bus delivers people from one port area to another, which as a measure helps to decrease traffic and improve safety in port. This is, for example, implemented in the industrial Port of Tornio.
- ☐ **provision of bikes for commuting:** It has to do with the introduction of bike use in and outside the port for employees. If applicable, this measure can help port workers stay fit and reduce their annual carbon footprint. There are existing examples when employees bike to work and also when they bike within the port.
- ☐ **bundling of power:** This measure is about negotiation with port operators to agree on joint purchasing of electricity from the energy provider. The idea is to get a discount on green energy: buy energy from renewable energy sources for the same price as one usually buys regular energy from conventional sources. This would make sense for the

energy provider because it will get multiple customers as a single package. Before bundling, all port operators and the port authority could be connected to different energy companies. But after bundling they all go to one “shop”, which makes a better deal for the power supplier.

- ☐ **cross-company use of waste heat:** This measure is usually applied to larger (industrial) ports but not exclusively. If the port has operators who produce large amounts of waste heat, it can be recuperated and sent forward to other buildings or port operators where it could be utilized. This is a good sustainable practice, which makes environmental and economic sense. *Carbon footprint reduction potential, %: from 7 to 20.*
- ☐ **heavy duty vehicle (HDV) emission control zone:** This is a port initiative that is related to stricter air emissions standards for vehicles within the port area. This can helps reduce the carbon footprint in the port and put the port authority in the leading role in the greenification process. Examples of such standards could be taken from general European vehicle requirements like EURO V or VI standards.
- ☐ **alternative HDV cooling, Dearman Transport Refrigeration Unit:** This measure represents an alternative option for cooling units in the port. It has to do with DTRU or “Dearman Transport Refrigeration Unit”. It has a generator run on liquid nitrogen which produces both cold and power. The advantage is carbon footprint reduction. The disadvantage is the relatively high investment need.
- ☐ **alternative HDV cooling, grid connection:** This measure also deals with an alternative option for cooling units in the port. But this particular option is about getting them connected to the local grid if this has not been done yet. The solution also contributes to carbon footprint reduction but only in case, the grid supplies renewable energy-based electricity.
- ☐ **green port fees:** It is a market-based tool addressing the environmental impact of the shipping industry. The idea of this environmental initiative is to differentiate port fees for vessel owners based on vessels' environmental performance. The better it is or the less negative impacts it has, the less one pays – for pilotage fee, security fee, harbour fee, quay due and others. The advantage of the measure is that desired environmental behaviour is being incentivized and as a result, the air emission level is lower. The port has the initiative in its hands. But the system should be transparent, the size of the fee rebate should be sufficiently large to support green upgrades in the shipping sector, and the fee rebate should always target relevant parameters.
- ☐ **slow steaming:** This is similar to the green port fees initiative. This measure (which can be stand-alone or be part of the aforementioned approach) has to do with a reward system for those vessels which voluntary reduce speed once reaching the port area. This helps to decrease air emission levels as well as improve the vessel’s fuel economy.

As a reward there can be slow steaming discounts on port dues. An example of low speed can be 12 knots when the distance from the port is 20-40 nm.

- ☐ **electrification of power train (battery or fuel cell):** It has to do with the full substitution of diesel motors in port vehicles for electric ones. Full electrification is achieved either with the use of a battery or fuel cell. Battery-based electric vehicles require charging: via electricity generation during operation or via a plug-in connection to the electric grid. In turn, fuel cell vehicles have their own inbuilt power plant that supplies electric energy to the motor. No battery is required here. Fuel – normally hydrogen – is transferred to electric energy. If we compare the two types, battery electric vehicles seem to perform better: having higher energy efficiency. Fuel cell-based vehicles can consume two times more energy than battery-driven vehicles. The advantages are carbon and noise reduction as well as the additional possibility to operate indoors. The drawback is a higher cost in comparison with common port vehicles, possible short driving distances and the need to be charged (battery case, plug-in hybrid) – it affects both, the practical use of vehicles as well as requires having a charging station. In the case of a fuel cell, which is based on hydrogen, enhanced safety is required for operation. Both options improve operational efficiency.
- ☐ **energy-saving tires:** This is a simple yet effective measure that can improve fuel economy (by up to 10%). It is about the application of state-of-the-art “low rolling resistance” tires on port vehicles. The advantage is less fuel used; the main drawback is a higher price per tire.
- ☐ **tire pressure control:** Another simple measure related to tires has to do with their pressure control. The appropriately inflated tires improve fuel economy, reduce braking distance, improve vehicle handling, and increase tyre service life. Examples of such systems are devices built into tires, which tell the pressure. Manual pressure control practices can be also a solution.
- ☐ **regenerative drives:** This measure is suitable for electrified (including hybrid solutions) vehicles and equipment. An example can be a crane, where regenerative drives recover energy from the cranes lowering and braking motions. The recovered energy is sent to the battery for later use, which makes the technology more energy efficient than the conventional one.
- ☐ **emission control technologies:** This measure is about improving currently used port cranes. The idea is to upgrade it with certain devices which will lower its emissions. Examples of such devices can be diesel oxidation catalysts; diesel particulate filters; exhaust gas recirculation, exhaust gas after-treatment systems, and others.
- ☐ **eco-driving lessons:** This measure relates also to personnel training programmes. This one is about learning to operate vehicles with the least possible fuel or energy consumption (by up to 10%): e.g. via special driving, lifting techniques, speed controlling and speed switching. By the way, speed control alone can reduce energy consumption

by 50%. The idea is to be able to operate the vehicle or equipment with optimal (lowest possible) speed, without losing control over the operation. With speed switching, which idea is to switch or reduce the engine speed to idle (neutral position in a mechanical gearbox) when equipment is not moving, fuel/electricity savings can be up to 25% on average, depending on the operation and utilization of the crane or vehicle. All these lessons can be organized as computer-simulated exercises or real-life practices. This is applicable for cargo handling equipment, cranes and other vehicles in port. The advantage is noise and air pollution level reductions.

Assessment of measures applicability in port

The action priority matrix is going to be used as an approach that helps to assess measures in terms of their applicability. It is usually used to select the best suitable actions from many available. There are four main fields in the matrix to help do that:

1. **Quick wins**: These are tasks requiring little effort but yielding high impact. As such, they are very attractive because they have high returns for a small outlay of energy. Completing quick wins should be your highest priority, and you should concentrate on these tasks as much as you can.

2. **Big projects**: These are tasks that can give you significant results (impact), but unlike quick wins, they require you to invest a lot of time into them. These types of tasks should be your next priority after quick wins. You'll need to invest a lot of time into these projects to get them done but be careful not to let these tasks consume all of your time.

3. **Fill-ins:** These are tasks that require low effort for you to perform, but they also have little impact on your results. As hinted at by the name, you use these tasks to fill in your time. You should only perform these tasks if you have the time available after working on your quick wins and big projects. Consider delegating these tasks if you have that as an option. Alternatively, consider dropping these tasks altogether if possible.

4. **Thankless tasks**: These are tasks that have a low impact but which still require high effort. You should aim to eliminate these tasks, as they are not worth your time to complete.

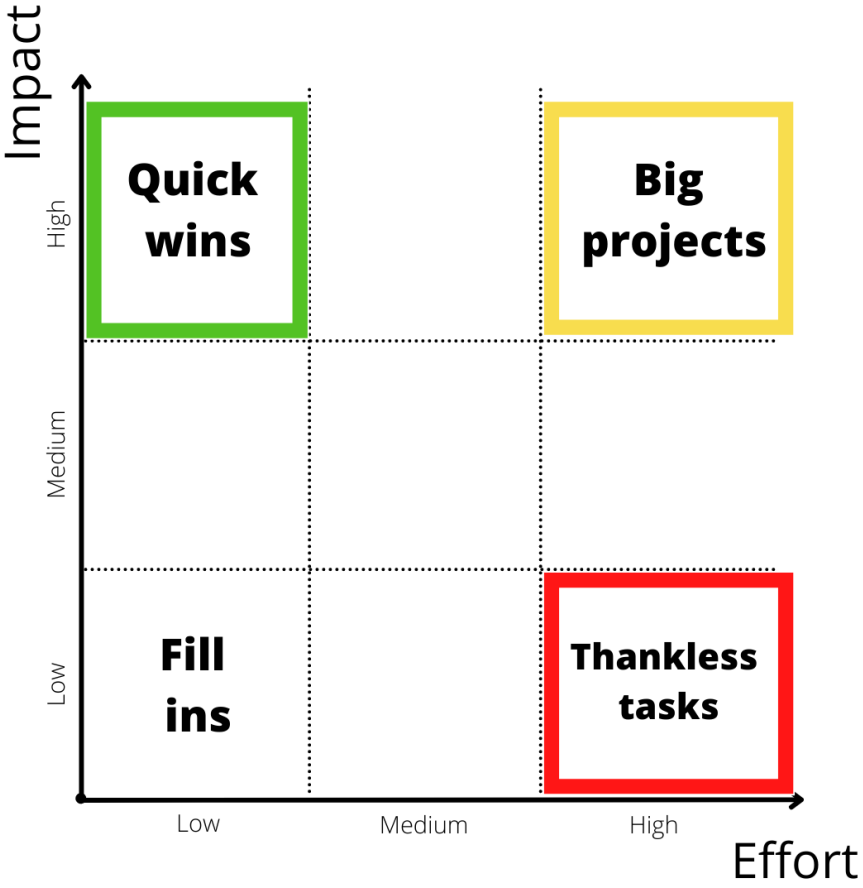

Figure 3. Action priority matrix.

As it comes to the system of axes, the **impact** here stands for energy savings and emission reduction potential. Energy savings can be expressed, for example, in fuel economy of port equipment and vehicles or cut-down in electricity consumption. Emission reduction stands for air emissions decrease and carbon footprint reduction. As for the **effort** axis, we mainly mean financial aspects such as expected expenses and payback of measures as well as operational efforts – for instance, time and resources required for implementation. All those issues are considered when estimating measures in the used assessment framework (action priority matrices). All assessments are based on results from previously conducted projects in European ports, where an expert group was used to provide such evaluations.

For all the listed 50+ measures in seven categories, there is an action priority matrix provided. It can be used as a valid assessment and be part of the decision-making of what to include in the strategic port energy management plan. For your convenience, there is also a separate file available in EVISA attachments. Below is a copy with content from that file, which you can use right in the document. Own measures can be added and self-evaluated in the matrix.

● “**METERS**”:

☐ ❶ ship environmental monitoring system
☐ ❷ additional meters by port area and building
☐ ❸ meters by port consumption: heating (electric and other) / water (hot and cold) / lighting / electric ventilation / fuel (benzine, diesel, gas)
☐ ❹ installation of an online metering system
☐ **Own measure**: Click or tap here to enter text.

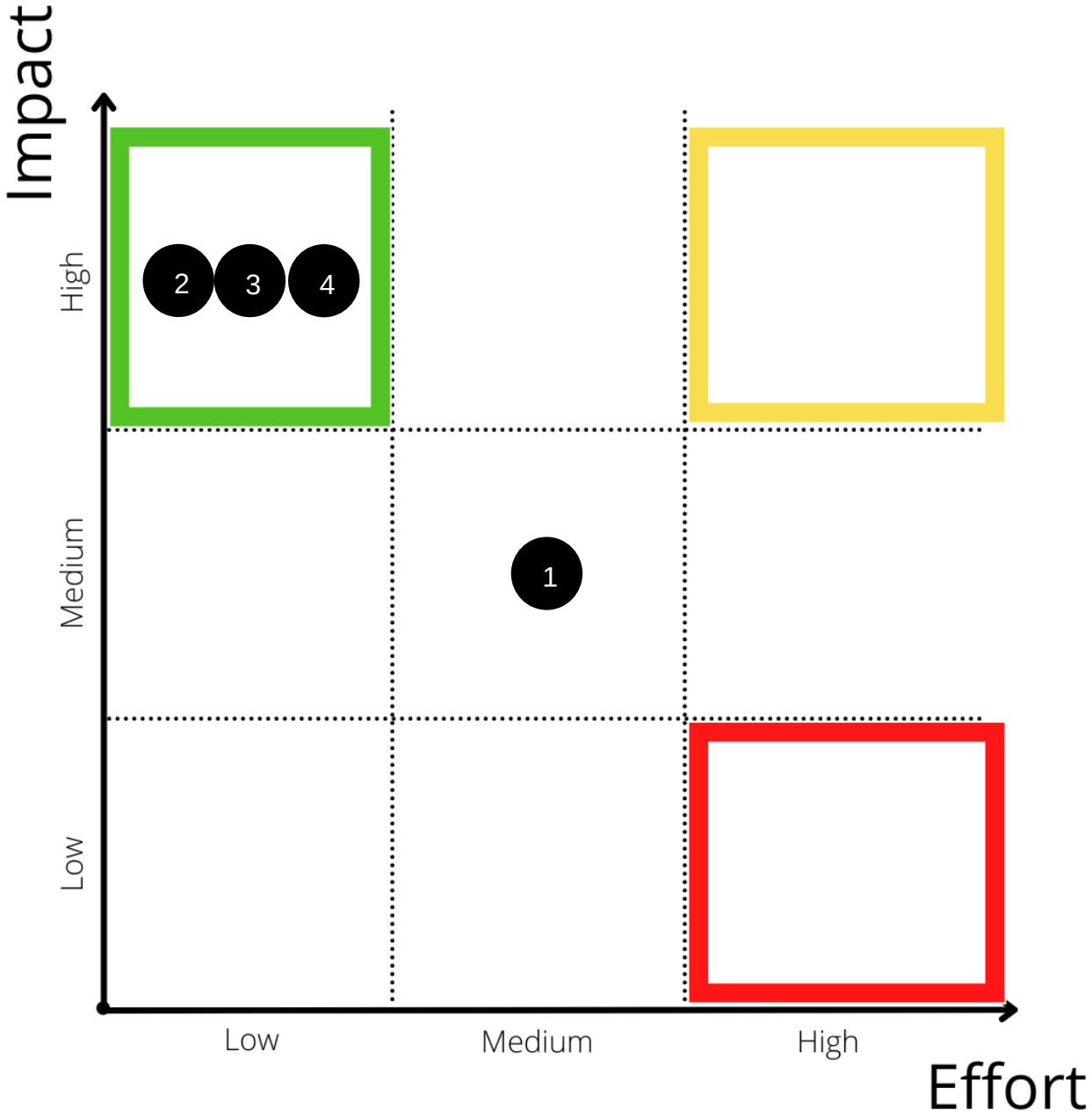

Figure 4. Meters: assessment of measures.

● “**HEATING**”:

☐ 1 district heating/cooling
☐ 2 seawater source heat pumps
☐ **Own measure**: Click or tap here to enter text.

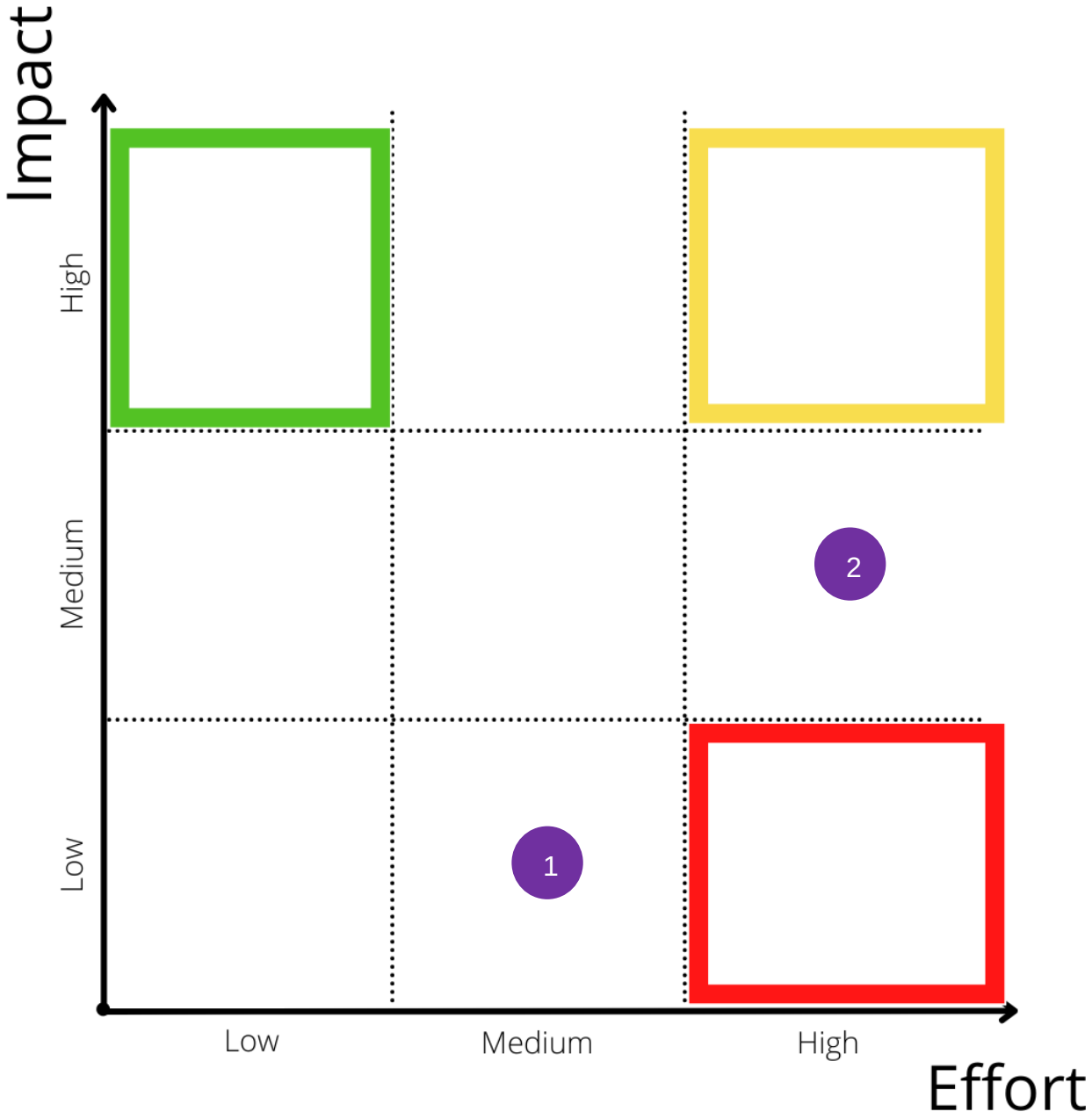

Figure 5. Heating: assessment of measures.

● “**LIGHTING**”:

☐ 1 LED lighting
☐ 2 adaptive lighting system
☐ 3 LED floodlights and walkway lights
☐ **Own measure**: Click or tap here to enter text.

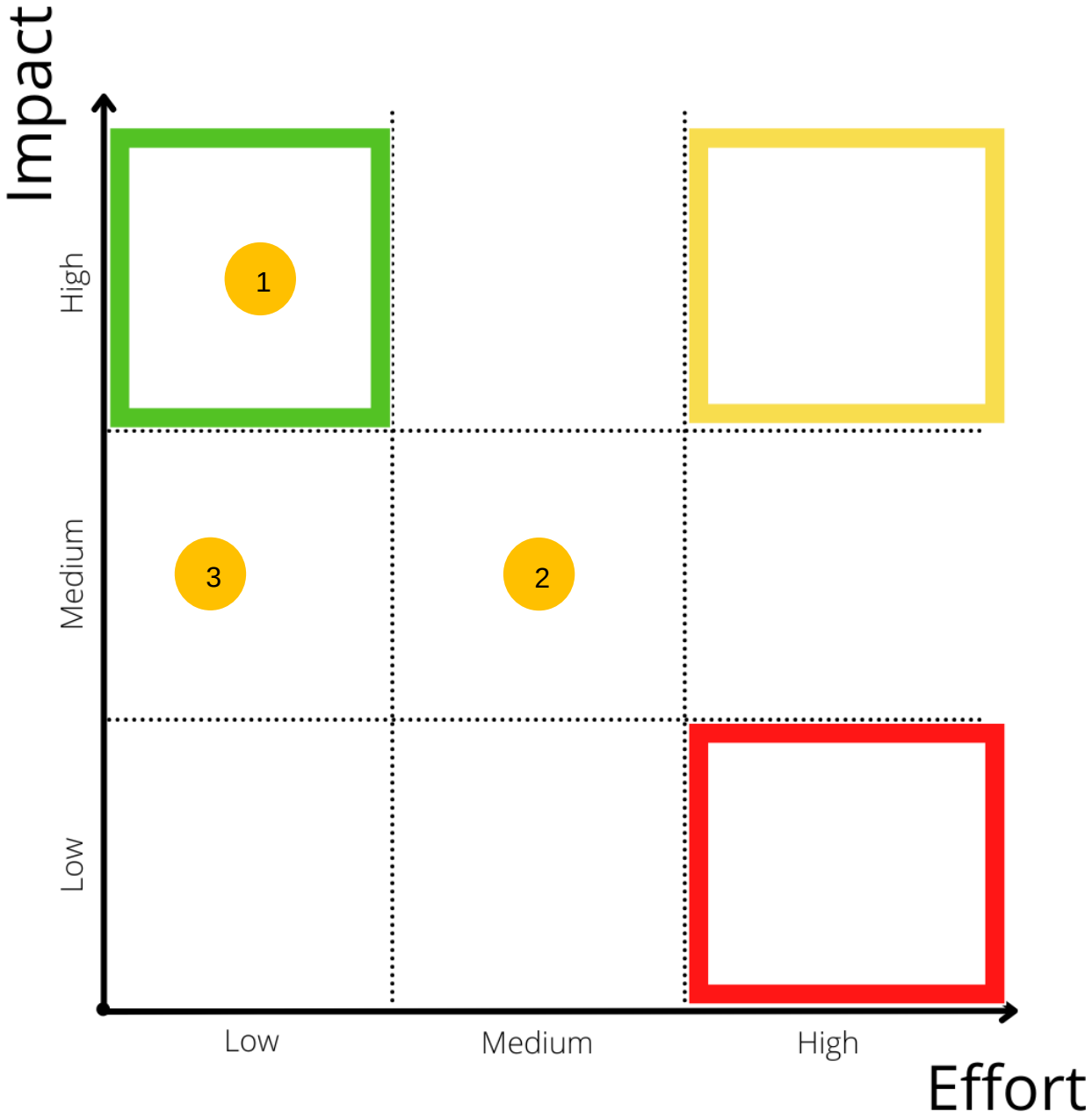

Figure 6. Lighting: assessment of measures.

● “**BUILDINGS**”:

- ☐ 1 painting walls white / add windows and skylights
- ☐ 2 install air curtain
- ☐ 3 optimization of HVAC system
- ☐ 4 insulation
- ☐ 5 nearly zero energy building
- ☐ 6 demand-controlled ventilation (DCV) system
- ☐ 7 adjusting air temperature
- ☐ 8 green roof
- ☐ **Own measure**: Click or tap here to enter text.

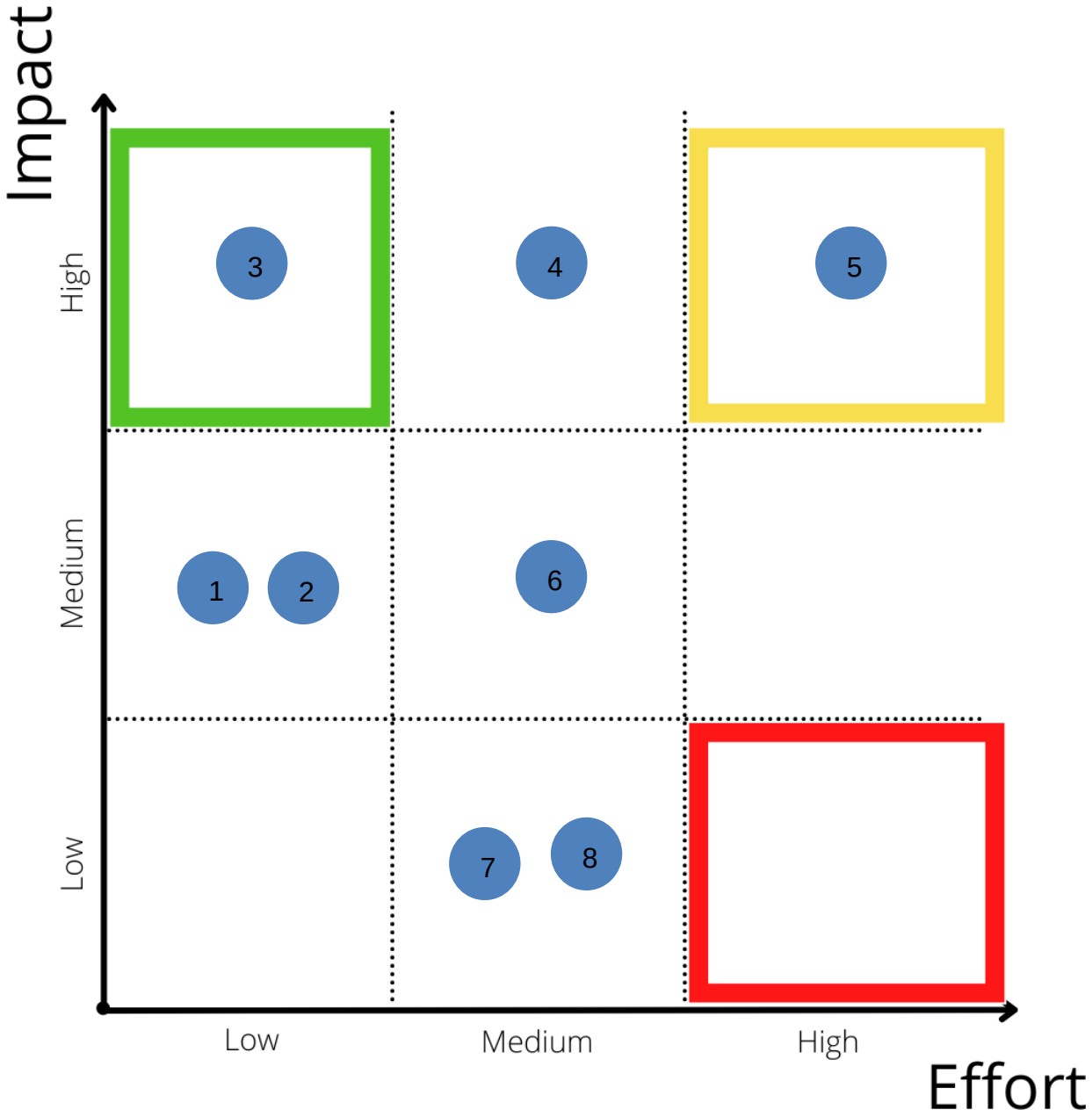

Figure 7. Buildings: assessment of measures.

● “**ALTERNATIVE FUELS**”:

- ☐ 1 onshore power supply (OPS)
- ☐ 2 LNG PowerPac
- ☐ 3 mobile LNG barge
- ☐ 4 LNG bunkering: truck-to-ship (TTS)
- ☐ 5 LNG bunkering: shore to ship
- ☐ 6 LNG bunkering: ship-to-ship (STS)
- ☐ 7 LNG bunkering: local liquefaction plant
- ☐ 8 alternative fuels
- ☐ 9 automated mooring systems
- ☐ 10 hybrid power train
- ☐ 11 hybrid power train (plug-in-hybrid)
- ☐ 12 electrification of power train (battery or fuel cell)
- ☐ **Own measure**: Click or tap here to enter text.

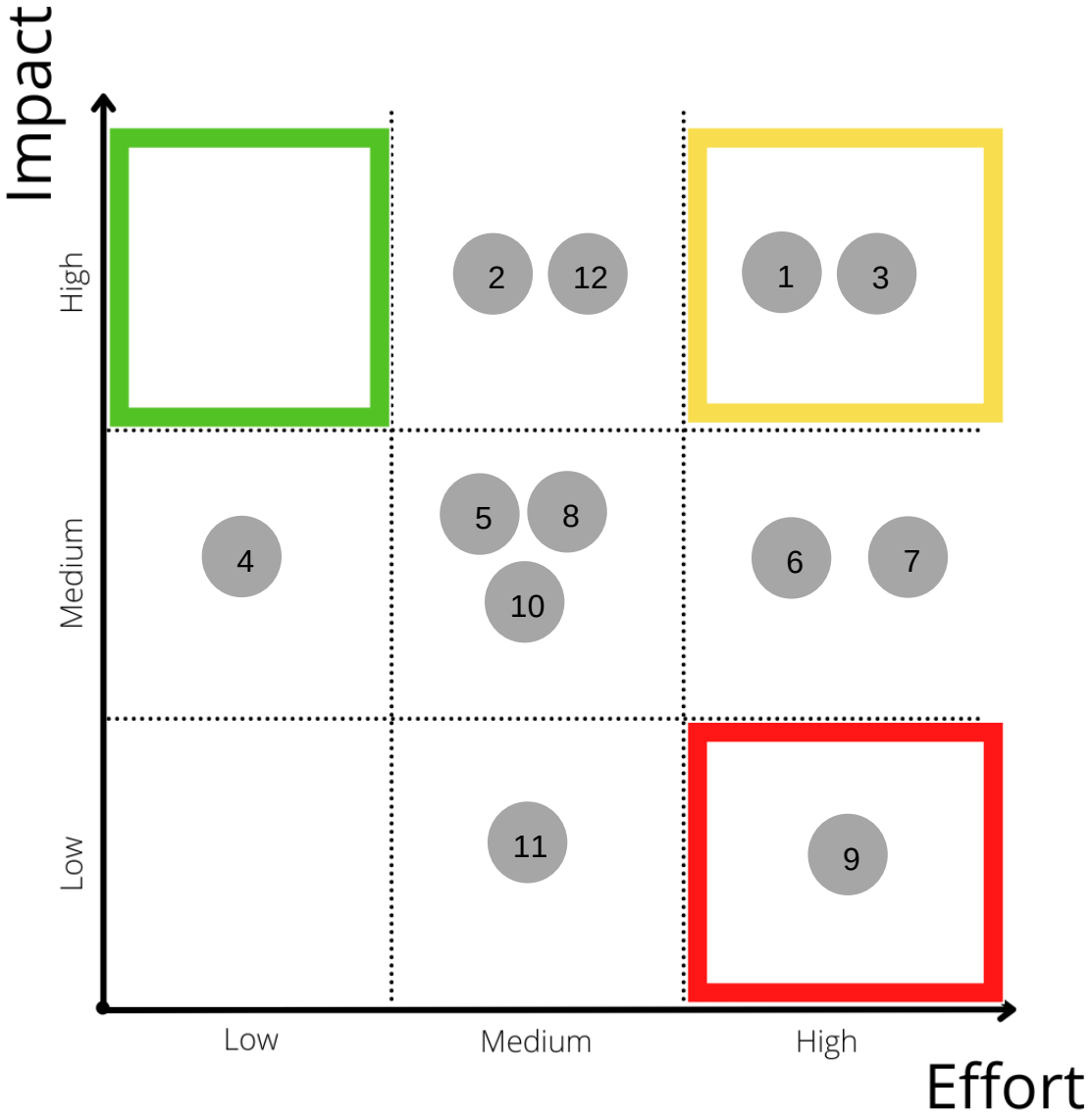

Figure 8. Alternative fuels: assessment of measures.

● “**RENEWABLES**”:

☐ 1 obtain “green” energy
☐ 2 solar photovoltaics (PV)
☐ 3 wind power
☐ 4 hydropower
☐ 5 biogas
☐ 6 geothermal
☐ 7 microturbine
☐ **Own measure**: Click or tap here to enter text.

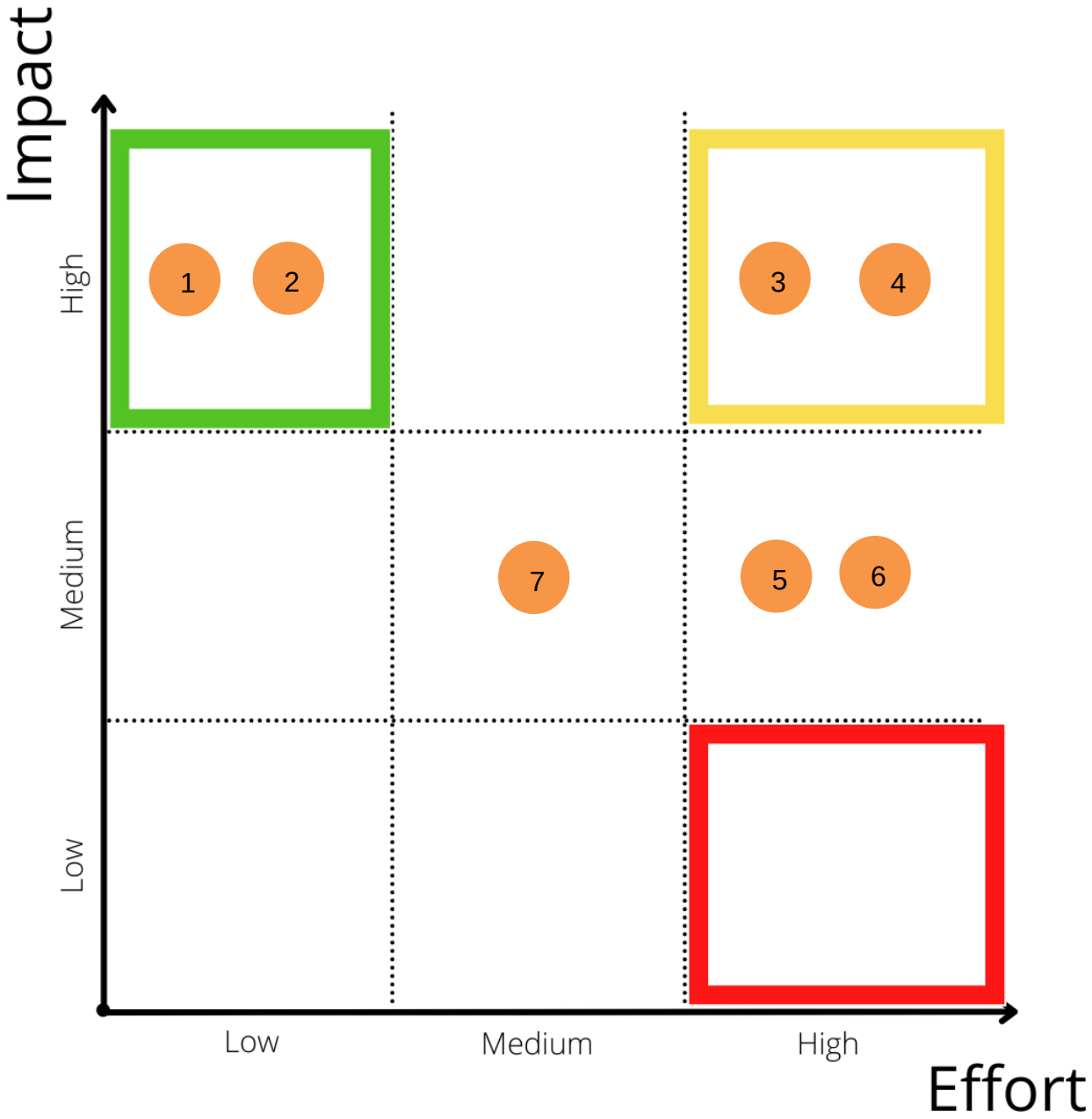

Figure 9. Renewables: assessment of measures.

● "**EFFICIENCY**":

- ☐ 1 energy / emission target
- ☐ 2 energy management system
- ☐ 3 energy audits
- ☐ 4 smart grid applications
- ☐ 5 employee suggestion system
- ☐ 13 alternative HDV cooling: grid feed
- ☐ 14 green port fees
- ☐ 15 slow steaming
- ☐ 16 electrification of power train
- ☐ 17 energy-saving tires

- ☐ 6 employee environment training
- ☐ 7 employee bus shuttle services
- ☐ 8 provision of bikes for commuting
- ☐ 9 bundling of power
- ☐ 10 cross-company use of waste heat
- ☐ 11 heavy-duty vehicle emission control zone
- ☐ 12 alternative HDV cooling: DTRU
- ☐ 18 tire pressure control
- ☐ 19 regenerative drives
- ☐ 20 emission control technologies
- ☐ 21 eco-driving lessons
- ☐ **Own measure**: Click or tap here to enter text.

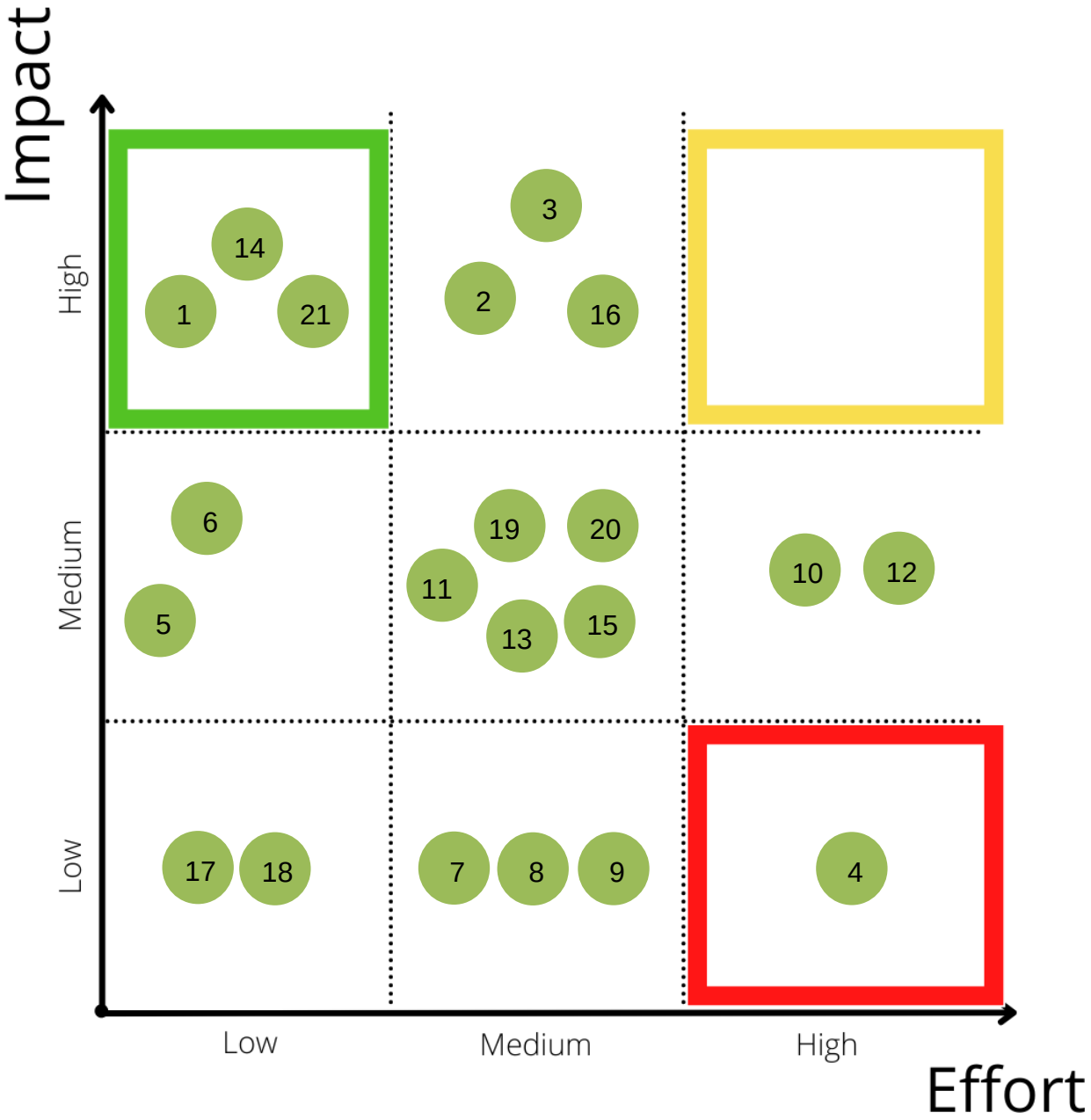

Figure 10. Efficiency: assessment of measures.

Below is a joint matrix for all measures coming from all seven categories: “meters”, “heating”, “lighting”, “buildings”, “alternative fuels”, “renewables” and “efficiency”. The graph provides the overall picture, presented in Figure 11.

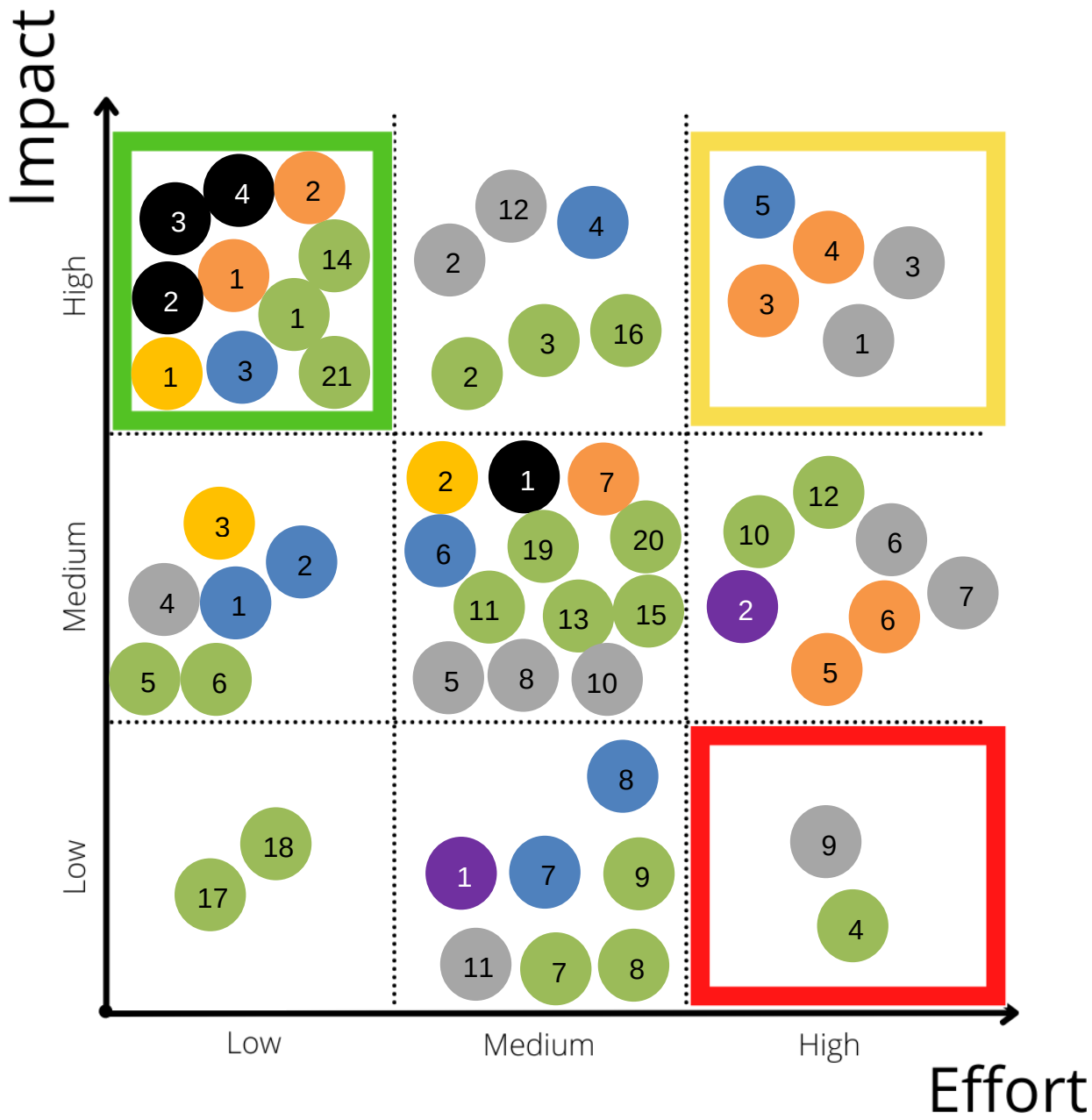

Figure 11. Applicability of all port measures in the action priority matrix.

Below is a collection with separate parts of the action priority matrix: a green area for “quick wins”, a yellow area for “big projects”, the left down area for “fill-ins” and a red area for “thankless tasks”. Those measures are clearly categorized. It is easy to decide about the 19 measures presented in those parts: should they be applied or not? All four categories are demonstrated in Table 1.

Table 1. Quick wins, big projects, fill-ins and thankless tasks: clear separation of measures.

CLEAR QUICK WINS	CLEAR BIG PROJECTS
☐ 2 additional meters by port area and building ☐ 3 meters by port consumption ☐ 4 installation of an online metering system ☐ 1 LED lighting ☐ 3 optimization of HVAC system ☐ 1 obtain “green” energy ☐ 2 renewable energy: solar photovoltaics ☐ 1 energy / emission target ☐ 14 green port fees ☐ 21 eco-driving lessons	☐ 5 nearly zero energy building ☐ 3 renewable energy: wind power ☐ 4 renewable energy: hydropower ☐ 1 onshore power supply ☐ 3 mobile LNG barge
CLEAR FILL-INS	**CLEAR THANKLESS TASKS**
☐ 17 energy-saving tires ☐ 18 tire pressure control	☐ 9 automated mooring systems ☐ 4 smart grid applications

For instance, there is a set of measures in the category “quick wins” which will give high environmental and energy-related positive impacts with the lowest possible efforts from the port. On the other hand, there are clearly “thankless tasks” which will be difficult to implement (a lot of financial and time resources required) and will provide a poor outcome. As for priorities, usually “quick wins” correspond to Priority 1, “big projects” – Priority 2, and “fill-ins” – Priority 3. “Thankless tasks” are recommended to avoid doing. If some measures seem feasible to you, do not hesitate to tick the box near it and mark it for your future use.

In contrast, there are other/grey measures that require more individual thinking and decision-making case-by-case, since they are placed on borders or mediums of the matrix. Table 2 has collected those measures. Criteria for working with them are suggested in the next passage of the guidelines.

Table 2. Measures that require case-by-case consideration.

MEDIUM IMPACT – MEDIUM EFFORT	MEDIUM IMPACT – HIGH EFFORT
☐ 1 ship environmental monitoring system ☐ 2 adaptive lighting system ☐ 6 demand-controlled ventilation system ☐ 5 LNG bunkering: shore to ship ☐ 8 alternative fuels ☐ 10 hybrid power train ☐ 7 renewable energy: microturbine ☐ 11 heavy duty vehicle (HDV) emission control zone ☐ 13 alternative HDV cooling: grid connection ☐ 15 slow steaming ☐ 19 regenerative drives ☐ 20 emission control technologies	☐ 2 seawater source heat pumps ☐ 6 LNG bunkering: ship-to-ship ☐ 7 LNG bunkering: local liquefaction plant ☐ 5 renewable energy: biogas ☐ 6 renewable energy: geothermal ☐ 10 cross-company use of waste heat ☐ 12 alternative HDV cooling: Dearman Transport Refrigeration Unit
MEDIUM IMPACT – LOW EFFORT	**LOW IMPACT – MEDIUM EFFORT**
☐ 3 LED floodlights and walkway lights ☐ 1 painting walls white/add windows and skylights ☐ 2 install air curtain ☐ 4 LNG bunkering: truck-to-ship ☐ 5 employee suggestion system ☐ 6 employee environment training	☐ 1 district heating/cooling ☐ 7 adjusting air temperature ☐ 8 green roof ☐ 11 hybrid power train (plug-in-hybrid) ☐ 7 employee bus shuttle services ☐ 8 provision of bikes for commuting ☐ 9 bundling of power
HIGH IMPACT – MEDIUM EFFORT	
☐ 4 insulation ☐ 2 LNG PowerPac ☐ 12 electrification of power train ☐ 2 energy management system	

Criteria for choosing measures for the port energy management plan

There is plenty of choice in different available measures. How to make a well-weighted decision about its implementation? We offer two sets of criteria that could help when considering grey measures from medium areas of the matrix: initial and important.

The initial five criteria include reliability, availability, resiliency, efficiency and sustainability. A short definition is presented hereafter. Bear them in mind.

- ***Reliability*** means that energy is delivered consistently well at all needed times for all port operations.
- ***Availability*** relates to access of energy to all port operations and energy demands.
- ***Resiliency*** highlights that port operations continue to function even in situations of a power outage or in a catastrophic event.
- ***Efficiency*** stands for maximizing operational productivity while minimizing energy demand for it.
- ***Sustainability*** includes technologies that aim at minimizing natural resource depletion: e.g. renewable energy generation.

Important criteria are time frame, carbon dioxide emissions reduction potential, cost, cost-effectiveness, technical feasibility, implementability, measurable results, co-benefits, funding opportunities and enforceability. Below we open the meaning for each of them.

- ***Time frame (timing, frequency, duration)*** aims at evaluating the schedule and sequence of activities required for the implementation of specific actions. The actions' timing, frequency, and duration, within the overall framework of related activities, are being considered.
- ***Carbon dioxide (CO_2) emissions reduction potential*** focuses on the potential of CO_2 emissions reduction as a result of the implementation of a specific action. It considers the difference in the emission level before and after the action has been implemented. The total contribution of the action under consideration with respect to a specific topic, field, or sector is being taken into account.
- ***Cost*** considers the overall costs required for the implementation of a specific action. It focuses on the identification of payments and delivery of the action's different implementation phases as well as on initial investments that are required and the sustainability of the implementation plan.
- ***Cost-effectiveness*** is evaluated according to the relationship between monetary inputs and the desired outcome (e.g., expenditure allocated for action with respect to its emissions reduction potential). Values are assigned by stakeholders involved in the elaboration of the strategy, according to their preferences.
- ***Technical feasibility*** considers on the one hand the technical aspects of the action and on the other hand the contextual conditions of the area and the stakeholders involved in the action's implementation.
- ***Implementability*** refers to the capacity of the stakeholders involved in the action's implementation. It considers potential difficulties, conflicts, and barriers encountered during the action's management and implementation between key actors and stakeholders as well as with local communities.

- ***Measurable results:*** *t*o establish the consistency of action, it is necessary to be able to measure its performance. To this end, this criterion considers (a) the advancement in the time of implementation, (b) the results that can contribute toward reducing emissions as external efficiency, and (c) measures complying with the established targets as internal efficiency. This criterion is closely connected with the criterion above, "CO2 emissions reduction potential."
- ***Co-benefits*** are additional benefits, to the direct target of the action. Those can be (a) social, addressing social aspects related to local communities or groups; (b) economical, as indirect (positive) effects—for example, addressing working activities or specific sectors; and (c) environmental, as indirect effects on ecosystems, biodiversity, or other environmental dynamics.
- ***Funding opportunities*** aim at considering the potential of funding opportunities for implementation of the action. The availability of different types of funds is being evaluated: (a) external sources, such as EU funds, and private funds; and (b) internal sources, such as funding opportunities deriving from stakeholders involved in the action's implementation.
- ***Enforceability*** reflects the legal basis for enforcement of the action. It aims to evaluate (a) whether the action is supported by an existing legal framework, (b) whether there is an authority responsible for implementing the action, and (c) whether stakeholders that are in charge of implementing the action are required to work on it by law or attend the action's design and implementation phases through voluntary agreements.

Welcome to using all those! We hope it will justify your decision-making process and help you form your upcoming strategic energy management plan. As an example of how a such plan can be organized here is a link to Port of Helsinki with their ideas.

Tentative timeline for implementation of the selected measures

As Figure 1 mentions, this is the last step in building a strategic energy management plan. When all measures are selected for implementation – with the idea that they cover existing energy management gaps in the port and help improve its overall energy performance, we go to the concrete action plan. An example of such is presented in Figure 12.

Feel free to distribute all considered measures in the implementation timeline. For your use, there is also a separate editable MS PowerPoint file available in EVISA attachments with the timeline. With the background work you have just conducted, this one-page summary table will serve as your first draft of a strategic energy management plan. We congratulate you upon finishing it!

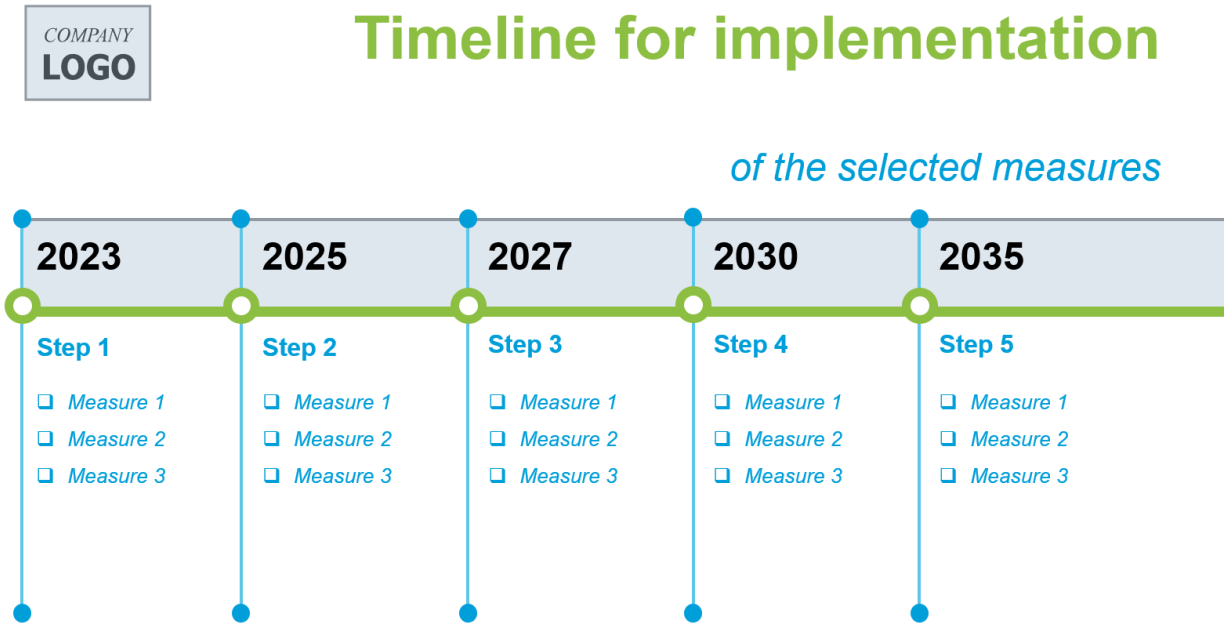

Figure 12. Tentative structure and timeline of a strategic energy management plan.

Conclusion

This publication was designed to draw your attention, as a port authority, to the creative yet very rewarding task of building a strategic energy management plan. We hope that behind the complexity of this work you found valuable insights along the step-by-step process presented here.