HOW TO SELECT GREEN TECHNOLOGIES IN A HARBOUR SETUP

E-Harbours towards sustainable, clean and energetic innovative harbour cities in the North Sea Region

The Interreg IVB North Sea Region Programme

pure ENERGY CENTRE

ACKNOWLEDGEMENT

This report has been realised with the support and input of many experts. We thank all those who have provided input and contributions and helped to shape the document. We also tanks The Interreg IVB North Sea Region (NSR) Program for supporting this project.

TABLE OF CONTENTS

INTRODUCTION

This report aims to provide and disseminate a method on how to identify and select the most favourable green energy technologies for a harbour. The green technologies discussed herewith are described in report 2. Therefore, the objective of this report is unique as it will provide the harbour community a means to understand how to select the most appropriate green energy technologies for a harbour setup.

The ultimate goal is to disseminate guidelines that support the shortlisting of green technologies so that, in the future, this can support other harbours at NSR, European level and beyond.

Through this report, harbour masters, harbour owners, harbour policy makers and harbour business organisations will be able to understand how to shortlist the green technology that will best suit their harbour setup, building, house or other form of real estate.

In summary, this document will support the harbour community in identifying which energy technology they can use and in which case they can use it with great effectiveness to reduce their consumption and emissions.

AIMS

The E-harbours Project as a whole aims to create a lasting change towards sustainable energy logistics for North Sea Region harbour cities. It aims at setting innovative energy standards to create a transformation of the energy network in harbour areas.

This report intends to increase the understanding of harbour owners, businesses and other entities related to harbours in selecting the most suitable energy technologies to be installed within a harbour set up.

This report provides a series of decision making flowcharts for guiding users on the selection of the most appropriate green energy technology. The selection is based on user requirements, site resources, legislative constrains, economic and environmental benefits.

OBJECTIVES

After reading this report, the reader should be able to:

1. Select the most appropriate green energy technology to be installed in a harbour set up.

2. Understand the requirements and constrains when selecting a green energy technology.

3. Devise a methodology for the deployment of green technologies in a harbour.

4. Have a clearer understanding on when and how to use the technologies described in report 2.

5. Enhance the assessment of a site by narrowing the choice on selecting a green energy technology.

HOW TO SELECT A GREEN ENERGY TECHNOLOGY IN A HARBOUR SETUP?

The selection process for identifying the most suitable green energy technology in a harbour setup is based on Flow Chart decision making diagram.

The user can select the most appropriate technology for a site based on the following information:

- **User needs**: this represents the type of energy required by the end-user: electricity, heating, cooling, fuel for transport, fuel for cooking, etc.
- **Site features**: This represents the geographical and constructive features of a site, such as location, building orientation, dimension and space available, landscape obstructions, insulation of the building, etc.
- **Site resources**: this represents the raw resources available on a specific site, such as solar irradiation, wind, organic waste, geothermal heat, water, etc.
- **Legislative aspects**: This represents the legislative constrains and benefit currently available. This could be a site within a conservative area, a Government Incentive scheme, planning permission rules, etc.

TYPE OF GREEN ENERGY TECHNOLOGIES FOR HARBOUR SETUP

As described in report 2, the most common green energy technologies applicable within a harbour environment are the followings:

- **Green Hydrogen fuel:** Only two main things are required to produce hydrogen fuel: water and electricity. All harbours are located near a source of water and all have electrical power available locally. Electricity is used to split water into its two constituents; that is splitting H_2O (water), into H_2 (hydrogen) gas and O_2 (oxygen) gas.

Hydrogen would be a perfect solution to use in conjunction with VPP/Smart Grid as it can act as a dump mechanism for renewable energy. **Hydrogen can be used as fuel for boats/ferries, vehicles, heat and in any other form of energy**.

- **Green Ammonia (NH3):** Ammonia needs three main components to be produced. It needs power, water and air, all of which are plentiful in a harbour set up. To produce ammonia, nitrogen needs to be extracted from the air using electricity. This nitrogen is then combined with hydrogen to form ammonia. Hydrogen is produced from water using the process described above.

- **Wind Turbines (WT):** A wind turbine just needs a good wind resource. If a harbour has space and wind, then it may be a technology that is suitable for that harbour. When wind is available, wind energy is converted into electricity by a rotating magnet generator. This electricity is then fed to the grid or used in offgrid energy systems.

- **Wind Turbines Heating system (WTHS):** In a wind turbine heating system the energy generated by the turbine is used directly for heating water in hot water tank. Hot water then can be used for any traditional heating system, such as underfloor or radiators heating system and for domestic hot water.

- **Solar Photovoltaics (PV):** Solar energy potential in the Shetland Islands is quite poor during the winter time, but quite good in the summer. Annual average irradiation is just under 900kWh/m^2. Solar PV can operate very well during the summer period due to the prolonged daylight and low Shetland ambient temperatures.

- **Solar Water Heating (SWH):** Solar water heating systems convert solar energy into heat, warming up water and storing it into hot water tanks. Solar water heating systems are ideally suited to reduce the energy consumption of traditional heating systems and for low temperature under floor heating systems.

- **Air Source Heat Pump (ASHP):** Air source heat pumps absorb heat from the outside air. This heat can then be used to heat radiators, under-floor heating systems, or warm air convectors and hot water for domestic use. An air source heat pump extracts heat from the outside air in the same way that a fridge extracts heat from its inside. It can get heat from the air even when the temperature is as low as -15° C. Heat pumps have some impact on the environment as they need electricity to run, but the heat they extract from the ground, air, or water is constantly being renewed naturally.

- **Ground Source Heat Pumps** (GSHP): a ground source heat pump system is simply a device that extracts ground/soil heat and dissipates it for heating houses or other premises (business, etc.). Like a refrigerator or air conditioner, GSHP systems use a compressor to force the transfer of heat from the ground to a surrounding given space. A typical GSHP has a high capital cost but very low operational cost (if electricity cost is low) and it can provide heating for more than 20 years.

- **Energy from Waste (EfW):** In general, harbours are hubs that produce large amount of waste. Advanced technologies are able to convert most of the biodegradable waste into useful biogas. Using anaerobic digestion technology and in-vessel composting processes, biodegradable waste can produce biogas to be used to generate stationary electrical power or for transport applications.

- **Biomass and Biofuel:** These technologies allow for producing energy from living organisms rather than fossilised ones. **A harbour, due its geographical location, is an ideal candidate for biomass and biofuel production**; the high potential for algaculture creates a unique opportunity to produce fuel locally.

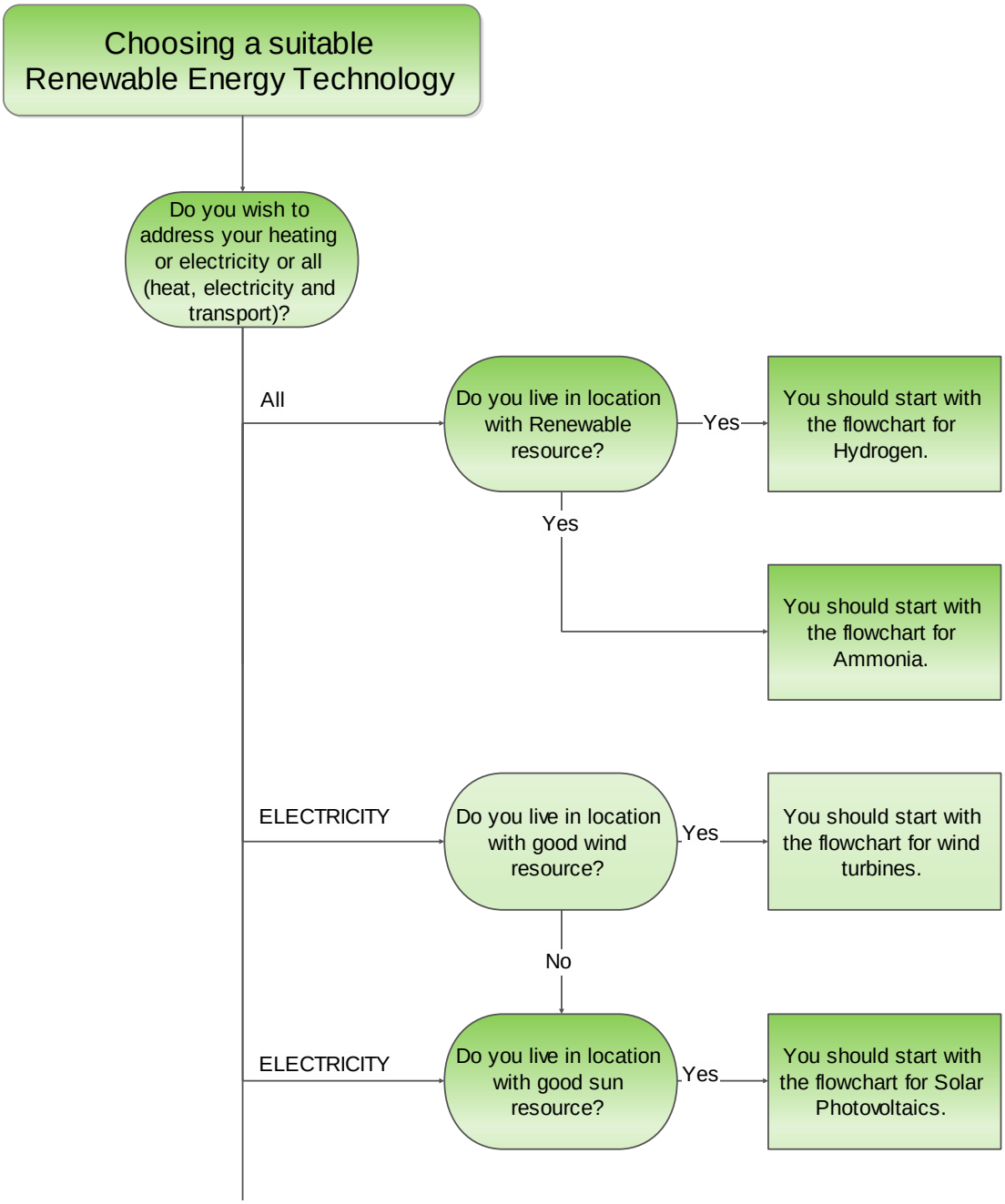
Biodiesel can be used in any diesel engine when mixed with mineral diesel. It is safe to handle and transport because of the biodegradable nature of the diesel and its low toxicity. In addition, production of biofuel with algae does not affect fresh water resources, as it can be produced using ocean and wastewater.

HOW TO SELECT THE MOST APPROPRIATE GREEN TECHNOLOGY

The selection of the green energy technology is achieved using the flow chart presented in Figure 1.

The Flow chart guides the user on the selection by pointing to the following sub-chart's links for each of the selected technology:

- **Hydrogen**
  http://pureenergycentre.com/report-4-1-hydrogen-decision-making-flowchart/
- **Ammonia**
  http://pureenergycentre.com/report-4-2-ammonia-decision-making-flowchart/
- **Wind turbine**
  http://pureenergycentre.com/report-4-3-wind-energy-decision-making-flowchart/
- **Photovoltaics**
  http://pureenergycentre.com/report-4-4-photovoltaics-decision-making-flowchart/
- **Wind Turbine Heating System**
  http://pureenergycentre.com/report-4-5-wind-turbine-heating-decision-making-flowchart/
- **Solar Heating system**
  http://pureenergycentre.com/report-4-6-solar-heating-decision-making-flowchart/
- **Air source heat pump**
  http://pureenergycentre.com/report-4-7-air-source-heat-pump-decision-making-flowchart/
- **Ground Source Heat Pump**
  http://pureenergycentre.com/report-4-8-ground-source-heat-pump-decision-making-flowchart/
- **Waste To Biogas**
  http://pureenergycentre.com/report-4-9-waste-to-biogas-decision-making-flowchart/
- **Biomass**
  http://pureenergycentre.com/report-4-10-biomass-decision-making-flowchart/
- **PV Financial assessment**
  http://pureenergycentre.com/report-4-11-how-much-money-can-you-make-from-a-solar-installation/


Choosing a suitable Renewable Energy Technology
Do you wish to address your heating or electricity or all (heat, electricity and transport)?
All
Do you live in location with Renewable resource?
Yes
You should start with the flowchart for Hydrogen.
Yes
You should start with the flowchart for Ammonia.
ELECTRICITY
Do you live in location with good wind resource?
Yes
You should start with the flowchart for wind turbines.
No
ELECTRICITY
Do you live in location with good sun resource?
Yes
You should start with the flowchart for Solar Photovoltaics.

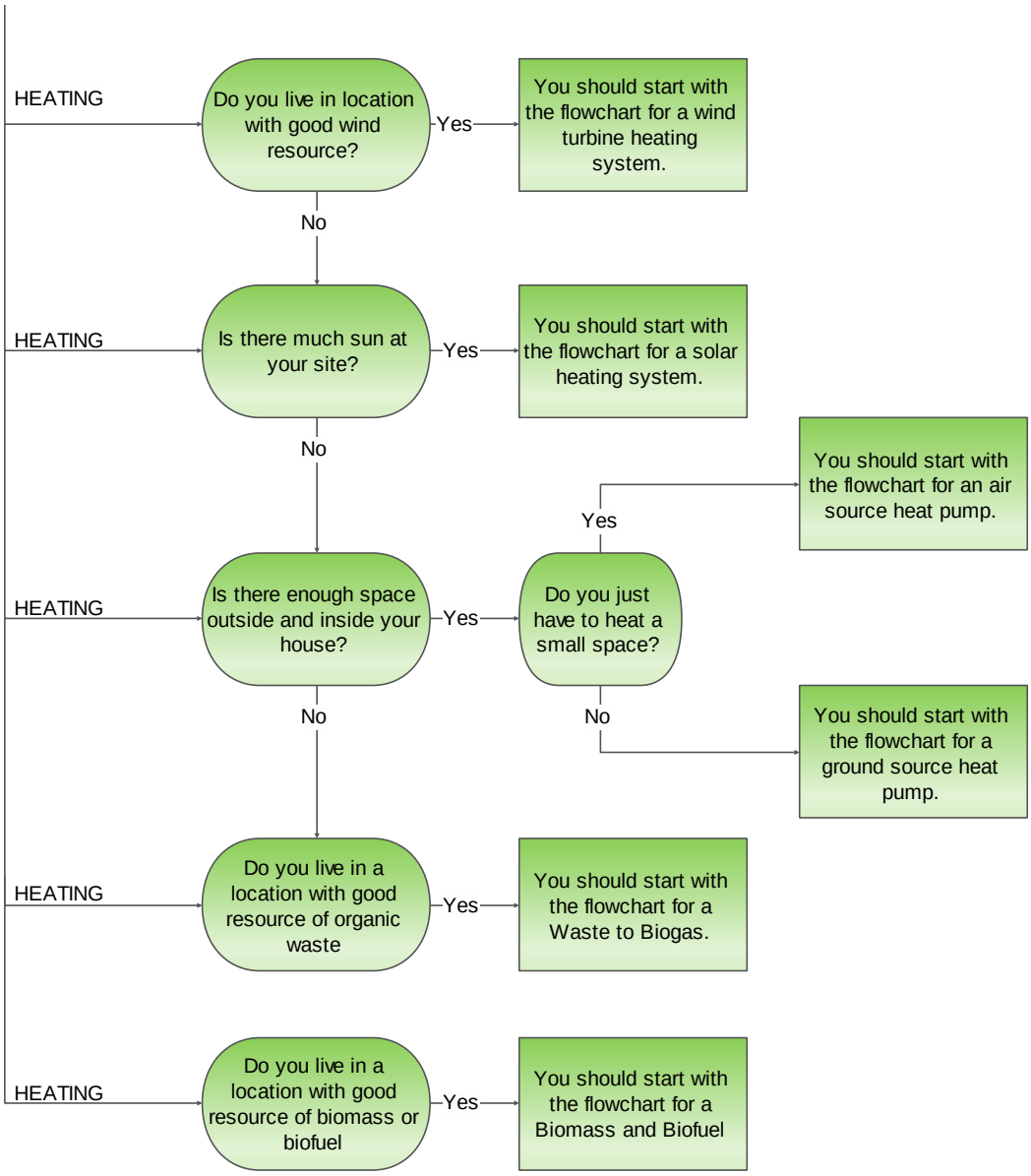


Figure 1. How To select Green Technology Flow Chart

DISCLAIMER

While every reasonable precaution has been taken in the preparation of this document, neither the Pure Energy® Centre nor the e-harbour project development partners assume responsibility for errors or omissions, nor makes any warranty or representation whatsoever, expressed or implied with respect to the use of any information disclosed in this document.