Current trends and solutions for port decarbonisation: a systematic literature review

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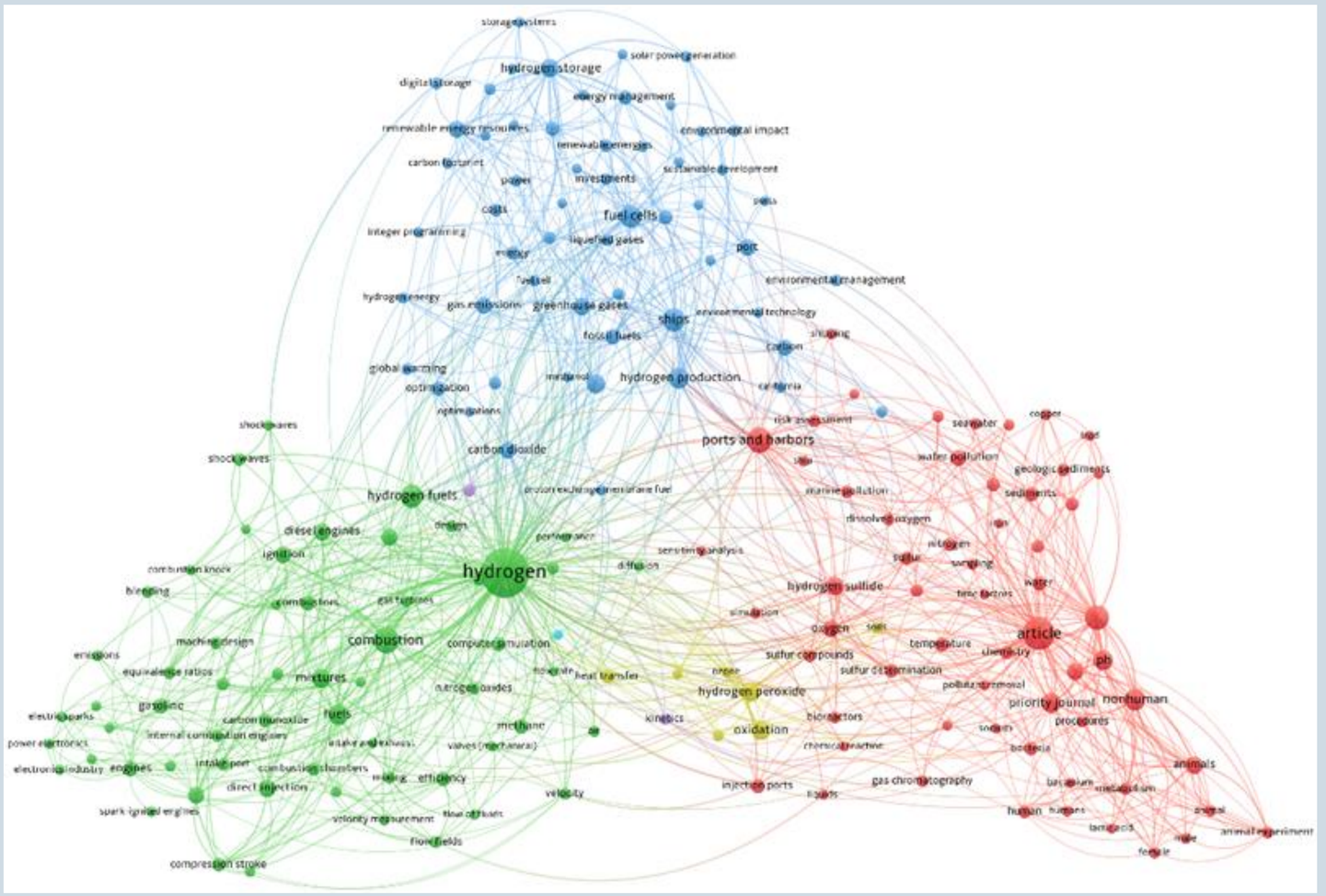
Researchers have realized that maritime transport sector is the least controlled from the point of view of nature pollution

Looking at the rapid growth of publications over the past years, it can be understood that it is a very important science and research development sector.

The most studied topics are decarbonisation, hydrogen storage and production, and water electrolysis.

VoSviewer assessed what directions the development of green ports with hydrogen technologies was explored and what research opportunities could be developed or improved.



Network visualization of the most common keywords related to port decarbonization.

Introduction

Air pollution in ports has a negative impact on people and living nature which are near. Air pollution is the greatest health hazard, mainly caused by exposure of human lungs to fine particles (PM 2,5). Secondary emission particles formed from exhaust gases – mainly nitrogen oxides (NOx) and sulphur oxides (SOx) also have adverse effects on humans. The study mentions that more than 238 000 people have died prematurely because of fine particle impacts based on 2021 data, while 49 000 worldwide in 2020.

Ports around the world are therefore beginning to develop their infrastructure to be ready to implement IMO (International Maritime Organization) requirements on green port development as quickly and efficiently as possible by 2030.

As one of the main port sustainability solutions, IMO recognized the creation of a green port infrastructure that would improve port energy efficiency (EE) and reduce greenhouse gas (GHG) pollution from transport and infrastructure within the port area.

The best way is to achieve synergies between systems capable of storing energy, renewable energy systems (RES) and an energy management system called the hybrid renewable energy system (HRES) to achieve a stable supply of electricity to port infrastructure at a time when RES conditions are not sufficiently stable.

Methodology

For a more complete understanding of what technologies have been used so far to reduce decarbonization in port areas and to understand which is the less studied direction, the author used a bibliometric review with the visualization program VoSviewer. The main advantage of bibliometric analysis is to get a helicopter view of a particular area of research.

The authors chose to use the **Scopus database**, because of the high pattern quality of records and possibility of exporting larger number of records and **VoSviewer** visualisation tool because the viewing capabilities are especially useful for maps containing at least a moderately large number of items.

Results and conclusions

The use of two main methods of bibliometric analysis **identified trends** in topics related to the port decarbonisation. The conclusions are:

1. The **number of publications on the subject increased** 7 times from 100 to 700 units in the last 3 years. Leaders in the field include the USA, China, as well as several European countries, including Italy, Germany, and the United Kingdom.

2. The results show that there are **different solutions for decarbonising ports**, focusing on one energy resource, or combining different technologies and energy resources.

3. **Hydrogen technology** is a pronounced leader and the fastest progress in promoting green port.

4. The results of the study carried out at the same time point to the fact that there are still many obstacles and **challenges to the transformation and decarbonisation of ports**, linked to technical, economic, and environmental aspects, as well as to energy security concerns, which today play a particularly important role.

5. The results of the study point to the **need to look more broadly at the issue of decarbonisation of ports** and not limit itself to assessing the feasibility and environmental aspects of renewable energy solutions. Issues of energy security and resilience are also no less important.

6. At the same time, by promoting rapid transformation of energy systems in the event of an energy crisis, it is necessary to choose **long-term solutions that will be resilient** in the long term. The bibliometric analysis carried out points to a lack of research in these directions. Therefore, the existing study will be continued and an innovative methodology for assessing port decarbonisation solutions will be developed using a multi-step screening approach.