Identifying suitable locations for offshore wind through GIS analysis; a regional case study

Cedric Muscat, Hugo Putuhena, Susan Gourvenec
RAEng Centre of Excellence for Intelligent & Resilient Ocean Engineering (IROE)
Southampton Marine and Maritime Institution, UK
University of Southampton, UK

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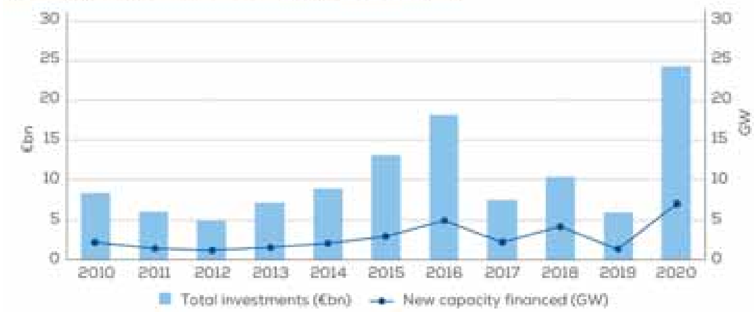
Introduction

- Transition to renewable energy crucial for reducing fossil fuel dependency
- Offshore wind (OW) rapidly growing sector key to meet net-zero targets globally
- European Union targets 60GW of OW by 2030 and 340GW by 2050 (European Commission, 2023)
- Mediterranean emerging as a key player in renewable energy with 30+ OW projects planned

Map of planned OW farms in the Med: Plan Bleu

FIGURE 18

New offshore wind investments and capacity financed: 2010 – 2020 (€bn)



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total investments (€bn)	8.4	6.1	5	7.2	8.8	13.1	18.2	7.5	10.3	6	24.2
New capacity financed (GW)	2.2	1.5	1.3	1.6	2.1	3	5	2.3	4.2	1.4	7.1

Offshore wind investments in Europe 2010 - 2020: WindEurope

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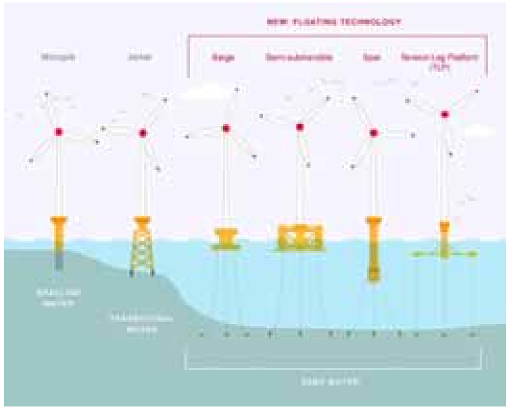
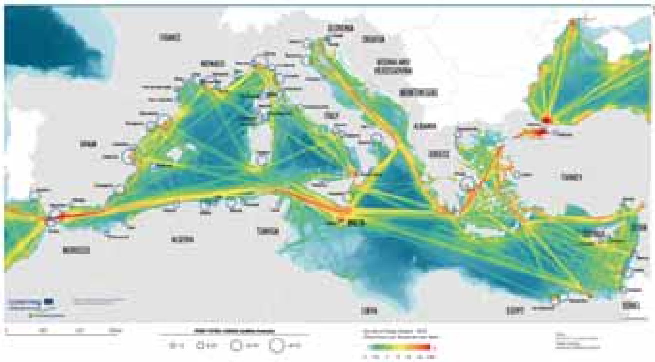
Innovation in technology

- Advancements in technology: **floating OW** beyond 60m suitable for Mediterranean's **deep water**
- Increase in blade size and power output over the years
- Scale of OW balanced with protection of ocean ecology and heritage sites
- **Sharing marine space**: co-existence with other activities (ecological and heritage assets)

Growing size of wind turbines
Windpower monthly



Different platforms for OW
EEW GROUP



Annual density of cargo vessels in the Mediterranean
WWF

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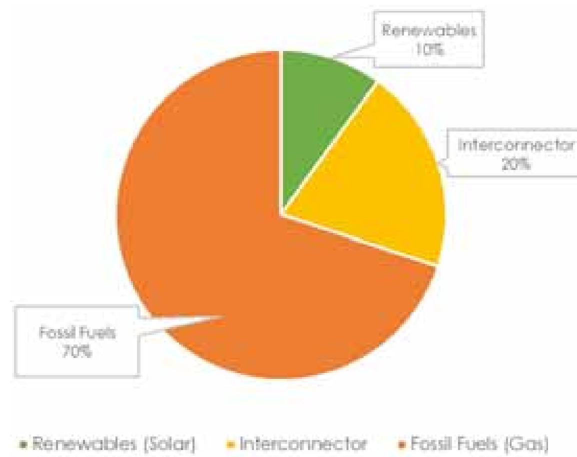
Regional application of method: Malta context

- **Malta**, centrally located in the Mediterranean, has a potential Exclusive Economic Zone (**EEZ**) over **70,000 sq.km** - (200x its land area)
- Producing currently only 10% of its energy from renewables, Malta targets net zero by 2050, making offshore wind a critical solution given its limited land space

Malta's EEZ: MarineRegions



Malta's energy mix in 2023: National Energy Statistics

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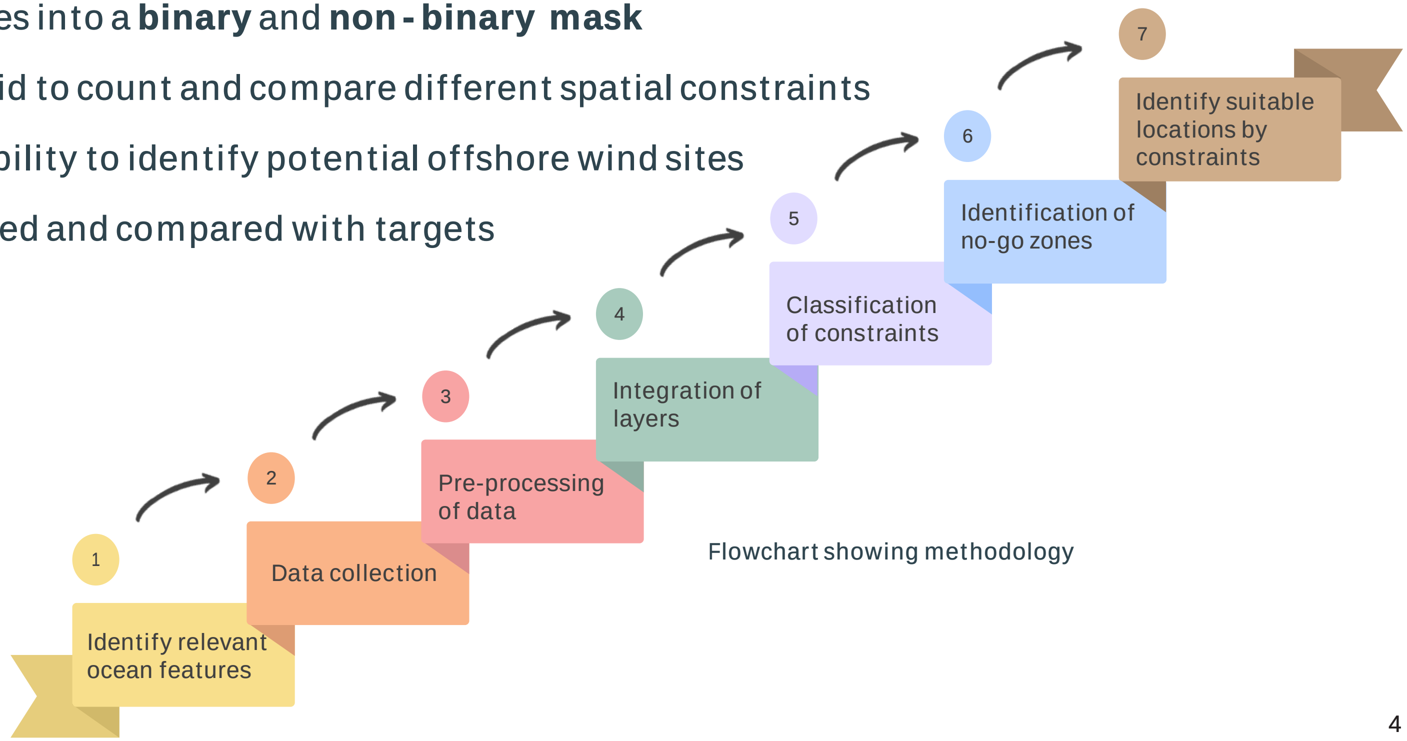
Methodology outline

- Geographic Information System (GIS) method to analyse spatial constraints from Putuhena et al
- Process integrated various **spatial layers**, including metocean conditions, geoscience, ecological, and anthropogenic features into a **binary** and **non - binary mask**
- GIS map split into a grid to count and compare different spatial constraints
- Areas ranked by suitability to identify potential offshore wind sites
- Power output estimated and compared with targets



Flowchart showing methodology

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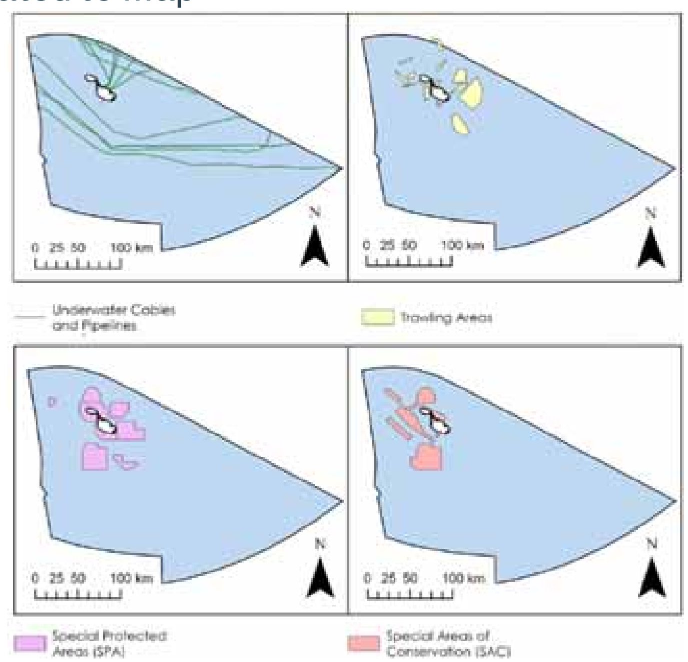
Malta case study

- Method applied to identify suitable locations for offshore wind within Malta's EEZ
- In the Malta case study **10 spatial constraints** were identified
- Data was collected from several European and national databases
- Using GIS these constraints were systematically integrated to map
- No-go areas and potential zones for OW identified

Anthropogenic	Environmental & Geological
Special Areas of Conservation	Wind speed 100m asl
Special Protection Areas	Geogenic reefs
Vessel traffic density	Bathymetry
Cables & pipelines	Pre-quaternary faults
Trawling areas	Seabed substrate folk 5

10 spatial layers used for Malta



4 of the spatial features integrated into GIS

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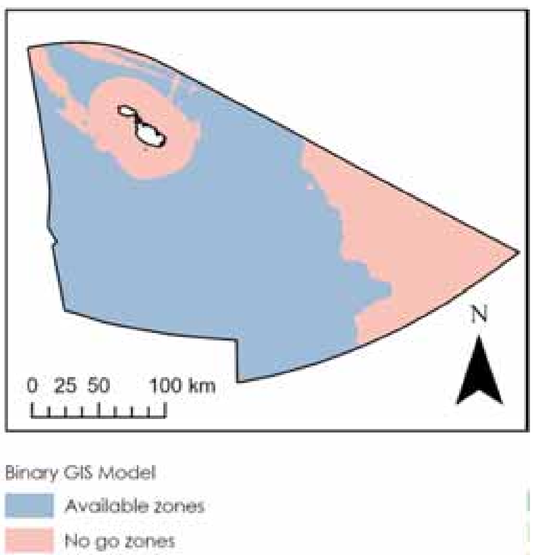
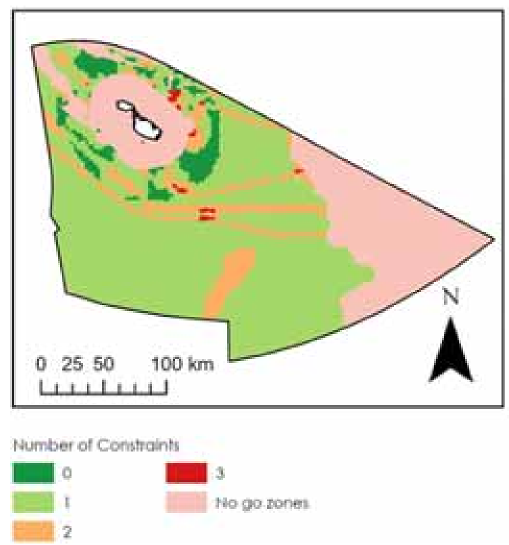
Classification of constraints used

- **Binary method** used to identify no-go zones
  - Average wind speed below 5 m/s (minimum operational speed)
  - Water depth beyond 1000m
  - Average daily vessel traffic above 2 (although ships could pass through)
  - Territorial water (state legislation)



Binary GIS model distinguishing no-go and available zones

- **Non-binary method** to list number of constraints
  - Marine Protected Areas
  - Cables & pipelines
  - Pre-Quaternary faults
  - Rocks & boulders
  - Trawling areas
  - Beyond 25 nautical miles fom shore



GIS model depicting number of constraints

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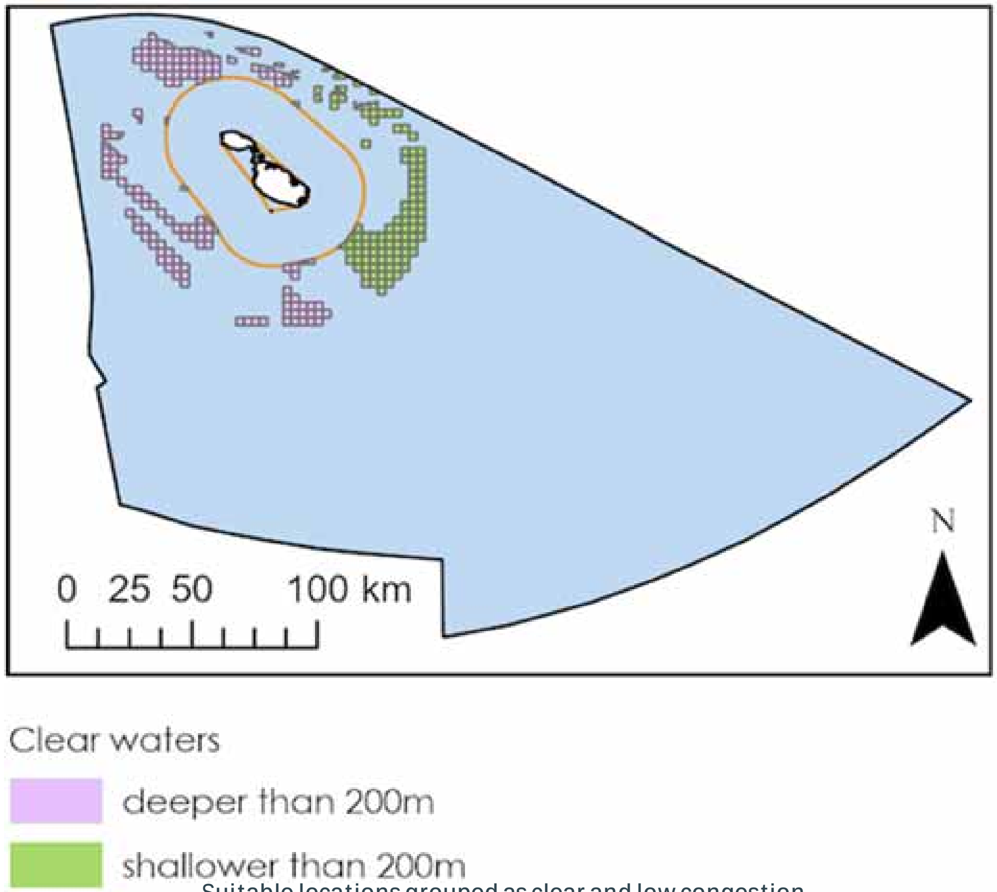
Results and analysis

- GIS analysis identifies over **40%** of Malta's waters as **suitable for OW**, primarily in **deeper waters (>60m)** requiring floating technologies
- Utilising a tenth of this space could produce 7 times Malta's peak energy demand
- **Clear water** identified as suitable area **without constraints**
- **Low congestion water** identified as suitable area **with only 1 constraint**



Suitable locations grouped as clear and low congestion

Clear water split by depth below and above 200m

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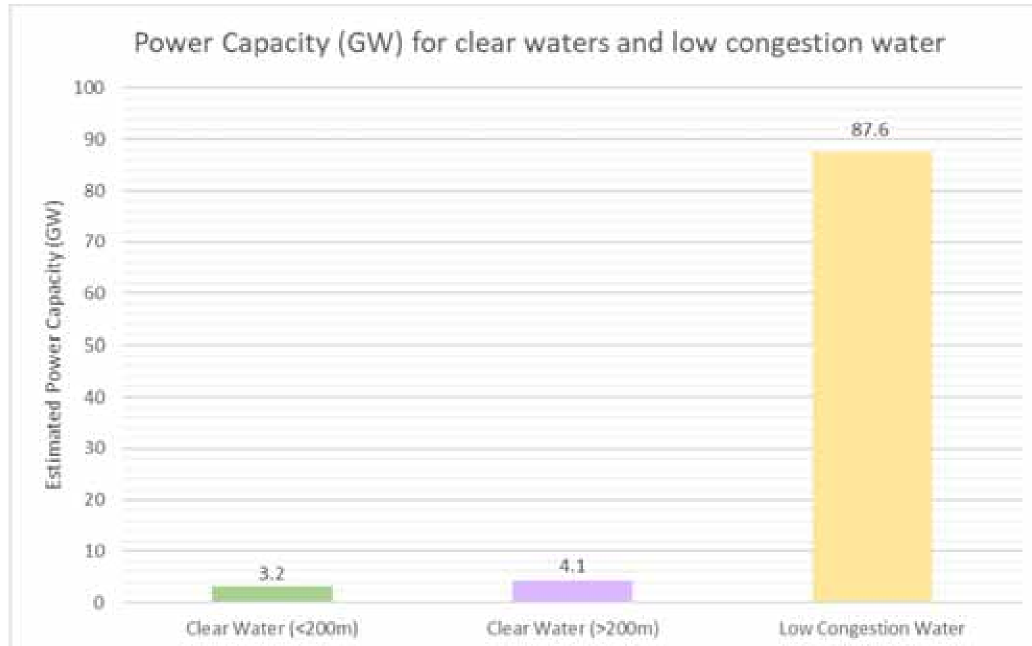
Potential power output

- Conservative estimate of 3 MW per sq km, considering wind speeds and height
- From the identified suitable areas, the estimated power output is several times Malta's **peak energy demand of 1GW**
- **Clear water areas (<200m depth)** show a potential power **capacity of 3.2 GW**
- Total potential in **clear water areas (all depths)** rises to **7.3 GW**
- Considering also **low congestion water** with 1 constraint potential reaches **87.6 GW**



Estimated power capacity

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Opportunities identified

- Energy surplus provides opportunity for Malta to **meet its domestic energy needs** and **export surplus energy** enhancing regional energy connectivity
- Exploration of **green hydrogen production** using surplus energy from OW as a form of energy **storage** could mitigate **intermittency**
- Challenges include **deep water, distance from shore** and **rocky seabeds** pose **cost** considerations
- Possibility of combining **floating solar panels** between installations to maximise output

Combined floating solar and offshore wind farm in Shandong coast : SPIC

Concept hydrgen production from offshore wind: Ramboll

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Possible future works

- **Scarcity** of detailed sediment **data** necessary for precise geological assessment
- **Sediment type and thickness** required to choose appropriate **anchorage system** as some systems require 30m+ of softer stratum
- **Further studies** are **needed** to explore advanced anchoring technologies for deep and rocky seabeds to reduce installation costs
- Conduct long-term environmental impact assessments of OW farms

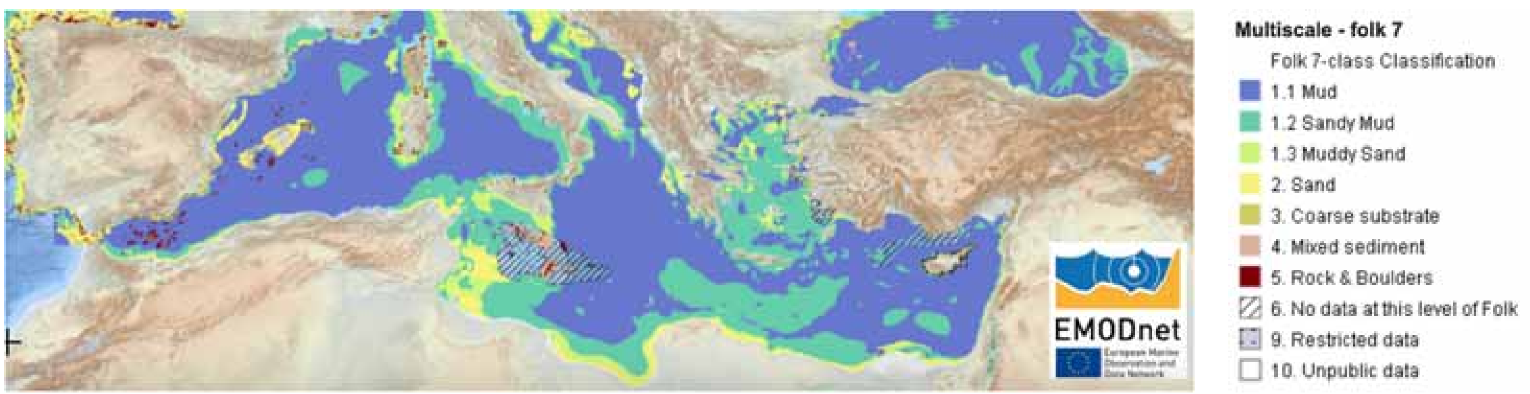

Figure showing incomplete sediment data: EMODnet

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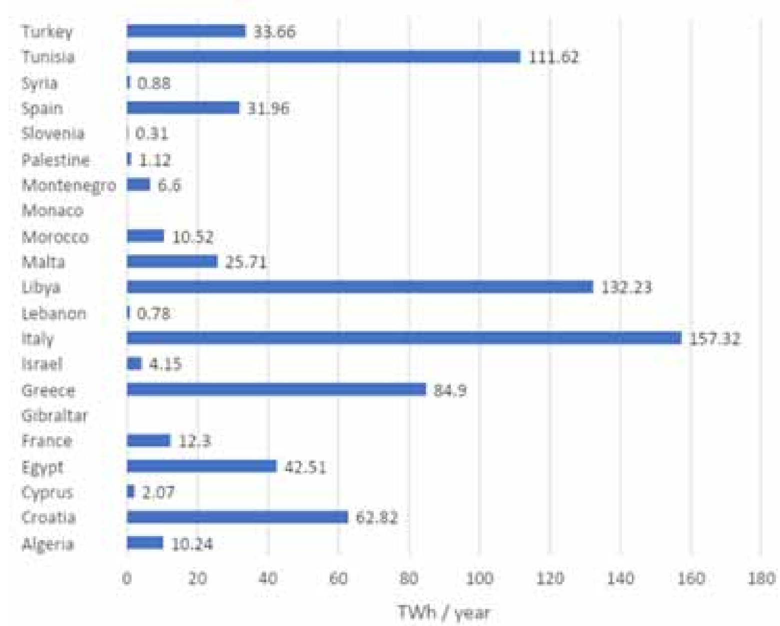
Broader Mediterranean application

- Application of the **GIS method** in Malta demonstrates potential for **adaptation to other Mediterranean countries** with similar marine characteristics
- Countries in the region can leverage this approach to **explore their OW potential**, tailored to meet **unique regional spatial and environmental challenges**
- Approach promotes a strategic and environmentally sensitive development of OW, contributing to **regional energy security and sustainability goals**



Theoretical max. annual OW production for Mediterranean countries
Source: Pantusa et al 2019

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Conclusion and Q&A

- **Project Overview**
  - Demonstrate the effective use of GIS method to identify suitable locations for offshore wind
  - Approach used for Malta's case study can be applied across the Mediterranean or other regions
- **Key opportunities**
  - Significant potential for Mediterranean to harness offshore wind energy
  - Aligns with local and global sustainability goals encouraging renewable energy implementation
- **Innovative integrations**
  - Potential to integrate floating solar PV systems with offshore wind farms
  - Surplus energy could enable green hydrogen production

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