# UK hydropower and marine energy capacity – a poorly tapped resource

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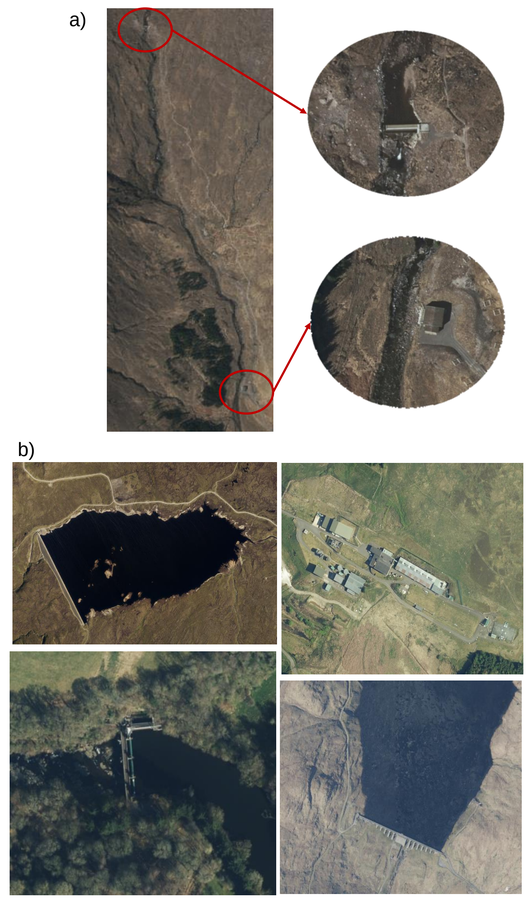
## OBJECTIVES

1. Review the implementation of hydropower and marine energy in the United Kingdom to date to understand the existing context and the benefits and challenges surrounding their development
2. Evaluate the available future development in three key sectors of hydropower and marine energy generation taking into account the impacts of climate change and future proofing energy generation:
   - Potential of large schemes; storage hydropower and pumped storage hydropower
   - Potential of small/micro schemes including run of river hydropower, and alternative energy sources such as water supply and waste water
   - Potential tidal energy schemes, i.e. tidal stream and tidal range

## OBJECTIVE 1

### METHODOLOGY TO DETERMINE THE INSTALLED CAPACITY AND LOCATION OF UK ONSHORE AND OFFSHORE HYDROPOWER

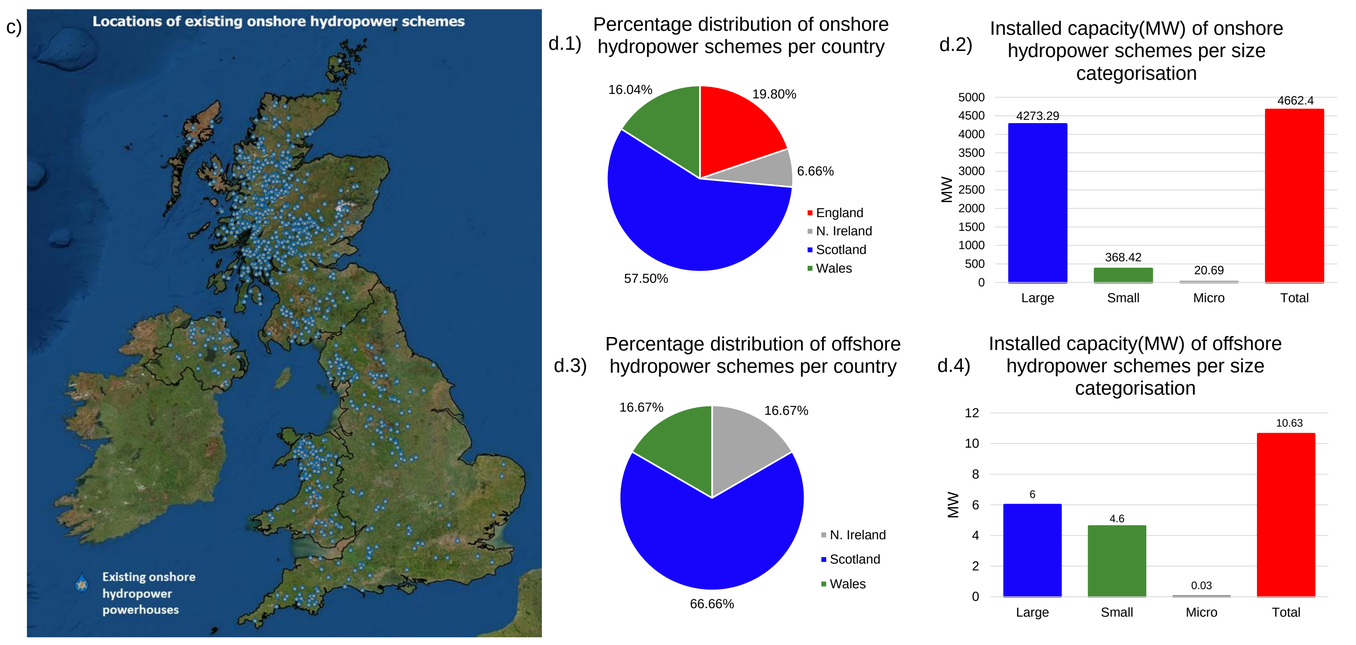
1. Develop initial list of operational hydropower sites
2. Confirm the location of sites utilising aerial imagery
3. Extract additional information of hydropower schemes so database provides some or all of:
   - Site name(s)/Generator name(s)
   - Country
   - Operator and/or developer
   - Installed capacity in MW
   - Size classification of the scheme
   - Hydropower type
   - Powerhouse/onshore connection coordinates
   - Intake/offshore turbine coordinates
   - Service life (as of 2021)




Figures: a) An example of a aerial view of a run of river hydropower plant showing the intake and the powerhouse, b) a selection of various types of onshore hydropower schemes, clockwise from top left a conventional (storage) scheme, a water treatments work, a pumped storage scheme and a run of river scheme

Table 1: The results of the existing hydropower picture of the United Kingdom

| | Onshore | Offshore |
|---|---|---|
| Number of operational sites | 1172 | 6 |
| Installed capacity | 4662.4 MW | 10.63 MW |
| Powerhouse/onshore connection coordinates identified | 963 (82%) | 6 (100%) |
| Intake/offshore turbine coordinates identified | 882 (75%) | 6 (100%) |




Figures: c) Geographic distribution of the UK's operational onshore hydropower stations as of December 2020, showing the 963 powerhouses that were able to be geographically identified, d) Statistical results of the United Kingdom's operational onshore hydropower schemes as of December 2020 , d.1) the percentage distribution of onshore hydropower schemes across the countries of the UK, d.2) the number of onshore hydropower schemes developed in terms of the size of the installed capacity, d.3) ) the percentage distribution of offshore hydropower schemes across the countries of the UK (note England is not included as no offshore hydropower schemes had been developed), d.4) The total installed capacity in MW of offshore hydropower schemes in terms of the size of the installed capacity

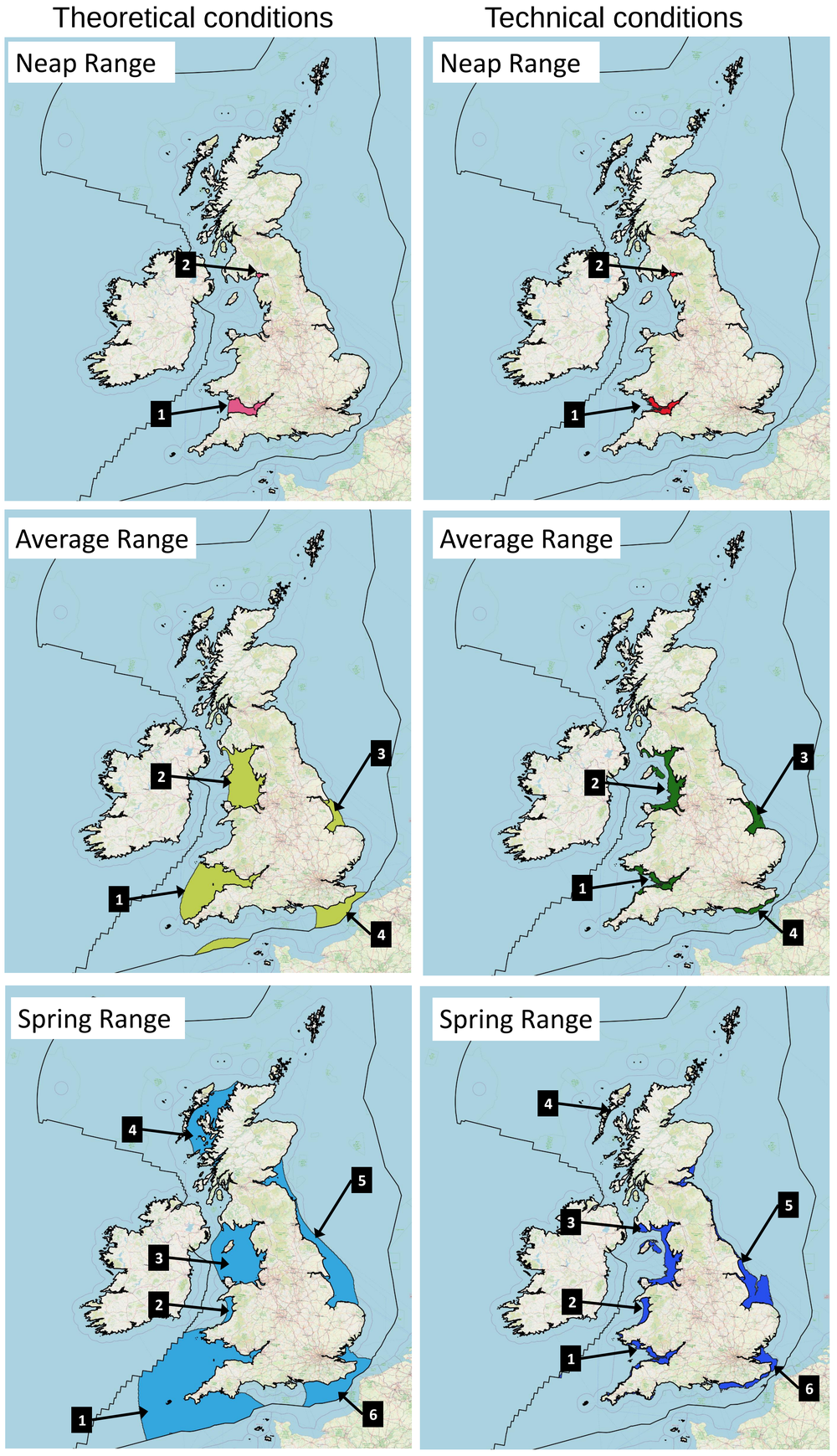
## OBJECTIVE 2

### METHODOLOGY TO DETERMINE THE OFFSHORE (TIDAL RANGE AND TIDAL STREAM) RESOURCE POTENTIAL

1. Data collection of parameters in GIS suitable format including:
   - Bathymetric data
   - UK coastline and exclusive economic zone
   - Tidal data – tidal range and tidal stream conditions
   - Offshore geological conditions
   - Constraints to development – environmental, transport, heritage, offshore industry, military.
2. Determine energy extraction potential for different levels:
   - Theoretical - energy available from the ocean
   - Technical – theoretical + technical conditions for development e.g. ground conditions
   - Economic – technical + cost constraints e.g. proximity to connection point, distance offshore
   - Exploitable – economic + realistic constraints e.g. environmental, other ocean users etc.

Table 2: The results of the energy potential for tidal range technology

| Neap Range | Theoretical Potential Energy (GW) | Technical Potential Energy (GW) |
|---|---|---|
| 1 | 14.27 | 10.48 |
| 2 | 0.81 | 0.8 |
| **Average Range** | **Theoretical Potential Energy (GW)** | **Technical Potential Energy (GW)** |
| 1 | 89.87 | 30.47 |
| 2 | 67.78 | 34.76 |
| 3 | 9.98 | 9.95 |
| 4 | 31.12 | 6.12 |
| **Spring Range** | **Theoretical Potential Energy (GW)** | **Technical Potential Energy (GW)** |
| 1 | 378.38 | 55.96 |
| 2 | 4.52 | 4.52 |
| 3 | 133.84 | 61.8 |
| 4 | 47.66 | 5.54 |
| 5 | 71.82 | 42.79 |
| 6 | 72.00 | 20.81 |




Figures: Areas suitable for tidal range based on theoretical conditions on the left (i.e. where tidal range is > 4m for neap, average and spring conditions) and technical conditions on the right (i.e. where tidal range >4 m and the sea bed is < 25 m) for neap average and spring. Numbers correspond to Table 2.

## FUTURE WORK

1. Complete resource assessment for tidal range energy development for economic and exploitable conditions
2. Undertake the same procedure for tidal stream technologies across the different levels using technology specific technical conditions.
3. Utilise the same methodology as offshore to determine the resource potential for onshore energy, utilising the appropriate data.