# International Assessment of Priority Environmental Issues for Land-Based and Offshore Wind Energy Development

**SUPPLEMENTARY MATERIAL**

**Table S1:** First questionnaire for land-based and offshore wind development.

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| **Category** | **Question** | **Question Type and Answer Options** |
| General | Professional sector (Select the sector where you have the most experience) | Choose from a list (Technology manufacturer, Technology provider, Wind farm operator, Wind farm developer, Financier, Academia, Environmental consultant, Non-governmental organization, Research institution, Government agency, Other) |
| What is your experience with environmental effects associated with wind energy? (length of time) | Choose from a list (< 5 years, 5-10 years, > 5 years) |
| What environmental context does your work cover? | Choose from a list (Land-based, Offshore, or both) |
| Environmental area of experience or focus (Choose all that apply) | Choose from a list (All countries listed) |
| Country where you have the most expertise and which your responses represent. | Choose from a list (General biology/ecology, Ecosystems, Habitats, Flora, Benthic communities, Marine invertebrates, Fish, Sea turtles, Marine mammals, Marine Birds (For example: gulls, shorebirds, auks), Terrestrial Birds (For example: songbirds, prairie grouse, raptors), Bats, Terrestrial mammals, Terrestrial reptiles, Terrestrial invertebrates) |
| To the best of your knowledge, what is the current installed capacity of wind energy (land-based and offshore) in your country? | Choose from a list (< 10MW, 10 – 100 MW, 100 – 100 MW, 1 – 10 GW, 10 – 100 GW, > 100 GW) |
| To the best of your knowledge, what is the expected growth of wind energy development (land-based and offshore) in the next 10 years in your country? | Choose from a list (No increase, Small increase (<25%), Moderate increase (25%- 50%), Large increase (> 50 %), Uncertain) |
| Environmental | What do you anticipate being the first priority environmental issue related to land-based/offshore wind energy development in your country (i.e., country indicated above) in the next 5–10 years? This question allows for broad, open-ended responses related to a particular stressor, receptor, cumulative effect, or ecosystem process. Each response will be followed by more specific questions related to the issue. | Short answer |
| If applicable, what is the specific stressor-receptor relationship associated with this issue? For example, collision and bats, or displacement and grouse (land-based); collision and seabirds, or underwater noise and marine mammals (offshore). | Short answer |
| What level of impact to the receptor do you anticipate for this issue? For example, individual, population, community, or biodiversity. | Short answer |
| What scale of impact do you anticipate for this issue? For example, local, regional, biogeographical, or global. | Short answer |
| What are the next steps to improving how we monitor this issue? For example, miniaturizing GPS tags to track the movement of smaller birds and bats or more cost-effective methods for carcass searches (land-based); study design considerations for monitoring collision of birds and bats or ocean bottom recorders to measure acoustic pressure and particle motion (offshore). | Short answer |
| What are the next steps to validating and implementing cost-effective mitigation strategies (avoid, reduce, minimize, compensate, restore) associated with this issue? For example, understanding the sensory perception of bats or advancing automated video detection of eagles (land-based); validating the effectiveness of bubble curtains or quantifying bird activity relative to distance from shore (offshore). | Short answer |
| Additional Considerations | What are the primary considerations, such as societal, financial, political, regulatory, environmental, or other, to implementing proven monitoring or mitigation approaches associated with this issue? For example, lack of scientific consensus or monitoring costs are too expensive. Please rank (up to three) in order of priority. | Short answer |

**Table S2:** Second questionnaire for land-based and offshore wind development.

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| **Category** | **Question** | **Question Type and Answer Options** |
| General | Professional Sector (Select the sector where you have the most experience) | Choose from a list (Technology manufacturer, Technology provider, Wind farm operator, Wind farm developer, Financier, Academia, Environmental consultant, Non-governmental organization, Research institution, Government agency, Other) |
| Environmental area of expertise (Choose all that apply) | Choose from a list (General biology/ecology, Ecosystems, Habitats, Flora, Benthic communities, Marine invertebrates, Fish, Sea turtles, Marine mammals, Marine Birds (For example: gulls, shorebirds, auks), Terrestrial Birds (For example: songbirds, prairie grouse, raptors), Bats, Terrestrial mammals, Terrestrial reptiles, Terrestrial invertebrates) |
| Country where you have the most expertise and which your responses represent. | Choose from a list (All countries listed) |
| Environmental | Please identify your top-priority stressor for land-based/offshore wind. | Choose from a list (Attraction, Avoidance, Barrier effect, Turbine Collision Decommissioning/ Repowering, Cumulative Effects, Displacement, Disturbance |
| Please identify your top-priority receptor. | Choose from a list (See Figure 2 for LBW and Figure 5 for OSW coded response options) |
| Please identify your second-priority stressor for land-based/offshore wind. (optional) | Choose from a list (See Figure 2 for LBW and Figure 5 for OSW coded response options) |
| Please identify the associated receptor (optional) | Choose from a list (See Figure 2 for LBW and Figure 5 for OSW coded response options) |
| Please identify your third-priority stressor for land-based/offshore wind. (optional) | Choose from a list (See Figure 2 for LBW and Figure 5 for OSW coded response options) |
| Please identify the associated receptor. (optional) | Choose from a list (See Figure 2 for LBW and Figure 5 for OSW coded response options) |
| Is there a truly "emerging" environmental issue (vs. persistent issue) that has not previously been identified? (open-ended question) | Short answer |
| Additional Considerations | For land-based/offshore wind, in general what are the primary challenges associated with implementing proven monitoring or mitigation approaches? (Choose up to three) | Choose from a list (See Figure 2 for LBW and Figure 5 for OSW coded response options) |
| Is there any additional feedback that you'd like to provide to inform this horizon scan? (Optional) | Short answer |

**Table S3.** Number of responses by region and country for questionnaires 1 and 2 (Q1 and Q2). In parentheses, responses are shown for the respondent’s expertise by land-based wind (LBW), offshore wind (OSW), or both.

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| **Region** | **Country** | **Q1 (LBW, OSW, Both)** | **Q2 (LBW, OSW, Both)** |
| North America | United States | 44 (15, 9, 20) | 39 (15, 12, 12) |
| Canada | 3 (2, 1, 0) | 2 (2, 0, 0) |
| Mexico | 1 (1, 0, 0) | 1 (1, 0, 0) |
| Europe | Portugal | 25 (18, 2, 5) | 20 (13, 3, 4) |
| Germany | 12 (8, 1, 3) | 9 (4, 2, 3) |
| United Kingdom | 11 (1, 8, 2) | 9 (1, 7, 1) |
| France | 10 (0, 8, 2) | 19 (0, 16, 3) |
| Netherlands | 9 (4, 0, 5) | 7 (2, 3, 2) |
| Belgium | 5 (1, 3, 1) | 4 (1, 3, 0) |
| Norway | 5 (2, 0, 3) | 4 (2, 0, 2) |
| Croatia | 2 (2, 0, 0) | 0 |
| Sweden | 2 (1, 0, 1) | 3 (0, 1, 2) |
| Austria | 1 (1, 0, 0) | 0 |
| Switzerland | 1 (1, 0, 0) | 4 (4, 0, 0) |
| Spain | 1 (0, 0, 1) | 2 (1, 0, 1) |
| Lithuania | 0 | 1 (1, 0, 0) |
| Bulgaria | 0 | 1 (1, 0, 0) |
| Italy | 0 | 1 (0, 0, 1) |
| Eurasia | Uzbekistan | 0 | 1 (1, 0, 0) |
| Jordan | 1 (0, 0, 1) | 0 |
| Israel | 0 | 1 (1, 0, 0) |
| Asia Pacific | Japan | 5 (2, 2, 1) | 1 (0, 0, 1) |
| Australia | 2 (2, 0, 0) | 4 (4, 0, 0) |
| Vietnam | 1 (0, 0, 1) | 0 |
| Central and South America | Brazil | 8 (7, 0, 1) | 4 (3, 0, 1) |
| Argentina | 1 (0, 0, 1) | 0 |
| Africa | South Africa | 2 (2, 0, 0) | 3 (3, 0, 0) |
| Kenya | 1 (0, 0, 1) | 1 (0, 0, 1) |