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TRADE AND ENVIRONMENTAL SUSTAINABILITY STRUCTURED DISCUSSIONS (TESSD)

COMMUNICATION FROM THE UNITED KINGDOM

The following communication, dated 23 May 2023, is being circulated at the request of the delegation of the United Kingdom.

OFFSHORE WIND ENERGY

Technical paper by the United Kingdom

Contents

1 INTRODUCTION

1.1 Executive summary

This paper explores the goods and services associated with the production and trade in offshore wind (OSW) energy. We begin by placing this study in perspective, summarising the importance of OSW technology in meeting climate mitigation goals, specifically net zero. We describe environmental services which are notable across the OSW lifecycle, and note some barriers to trade. We also develop specific (though indicative) 'value chain diagrams', describing goods and services across all OSW lifecycle phases. There are three value chain diagrams contained in this paper. A more comprehensive set of diagrams covering the full lifecycle are tabled in a separate Annex (INF/TE/SSD/W/26/Add.1).

Our hope is to continue to develop this report, sharing additional information with TESSD covering further barriers to trade and ideas for steps that can be taken to overcome them.

This individual report follows from the UK's earlier technical paper titled "Building our Evidence Base around Environmental Goods"[1], shared with TESSD in March 2023.

1.2 The importance of offshore wind energy in achieving climate mitigation goals

Wind energy solutions will be important in achieving climate mitigation objectives by reducing greenhouse gas emissions through displacement of thermal power generation and reducing operational costs compared with fossil-fuel based electricity generation.

That wind energy makes a significant positive impact towards meeting environmental objectives is well understood. Reference is made below to several useful and credible resources which support this. We envisage that the case for wind energy will be subject to revision, and that further evidence can be added to this document in future versions.

The **UN Climate Technology Centre and Network (CTCN)** clearly sets out that due to the renewable nature of wind energy, the large resource availability, and the relatively advanced nature of the technology, wind energy technologies have the potential to make a significant contribution to climate change mitigation efforts. The uptake of wind energy can displace generation from thermal power plants, which can prevent rises in CO2 emissions.[2]

Project Drawdown documents the impact that offshore wind energy solutions have according to growth in energy output and avoidance of GHG emissions worldwide:

"Offshore wind turbines growing from the current estimated 60 terawatt-hours, to 1,850.04–2,175.56 terawatt-hours by 2050, could avoid 10.22–9.89 gigatons of greenhouse gas emissions."

The **International Energy Association** (IEA) stress that while offshore wind represents a small fraction of current power generation, it is important to prioritise efforts in this area since improvements in technology and steep cost reductions make harnessing the near limitless potential of wind within our collective grasp. Indeed, the IEA have reported record growth in wind electricity production in 2021 (up 273 TWh or 17%) – 55% higher than for 2020, and the highest growth among all renewable power technologies.[3]

Both the **International Renewable Energy Association** (IRENA) and the IEA have said they expect offshore wind capacity will need to exceed 2000 GW in 2050, from just over 60 GW today to achieve net zero. The Global Offshore Wind Alliance (GOWA), launched at COP27 in November 2022, have pledged to a rapid ramp up of offshore wind, aiming to accelerating growth to reach a total of

[1] INF/TE/SSD/W/23.
[2] https://www.ctc-n.org/technologies/offshore-wind.
[3] https://www.iea.org/reports/offshore-wind-outlook-2019.

at least 380 GW installed capacity by the end of 2030. This work includes active collaboration to remove barriers to the deployment of offshore wind in new and existing markets.[4]

The **UNIDO ITPO Tokyo STePP platform** describes the major features and advantages of a mid-sized wind turbine.[5] A common problem for the deployment of wind energy in regions prone to periodic high wind conditions is that the turbines can become damaged during extreme weather events or other natural disasters. The platform documents a medium-sized turbine which is designed to be easily transportable, relatively simple to install, with strong lightning and earthquake protection, and resistant to extreme and unstable winds (beyond the requirements of the relevant IEC standard).

Similarly, the **World Intellectual Property Organisation's (WIPO) Marketplace for Sustainable Technologies** contains entries for typhoon-proof wind turbines[6], among a variety of other wind energy technologies.[7] This resource shows not only that there are a wide array of benefits to be realised from the uptake of these technologies, but also that these technologies frequently have a high Technology Readiness Level (TRL). This resource also documents a wide variety of cooperation types under which wind energy technology transfer is possible under voluntary but mutually agreed terms.

1.3 Lifecycle considerations for offshore wind turbines

The benefits to the environment from the uptake of wind energy are clear from the sources above. Industry is now homing in on the outstanding lifecycle challenges associated with select components to maximise the environmental compatibility of this technology. A selection of these challenges has been outlined below.

The disposal of turbine blades poses a challenge during the end-of-life stage of a turbine's lifecycle. Whilst 85-90% of wind turbines' total mass can be recycled, this is not the case for the blades, which often end up in landfill.[8,9] Turbine blades are made from reinforced fibres (typically glass or carbon fibres) and a polymer matrix. Whilst they are non-toxic and landfill safe, commercially viable recycling methods are limited.[10]

The majority of currently viable recycling methods are some form of 'down-cycling', where the new material produced is of lower quality than the original material. Many recycling methods that produce higher quality material involve much higher energy costs, however more research is needed for accurate lifecycle assessment of these techniques.[11,12]

New materials are under development which can be used for wind turbine blades that are more easily recycled into useful products, however it remains to be seen whether these materials will be economically viable at scale.[13] In the meantime, the challenge remains regarding how current

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[4] https://www.irena.org/News/pressreleases/2022/Nov/Nine-new-countries-sign-up-for-Global-Offshore-Wind-Alliance-at-COP27.

[5] http://www.unido.or.jp/en/technology_db/1685/.

[6] https://wipogreen.wipo.int/wipogreen-database/articles/147595?queryFilters.0.field=TECH_FIELD_ID&queryFilters.0.value=54&queryFilters.1.field=TECH_TYPE&queryFilters.1.value=5&type=BASIC&query=&pagination.size=30&pagination.page=0&sort.0.field=CREATED_AT&sort.0.direction=DESC.

[7] https://wipogreen.wipo.int/wipogreen-database/search?queryFilters.0.field=TECH_FIELD_ID&queryFilters.0.value=54&queryFilters.1.field=TECH_TYPE&queryFilters.1.value=5&type=BASIC&query=&pagination.size=30&pagination.page=0&&sort.0.field=CREATED_AT&sort.0.direction=DESC.

[8] https://cleangridalliance.org/blog/137/wind-turbine-recycling-and-disposal.

[9] WindEurope, "Accelerating Wind Turbine Blade Circularity", 2020.

[10] https://windeurope.org/newsroom/press-releases/wind-industry-calls-for-europe-wide-ban-on-landfilling-turbine-blades/.

[11] Beauson, J., Laurent, A., Rudolph, D.P. and Jensen, J.P., 2022. The complex end-of-life of wind turbine blades: A review of the European context. *Renewable and Sustainable Energy Reviews*, 155, p. 111847.

[12] Sustainable decommissioning: Wind Turbine Blade Recycling, Catapult Offshore Renewable Energy

[13] https://www.scientificamerican.com/article/recycled-wind-turbines-could-be-made-into-plexiglass-diapers-or-gummy-bears/.

turbine blades are disposed of when they are decommissioned, with a predicted 43 million tonnes of blade waste being produced worldwide by 2050.[14]

2 ROLE OF SERVICES

2.1 Technical services

There are a wide variety of services (many of which are highly technical) in the generation of Offshore Wind (OSW). These services are intrinsic to every stage, from the development and management of an OSW project, through to the manufacture of wind turbines, balancing the plant, installation and commissioning of turbines and wind farms. Section 4 (below) details the technical service activities that contribute to elements of an OSW project.

Many of these technical services are specific to a particular stage of the OSW lifecycle. Engineering and construction are key elements in the installation and assembly of wind turbines and offshore substation construction. Maintenance and repair services are needed at later stages of the OSW lifecycle. They are often complementary to goods used in an OSW project and are typically undertaken by the original system supplier who will chart vessels for the purpose.[15]

2.2 Ancillary services

Both industry and academics have acknowledged the scope of environmental services needs to be broader than the 'core' services as designated by the CPC 94 classification (OECD, 2022; Swedish National Board of Trade, 2014; KPMG, 2021). Environmentally related services, particularly those relating to the development, deployment, implementation, maintenance, and decommissioning of environmental goods, contribute to a green end-use, but are not included in the classical definition of environmental services.

As OSW has developed, the services that are necessary to enable the success of these projects similarly grows. Services such as research and development, financial services, insurance, and maintenance are utilised in OSW projects. As section 4 demonstrates, PBS and digital services are used across the development, installation, maintenance, and decommissioning of OSW. However, these are not classified as environmental services under the CPC 94 definition (OECD, 2022).

Expertise is required throughout the early stages of the project lifecycle, including the development of environmental strategy, and modelling feasibility, risk and resilience. A variety of services then support the establishment and day-to-day running of the project and its operation, including; the creation of a Special Purpose Vehicle, accounting and tax services, asset managers, operation and maintenance providers, and technical consultants. For example:

- **Legal services:** Legal services and consultants are key at many stages of an OSW project. A special purpose vehicle (SPV) is typically set up at project initiation which manages the development process and subcontracts work to a range of specialist consultancies. The SPV is a legal entity, which invests in and owns the wind farm project. Tasks such as obtaining planning consent, land leases are all supported by various professional business services.

- **Financial services:** Projects can be financed in different ways. OSW is capital-intensive, with large upfront costs for equipment and costs then decreasing to operate and maintain. A case study of the company UK Wind1 – a UK offshore wind farm – shows one example of this. The project is sized on a circa 80% debt to 20% equity ratio. The debt is secured over all material project contracts and assets. Insurers sit behind the lenders.[16] Greencoat UK Wind PLC is a UK investment fund investing in UK Wind farms. The fund itself utilises adjacent services, in this case BDO; a firm providing accountancy and business advice. BDO acted as a reporting accountant, and covered many aspects from due diligence, reviewing forecast financial

[14] Wind Turbine Blade Waste in 2050. Authors: Pu Liu and Claire Y Barlow. University of Cambridge Institute for Manufacturing.
[15] https://www.thecrownestate.co.uk/media/2861/guide-to-offshore-wind-farm-2019.pdf.
[16] https://www.scor.com/sites/default/files/2021-04/Offshore_Wind_Farm_Finance-CaseStudy_0.pdf.

information, and providing assurance on financial information of assets being acquired by the fund.[17]

- **Consultancy services:** Packages of work are commissioned to environmental and engineering consultancies – key work need to be completed in the development stage of OSW, such as environmental surveying before the project can progress to the next stage.

- **R&D services:** Research and development services are key to both creating new energy projects and to improving existing energy projects. Research interests contribute to pre-project design and manufacture for example, improving turbine reliability as well as development of novel installation technologies to reduce costs and risks. R&D also contributes once the project is up and running, such as improving drone techniques and data analysis for better operations and maintenance.[18]

2.3 Barriers to services trade

The adoption of ICT has boosted the tradability of services and many of the services above can now be delivered using computer networks.[19] However, there remain regulatory barriers such as restrictions to cross-border data flows and commercial presence requirements that restrict digitally delivered services. The OECD Digital Services Trade Restrictiveness Index (DSTRI) shows there are cross-cutting barriers that inhibit or completely prohibit firms' ability to supply services using electronic networks, and these have been increasing. This is primarily driven by restrictions related to interconnection on communication infrastructures and restrictions affecting connectivity.

The OECD find large benefits from removing barriers to digital services trade and the case is even stronger in emerging economies where the benefits of reform deliver greater export gains.[20]

Services barriers tend to be behind rather than on the border, and are often a result of balancing competing domestic policy challenges. For example, services used in the offshore wind sector can be subject to cross-cutting barriers to investment and restrictions to the movement of people. In engineering, near a third of all restrictions captured in the OECD Services Trade Restrictiveness Index (STRI) relates to quotas, labour market test and limitations on duration of stay for business persons. Almost half of the countries in the OECD STRI impose some form of nationality or citizenship requirements for senior managers and board of directors which restricts trade in services including finance and insurance. Free trade agreements are good examples of where countries have removed or eased these restrictions.

Professional services such as accounting, architecture, legal and engineering services are also subject to restrictions on recognition of qualifications which have a negative impact on international trade in these services. STRI date shows some countries impose nationality of citizenship requirements to practice architecture, and/or lack laws or regulation to establish processes for recognising qualifications gained abroad. Countries can facilitate trade in services through cooperation on recognition of qualifications, and can also encourage relevant bodies to discuss the potential inclusion of sustainability skills as a requirement for recognition to better promote environmental goals.

3 VALUE CHAIN DIAGRAMS

We introduced value chain diagrams for environmental goods in our technical paper titled "Building our Evidence Base around Environmental Goods"[21], as a powerful tool for organising key information relating to goods.

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[17] https://www.cityoflondon.gov.uk/supporting-businesses/economic-research/research-publications/in-service-of-sustainable-infrastructure.

[18] https://ore.catapult.org.uk/what-we-do/supply-chain-growth/torc-2/.

[19] See OECD, WTO, IMF Handbook for Measuring Digital Trade Volume 1.

[20] OECD (2023) 'Of bytes and trade: Quantifying the impact of digitalisation on trade', https://www.oecd-ilibrary.org/trade/of-bytes-and-trade-quantifying-the-impact-of-digitalisation-on-trade_11889f2a-en.

[21] INF/TE/SSD/W/23.

Value chain diagrams visualise and describe a range of manufacturing activities or production processes that are applied to raw material inputs and intermediate products as these are transformed into final goods, that combine to form technological solutions to environmental challenges. These diagrams describe both goods and services, production, and trade. They can therefore drive research into trade barriers and connected problems and be annotated with additional information.

By bringing together these different kinds of information, they can deepen our understanding of the relationship between goods, services, production, trade – and the environment, and can help us develop better and more coordinated trade, industrial, and environmental policies.

The value chain diagrams in this section have been annotated with commodity codes for illustrative purposes only. Simple names of products are generally insufficient for seeking formal classification opinions because they do not contain an explanation of the product's essential characteristics. These characteristics would need to be compared with the explanatory notes of the harmonised system to seek a formal opinion.

The information within these diagrams is sourced from the UK Offshore Renewable Energy Catapult Project's guide to an offshore wind farm.[22] The aim of the guide is to help develop a greater understanding of the components and processes involved in the development UK offshore wind farms. This publication builds on that by applying a value chain framework to the contents of the guide, which can be annotated with relevant trade policy information, as illustrated by the commodity codes. The guide itself contains further qualitative information about each stage of the wind farm lifecycle[23], and presents a full cost breakdown in £/MW.[24] It also contains a supply chain map of UK offshore wind farms in the UK, Europe, and around the world.[25]

More value chain diagrams are contained in the Annex to this paper, document INF/TE/SSD/W/26/Add.1.

Value chain diagrams – key:

Chevron Colour	Meaning
(orange)	Manufacturing activity or production process involved in either the manufacture or assembly of a **wind turbine**
(dark grey)	Input product, intermediate product, final product, or a service deliverable in any stage of an offshore wind farm's lifecycle

[22] https://guidetoanoffshorewindfarm.com/.
[23] https://guidetoanoffshorewindfarm.com/lifecycle.
[24] https://guidetoanoffshorewindfarm.com/wind-farm-costs.
[25] https://guidetoanoffshorewindfarm.com/supply-chain-map.

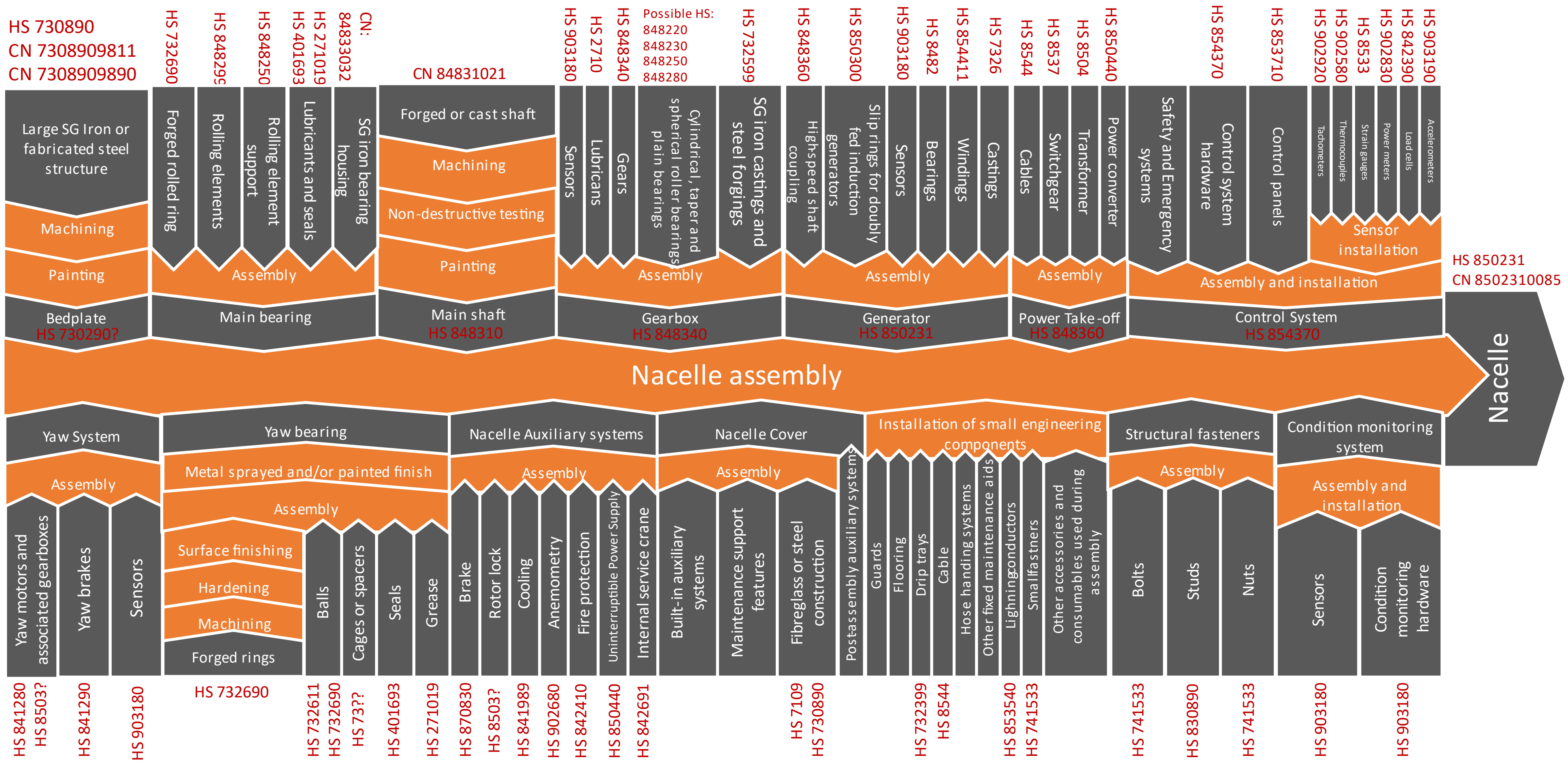
3.1 Wind turbine

The turbine converts kinetic energy from the wind into three-phase AC electrical energy.

3.1.1 Nacelle

The nacelle supports the Rotor and converts the rotational energy from the rotor into three-phase AC electrical energy.

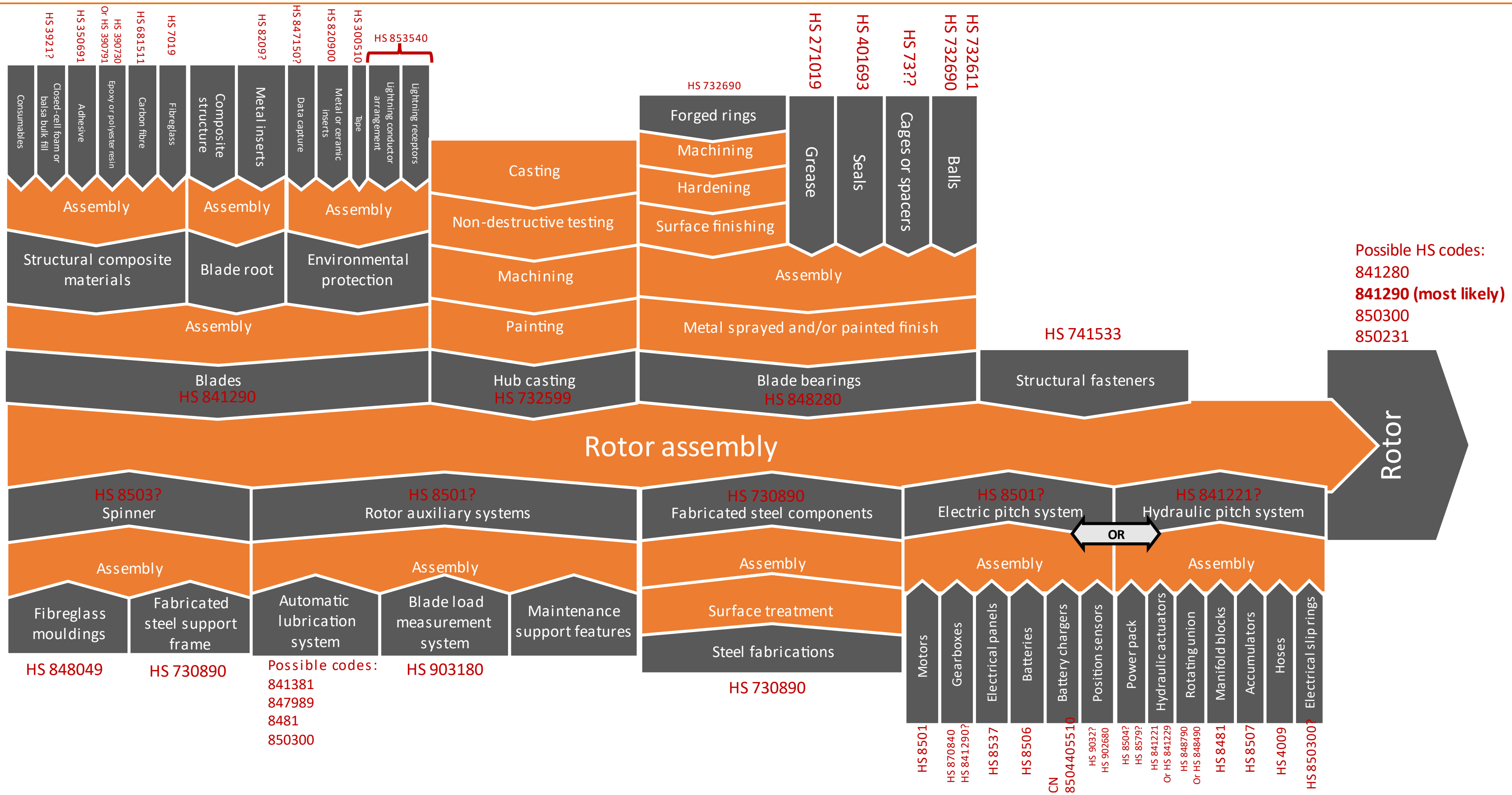
- **Bedplate:** supports the drive train and the rest of the nacelle components and transfers loads from the rotor to the tower.
- **Main bearing:** supports the rotor and transfers some of the rotor loading to the nacelle Bedplate.
- **Main shaft:** transfers torque from the rotor to the gearbox or, for some direct drive designs, the generator. It is supported at the rotor end by the main shaft bearing and at the other end either by the gearbox / generator or separately mounted bearing.
- **Gearbox:** converts rotor torque at a speed of 5-15 rpm to a speed of up to about 600 rpm for a medium speed gearbox and 1500 rpm for a high-speed gearbox for conversion to electrical energy by the generator.
- **Generator:** converts mechanical energy to electrical energy.
- **Power take-off:** receives electrical energy from the generator and adjusts voltage and frequency for onward transfer to the wind farm distribution system.
- **Control system:** provides supervisory control (including health monitoring) and active power and load control in order to optimise wind turbine life and revenue generation, while meeting externally imposed requirements.
- **Yaw system:** orients the nacelle to the wind direction during operation.
- **Yaw bearing:** connects the nacelle and tower, enabling the yaw system to orient the nacelle to any wind direction during operation.
- **Auxiliary systems:** facilitate ongoing unattended operation of the wind turbine for the vast majority of the time, and support planned maintenance, which typically should be only on an annual basis.
- **Nacelle cover:** provides weatherproof protection to the nacelle components plus support and access to external components such as coolers, wind measurement equipment and lighting protection devices.
- **Small engineering components:** make up the rest of the nacelle assembly.
- **Structural fasteners (either bolts or studs):** are used in a range of critical bolted joints, for example connecting rotor to main shaft, main bearing housings to nacelle bedplate and yaw bearing to the underside of nacelle bedplate.
- **Condition monitoring systems:** provide additional health checking and failure prediction capability.


Nacelle assembly
Nacelle
HS 730890
CN 7308909811
CN 7308909890
Large SG Iron or fabricated steel structure
Machining
Painting
Bedplate
HS 730290?
HS 732690
HS 848299
HS 848250
HS 401693
HS 271019
CN: 84833032
Forged rolled ring
Rolling elements
Rolling element support
Lubricants and seals
SG iron bearing housing
Assembly
Main bearing
CN 84831021
Forged or cast shaft
Machining
Non-destructive testing
Painting
Main shaft
HS 848310
HS 903180
HS 2710
HS 848340
Possible HS: 848220 848230 848250 848280
HS 732599
Sensors
Lubricants
Gears
Cylindrical, taper and spherical roller bearings plain bearings
SG iron castings and steel forgings
Assembly
Gearbox
HS 848340
HS 848360
HS 850300
HS 903180
HS 8482
HS 854411
HS 7326
Highspeed shaft coupling
Slip rings for doubly fed induction generators
Sensors
Bearings
Windings
Castings
Assembly
Generator
HS 850231
HS 8544
HS 8537
HS 8504
HS 850440
Cables
Switchgear
Transformer
Power converter
Assembly
Power Take-off
HS 848360
HS 854370
HS 853710
HS 902920
HS 902580
HS 8533
HS 902830
HS 842390
HS 903190
Safety and Emergency systems
Control system hardware
Control panels
Tachometers
Thermocouples
Strain gauges
Power meters
Load cells
Accelerometers
Sensor installation
Assembly and installation
Control System
HS 854370
HS 850231
CN 8502310085
Yaw System
Assembly
Yaw motors and associated gearboxes
Yaw brakes
Sensors
HS 841280
HS 8503?
HS 841290
HS 903180
Yaw bearing
Metal sprayed and/or painted finish
Assembly
Surface finishing
Hardening
Machining
Forged rings
Balls
Cages or spacers
Seals
Grease
HS 732690
HS 732611
HS 732690
HS 73??
HS 401693
HS 271019
Nacelle Auxiliary systems
Assembly
Brake
Rotor lock
Cooling
Anemometry
Fire protection
Uninterruptible Power Supply
Internal service crane
HS 870830
HS 8503?
HS 841989
HS 902680
HS 842410
HS 850440
HS 842691
Nacelle Cover
Assembly
Built-in auxiliary systems
Maintenance support features
Fibreglass or steel construction
HS 7109
HS 730890
Installation of small engineering components
Postassembly auxiliary systems
Guards
Flooring
Drip trays
Cable
Hose handing systems
Other fixed maintenance aids
Lightningconductors
Smallfastners
Other accessories and consumables used during assembly
HS 732399
HS 8544
HS 853540
HS 741533
Structural fasteners
Assembly
Bolts
Studs
Nuts
HS 741533
HS 830890
HS 741533
Condition monitoring system
Assembly and installation
Sensors
Condition monitoring hardware
HS 903180
HS 903180

3.1.2 Rotor

The rotor extracts kinetic energy from the air and converts this into rotational energy in the drive train.

- **Blades:** capture the energy in the wind and transfer torque and other unwanted loads to the drive train and rest of the turbine.
- **Hub:** connects the blades to the main shaft.
- **Blade bearings:** enable adjustment of blade pitch angle to control power output from the turbine, minimise loads and start/stop turbine as required.
- **Pitch system:** adjusts the pitch angle of the blades to control power output from the turbine, minimise loads and start/stop turbine as required.
- **Spinner:** provides environmental protection to the hub assembly and access into the hub and blades for maintenance personnel.
- **Rotor auxiliary systems:** may be incorporated to lubricate bearings and provide condition monitoring and advanced control inputs.
- **Fabricated steel components:** often required to stiffen the blade bearing support and provide a connection for hydraulic pitch system actuators.

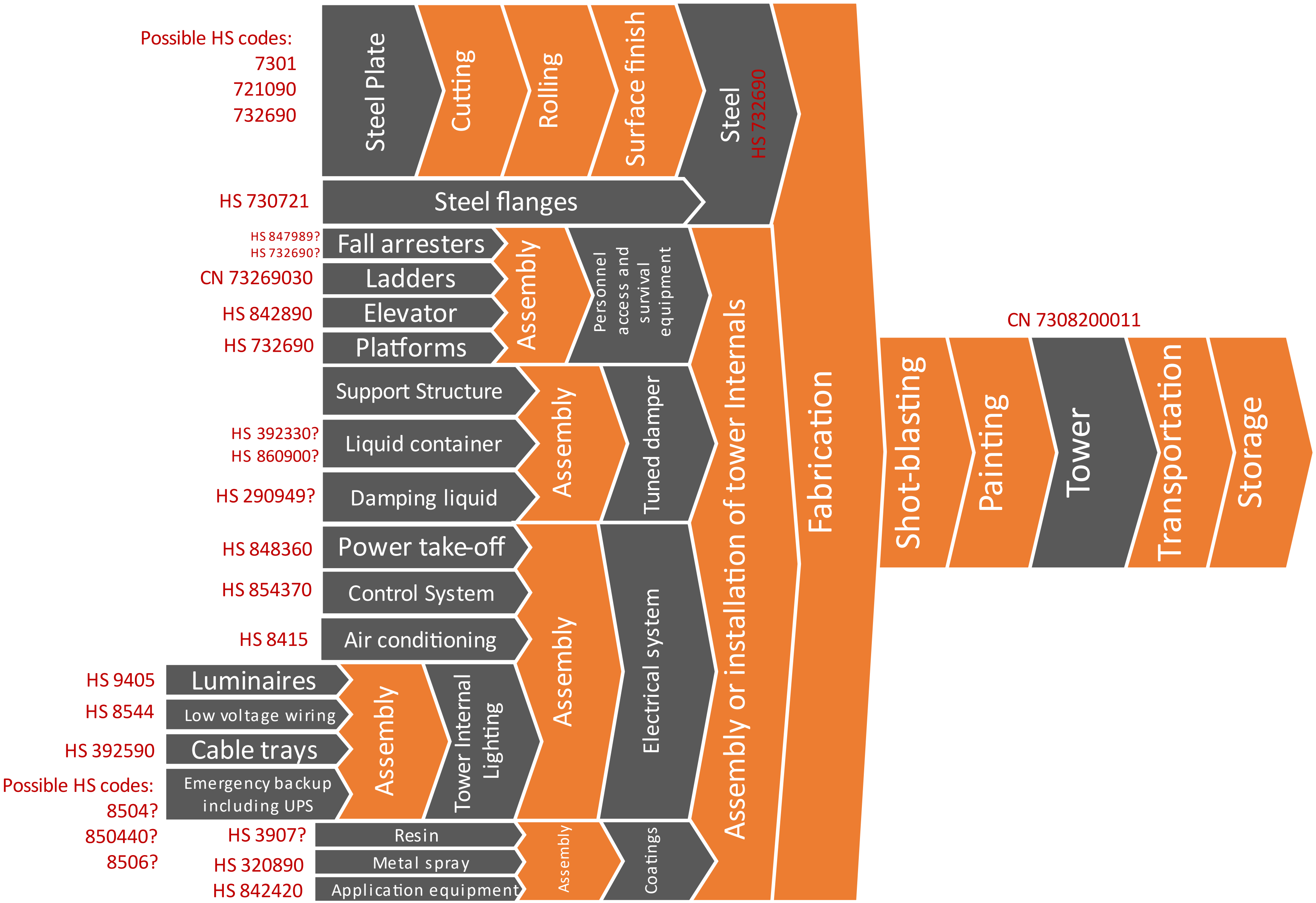

Consumables
Closed-cell foam or balsa bulk fill
Adhesive
Epoxy or polyester resin
Carbon fibre
Fibreglass
Composite structure
Metal inserts
Data capture
Metal or ceramic inserts
Tape
Lightning conductor arrangement
Lightning receptors
HS 3921?
HS 350691
HS 390730 Or HS 390791
HS 681511
HS 7019
HS 8209?
HS 847150?
HS 820900
HS 300510
HS 853540
Assembly
Assembly
Assembly
Structural composite materials
Blade root
Environmental protection
Assembly
Blades
HS 841290
Casting
Non-destructive testing
Machining
Painting
Hub casting
HS 732599
HS 732690
Forged rings
Machining
Hardening
Surface finishing
Grease
Seals
Cages or spacers
Balls
HS 271019
HS 401693
HS 73??
HS 732690
HS 732611
Assembly
Metal sprayed and/or painted finish
Blade bearings
HS 848280
HS 741533
Structural fasteners
Possible HS codes:
841280
841290 (most likely)
850300
850231
Rotor
Rotor assembly
HS 8503?
Spinner
Assembly
Fibreglass mouldings
Fabricated steel support frame
HS 848049
HS 730890
HS 8501?
Rotor auxiliary systems
Assembly
Automatic lubrication system
Blade load measurement system
Maintenance support features
Possible codes:
841381
847989
8481
850300
HS 903180
HS 730890
Fabricated steel components
Assembly
Surface treatment
Steel fabrications
HS 730890
HS 8501?
Electric pitch system
OR
HS 841221?
Hydraulic pitch system
Assembly
Assembly
Motors
Gearboxes
Electrical panels
Batteries
Battery chargers
Position sensors
Power pack
Hydraulic actuators
Rotating union
Manifold blocks
Accumulators
Hoses
Electrical slip rings
HS 8501
HS 870840
HS 841290?
HS 8537
HS 8506
CN 8504405510
HS 9032?
HS 902680
HS 8504?
HS 8579?
HS 841221
Or HS 841229
HS 848790
Or HS 848490
HS 8481
HS 8507
HS 4009
HS 850300?

3.1.3 Tower

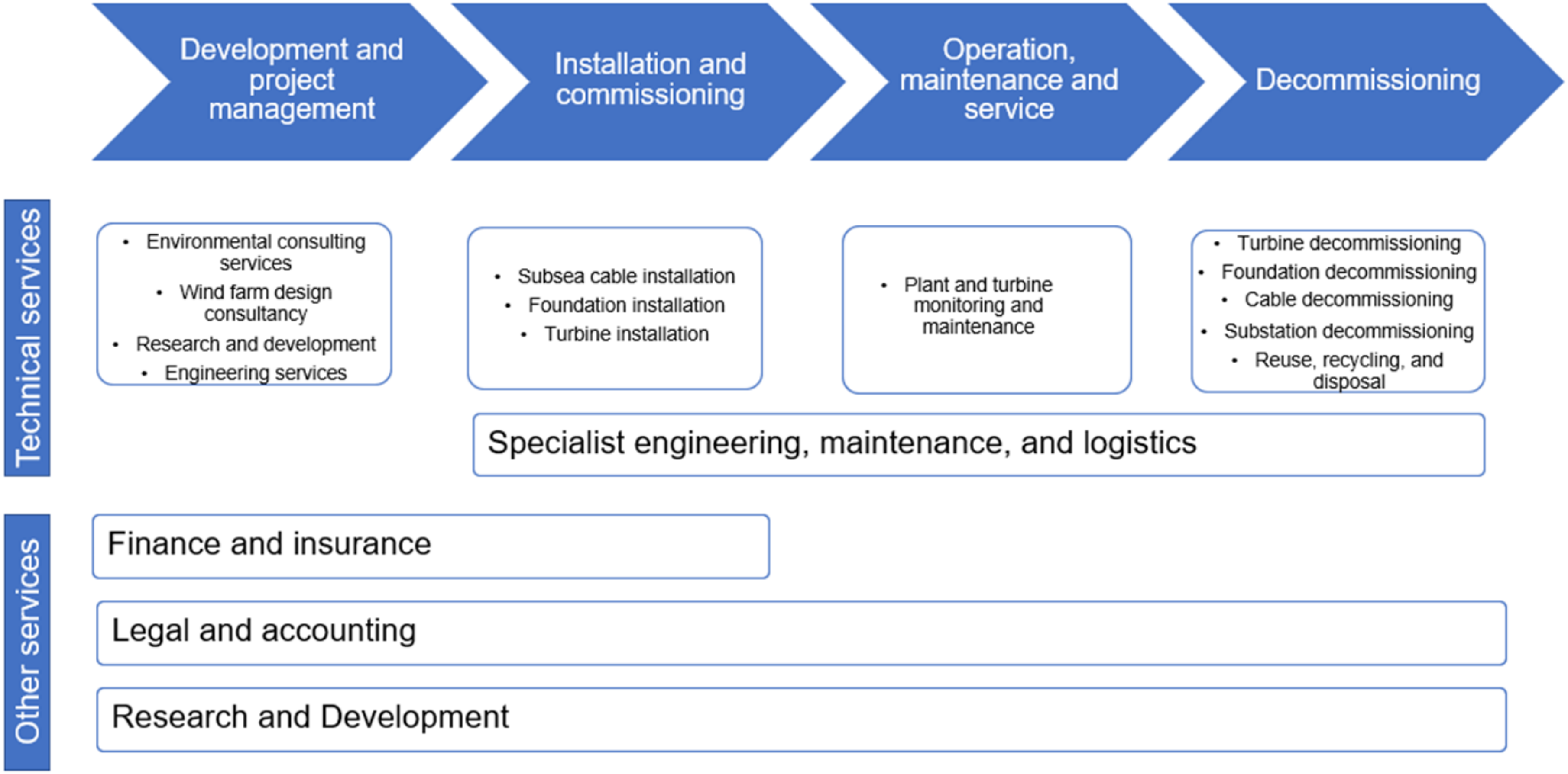
The tower is typically a tubular steel structure that supports the nacelle. It also provides access to the nacelle and houses electrical and control equipment. Also provides shelter and storage for safety equipment.

- **Steel:** the most commonly used material for the manufacture of towers.

- **Tower internals:** provide means of access, lighting and safety for maintenance and service personnel, plus means of transferring hand tools and components to the nacelle. They provide support for control and electrical cables and housing of switch-gear, transformers and other elements of power take-off. Tower internals also provide storage for survival equipment. A tuned damper may be located at the top of the tower to aide damping of tower and structure resonances.


Possible HS codes:
7301
721090
732690
Steel Plate
Cutting
Rolling
Surface finish
Steel
HS 732690
HS 730721
Steel flanges
HS 847989?
HS 732690?
Fall arresters
CN 73269030
Ladders
HS 842890
Elevator
HS 732690
Platforms
Assembly
Personnel access and survival equipment
Support Structure
HS 392330?
HS 860900?
Liquid container
HS 290949?
Damping liquid
Assembly
Tuned damper
HS 848360
Power take-off
HS 854370
Control System
HS 8415
Air conditioning
HS 9405
Luminaires
HS 8544
Low voltage wiring
HS 392590
Cable trays
Possible HS codes:
8504?
850440?
8506?
Emergency backup including UPS
Assembly
Tower Internal Lighting
Assembly
Electrical system
HS 3907?
Resin
HS 320890
Metal spray
HS 842420
Application equipment
Assembly
Coatings
Assembly or installation of tower Internals
Fabrication
CN 7308200011
Shot-blasting
Painting
Tower
Transportation
Storage

4 EXAMPLES OF SERVICES (TECHNICAL AND ANCILLARY) INVOLVED IN THE OFFSHORE WIND PROJECT LIFECYCLE



This is indicative of examples of services (technical and ancillary) that may be involved in an Offshore Wind project lifecycle. It should not be considered as exhaustive and is a work in progress.

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